APPENDIX K BUSHFIRE ASSESSMENT

Wind Energy Partners Pty Limited

Hills of Gold Wind Farm

Bushfire Risk Assessment

Developed in Partnership by Clean Energy Partners Pty Limited

7 December 2021

Development Management by:

Project No: 0550690

The business of sustainability

Document details	
Document title	Hills of Gold Wind Farm
Document subtitle	Bushfire Risk Assessment
Project No.	0550690
Date	7 December 2021
Version	4.0
Author	Joanne Woodhouse
Client Name	Wind Energy Partners Pty Ltd

Document history

				ERM approval to issue		
Version	Revision	Author	Reviewed by	Name	Date	Comments
Draft	00	Joanne Woodhouse	Amanda Antcliff	Murray Curtis	06.10.2020	Draft for client review
Draft	1.0	Joanne Woodhouse	Amanda Antcliff	Murray Curtis	16.10.2020	Draft for stakeholder review
Final	1.0	Joanne Woodhouse	Amanda Antcliff	Murray Curtis	02.11.2020	Final for adequacy review
Final	2.0	Joanne Woodhouse	Amanda Antcliff	Murray Curtis	10.11.2020	Final for EIS Exhibition
Final	3.0	Joanne Woodhouse	Amanda Antcliff	Murray Curtis	4.05.2021	Final in response to agency review
Final	4.0	Joanne Woodhouse	Amanda Antcliff	Murray Curtis	10.09.2021	Final to support Amendment Report
Final	5.0	Joanne Woodhouse	Amanda Antcliff	Murray Curtis	07.12.2021	Final to support Amendment Report

Signature Page

7 December 2021

Hills of Gold Wind Farm

Bushfire Risk Assessment

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Acronyms and Abbreviations

Name	Description
AFAC	Australasian Fire and Emergency Services Council
APZ	Asset Protection Zones
AS 3959-2018	*Australian Standard 3959 - 2018 Construction of Buildings in Bushfire-prone Areas*
BAL	Bushfire Attack Level
BC Act	*Biodiversity Conservation Act 2016*
BESS	battery energy storage system
BOM	Bureau of Meteorology
CASA	Civil Aviation Safety Authority
EIS	Environmental Impact Statement
EP&A Act	*NSW Environmental Planning and Assessment Act 1979*
ERM	Environmental Resources Management Australia Pty Ltd
FCNSW	Forestry Corporation of NSW
ha	hectare
IFEG	*International Fire Engineering Guidelines*
IPA	inner protection area
km/h	Kilometres per hour
kW/m^2	Kilowatts per metre squared
MNES	Matter of National Environmental Significance
NSW RFS	New South Wales Rural Fire Service
PBP	Planning for Bushfire Protection 2019
RF Act	*NSW Rural Fires Act 1997*
SCADA	supervisory control and data acquisition
SEARs	Secretary's Environmental Assessment Requirements
SFAZ	Strategic Fire Advantage Zone
SFPP	special fire protection purpose
SSD	State Significant Development
TOBAN	Total Fire Ban
WEP	Wind Energy Partners
WTG	wind turbine generators

1. INTRODUCTION

Environmental Resources Management Australia Pty Ltd (ERM) has been commissioned by Wind Energy Partners (WEP) to consider bushfire risk in the vicinity of the proposed Hills of Gold Energy Project (the Project). The location of the Project Area is shown in Figure 1.1 and the proposed wind farm development footprint and conceptual layout is shown in Figure 1.2.

The need for a Bushfire Risk Assessment was identified within the Secretary's Environmental Assessment Requirements (SEARs), and the *Rural Fires Act 1997* imposes obligations on land occupiers to take all practicable steps to prevent the occurrence and spread of wildfire to adjoining lands from lands under their care and management.

This report identifies potential hazards and risks associated with the Project and use of bushfire prone land. It contains management and mitigation measures designed to address these obligations consistent with similar projects of this nature in other parts of NSW/Australia and in accordance with NSW Rural Fire Service (RFS) guidelines including Planning for Bush Fire Protection (2019). It does not assess the individual design or engineering components of the turbines (or other infrastructure as described in Section 1.1) themselves but does consider locations of the infrastructure relative to the identified hazards.

1.1 Description of the Project

The Project involves the construction, operation and commissioning of a wind farm with up to 65 wind turbine generators (WTG), together with associated and ancillary infrastructure.

The key components of the Project are:

- 65 WTGs, each with:
  - a generating capacity of approximately 6 MW;
  - three blades mounted to a rotor hub on a tubular steel tower, with a combined height of blade and tower limited to a maximum tip height of 230 m AGL (to the blade tip);
  - a gearbox and generator assembly housed in a nacelle; and
  - adjacent hardstands for use as crane pads and assembly and laydown areas;
- decommissioning of three current monitoring masts and installation of up to 10 additional temporary monitoring masts for power testing (the up to five previously proposed in the EIS and an up to additional five now proposed). The new monitoring masts will be located close to a WTG location with a maximum height of approximately 150 m AGL, equivalent to the hub height of the installed WTGs. The additional five temporary masts proposed as part of Project amendment will be installed on the same location as a WTG prior to its installation and removed shortly before WTG installation. The exact number and location of temporary monitoring masts will be defined at the detailed design stage;
- a central 330 kV electrical substation, including transformers, insulators, switchyard and other ancillary equipment;
- an operations and maintenance facility located either adjacent to the BESS / substation, or within the compound area between WTGs 55 and 56;
- a battery energy storage system (BESS) of 100MW/400 MWh (4 hours of storage for 100MW);
- aboveground and underground 33 kV electrical reticulation and fibre optic cabling connecting the WTGs to the onsite substation (following site access tracks where practicable) (connection lines);
- a 330 kV single circuit twin conductor overhead transmission line (transmission line)to connect the onsite substation to the existing 330 kV TransGrid Liddell to Tamworth overhead transmission line network, located approximately 23.2 km west of the substation;

- a switching station to connect the Project 330 kV TransGrid Liddell to Tamworth transmission line and enable the Project to connect to the grid. The switching station will also be located approximately 23.2 km west of the substation, or approximately 13.5 km from the WTG Project Area;
- an internal private access road network (combined total length of approximately 40 km) connecting the WTGs and other Project infrastructure to the public road network; and
- upgrades to local roads and crossings required for the delivery, installation and maintenance of WTG components and associated materials and structures.

The following temporary elements will be required during construction of the Project:

- temporary site buildings and facilities for construction contractors / equipment, including two compounds, site offices, car parking and amenities for the construction workforce;
- two temporary concrete batching plants to supply concrete for WTG footings and substation construction works with the option to use any construction laydown areas with the exception of the laydowns area along Morrisons Gap Road;
- earthworks for access roads, WTG platforms and foundations, potentially including controlled blasting in certain areas;
- potentially rock crushing facilities for the generation of suitable aggregates for concrete batching and/or sized rock for access road and hardstand construction;
- up to seven laydown areas for the temporary storage of construction materials, plant, and equipment construction;
- external water supply for concrete batching and construction activities;
- the transport, storage and handling of fuels, oils and other hazardous materials for construction and operation of wind farm infrastructure and
- beneficial reuse of materials won from the development footprint during cut and fill and WTG foundation excavation for use in roads, hardstands and foundation material.

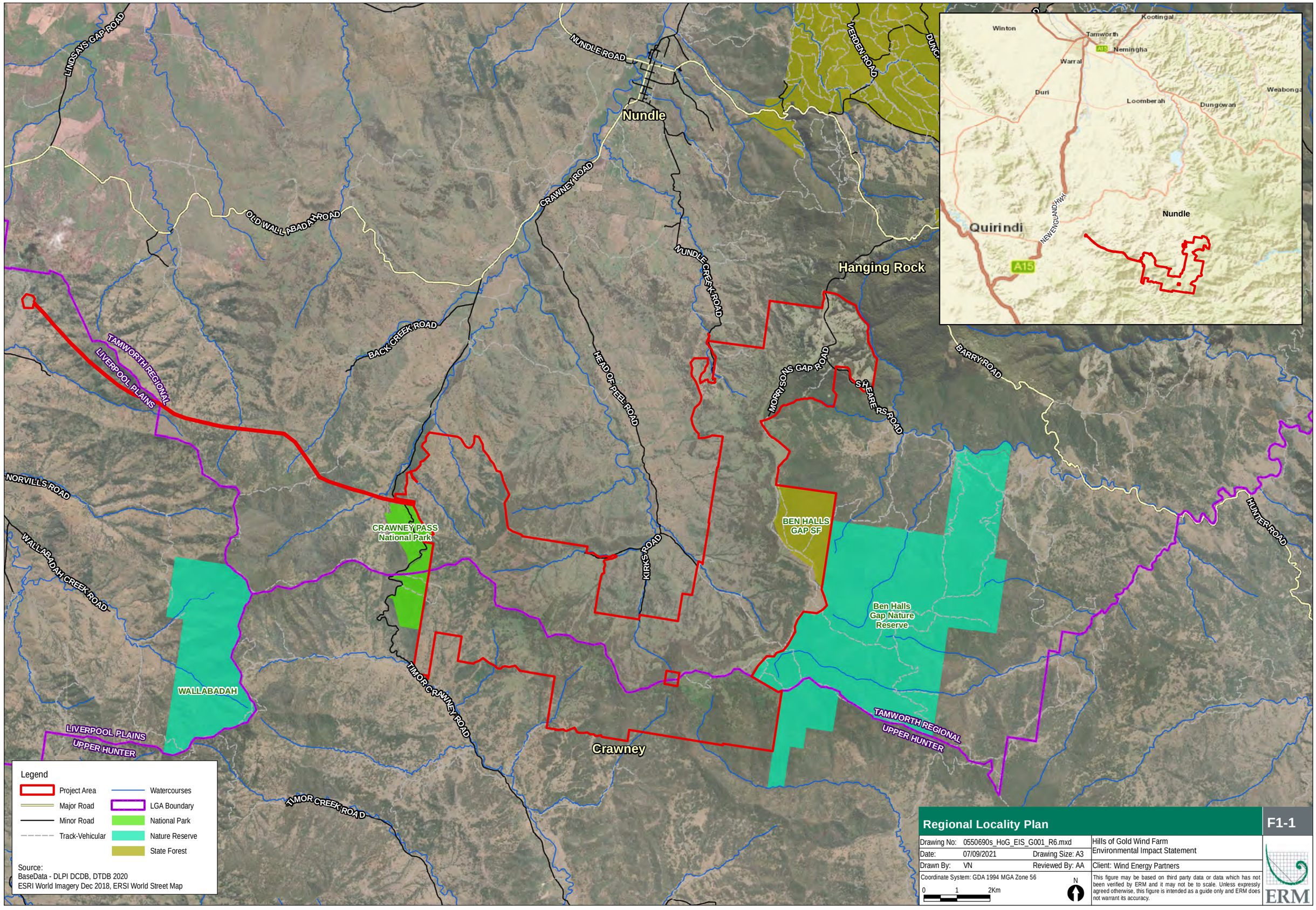
The proposed Project layout including the WTGs, access roads and options for supporting infrastructure is shown in Figure 1.2.

1.2 Aims and Objectives

Bushfire presents a threat to human life and assets and can adversely impact ecological values. Bushfire risk can be considered in terms of environmental factors that increase the risk of fire (fuel quantity and type, topography and weather patterns), as well as specific activities (such as hot works and construction activities) or infrastructure components that exacerbate combustion or ignition risks (such as transmission lines and other electrical components).

This Bushfire Risk Assessment aims to address the requirements identified by the Secretary's Environmental Assessment Requirements (SEARs) to identify potential hazards and risks associated with bushfires / use of bushfire prone land, and demonstrate that the proposed wind farm can be designed, constructed and operated to minimise ignition risks and provide for asset protection consistent with relevant NSW RFS design guidelines (Planning for Bushfire Protection (PBP) 2019 and Standards for Asset Protection).

The objectives of this assessment are to identify and where possible reduce the likelihood of a bushfire impacting the Project Area or spreading from the Project Area to surrounding properties. Despite the mitigation measures and treatments that are put in place, it is noted that some bushfire risk will always remain and that some of the infrastructure may be subject to direct flame contact. The absence of any identified hazard or asset on the Project site should not be interpreted as a guarantee that such hazards or impacts do not exist.



Regional Locality Plan

F1-1

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Date:	07/09/2021	Drawing Size: A3	
Drawn By:	VN	Reviewed By: AA	Client: Wind Energy Partners

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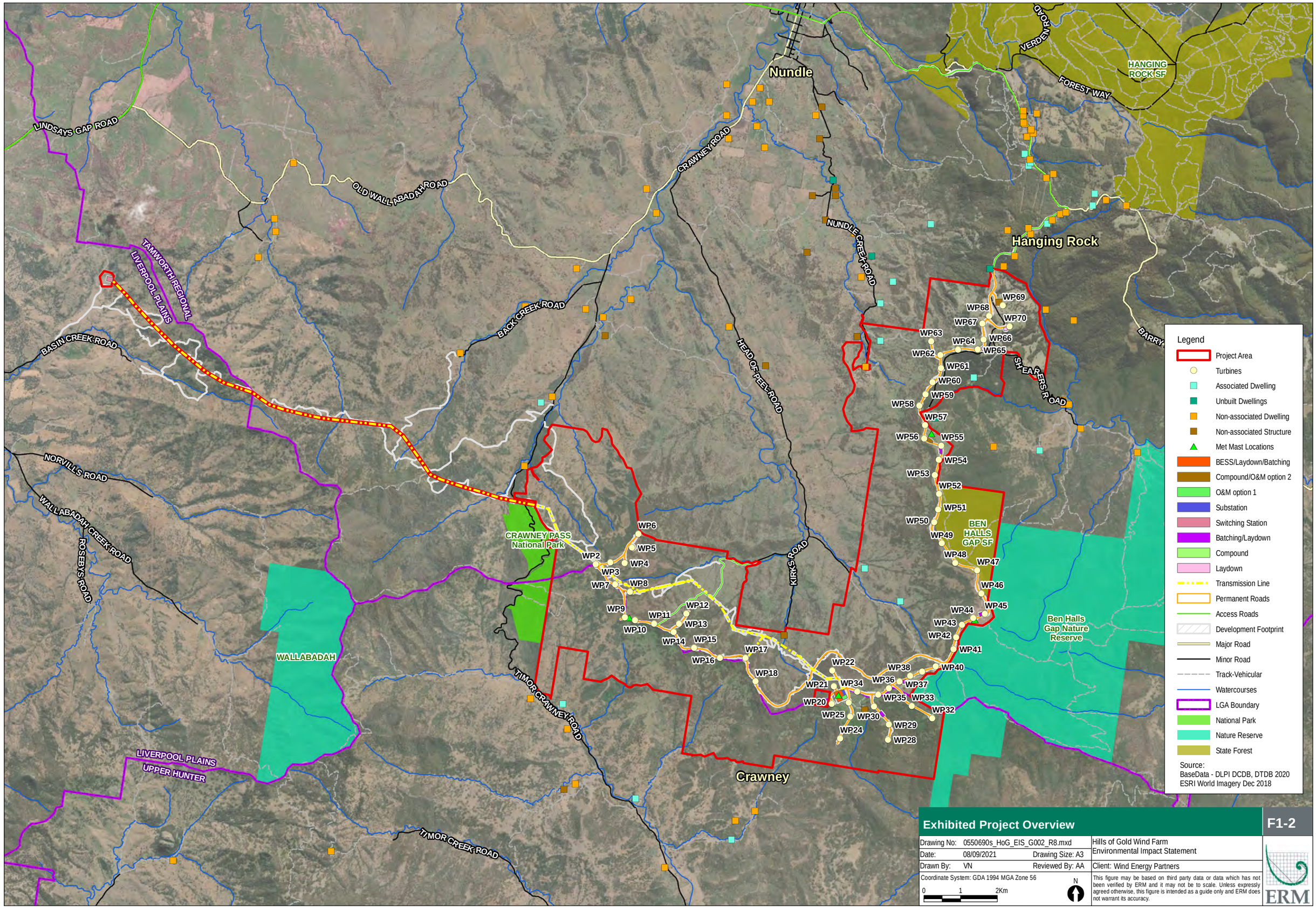

Exhibited Project Overview

F1-2

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2. PLANNING FRAMEWORK

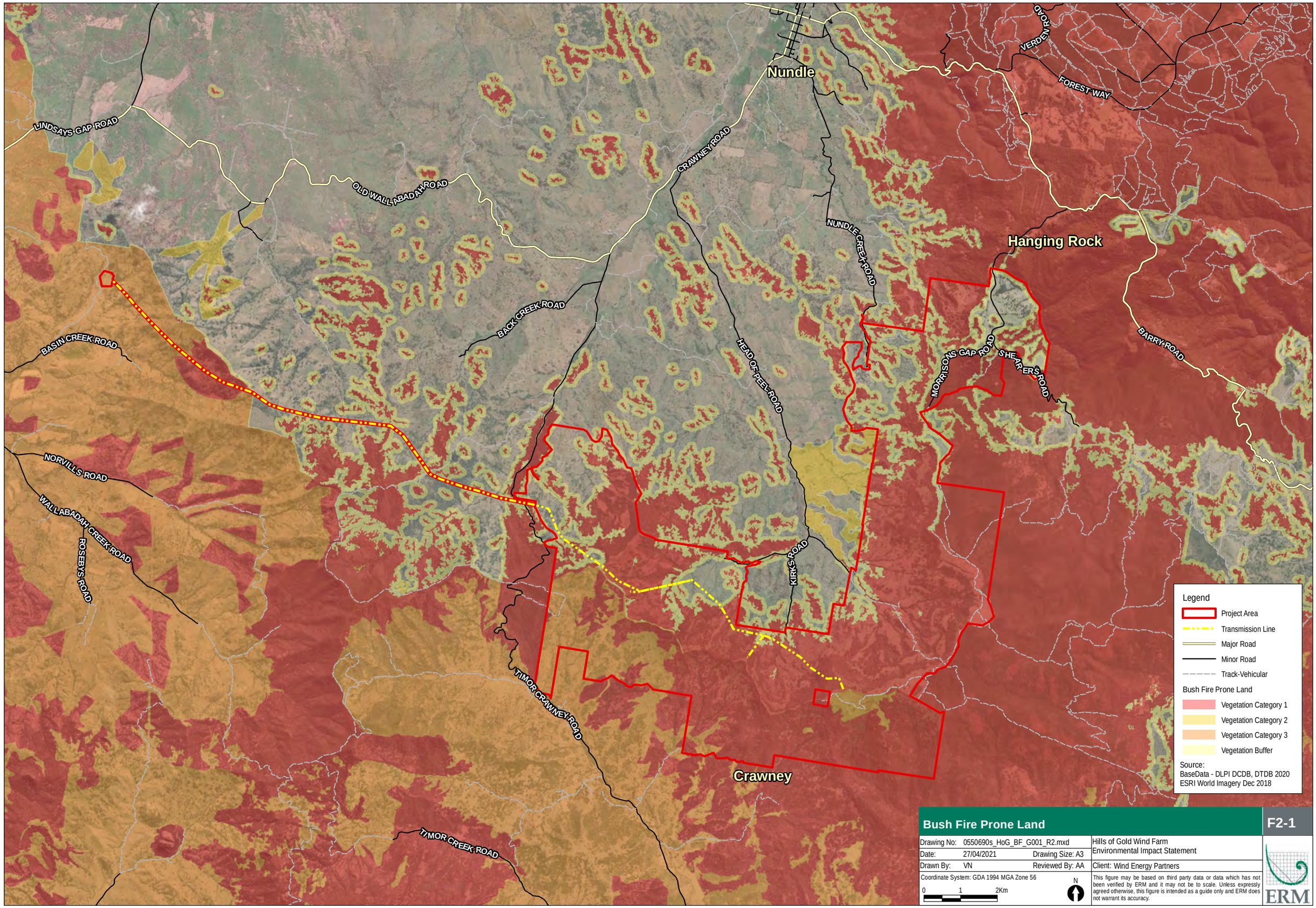
Table 2.1 outlines the relevant legislation and planning controls and how they have been considered in this Bushfire Risk Assessment.

Table 2.1 Key Legislation and Guidelines Addressed within the Assessment

Key Legislation/Guideline	Description
NSW Rural Fires Act 1997	The main objectives of the Rural Fires Act 1997 (RF Act) are to: ■ prevent, mitigate and suppress bush and other fires in NSW; ■ co-ordinate bushfire fighting and bushfire prevention throughout the State; ■ protect people from injury or death and property from damage as a result of bushfires; and ■ protect the environment. The proposed development does not require subdivision of land and is not defined as a special fire protection purpose (SFPP) development under Section 100B of the RF Act. Accordingly, the proposal does not require a bushfire safety authority. It is also noted that under Section 63 of the RF Act, owners and occupiers of land have a duty to take practicable steps to prevent the occurrence of bushfires on, and to minimise the danger of the spread of bushfires on or from, that land. This assessment considers the risk of spread of bushfires from the Project to the surrounds and provides measures to minimise the risk of bushfires.
Planning for Bushfire Protection 2019	Planning for *Bushfire Protection 2019* (NSW RFS) (PBP 2019) is a planning document to link responsible planning and development control with the protection of life, property and the environment. PBP 2019 was legislatively adopted in the *Environmental Planning & Assessment Regulations* on 1 March 2020. PBP 2019 is the culmination of significant investment in scientific research and policy development to provide appropriate bush fire protection whilst still having due consideration for development potential and economic sustainability. PBP applies to all development applications on land that is classified as bushfire prone land on a council's Bushfire Prone Land Mapping. The Tamworth Regional Council Bushfire Prone Land mapping shows the Project Area as bushfire prone land (refer to Figure 2.1). Therefore, consideration has been given to the following overall aims and objectives of PBP 2019: ■ afford buildings and their occupants protection from exposure to a bushfire; ■ provide for a defendable space to be located around buildings; ■ provide appropriate separation between a hazard and buildings which, in combination with other measures, minimises material ignition; ■ ensure that appropriate operational access and egress for emergency service personnel and residents is available; ■ provide for ongoing management and maintenance of bushfire protection measures; and ■ ensure that utility services are adequate to meet the needs of firefighters. PBP 2019 provides specific requirements for wind farm development and notes that wind and solar farms require special consideration and should be provided with adequate clearances to combustible vegetation as well as firefighting access and water. The following should be provided for wind farms: ■ 10m APZ from the structures/associated buildings/ infrastructure; and ■ the APZ will be maintained to the standard of an inner protection area (IPA) for the life of the development to provide adequate access for firefighting purposes.

Key Legislation/Guideline	Description
Australian Standard 3959 - 2018 Construction of Buildings in Bushfire-prone Areas (AS 3959-2018)	For the purposes of this assessment the Project is considered 'other development', as it is not residential subdivision, residential infill, or Special Fire Protection Purpose (SFPP) and the National Construction Code 2019 does not provide for any bushfire specific performance requirements. In a designated bushfire prone area, a Class 2 building, a Class 3 building, a Class 4 part of a building or a Class 9 building that is a special fire protection purpose or a Class 10a building or deck associated with such a building or part, must comply with *AS 3959-2018* as a set of 'deemed to satisfy' provisions. These deemed-to-satisfy provisions are not applicable to this Project. General fire safety provisions and the methodology for determining the bushfire attack level (Section 2 *AS 3959-2018*) are taken as acceptable solutions. The aims and objectives of PBP 2019 apply in relation to other matters such as access, water and services, emergency planning and landscaping/vegetation management. The proposed mitigation measures meet the aims and objectives of PBP 2019 as discussed in Section 6. Given the steep slopes and existing fire history within the adjacent National Parks estates, this risk assessment is also undertaken with due consideration of the potential flame zone that may impact on the Project infrastructure. Calculations of Bushfire Attack Levels and flame length have been undertaken using Method 2 as outlined within Appendix B of AS3959. *Also note that the new National Construction Code 2019 was adopted on 1 May 2019. A new non-mandatory Fire Safety Verification Method (VM) has been introduced with a delayed adoption date from 1 May 2020. The new VM, which is a voluntary tool under a Performance Solution pathway, provides for a documented process in the design of fire safety Performance Solutions, and is based on the International Fire Engineering Guidelines (IFEG). The applicability of this VM has not been addressed in this assessment and does not apply to this wind farm proposal.*
Biodiversity Conservation Act 2016	Projects determined by a statutory authority of the NSW State Government are required to be assessed in accordance with the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Biodiversity Conservation Act 2016* (BC Act). The BC 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. Schedule 3 of the BC Act lists Key Threatening Processes for species, populations and ecological communities within NSW. 'Clearing of native vegetation', 'high frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition' and 'removal of dead wood and dead trees', are listed by the TSC Act as Key Threatening Processes and need to be carefully considered and managed when implementing fire management activities. The Project Area contains threatened species that may be impacted by the proposal (refer to Section 3). *Refer to Hills of Gold Wind Farm Biodiversity Development Assessment Report (ARUP 2021) for more detail on the habitat requirements and confirmed records of these species (Appendix D of the Amendment Report).*

Key Legislation/Guideline	Description
Commonwealth Environment Protection and Biodiversity Act 1999	*The Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the primary piece of Federal legislation relating to the environment. Under the EPBC Act any action that has, or is likely to have, a significant impact on a Matter of National Environmental Significance (MNES) requires approval from the Commonwealth Minister for the Environment. An action is defined as a project, development, undertaking, activity (or series of activities), or alteration to any of these. *Consideration of the impact of the proposed activity on MNES has been provided in Hills of Gold Wind Farm Biodiversity Development Assessment Report (ARUP, 2021) (Appendix D of the Amendment Report).*
Environment Planning and Assessment Act 1979	The Project was declared a State Significant Development (SSD) in accordance with clause 20 of Schedule 1 the State Environmental Planning Policy (State and Regional Development) 2011 and will be assessed under Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act). Section 4.41 of the EP&A Act excludes projects approved under Part 4 of the EP&A Act from requiring “a bush fire safety authority under section 100B of the Rural Fires Act 1997”.



Bush Fire Prone Land

F2-1

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Coordinate System: GDA 1994 MGA Zone 56

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2.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements (SEARs) were issued for the proposed development, as revised, on 22 November 2018. Supplemental SEARS were issued on 18 February 2020 in relation to the declaration of the Project as a Controlled Action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

The SEARS state the following with regard to bush fire risk:

> *"Hazards/Risks – The EIS must include an assessment of the following: … Bushfire – identify potential hazards and risks associated with bushfires / use of bushfire prone land, including the risks that a wind farm would cause bush fire and any potential impacts on the aerial fighting of bush fires and demonstrate compliance with Planning for Bush Fire Protection 2006 (if located on bushfire prone land)."*

In addition, the NSW RFS provided advice on 1 November 2018 for consideration in the development of the SEARs. In their advice, the NSW RFS supports the inclusion of a requirement for the preparation of a bushfire hazard assessment as outlined above. They further state that the assessment should:

> *"include flame length modelling for all turbines, ancillary buildings, internal roads and transmission lines and identify required vegetation management practices to achieve asset protection zone standard that will prevent flame contact on the proposed infrastructure components*."

2.2 Consultation

To inform the preparation of this bushfire risk assessment, ERM and the Proponent consulted with key local stakeholders to discuss the recent fires affecting the Project Area and immediate surrounds to gain a better understanding of the local fire conditions and to ensure that management and mitigation measures are developed to meet the needs of those on the ground. All of these stakeholders have been provided an opportunity to review the draft assessment (sent via email 19 October 2020) and have been invited to provide input in to the development of the recommended mitigation strategies.

A summary of the consultation is provided in Table 2.2 below. A detailed consultation log is included within the EIS.

Table 2.2 Summary of Key Consultation

Contact Name	Summary	Key Response/Action
Catherine Watt NSW National Parks & Wildlife Service	Catherine made specific note that no bushfire mitigation such as APZ or strategic fire zones are to extend into the National Park. Asset Protection Zones (APZs) and Strategic Fire Advantage Zones (SFAZs) for all infrastructure must be totally on Wind Farm lands with no expectation of additional fire protection works on NPWS estate. The turbines are located on the ridgeline above very steep country to north, south and west. In terms of the 2019/2020 fires, this ridgeline was extremely important in bushfire control and provided a strategic advantage for back burns. Aerial firefighting was also paramount during the 2019/2020 fires and the large dam on Nycooma (31° 37.781'S 151° 8.476'E) was used as water supply for both vehicles and aircraft. It is important that the water supply be at the top of the hill rather than in a valley because it takes a lot of power to lift. Extremely hot conditions exacerbate the lifting difficulty. Helicopters also require an obstacle-free area on approach and departure from a water point. This varies with wind direction. What is the arcing potential from the turbines or power lines in smoky conditions? This is important for firefighter safety.	■ Ensure that the Project does not reduce or restrict access along this ridgeline for use as a containment line. ■ No asset protection zones extend into the National Park. ■ The Project aims to increase water supply along the ridgeline available to support both vehicle and aerial firefighting capabilities within the local area. ■ The location of all fire control advantages within the Project Area (water points, helipad, staging area and refuge area) currently mapped on the Ben Halls Gap National Park Fire Management Strategy (dated 2005) (refer to Figure 6.1 and Appendix D) will be reviewed and updated in consultation with the NSW RFS and NSW NPWS as part of the recommended Bushfire Emergency Management and Operations Plan. ■ The large dam was considered in the Aviation Impact Assessment (Aviation Projects, 2020). The continued availability of this dam during a bushfire event could not be confirmed. It was concluded that further consultation should be held with NSW NPWS and NSW RFS to ensure that appropriate mitigation methods are in place, so that a suitable alternative is available in the event of a bushfire in the area. This is to be reported to Liverpool Range and Tamworth BFMC prior to each bushfire season. ■ The increased risk of arcing in dense smoke has been considered by the Proponent. In terms or arcing potential, the Proponent has advised that the turbines have a detection system that protects them from surges, arcing and other electrical hazards. Arcing would be detected and electrical systems shut off if these persisted over several split seconds. ■ The majority of the internal power lines are underground however where these are overhead, the Proponent has again confirmed that similar detection systems will be installed to monitor changes over split seconds and within tight bands. Automatic Circuit Breakers at either end of the lines would open to stop transmission of electricity in the event that any arcing is detected.

Contact Name	Summary	Key Response/Action
Myles O'Riely Liverpool Range Rural Fire Service (District)	Myles made specific note that while the local RFS branches can provide valuable site knowledge and input in terms of local conditions, formal consultation for the purposes of the EIS must be with the district offices. Myles requested that information is provided via email and at this stage does not require to meet on site. ERM confirmed that consultation will be ongoing throughout the process. Myles provided contact details (email addresses) for both the Tamworth District RFS and NSW Fire and Rescue.	■ Consultation with the local RFS is noted as being valuable in terms of understanding local conditions and will be led by the Proponent as part of their commitment to community engagement. ■ Formal consultation and review of the draft bushfire mitigation measures by Liverpool Range and Tamworth RFS District Offices will be documented in this assessment. ■ No specific comments have been received on the draft report at the time of report production. Any comments received will be incorporated into the detailed design.
Allyn Purkiss Tamworth Rural Fire Service (District)	Contact has been made via phone and email.	■ No specific comments have been received on the draft report at the time of report production. Any comments received will be incorporated into the detailed design. ■ Allyn has confirmed that they have no objections to the Devils Elbow Bypass Road and would like to be able to access the private bypass as required. They do note any construction work that causes the temporary closure of Barry Road during the Bush Fire Danger period should be closely consulted with the residents of Hanging Rock village and surrounding properties, as well as the Rural Fire Service. This road is one of the main escape routes if the Village was to come under a Bush Fire attack. The Hanging Rock residents will have to adjust their Bush Fire Survival plans if this road was to be closed during that period.
Alan Cooper NSW Fire and Rescue	Alan confirmed that NSW RFS will be the combat agency but NSW Fire and Rescue would like to be involved in the project - particularly around site access arrangements in the event that a fire requires a dual response (both RFS and NSW Fire and Rescue).	■ The recommended Bushfire Emergency Management and Operations Plan will be prepared in conjunction with relevant stakeholders, including local fire services, NSW RFS, NSW Fire and Rescue, NPWS, FCNSW, adjoining property owners and employees.

Contact Name	Summary	Key Response/Action
Brian Tomalin Hanging Rock Rural Fire Service (local)	Consultation between the Proponent and Brian Tomalin (RFS Hanging Rock) has indicated that fires in the Nundle and Hanging Rock area, under extreme conditions are uncontrollable. Hanging Rock Village is particularly vulnerable to fires due to limited escape options and limited fire trails to defend the village. The Hanging Rock RFS modelled a fire starting near Nundle Sawmill, on a reasonable day the fire in 2 hours and 15 minutes would be running up at Hanging Rock Village, on a day with severe conditions it would only take minutes to reach Hanging Rock. The village would have been lost if the Pearson's trail and Pages creek fires joined during the 2019/2020 bushfire season, noting that these fires did burn through the hazard reduction lines. The danger is south-west and south easterly winds, the winds drive the fire up the valleys, and each valley has its own micro-climate. Opportunities to do hazard reduction burning are being significantly reduced and Indigenous land use practices should be explored. Both Hanging Rock RFS and Nundle RFS have 4-5 active volunteers. The demographic of the area is causing a lack of volunteers.	■ This is noted as an existing public safety hazard and an area of significant concern. It is not a direct result of the proposed wind farm, nor will the wind farm result in further isolation or access restrictions. ■ The proposed upgrade of the internal road network would increase the level of access available to fire fighters along the entire length of this ridgeline (which forms a strategic fire containment line) and would assist to reduce the likelihood of a widespread fire. Site access points will be constructed as the first stage of development and the final design of access roads will enable safe access and egress for residents attempting to leave the area at the same time that emergency service personnel are arriving to undertake firefighting operations. ■ Indigenous land use and burning practices were recognised in the recent 2020 National Bushfire and Climate Summit and are being addressed within the Royal Commission into National Natural Disaster Arrangements (final report yet to be released). ■ The recommended SFAZ may also present an opportunity (in co-ordination with the NSW RFS and NSW NPWS) to explore additional options and integrate Indigenous land and fire management practices.
Alan Bawden NSW Rural Fire Service	ERM consulted with NSW RFS to confirm that a number of the turbines, transmission line and access road will be located within the flame zone. Alan confirmed that their main concern will be to ensure that substations, BESS, O&M building and other high risk assets are not located within the flame zone. As these assets would be the focus of any firefighting activities, it is important that they are surrounded by adequate defendable space. In regard to turbines, they are not considered a key risk in terms of either ignition or spreading fire across the landscape. Preparation of the Bushfire Emergency Management and Operations Plan will also be a key recommendation.	■ Key assets that have the potential to influence the spread of fire such as the switching station, substation, BESS and O&M buildings are all located outside of the flame zone and have a minimum 20m APZ. ■ Those turbines at risk of direct flame contact have been identified and key mitigation measures including non-combustible steel construction, remote operation of all WTGs with the ability to shut-down individual or all WTGs if required and the provision of defendable space around each turbine is provided in Section 6. ■ The recommended Bushfire Emergency Management and Operations Plan will be prepared in conjunction with relevant stakeholders, including local fire services, NSW RFS, NSW Fire and Rescue, NPWS, FCNSW, adjoining property owners and employees.

3. EXISITING CONDITIONS

The following steps were undertaken in the assessment process:

- determine whether the development area has been mapped as bushfire prone land (Figure 2.1) and whether the Project is in compliance with NSW Rural Fire Service (RFS) guidelines including *Planning for Bush Fire Protection* (2019), which replaced the 2006 guidelines referred to in the SEARs;
- identification of the assets within and surrounding the Project Area requiring protection (Section 3.1);
- identification of the bushfire risk factors such as bushfire history and known bushfire behaviour in the Project Area and within the surrounding lands (Section 5);
- identify infrastructure that may be subject to direct flame contact (Section 5.3); and
- produce risk mitigation and management treatments and satisfy PBP 2019 requirements (Section 6).

3.1 Identification of Assets

Assets within and surrounding the Project Area are shown in Figure 3.1 and described in Table 3.1. A detailed description of the Project components is provided in the Environmental Impact Statement (EIS) (ERM, 2020).

Table 3.1 Identification of Assets

Asset	Description
Assets Within The Project Area	
Project Infrastructure	Wind Turbine Generators The WTG model to be used for the Project is yet to be selected, with a range of models currently under consideration. The selected model will have a generation capacity of approximately six (6) MegaWatts (MW), however the dimensions of the WTG components, including blade length and hub and blade tip heights, will vary dependent on the model selected. In order to provide flexibility in selecting the WTG model, the WTG dimensions adopted for the Bushfire Risk and Hazard Assessment are the largest of the model options being considered including a WTG with a rotor diameter of up to 170 m (blade length of up to 83.5 m) giving an overall tip height of up to 230 m. Each WTG consists of a tower, nacelle, hub and rotor. These elements will all be painted a similar colour, with a white to light grey colour palette. The painted surface will be non-reflective. The process of installing the WTGs is outlined in the accompanying EIS (ERM 2020). Each WTG will be mounted on a concrete foundation (approximately 25 m in diameter) located on a cleared hardstand area. The actual foundation type to be utilised will be based on the results of geotechnical surveys undertaken prior to commencement of the construction at each WTG site. The nacelle is the housing that sits on the top of the turbine tower and accommodates the generator, control systems, pitch and yaw drives. The nacelle may also include the transformer and gearbox (if used) and is typically constructed of fibreglass. Given the nature of the components housed within the nacelle, oil containment and sound insulation will be provided for within each WTG. The rotor, which includes the blades, is the portion of the WTG that captures the energy from the wind. The energy captured by the rotating blades is transferred to a generator housed within the nacelle. Blades are generally made of fibreglass reinforced with epoxy and carbon fibre. The rotor is controlled by a central wind turbine control unit (microprocessor). The microprocessor controls the rotational speed of the rotor and the pitch of the blades, therefore enabling the rotor to maximise energy production from the wind resource and ensure the safe and reliable operation of the WTG. When wind speeds get too high the microprocessor controls the pitch of the blades to stop the WTG rotating, which minimises wear on the components from operating at too high wind speeds. Each WTG will have a transformer located in either the tower behind the nacelle or mounted external to the WTG on the hardstand area. Each WTG will be connected to the on-site substation via a network of underground power and communication cables.
	Obstacle Lighting The Project may require obstacle lighting at night time or during periods of reduced visibility. Whilst the Aviation Impact Assessment (Aviation Projects, 2020) provided in EIS concluded that the Project will not require obstacle lighting to maintain an acceptable level of aviation safety, the Civil Aviation Safety Authority (CASA) may require lighting where turbines exceed 150 m in tip height, as has been the case for other wind farm developments in NSW. Although subject to future detail in accordance with CASA requirements; the potential night lighting requirements for the Project may include: ■ two steady red medium intensity obstacle lights per turbine; ■ mounting of the light fixtures sufficiently above the surface of the nacelle so that the lights are not obscured by the rotor hub, and are at a horizontal separation to ensure an unobstructed view of at least one of the lights by a pilot approaching form any direction; ■ sufficient individual wind turbines to be lit to indicate the extent of a group of turbines; and ■ interval between obstacle lighted turbines not exceeding 900 m, and the most prominent (highest for the terrain) turbine(s) to be lit. The Landscape and Visual Impact Assessment (refer Chapter 11 and Appendix F of the EIS, and LVIA Addendum (refer Appendix G of the Amendment Report) assesses the impact of night lighting.

Asset	Description
	Meteorological Monitoring Mast The Project includes decommissioning of three current monitoring masts and installation of up to 10 additional monitoring masts for power testing. The ten monitoring masts will be located close to a WTG location and will have same WTG hub height. The exact number and location will be defined at the detailed design stage. It is noted that unmarked meteorological monitoring towers and guy ropes present greater risks for aerial firefighting operations than wind turbines. This has been considered in Section 6.
	Permanent Operations and Maintenance Building (O&M Building) A permanent site operations and maintenance facility with approximate dimensions of 120 m by 220 m will be constructed to provide for all operations and maintenance activities associated with the Project. Car parking facilities will also be provided for employee and service vehicles. Two options have been considered within this assessment. During operations, up to 31 permanent staff will occupy these premises. Whilst most activity is anticipated to occur during business hours Monday to Friday, access to the wind farm site will be required on a 24 hour basis, seven days a week.
Electrical Reticulation	Overhead Transmission Line Connection A 330 kV overhead transmission line connection is proposed to connect the onsite substation to the existing 330 kV overhead transmission line network at a proposed switching station. The transmission line will be centred on a 60 m wide easement. For the safe operation of the transmission line, certain activities will be restricted within the easement such as planting and growing trees, construction of buildings, or erection of antennae or masts. While it has not be confirmed how the easement will be formally registered, for the purposes of this bushfire risk assessment, key responsibilities and management measures will been applied in accordance with the TransGrid Bushfire Risk Management Plan and ISSC3 Guide for the Management of Vegetation in the Vicinity of Electricity Assets which requires assets to be maintained to minimise the risk of fire ignition and to ensure that vegetation clearance are maintained. The proposed 330 kV transmission line is anticipated to comprise concrete or galvanised steel poles, typically 50 m high and spaced between 150-1000 m apart. The conductors (wires) will be aluminium and will be designed to be a minimum of 9 m above the ground at maximum operating temperature. There will be three pairs of conductors and an earth shield wire, protecting the line from lightning strikes. The line will ideally have a minimum of deviations as they necessitate 'backstays' to support the conductor tension. Minimising backstays reduces the impact on cropping and machinery operations in the vicinity of the poles.
	Onsite Substation An electrical substation compound is proposed on-site with approximate dimensions of 70 m by 160 m. The primary purpose of the electrical substation is the reception, transformation and distribution of electrical power and energy. The electrical substation will house a series of transformers, switch gear, and ancillary equipment for the transformation and distribution of energy. The transformers and radiators in the electrical substation will be located on foundations and will be surrounded by concrete bunds designed with sufficient capacity to retain 110 % of the oil contained within each transformer.
	Switching Station A switching station with approximate dimensions of 165 m by 100 m will be constructed to connect to the Project transmission line to the existing 330kV TransGrid Liddell to Tamworth overhead transmission line network.

Asset	Description
	Battery Energy Storage System (BESS) The Project includes the installation of a lithium-ion battery energy storage system (BESS). A 5.4 ha footprint area has been set aside for the installation of the BESS. Given the substantive advances in storage technologies over time, the exact storage capacity cannot be confirmed at this time, however it is anticipated that a 100/400 MWh facility would allow the optimisation of the Hills of Gold Wind Farm in the National Electricity Market (NEM). The major components for each BESS include batteries, inverters, transformers, heating ventilation air conditioning and fire protection. The specific design details for the BESS will not be finalised until the completion of the detailed design stage of the Project.
	33 kV Cable and Fibre Optic Network Each of the 65 WTGs will be connected to the onsite substation via aboveground and underground 33 kV electrical cable and fibre optic network. Whilst the electrical reticulation network will be finalised during the detailed design phase, it is anticipated that the cabling and overhead power line will generally fall within the footprint of the internal access roads, however some deviations away from the access roads are required given potential topographical or other constraints.
Construction Laydown Areas	A hardstand pad will be required adjacent to the base of the WTGs to enable the assembly and erection of the tower, nacelle and blade components. Although the final design will depend on the topography of the surrounding land, each crane pad will consist of crushed rock hardstand approximately 115 m by 60 m. Additional construction laydown areas may be required at select locations within the wind farm site to support the delivery of equipment and WTG components during construction.
Site Access	Site access will be via Morrisons Gap Road, located to the north east of the Project Area. This Tamworth Regional Council road is unsealed for approximately 3 km prior to the Project Area. An alternate emergency access point to the Project Area is also considered via Head of Peel Road. This access point will remain accessible for use in the event of emergency only. It will not be used by Project related traffic. The construction and maintenance of the Project will require construction of up to approximately 40 km of private all-weather access roads within the Project Area. The roads will provide ongoing access to the WTGs and other Project infrastructure. Where possible, the internal road network will be aligned on the route of existing farm or other access roads. The internal roads will be up to 5.5 m wide (with approximately 1.5 m shoulders on either side), with localised widening where required to support transportation of the WTG components. Included within the internal road construction and maintenance for ongoing use is the 'transverse track', providing internal road access between WTG 18 to WTG 40 to overcome topography challenges for road construction between WTG 19 and WTG 20. As a minimum, and to enable access for RFS all roads will be maintained to the minimum standards as outlined within the NSW RFS Fire Trail Standards and the NSW RFS Fire Trail Design, Construction and Maintenance Manual (refer to Appendix B).
Heritage	The Project is located in a resource rich area known to have been important to and extensively used by past Aboriginal people. As outlined by Kelleher Nightingale Consulting (KNC, 2020), seven Aboriginal archaeological sites comprising Aboriginal objects and one potential archaeological deposit (PAD) have been recorded within the Project Area. The sites comprised four artefact scatters and three isolated finds. A full description of heritage values is provided in the Hills of Gold Wind Farm Aboriginal Cultural Heritage Assessment (KNC, 2020) (refer Chapter 14 and Appendix M of the EIS).

Asset	Description
Biodiversity	A Biodiversity Development Assessment Report (BDAR) has been prepared by Arup Pty Ltd (Arup 2020) and confirms that the Project Area has a long history of agricultural use, specifically cattle and sheep grazing. Arup (2020) has mapped a total of 220.61 ha of native vegetation within the Project Area comprising 22 Plant Community Types (PCT) with varying levels of disturbance and condition. These include a total of two Endangered Ecological Communities (EECs) listed under the NSW Biodiversity Conservation Act 2016 (BC Act) and one Threatened Ecological Communities (TECs) listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). For the purposes of this bushfire risk assessment, the vegetation has been simplified in line with the vegetation formations as per Keith (2004) (refer to Table 3.2). One threatened flora species, Broad-leaved Pepperbush *Tasmannia purpurescens,* was identified within the Project Area, and an additional 10 threatened flora species have a potential to occur. Fourteen species listed under the BC Act and/or EPBC Act have been recorded by Arup (2020). Frequent, high intensity fires may cause the degradation of roosting, nesting and foraging habitats and direct mortality of individuals. Modification of habitat from fires is listed as a threat to many of these species including *Phascolarctos cinereus* (Koala), *Petauroides volans* (Greater Glider) and *Dasyurus maculatus* (Spotted-tailed Quoll) although it is noted that mobile species such as birds and bats are less likely to be impacted by bushfire as they are able to escape the direct impacts of flame and smoke. A full description of biodiversity values is provided in the Hills of Gold Wind Farm Biodiversity Development Assessment Report (Arup 2021) (refer Appendix D of the Amendment Report).
Assets Surrounding The Project Area	
Residential Properties and Farms	Land on which the Project is proposed to be located is owned by 14 freehold landholdings and includes Crown land paper roads and one Crown allotment under perpetual lease. The Project Area is predominately agricultural land with a high percentage of overstorey native vegetation adjacent to the development footprint and within steeper terrain. The Project Area has a history of agricultural use (grazing cattle). Native understorey has been converted to exotic pastures in many locations. There are five (5) associated dwellings and three (3) associated structures located within the Project Area; seven (7) associated dwellings and seven (7) non associated dwellings within 2 km of a turbine; and seven (7) associated dwellings, 23 non associated dwellings and two (2) non associated structures between 2 km and 4 km of a turbine. There are also a number of other non - residential structures located nearby.
Nearest Towns and Localities	The Project is located approximately 5 km south of Hanging Rock, 8 km south east of Nundle and 60 km south east of Tamworth. The proposal is located within the Tamworth Regional, Upper Hunter and Liverpool Plains local government areas. The general locality includes Hanging Rock State Forest, Nundle State Forest and Ben Halls Gap National Park, formally known as Ben Halls Gap State Forest. The name of the Project “Hills of Gold” refers to the economic opportunities brought about by the gold mining history of Nundle and Hanging Rock. Hanging Rock Village is currently vulnerable to fires due to limited escape options and limited fire trails to defend the village (Brian Tomalin pers. com).
Conservation Areas	Adjacent land uses include bison grazing, sheep and cattle grazing as well as the following Forestry Corporation of NSW (FCNSW) and national park estates: ■ Ben Halls Gap State Forest, located within the eastern portion of the Project Area; ■ Hanging Rock and Nundle State Forest located 4 km to the north of the Project Area; ■ Ben Halls Gap Nature Reserve / National Park bordering the Project Area to the east; and ■ Crawney Pass National Park border the Project Area to the west. Ben Halls Gap and Crawney Pass National Parks are currently managed in accordance with their respective fire management strategies (Appendix D).

Turbine	X (GDA 94)	Y (GDA 94)
WP50	325872.15	6504011.02
WP51	325975.23	6504359.62
WP52	326001.77	6504778.28
WP53	325887.63	6505288.79
WP54	325995.06	6505707.10
WP55	326064.00	6506091.80
WP56	325597.43	6506290.32
WP57	325618.03	6506644.82
WP58	325468.55	6507176.88
WP59	325632.77	6507482.55
WP60	325827.07	6507813.57
WP61	326056.20	6508201.73
WP62	326035.87	6508550.51
WP63	325787.51	6508927.48
WP64	326518.50	6508699.39
WP65	327050.47	6508701.46
WP66	327215.07	6508969.01
WP67	327184.58	6509402.79
WP68	327366.55	6509622.76
WP69	327737.18	6509901.34
WP70	327921.58	6509330.63

WP50 WP51 WP52 WP53 WP54 WP55 WP56 WP57 WP58 WP59 WP60 WP61 WP62 WP63 WP64 WP65 WP66 WP67 WP68 WP69 WP70

NUNDLE CREEK ROAD
MORRISONS GAP ROAD
SHEARERS ROAD
BARRY ROAD
HEAD OF PEEL ROAD
BEN HALLS GAP SF

Legend

- Associated Dwelling
- Unbuilt Dwellings
- Non-associated Dwelling
- Non-associated Structure
- Turbines
- Project Area
- Compound/O&M option 2
- Batching/Laydown
- Compound
- Laydown
- Internal Tracks
- Major Road
- Minor Road
- Track-Vehicular
- Contours
- Nature Reserve
- State Forest

Threatened Species

- Greater Glider
- Broad Leaved Pepper Bush
- Ribbon Gum - Mountain Gum - Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion
- White Box Yellow Box Blakely's Red Gum Woodland

Source:
Threatened Species - ARUP 2020
BaseData - DLPI DCDB, DTDB 2020
ESRI World Imagery Dec 2018

Layout Map

F3-1a

Drawing No:	0550690s_HoG_BF_G002_R4.mxd		Hills of Gold Wind Farm Environmental Impact Statement
Date:	09/09/2021	Drawing Size: A3	
Drawn By:	VN	Reviewed By: AA	Client: Wind Energy Partner

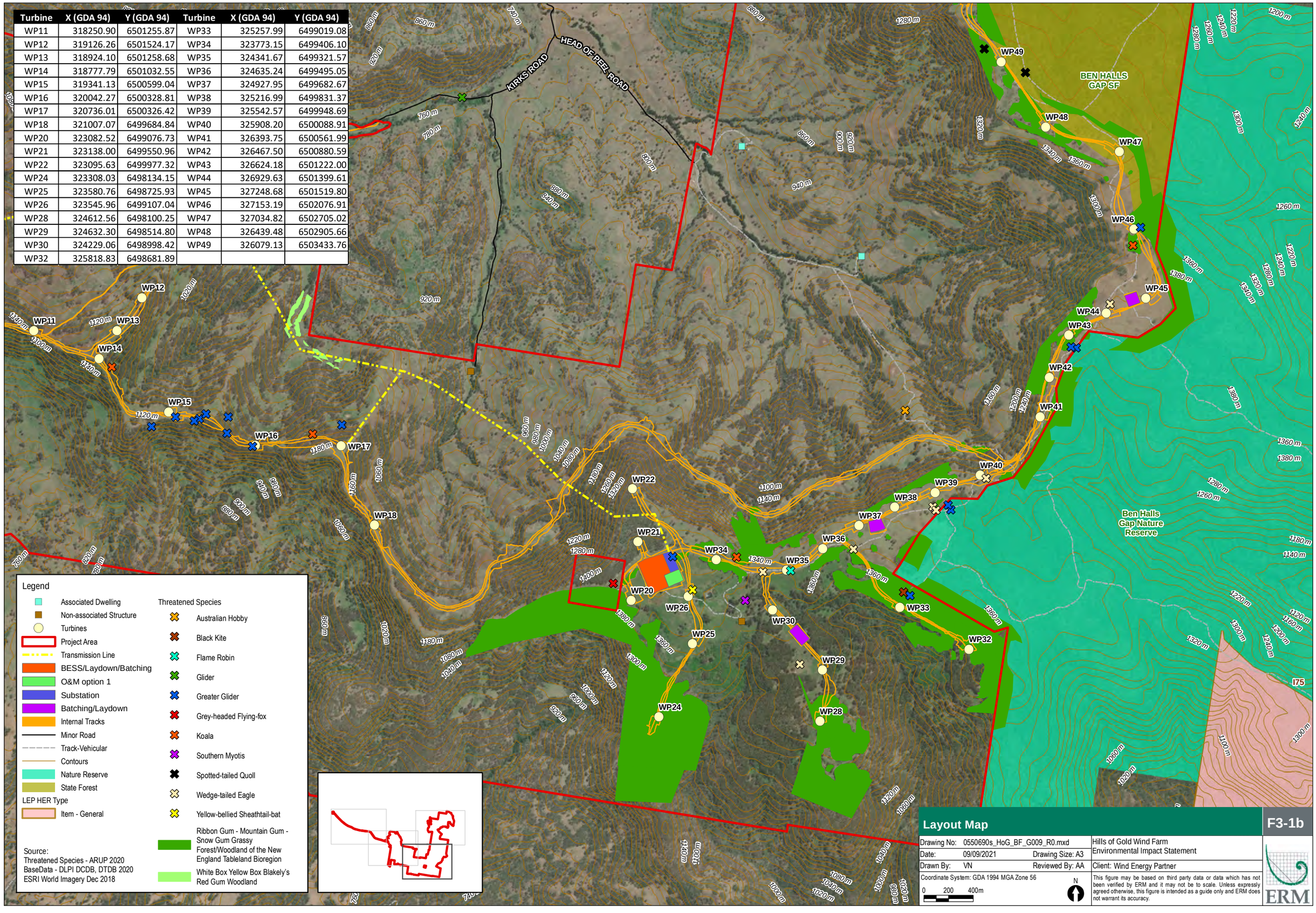
Coordinate System: GDA 1994 MGA Zone 56

0 200 400m

N

ERM

Turbine	X (GDA 94)	Y (GDA 94)	Turbine	X (GDA 94)	Y (GDA 94)
WP11	318250.90	6501255.87	WP33	325257.99	6499019.08
WP12	319126.26	6501524.17	WP34	323773.15	6499406.10
WP13	318924.10	6501258.68	WP35	324341.67	6499321.57
WP14	318777.79	6501032.55	WP36	324635.24	6499495.05
WP15	319341.13	6500599.04	WP37	324927.95	6499682.67
WP16	320042.27	6500328.81	WP38	325216.99	6499831.37
WP17	320736.01	6500326.42	WP39	325542.57	6499948.69
WP18	321007.07	6499684.84	WP40	325908.20	6500088.91
WP20	323082.52	6499076.73	WP41	326393.75	6500561.99
WP21	323138.00	6499550.96	WP42	326467.50	6500880.59
WP22	323095.63	6499977.32	WP43	326624.18	6501222.00
WP24	323308.03	6498134.15	WP44	326929.63	6501399.61
WP25	323580.76	6498725.93	WP45	327248.68	6501519.80
WP26	323545.96	6499107.04	WP46	327153.19	6502076.91
WP28	324612.56	6498100.25	WP47	327034.82	6502705.02
WP29	324632.30	6498514.80	WP48	326439.48	6502905.66
WP30	324229.06	6498998.42	WP49	326079.13	6503433.76
WP32	325818.83	6498681.89			



Layout Map

F3-1b

Drawing No:	0550690s_HoG_BF_G009_R0.mxd	Hills of Gold Wind Farm Environmental Impact Statement
Date:	09/09/2021	Drawing Size: A3
Drawn By:	VN	Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56		Client: Wind Energy Partner

0 200 400m

N

ERM

Turbine	X (GDA 94)	Y (GDA 94)
WP2	316660.03	6502869.95
WP3	317061.85	6502922.86
WP4	317449.24	6502903.10
WP5	317646.58	6503320.59
WP6	317817.55	6503696.30
WP7	317184.44	6502322.26
WP8	317588.55	6502126.60
WP9	317453.03	6501426.24
WP10	317732.46	6501347.19
WP11	318250.90	6501255.87
WP12	319126.26	6501524.17
WP13	318924.10	6501258.68
WP14	318777.79	6501032.55
WP15	319341.13	6500599.04
WP16	320042.27	6500328.81
WP17	320736.01	6500326.42

Legend

- Non-associated Dwelling
- Turbines
- Project Area
- Transmission Line
- Internal Tracks
- Minor Road
- Track-Vehicular
- Contours
- National Park

Threatened Species

- Greater Glider
- Koala
- Large-eared Pied Bat
- Little Pied Bat
- Wedge-tailed Eagle
- White Box Yellow Box Blakely's Red Gum Woodland

CRAWNEY PASS National Park

CRAWNEY ROAD

MINOR CRAWNEY ROAD

WP2 WP3 WP4 WP5 WP6 WP7 WP8 WP9 WP10 WP11 WP12 WP13 WP14 WP15 WP16 WP17

Source:
Threatened Species - ARUP 2020
BaseData - DLPI DCDB, DTDB 2020
ESRI World Imagery Dec 2018

Layout Map

F3-1c

Drawing No:	0550690s_HoG_BF_G010_R0.mxd		Hills of Gold Wind Farm Environmental Impact Statement
Date:	09/09/2021	Drawing Size: A3	
Drawn By:	VN	Reviewed By: AA	Client: Wind Energy Partner

Coordinate System: GDA 1994 MGA Zone 56

0 200 400m

N

ERM

BASIN CREEK ROAD

BACK CREEK ROAD

CRAWNEY ROAD

Legend

- Non-associated Dwelling
- Project Area
- Transmission Line
- Switching Station
- Major Road
- Minor Road
- Track-Vehicular
- Contours

Threatened Species

- Wedge-tailed Eagle
- White Box Yellow Box Blakely's Red Gum Woodland

Source:
Threatened Species - ARUP 2020
BaseData - DLPI DCDB, DTDB 2020
ESRI World Imagery Dec 2018

Layout Map

F3-1d

Drawing No:	0550690s_HoG_BF_G010_R0.mxd		Hills of Gold Wind Farm Environmental Impact Statement
Date:	09/09/2021	Drawing Size: A3	
Drawn By:	VN	Reviewed By: AA	Client: Wind Energy Partner

Coordinate System: GDA 1994 MGA Zone 56

0 200 400m

N

ERM

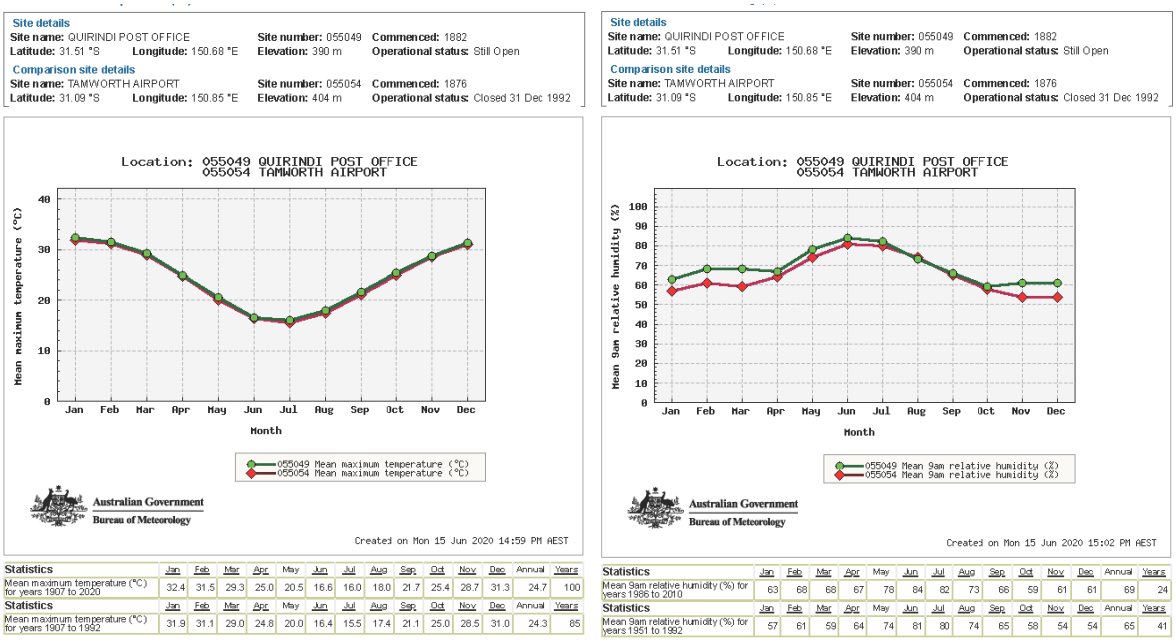
3.2 Climate and Fire Weather

Weather conditions influence the size, intensity, speed, and predictability of bushfires and how dangerous they can be to the community. While bushfires can happen at any time of the year in Australia, the time of peak bushfire activity varies across the country with the changes in the seasonal weather patterns. In New South Wales and southern Queensland this generally occurs in spring to mid-summer.

As described by the BOM (2020), the greatest danger occurs following a dry winter and spring (as seen in 2019). The worst conditions occur when deep low-pressure systems near Tasmania bring strong, hot and dry, westerly winds to the coastal districts. The end of the fire season is determined by the onset of moister conditions, sometimes the result of a tropical cyclone developing near the Queensland coast.

Prevailing weather conditions associated with the bushfire season as reported by the Tamworth Bushfire Management Committee (BFMC 2011) are north westerly winds accompanied by high daytime temperatures and low relative humidity during summer. There are also frequent dry lightning storms occurring throughout the area during the bushfire season. The winds during thunderstorms can make it hard to predict the behaviour and movement of a bushfire.

Data from the Bureau of Meteorology weather stations confirms that both low humidity and high temperature occur within the bushfire season and would contribute to the fire hazard within this region (Figure 3.2).



Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean maximum temperature (°C) for years 1907 to 2020	32.4	31.5	29.3	25.0	20.5	16.6	16.0	18.0	21.7	25.4	28.7	31.3	24.7	100
Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean maximum temperature (°C) for years 1907 to 1992	31.9	31.1	29.0	24.8	20.0	16.4	15.5	17.4	21.1	25.0	28.5	31.0	24.3	85

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean 9am relative humidity (%) for years 1986 to 2010	63	68	68	67	78	84	82	73	66	59	61	61	69	24
Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean 9am relative humidity (%) for years 1951 to 1992	57	61	59	64	74	81	80	74	65	58	54	54	65	41

Figure 3.2 Low humidity and high temperature within the bushfire season (BOM 2020)

Strong gusty winds help fan the flames and cause a fire to spread faster across the landscape. Strong winds can carry hot embers long distances - these can start spot fires many kilometres ahead of the main fire front. Data from the Bureau of Meteorology weather stations at Quirindi Post Office (#055049) suggest that strong north westerly and southerly winds (moving to south easterly winds in late summer) are common during the bushfire season (Figure 3.3). Consultation with Brain Tomalin (Hanging Rock RFS) also confirms that the local fire danger is south west and south easterly winds which drive the fire up the valleys.

3.3 Climate Change and Bushfires

Eastern Australia is documented to be one of the most bushfire-prone areas in the world. As reported by the Bureau of Meteorology (BOM 2020 http://www.bom.gov.au/weather-services/fire-weather-centre/bushfire-weather/index.shtml), human induced climate change is influencing the frequency and severity of dangerous bushfire conditions in Australia and other regions of the world, influencing temperature, environmental moisture, weather patterns and fuel conditions. Observed changes in southern and eastern Australia include more extreme conditions during summer, as well as an earlier start to the bushfire season with dangerous weather conditions occurring significantly earlier in spring than they used to.

While climate change might not ignite the fire, it is giving fires the chance to turn into catastrophic fires by creating warmer temperatures, increasing the amount of fuel (dried vegetation) available, and reducing water availability due to higher evaporation. In relation to fire ignition, there is some indication that human induced climate change could also influence the risk of ignitions from dry-lightning (i.e., lightning that occurs without significant rainfall).

Bushfire weather conditions in future years are projected to increase in severity for many regions. This will result in:

- an earlier start to the bushfire season;
- reduced opportunities for fuel reduction burning;
- management of fire risk to property, people and biodiversity will become increasingly challenging; and
- an increase in the number of extreme fire danger days.

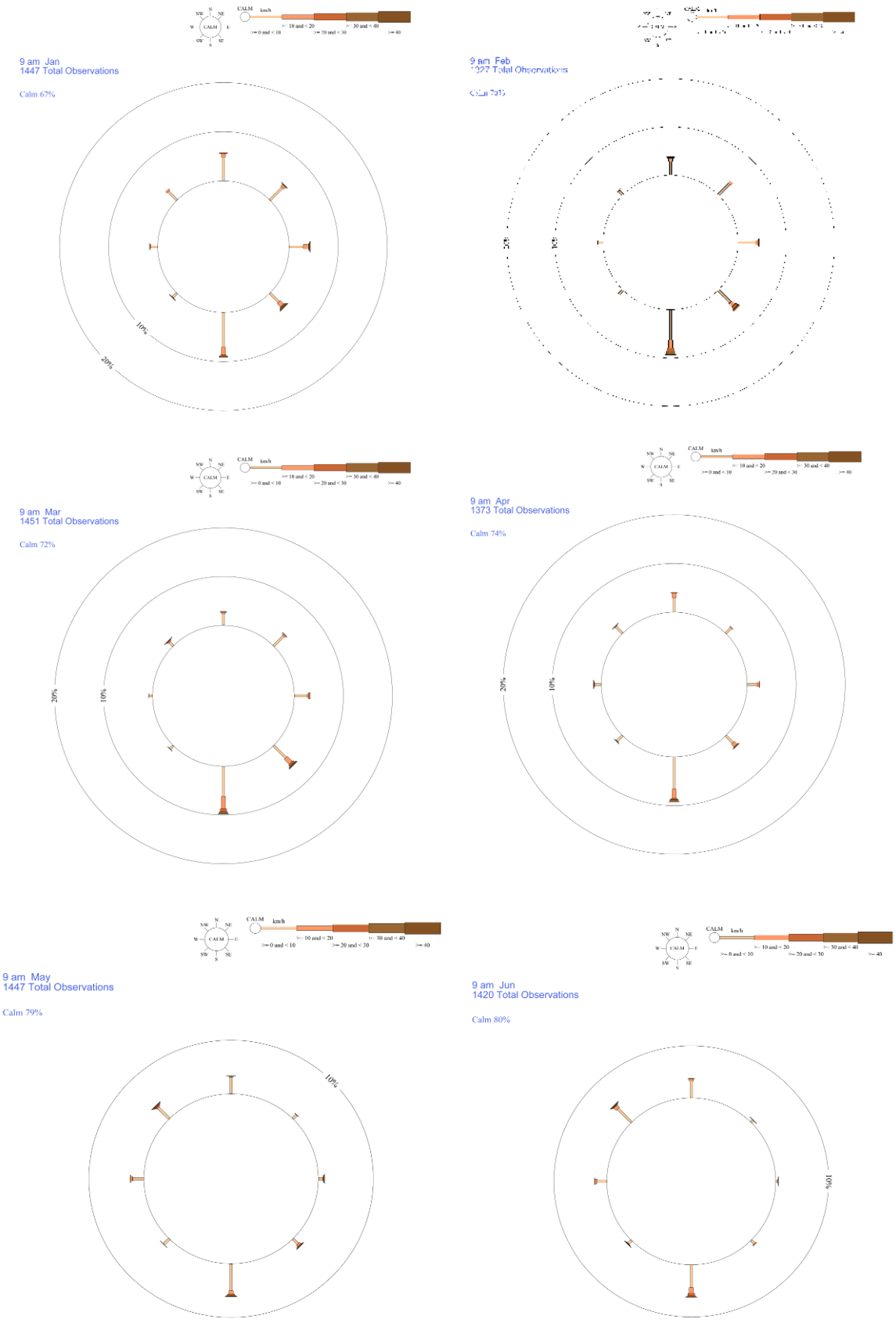


Figure 3.3a Monthly Wind direction versus Wind speed (km/h), Quirindi 1971-2020 (BOM 2020)

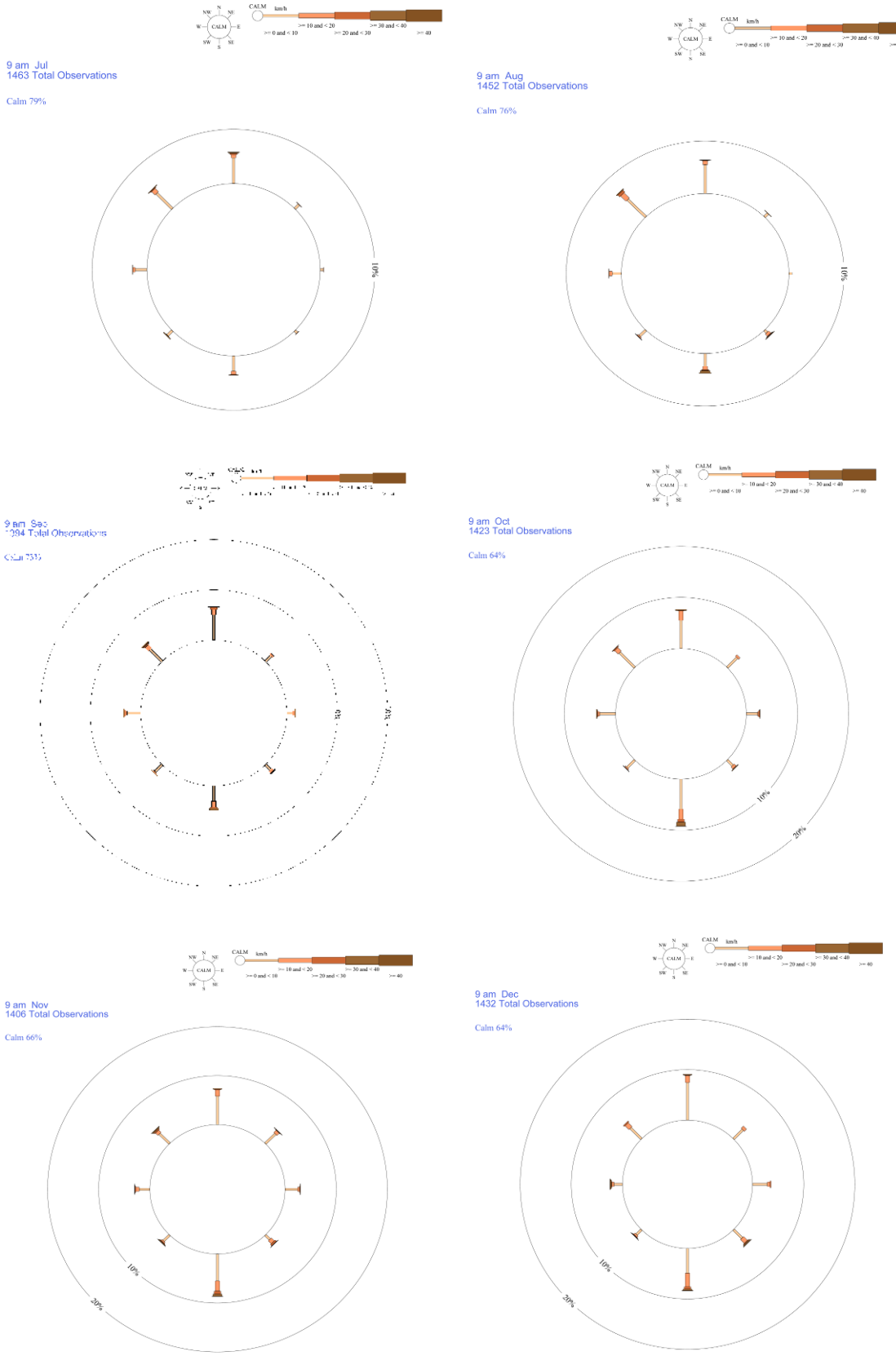


Figure 3.3b Monthly Wind direction versus Wind speed (km/h), Quirindi 1971-2020 (BOM 2020)

3.4 Vegetation Hazard

Descriptions of the vegetation types including species composition and structural diversity is provided in Hills of Gold Wind Farm Biodiversity Development Assessment Report (ARUP 2021) (refer Appendix D of the Amendment Report).

Vegetation growth can be encouraged by periods of wet weather, increasing the amount of fuel available (grass, leaf litter, twigs, bark). When the weather is hot, the humidity is low and there's been little recent rain, this vegetation dries out and becomes more flammable. A fire is more likely to start, and continue to burn, in hot, dry and windy weather.

For the purposes of this bushfire risk assessment, the vegetation has been simplified in line with the vegetation formations as per Keith (2004). The vegetation types have been classified into fuel groups using the following parameters (refer to Table 3.2):

- frequency that the vegetation provides 'available fire fuel';
- structure of the vegetation and the ability of ground level fuels to carry fire into higher vegetation levels eg. from understorey into crown fire;
- arrangement of the fuel within the vegetation type, eg fine fuels that are elevated, such as in heath, contribute more to fire intensity than a similar quantity of leaf litter fuel; and
- amount of fuel that accumulates after a long period without fire.

The vegetation classifications are shown in Figure 3.4.

It is intended that the vegetation fuel around the turbine (hardstands), within the overhead transmission line easements and access roads will be maintained in a low fuel state by mechanical, manual and chemical clearing methods prior to construction activities commencing and as part of ongoing maintenance activities for the duration of the Project. Refer to Section 6.1 for detailed description of the recommended APZ.

Table 3.2 Description and Characteristics of Fuel Groups within the Project Area

PCT	PCT Description	Vegetation Formation[1, 2]	Characteristics	Bushfire Fuel Group
526	Mountain Ribbon Gum - Messmate - Broad-leaved Stringybark open forest on granitic soils of the New England Tableland Bioregion	Dry Sclerophyll Forests (Shrub/grass sub-formation) Total fuel load[3]: 35 t/ha	Sclerophyll Forests tend to have continuous fuels that are available to burn during average seasons (higher fire intensity expected). Bushfires play a vital role in regeneration of dry sclerophyll forests. Many species are able to re-sprout from buds protected beneath soils or within the trunk or branches. Other species have seeds that are protected by a hard seed-coat or woody fruit, which are stimulated to open or germinate by fire. The frequency, intensity, season of occurrence of fire ('fire regime') has an enormous effect on the composition and structure of these forests[2]. There are two sub-formations of dry sclerophyll forests: shrub/grass and shrubby. The shrubby dry sclerophyll forest has typically Australian species such as waratahs, banksias, wattles, pea-flowers and tea-trees. There is a sparse ground cover of sedges and grasses are rare. They grow on sandy soils that are among the world's least fertile[2].	High
540	Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion			
591	White Box shrubby open forest on hills mainly in the Nandewar Bioregion			
541	Silvertop Stringybark - Rough-barked Apple grassy open forest of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion			
450	Smooth-barked Apple - White Cypress Pine grass shrub woodland on lower slopes and sandy flats, north western Brigalow Belt South Bioregion	Dry Sclerophyll Forests (Shrubby sub-formation) Total fuel load[3]: 35 t/ha		
538	Rough-barked Apple - Blakely's Red Gum open forest of the Nandewar Bioregion and western New England Tableland Bioregion			

PCT	PCT Description	Vegetation Formation[1, 2]	Characteristics	Bushfire Fuel Group
1194	Snow Gum - Mountain Gum - Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tableland Bioregion	Wet Sclerophyll Forests (Grassy sub-formation) Total fuel load[3]: 35 t/ha	Wet sclerophyll forests can be divided into two subgroups according to their understoreys; the shrubby sub-formation and the grassy sub-formation. Both have a tall, straight-trunked eucalypt canopy and a mesophyllous understorey, however the grassy sub-formation has a more open form with fewer shrubs and small trees, and occurs in slightly drier habitats[2]. Wet sclerophyll forests are highly combustible and the regional climatic conditions (see Section 3.2 - low rainfall, low humidity. high temperatures and high winds) combined with the steep terrain within the adjacent National Park may produce fierce crown fires (fires that spread between the top of canopies).	High
954	Mountain Ribbon Gum - Messmate open forest of escarpment ranges of the NSW North Coast Bioregion and New England Tableland Bioregion			
927	Messmate - Brown Barrel grassy open forest of escarpment ranges of the NSW North Coast Bioregion and New England Tableland Bioregion	Wet Sclerophyll Forests (Shrubby sub-formation) Total fuel load[3]: 35 t/ha		
931	Messmate - Mountain Gum tall moist forest of the far southern New England Tableland Bioregion			
934	Messmate open forest of the tableland edge of the NSW North Coast Bioregion and New England Tableland Bioregion			
486	River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range	Forested Wetlands Total fuel load[3]: 25 t/ha	Less continuous fuels, medium level quantity, available to burn during average seasons but may be less often than high (medium or high fire intensity expected).	Medium
84	Yellow Box woodland on sandy loam soils on alluvial plains mainly in the upper Darling Riverine Plain Bioregion			
1192	Snow Gum - Mountain Gum - Mountain Ribbon Gum grassy open forest of the New England Tableland Bioregion	Grassy Woodlands	Less continuous fuels, medium level quantity, available to burn during average seasons but may be less often than high (medium or high fire intensity expected).	Medium

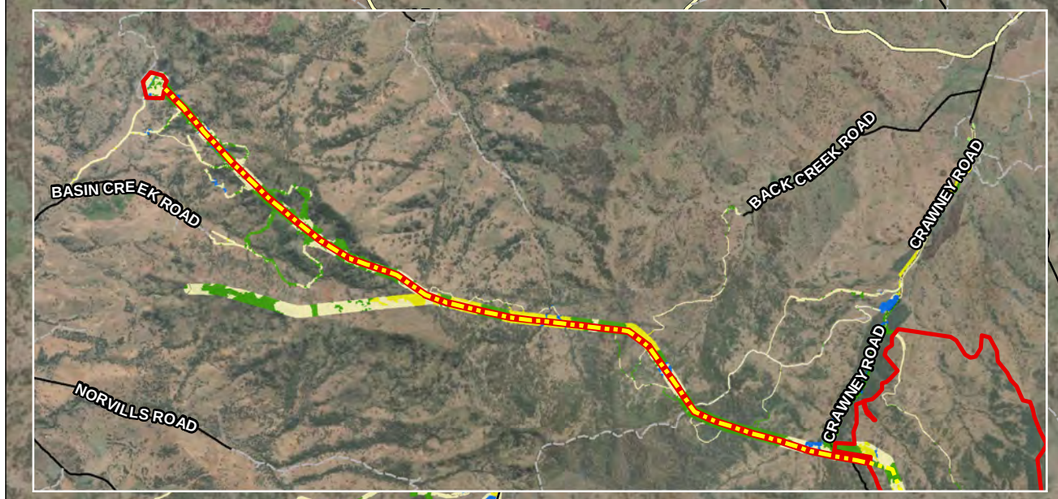
PCT	PCT Description	Vegetation Formation[1, 2]	Characteristics	Bushfire Fuel Group
433	White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region, Brigalow Belt South Bioregion	Total fuel load[3]: 25 t/ha		
490	Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range, Brigalow Belt South Bioregion			
492	Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion			
494	Snow Gum - Mountain Gum - Silver Wattle tall open forest of the Liverpool Range, Brigalow Belt South Bioregion			
507	Black Sallee - Snow Gum grassy woodland of the New England Tableland Bioregion			
599	Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion			
1604	Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter			
1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter			

PCT	PCT Description	Vegetation Formation[1, 2]	Characteristics	Bushfire Fuel Group
433	White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region, BBS Bioregion			
434	White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern Brigalow Belt South Bioregion			
-	Not mapped	Grassland	Possibly discontinuous fuels, low-medium fuel quantity, moister fuels unlikely to contribute to high intensity fires in average season, fuel structure facilitates easier control, (fire intensities expected range from low-high and generally regarded as easier to control e.g. moist and wet forests).	Low
-	Not mapped	N/A	Existing access roads and farm dams. Unlikely to burn or always burn within controllable limits.	Minimal

1. Keith (2004) From ocean shores to desert dunes: the vegetation of New South Wales and the ACT.
2. DPIE (2020) Online Vegetation Formation Profiles. https://www.environment.nsw.gov.au/threatenedSpeciesApp/
3. Table B3, AS3959:2018 Construction of buildings in bushfire-prone areas.

Note, in this assessment we have used the precautionary approach and applied the fuel loads specified in AS3959 instead of the slightly reduced fuel loads specified in the NSW RFS Comprehensive Vegetation Fuel Loads (March 2019).

Hanging Rock



MUNDLE CREEK ROAD
MORRISONS GAP ROAD
BARRY ROAD
SHEARERS ROAD
WOODLEYS ROAD
KIRKS ROAD
HEAD OF PEEL ROAD
TIMOR CRAWNEY ROAD
Crawney

WP1 WP2 WP3 WP4 WP5 WP6 WP7 WP8 WP9 WP10 WP11 WP12 WP13 WP14 WP15 WP16 WP17 WP18 WP19 WP20 WP21 WP22 WP23 WP24 WP25 WP26 WP27 WP28 WP29 WP30 WP31 WP32 WP33 WP34 WP35 WP36 WP37 WP38 WP39 WP40 WP41 WP42 WP43 WP44 WP45 WP46 WP47 WP48 WP49 WP50 WP51 WP52 WP53 WP54 WP55 WP56 WP57 WP58 WP59 WP60 WP61 WP62 WP63 WP64 WP65 WP66 WP67 WP68 WP69 WP70

Legend

- Turbines
- Transmission Line
- Project Area
- BESS/Laydown/Batching
- Compound/O&M option 2
- O&M option 1
- Substation
- Batching/Laydown
- Compound
- Laydown
- Access Roads
- Major Road
- Minor Road
- Track-Vehicular

Vegetation Classification (Keith 2004)

- Dry Sclerophyll Forests (Shrubby sub-formation)
- Dry Sclerophyll Forests (Shrub/grass sub-formation)
- Wet Sclerophyll Forests (Shrubby sub-formation)
- Wet Sclerophyll Forests (Grassy sub-formation)
- Grassy Woodlands
- Forested Wetlands
- Non-PCT

Source:
Vegetation Data - ARUP April 2021
BaseData - DLPI DCDB, DTDB 2020
ESRI World Imagery Dec 2018

Vegetation Classification

F3-4

Drawing No:	0550690s_HoG_BF_G003_R3.mxd		Hills of Gold Wind Farm Environmental Impact Statement
Date:	09/09/2021	Drawing Size: A3	
Drawn By:	VN	Reviewed By: AA	Client: Wind Energy Partners

Coordinate System: GDA 1994 MGA Zone 56

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3.5 Topography

Steeper slopes significantly increase the rate of spread of fires, and the relationship of the steepness of slope, and whether a fire moves upslope or downslope, is vital to understanding bushfire behaviour potential. For every 10˚ slope, the fire will double its speed. Slope and wind are often the major factors determining the direction of fire spread.

As identified in Figure 3.5, the Project Area is located along the upper ridgeline that is exposed to prevailing wind directions. These ridgelines and plateaus are flanked by very steep and rugged terrain that not only increases the rate of fire spread, it also creates erratic fire behaviour and makes access difficult. Given the large expanse of the site, the 65 WTG locations would be exposed to slopes varying from upslope to 25 degrees downslope.

Recent research[1] has shown that dynamic fire behaviour can occur on steep slopes of over 24-26 degrees. Areas downwind of these slopes can be exposed to a much greater risk of damage than normal, due to the occurrence of dynamic fire propagation and the development of catastrophic 'firestorms'. In the case of eruptive fire behaviour, the spread will be dominated by convective heat transfer (by strong air movement) rather than radiant heat transfer alone. In addition, eruptive fires may produce a larger area of active flame than the standard fire front, which makes containment of a bushfire more difficult. This has implications for the selection of appropriate size of APZs and has been considered further in AS3939:2018 Construction of buildings in bushfire-prone areas.

The recommended APZ in Section 6.1 are consistent with the recommendations of PBP 2019. The potential flame length and forward rate of spread (adjusted for slope) has also been considered in Section 5.3 and identifies those assets that have the potential for direct flame contact.

[1] Sharples, J.J. Risk implications of Dynamic Fire Propagation – A case study of the Ginninderra region, 2017. http://ginninderra.org.au/Sharples-Fire-Report

Slope Classes

F3-5

Drawing No:	0550690s_HoG_BF_G007_R2.mxd		Hills of Gold Wind Farm Environmental Impact Statement
Date:	09/09/2021	Drawing Size: A3	
Drawn By:	VN	Reviewed By: AA	Client: Wind Energy Partners

Coordinate System: GDA 1994 MGA Zone 56

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4. HISTORY OF FIRE AND WIND FARMS IN AUSTRALIA

The likelihood of a fire spreading within the area as a result of the proposed wind turbines is uncertain, because a detailed case history (i.e. previous fire records from fire agencies and wind farm sites) and experiments are required for similar environments, climate and wind farm components, ideally from within Australia is not available to enable assessment with more confidence.

A technical report into the financial and market impacts of wind turbine fires (Sharma, 2015) found that turbine fires are relatively infrequent, with approximately around 50 each year out of 300,000 wind turbines internationally (a rate of 1:6000).

A review of available literature identifies that there have been five reported fires involving wind farms within Australia:

- Ten Mile Lagoon in Western Australia in the mid-1990s. Damage limited to the relevant turbines, no damage to surrounding environment. Involved technology that is now redundant;
- Lake Bonney in South Australia in 2006. This fire was related to maintenance works during a shutdown. Damage limited to the relevant turbines, no damage to surrounding environment;
- the Star Fish Hill Wind Farm near Cape Jervis in South Australia experienced a turbine fire in October 2010. The turbine was damaged and surrounding spot fires were extinguished. The blades did not cease rotating in this instance, compounding the firefighting response due to the exclusion perimeter that was established and the spot fires due to flames coming off the rotating blades;
- a turbine fire occurred at Cathedral Rocks Wind Farm, South Australia, in February 2009. The turbine was damaged and surrounding spot fires required extinguishing (Parsons Brinkerhoff, 2012); and
- the Currandooley Fire in January 2017 was caused when a crow connected with overhead electrical infrastructure, caught alight and dropped into dry foliage underneath a power line that transfers electricity from Infigen's Woodlawn Windfarm to a substation at their Capital Wind Farm. The fire burnt approximately 3,400 hectares and was subject to a class action.

Another example of a fire that impacted on a wind farm (as opposed to the previous five examples that involved wind farm infrastructure) a bushfire started on a paddock near the Waterloo Wind Farm in South Australia. Fanned by gusty westerly and north westerly winds, the fire quickly spread through the area and raced up the ridge where the wind farm was located. 200 Country Fire Service volunteers were involved in firefighting operations and were supported by three water bombing aircraft. The wind farm operator confirmed that there was no damage to any wind farm infrastructure and no danger at any time to human life as a result of the fire. Normal wind farm operations resumed once the Country Fire Service advised the operator that it was safe to do so. Similarly, Pacific Hydro reported that a bushfire near Taralga Wind Farm in January 2018 was attended by NSW RFS firefighting teams on the ground, supported by firefighting aircraft and heavy plant. Turbines were shut down to assist aerial firefighting and no injuries to staff or damage to the wind farm was reported.

A number of learnings for emergency management procedures and protocols in relation to wind farms and bushfires have been reported by AFAC (2018) and Clean Energy Council (2017). These include:

- the wind farm's access roads were beneficial in helping fight the bushfire on the ground and provided an effective firebreak;
- the wind farm's turbines did not present a hazard to aerial firefighting and the turbines were clearly visible to the pilots involved in operations. However, transmission infrastructure, transmission lines and meteorological masts were difficult to see by pilots and did pose a safety risk;
- to maximise air space for firefighting between the turbines, turbines should be locked in the 'Y' position;

- improved communication protocols need to be in place between wind farm operators and fire and land management agencies to direct turbine shut-down procedures in an emergency situation and initiate emergency response plans;
- wind farm operators should ensure that they have the capacity to respond to emergency events; and
- additional precautionary measures should be considered to allow for aerial identification of meteorological masts (measurement towers), guy wires and other infrastructure such as transmission lines that are not easily visible from air.

The Australia Institute (2006) describe the fire risk associated with wind farms as minuscule provided the wind farm is properly constructed and managed. They determine fires caused by wind turbines are very rare and pose little risk to surrounding property. While it is possible for a catastrophic failure to cause fire within the turbine mechanism, the system is designed to contain fire and the likelihood of fire commencing from a tower equipment failure is much lower than from a faulty header or other farm machinery. The Government of South Australia (2004) also conclude that with normal maintenance and servicing practices in place, a wind farm will not pose an increased fire hazard to the host community and further that there has never been an incident involving a member of the public during normal operation.

Sophisticated monitoring technology is utilised to ensure that electrical, mechanical and hydraulic systems are functioning correctly and to isolate equipment if operating thresholds such as temperature or blade speed are reached (Government of South Australia 2004). Instances of extreme wind have been linked to wind turbine fire due to friction generated by the excessive speed of the blades (Government of South Australia 2004). Fire hazards can present when turbine bearings wear out, crankcases run out of lubricant, cables are damaged during rotation, there are electrical shorts or electrical arcing occurs in the transmission and distribution facilities (Government of South Australia 2004). This highlights the importance of scheduled and preventative maintenance routines as well as monitoring systems.

5. BUSHFIRE RISK

5.1 Fire history within the Project Area

A review of the NSW RFS Fire History Mapping available via SEED maps shows three major fires within the Project Area during the past 20 years (refer to Figure 5.1).

A summary of the publically available information for all major fires within the surrounding area is presented in

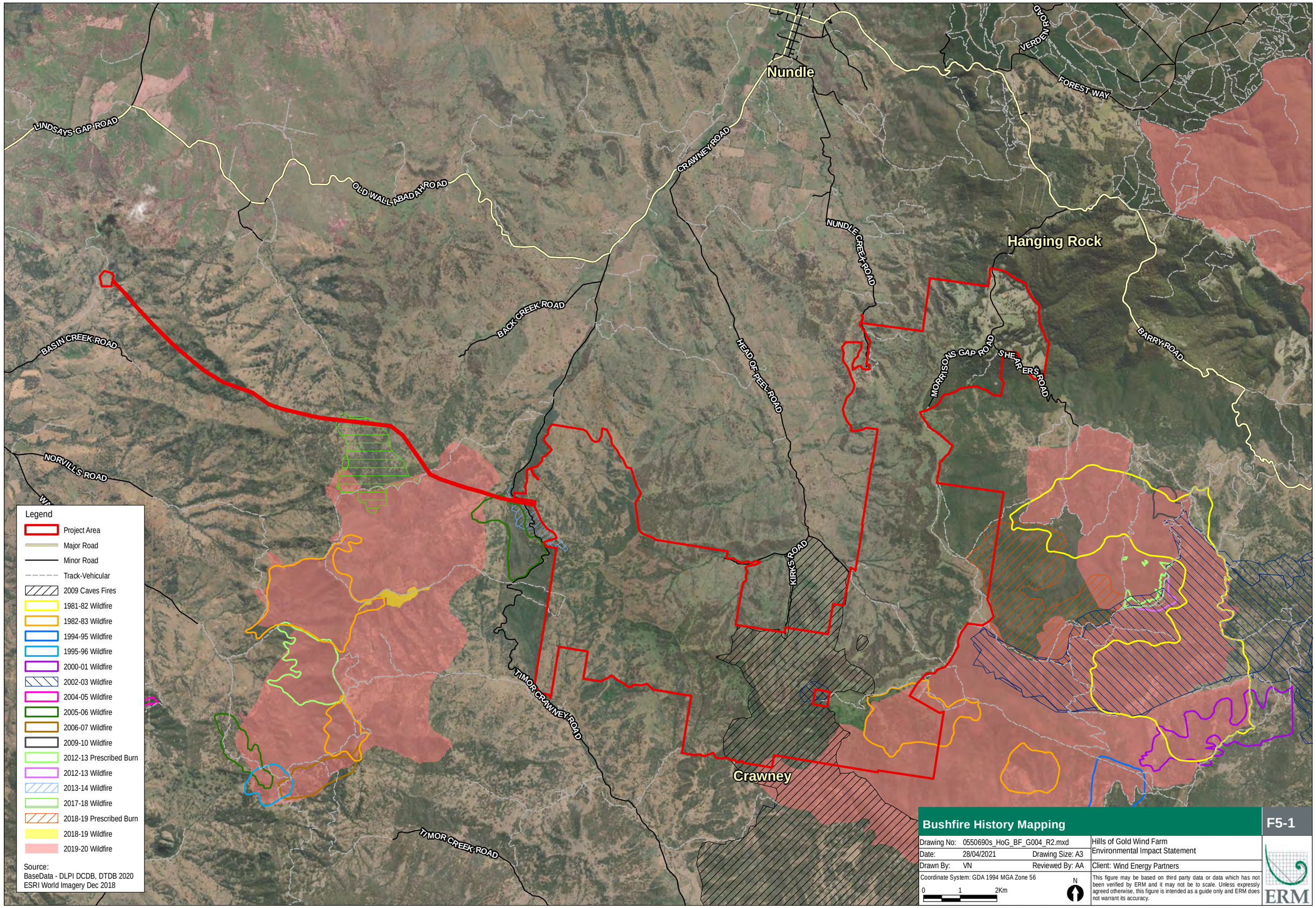
Table 5.1 Majors Fires Reported within the Immediate Area

Fire Name	Fire No. and Label	Dates	Area burnt (ha)	Comments
Fires directly impacting the Project Area				
Pages Creek Road Fire	Fire No.19121263653 Label 2019-20 Wildfire	Start Date 11/12/2019, End Date 10/1/2020	7,494.26	Ben Hall National Park. Difficult steep terrain. This fire is reported to have been the result of a lightning strike.
Crawney Road Fire	Fire No.13120984154 Label 2013-14 Wildfire	Start Date 8/12/2013, End Date 15/12/2013	69.44	
Caves Fire	Fire No. 29164	Start Date 8/12/2009, End Date 22/12/2009	5,214	A number of lightning ignitions south of Liverpool Range in Timor burnt north up the hill and crossed into the Peel Valley. Aerial support was required.
Head of Peel	Fire No.28675	Start Date 21/11/2009, End Date 24/11/2009	9.78	This was a re-ignition of an agricultural pile burn on Head of Peel property.
Nycomma Fire	Fire No.HUN02048 Label 2002-03 Wildfire	Start Date 22/12/2002	31.35	
Fires bordering the Project Area to the west and south west				
Wallabadah South	Fire No. 19121464008 Label 2019-20 Wildfire	Start Date 13/12/2019, End Date 6/1/2020,	4,041.41	Limited access due to steep terrain
Back Creek	Fire No. 17092576097 Label 2017-18 Wildfire	Start Date 25/9/2017, End Date 11/10/2017	325.98	
Crawney Pass Fire	Fire No. HUN05028 Label 2005-06 Wildfire	Start Date 29/3/2006, End Date 31/3/2006	183.85	
Fires bordering the Project Area to the east				
HCCO - BARR - Brayshaw - HR	Fire No. HR11022249774 Label 2018-19 Prescribed Burn	Start Date 4/3/2019, End Date 6/3/2019	849.91	
Schofield	Fire No. 12121360845 Label 2012-13 Wildfire	Start Date 13/12/2012, End Date 28/12/2012	1,226.04	
Gulf Gogs Complex	Fire No. HUN02042 Label 2002-03 Wildfire	Start Date 4/11/2002	6,017.52	
Fires bordering the Project Area to the north east				
Pearson Trail Complex	Fire No. 19121163462 Label 2019-20 Wildfire	Start Date 10/12/2019, End Date 31/12/2019	23,053.52	Dungowan Dam Catchment in difficult steep terrain. This fire is reported to have been the result of a lightning strike.

Based on a review of the publically available information as well as consultation with key stakeholders lightning is noted to be a key ignition source within the region, and the steep terrain results in fast moving fires that are difficult to control due to both unpredictable fire behaviour as well as maintaining safe access for firefighting crews.

Consultation between the Proponent and Brian Tomalin (RFS Hanging Rock) has also indicated that fires in the Nundle and Hanging Rock area, under extreme conditions are uncontrollable. Hanging Rock Village is particularly vulnerable to fires due to limited escape options and limited fire trails to defend the village. The village would have been lost if the Pearson's trail and Pages creek fires joined during the 2019/2020 bushfire season (Brian Tomalin pers. comm). This is noted as part of the community consultation process as an existing public safety hazard and an area of significant concern. It is not a direct result of the proposed wind farm, nor will the wind farm result in further isolation or access restrictions. The proposed upgrade of the internal road network would increase the level of access available to fire fighters along the entire length of this ridgeline (which forms a strategic fire containment line) and would assist to reduce the likelihood of a widespread fire. Site access points will be constructed as the first stage of development and the final design of access roads will enable safe access and egress for residents attempting to leave the area at the same time that emergency service personnel are arriving to undertake firefighting operations.

The results of the consultation, and review of the local fire history also reaffirms the requirement that site access points will be maintained for the life of the Project and include appropriate signs throughout the wind farm to assist emergency response crews determine track names, location of turbines and location of any locked gates. This includes a schedule for ongoing site familiarisation with both the NSW RFS, NSW Fire and Rescue and NPWS to account for changing personnel, site infrastructure and hazards.


Nundle
Hanging Rock
Crawney
LINDSAYS GAP ROAD
OLD WALLABADAH ROAD
CRAWNEY ROAD
NUNDLE CREEK ROAD
VERDEN ROAD
FOREST WAY
BASIN CREEK ROAD
BACK CREEK ROAD
HEAD OF REEL ROAD
MORRISONS GAP ROAD
SHEARERS ROAD
BARRY ROAD
NORVILLS ROAD
KIRKS ROAD
TIMOR CRAWNEY ROAD
TIMOR CREEK ROAD
Legend
Project Area
Major Road
Minor Road
Track-Vehicular
2009 Caves Fires
1981-82 Wildfire
1982-83 Wildfire
1994-95 Wildfire
1995-96 Wildfire
2000-01 Wildfire
2002-03 Wildfire
2004-05 Wildfire
2005-06 Wildfire
2006-07 Wildfire
2009-10 Wildfire
2012-13 Prescribed Burn
2012-13 Wildfire
2013-14 Wildfire
2017-18 Wildfire
2018-19 Prescribed Burn
2018-19 Wildfire
2019-20 Wildfire
Source:
BaseData - DLPI DCDB, DTDB 2020
ESRI World Imagery Dec 2018
Bushfire History Mapping
F5-1
Drawing No: 0550690s_HoG_BF_G004_R2.mxd
Date: 28/04/2021
Drawing Size: A3
Drawn By: VN
Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56
0 1 2Km
N
Hills of Gold Wind Farm
Environmental Impact Statement
Client: Wind Energy Partners
This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.
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5.2 Fire ignition

Bushfires occur in most years in this district, and natural ignitions such as lightning strikes are likely and historically common across the region. Human induced ignitions (both accidental and arson) are also known to occur across the region. The risk of fire starting as a result of a lightning strike may actually be reduced by the presence of wind turbines, particularly if they are located along a ridgeline (AFAC 2018). A built-in lightning protection system safely dissipates the electricity from the blades or the nacelle into the ground although there are no ignition occurrence records for the Project Area that provide statistical validity or a guide to likelihood of ignition.

Wind turbines also have a variety of on-board control systems specifically designed to mitigate the risk of fire. Each wind turbine is connected to a control centre which constantly monitors the wind turbine and shuts down the turbines if there is a risk of overheating. Turbines also automatically shut down if they are close to functioning outside their design conditions such as wind speeds greater than 25 m/s.

Earth moving equipment, power tools (e.g. welders, grinders), mowers and slashers are well known for starting bushfires under conditions of high temperature, low humidity and high wind. Therefore, construction and ongoing maintenance of the wind farm will be a potential source of ignitions. However, the level of risk from faults cannot be assessed at this stage because there is no case history available and it is not possible to compare the existing ignition risk from farm operations (e.g. crop harvesting) relative to wind farm operation.

As evidenced by the Curran Dooley fire in 2017, bird flashover faults on high voltage power lines can also cause bushfires when fuel conditions beneath the fault location are conducive to fire ignition and spread. This risk can be reduced by maintaining reduced fuel loads beneath transmission lines and will be the responsibility of the asset owner.

The risk that a wind farm itself will cause a fire is considered low given appropriate protection measures (AFAC 2018). The proposed upgrade of the internal road network would increase the level of access available to fire fighters along the entire length of this ridgeline (which forms a strategic fire containment line) and would assist to reduce the likelihood of a widespread fire. A minimum 20m wide APZ will also be provided around the proposed substation, switching station, BESS and O&M buildings to ensure that these assets are outside of the identified flame zone and will not increase the risk of a fire spreading across the landscape.

5.3 Fire behaviour potential

Based on the information provided above, the greatest hazard already present in the landscape is a combination of undesirable fire weather (ie. hot and dry winds and low humidity during summer) and the potential for a fire to spread across the steep topography from the adjacent properties towards farm assets in the surrounding area.

Strong north westerly and southerly winds (moving to south easterly winds in late summer) are common during the bushfire season in this region (based on BOM data from the nearby Quirindi Post Office) and would quickly carry a bushfire or grassfire from surrounding properties towards the wind farm assets. A fire under the influence of wind may travel upslope very fast, reaching assets before firefighters can attend the scene. This is noted to be an existing hazard and is not influenced by the proposed wind farm development.

Grassland

Grassfires should not be underestimated and can start and spread quickly. They can travel up to 25 km per hour and pulse even faster over short distances. As described by Bradstock et al (2012), grass is a fine, high surface area to volume ratio fuel with high thermal conductivity, low density and vertical orientation, which rapidly ignites (and rapidly burns out). Grassfires are also generally more open to wind than forest fuels (Cheney and Sullivan 2008) making them unpredictable. Grassfires tend to be less intense and produce fewer embers than bushfires, but still generate enormous amounts of radiant heat. Grassfires can also start earlier in the day than bushfires, because grass dries out more quickly when temperatures are high and humidity is low.

It should be assumed that, under the most extreme weather, a fire would spread even in heavily grazed grass and embers may breach any APZ.

Forest and Woodland

There are large continuous patches of woodland and forest vegetation on the site and the adjacent National Parks' estates (Figure 3.4) that will greatly influence fire behaviour. As outlined within Table 3.2, these have been classified as Forest. They tend to have continuous fuels that are available to burn during average seasons. They are highly combustible and the regional climatic conditions (see Section 3.2 - low rainfall, low humidity. high temperatures and high winds) combined with the steep terrain within the adjacent National Park may support crown fires.

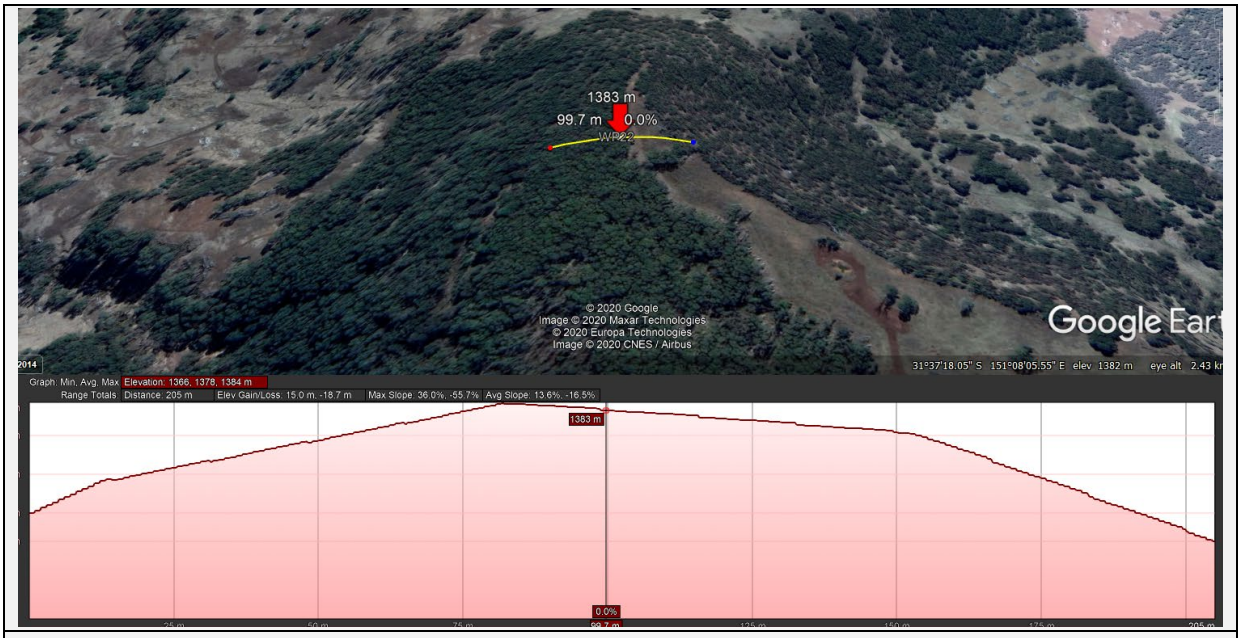
Flame Length

While PBP 2019 specifies an asset protection zone of 10 m for windfarm assets, given the steep slopes and existing fire history within the adjacent National Parks estates, this risk assessment is also undertaken with due consideration of the potential flame zone that may impact on the Project infrastructure. AS3959 and the PBP 2019 describe flame zone as:

> *the distance from a bushfire at which there is considered to be significant potential for sustained flame contact to a building or other infrastructure*.

The Bushfire Attack Level (BAL) Method 2 calculations within Appendix B of AS3959 have been used in this assessment and are applicable where the effective slope under the classified vegetation is no more than 30 degrees downslope (or 15 degrees upslope) and the slope of the land between the site and the classified vegetation is no more than 20 degrees. Detailed results are provided in Appendix C, and summarised in Table 5.2 and Table 5.3 below.

A detailed worked example is also provided below.



Calculated Flame Length at Turbine 22 (western elevation).

FDI = 80 surface fuel load (w) = 25 t/ha total fuel load (W) = 35 t/ha slope = 24.15 degrees	rate of spread (R): R = 0.0012 * FDI * w R = 2.4 km/h	R_{slope}= forward rate of spread adjusted for slope (km/h): R_{slope} = R exp (0.069 slope) R_{slope} = 2.4 exp (1.6663) R_{slope} = 12.706 km/h
Calculate flame length (L_f):	L_f = (13 R_{slope} + 0.24W)/2 L_f = (13 R_{slope} + 0.24W)/2 L_f = [(13 x 12.706) + (0.24 x 35)]/2 L_f = (165.18 + 8.4)/2 **L_f = 86.79 m**	

Detailed Method 2 Results (AS 3959:2018, Appendix B)
FDI: Fire Danger Indices

In comparison, the flame length reduces significantly, as the slope reduces. Using the same inputs as those above (i.e. forest vegetation):

- Slope 25 degrees downslope: Flame length 91.3 m
- Slope 20 degrees downslope: Flame length 66.2 m
- Slope 15 degrees downslope: Flame length 48.1 m
- Slope 10 degrees downslope: Flame length 35.3 m

Table 5.2 Flame Length Calculations (Project Infrastructure), Method 2 AS3959

		North			East			South			West		
Infrastructure Type	**ID**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**
~~*Turbine*~~	~~*WP1*~~												
Turbine	WP2	27.64	43.07	FZ	22.61	37.32	FZ	58.22	10.68	No	36.58	54.85	FZ
Turbine	WP3	21.46	11.92	No	27.13	10.81	No	67.76	68.23	FZ	49.83	9.77	No
Turbine	WP4	>100	-	-	15.90	73.99	FZ	15.49	77.80	FZ	72.88	6.32	No
Turbine	WP5	>100	-	-	>100	-	-	43.29	10.50	No	43.07	12.92	No
Turbine	WP6	33.49	9.97	No	50.88	10.71	No	48.74	58.32	FZ	26.55	90.93	FZ
Turbine	WP7	>100	-	-	>100	-	-	33.17	56.92	FZ	35.92	45.36	FZ
Turbine	WP8	38.13	83.19	FZ	41.48	58.34	FZ	61.51	9.74	No	69.31	52.53	No
Turbine	WP9	26.40	38.77	FZ	43.33	12.87	No	35.03	50.53	FZ	22.88	38.56	FZ
Turbine	WP10	>100	-	-	93.00	29.30	No	66.42	50.09	No	73.82	31.92	No
Turbine	WP11	20.67	67.09	FZ	25.30	44.77	FZ	34.98	69.32	FZ	25.94	8.72	No
Turbine	WP12	34.00	90.50	FZ	43.14	87.40	FZ	50.27	9.74	No	22.27	90.50	FZ
Turbine	WP13	>100	-	-	52.31	11.53	No	52.95	13.86	No	98.72	9.76	No
Turbine	WP14	37.02	15.76	No	15.73	11.25	No	34.90	50.21	FZ	57.28	34.93	No
Turbine	WP15	16.86	53.04	FZ	60.14	38.53	No	35.47	10.96	No	11.85	38.13	FZ
Turbine	WP16	32.24	43.80	FZ	46.11	9.74	No	18.92	74.07	FZ	16.07	9.74	No
Turbine	WP17	21.35	83.95	FZ	62.41	9.74	No	75.07	12.51	No	55.51	59.00	No
Turbine	WP18	>100			28.96	72.21	FZ	38.55	62.76	FZ	31.43	84.91	FZ
~~*Turbine*~~	~~*WP19*~~												
Turbine	WP20	>100	-	-	54.68	29.09	No	23.37	27.86	No	23.40	22.69	No
Turbine	WP21	19.15	25.89	FZ	24.16	27.35	FZ	16.86	14.56	No	15.97	30.41	FZ
Turbine	WP22	13.00	66.21	FZ	65.46	57.37	No	25.13	11.64	No	13.43	86.79	FZ
~~*Turbine*~~	~~*WP23*~~												
Turbine	WP24	14.78	11.94	No	16.79	12.69	No	20.62	26.96	FZ	27.86	52.49	FZ

		North			East			South			West		
Infrastructure Type	**ID**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**
Turbine	WP25	>100	-	-	97.44	24.88	No	93.27	25.60	No	>100	-	-
Turbine	WP26	>100	-	-	>100	-	-	>100	-	-	>100	-	-
~~*Turbine*~~	~~*WP27*~~												
Turbine	WP28	62.69	14.48	No	50.48	16.16	No	79.90	34.15	No	>100	-	-
Turbine	WP29	55.71	16.79	No	43.46	38.04	No	12.72	15.01	FZ	27.18	17.89	No
Turbine	WP30	29.54	26.58	No	12.62	25.47	FZ	12.63	16.64	FZ	33.95	16.39	No
~~*Turbine*~~	~~*WP31*~~												
Turbine	WP32	44.49	11.29	No	19.64	10.31	No	16.79	13.23	No	35.69	31.55	No
Turbine	WP33	27.40	14.82	No	12.74	29.45	FZ	13.57	67.24	FZ	35.99	37.43	FZ
Turbine	WP34	67.85	12.55	No	15.04	26.58	FZ	16.49	33.03	FZ	19.02	14.55	No
Turbine	WP35	>100			>100	-	-	>100	-	-	>100	-	-
Turbine	WP36	87.95	31.22	No	33.07	24.11	No	34.46	22.75	No	67.36	30.44	No
Turbine	WP37	78.76	40.85	No	>100	-	-	>100	-	-	>100	-	-
Turbine	WP38	43.11	27.71	No	>100	-	-	>100	-	-	57.91	25.45	No
Turbine	WP39	59.08	44.71	No	>100	-	-	>100	-	-	98.01	24.67	No
Turbine	WP40	25.38	71.09	FZ	67.45	59.36	No	99.47	10.21	No	41.86	57.26	FZ
Turbine	WP41	38.47	71.40	FZ	61.87	13.19	No	51.76	9.91	No	29.15	86.60	FZ
Turbine	WP42	34.27	78.26	FZ	73.62	14.38	No	43.44	56.00	FZ	28.57	90.97	FZ
Turbine	WP43	51.20	45.41	No	22.00	17.20	No	13.00	25.91	FZ	13.48	48.42	FZ
Turbine	WP44	>100	-	-	>100	-	-	>100	-	-	95.29	31.52	No
Turbine	WP45	>100	-	-	>100	-	-	>100	-	-	>100	-	-
Turbine	WP46	25.56	28.38	FZ	24.50	13.69	No	40.04	13.40	No	46.15	29.11	No
Turbine	WP47	83.65	16.02	No	93.74	26.97	No	>100	-	-	>100	-	-
Turbine	WP48	58.33	23.45	No	66.26	15.13	No	37.74	39.86	FZ	41.23	32.01	No
Turbine	WP49	>100	-	-	17.20	18.04	FZ	23.66	28.40	FZ	36.57	43.78	FZ

		North			East			South			West		
Infrastructure Type	**ID**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**
Turbine	WP50	75.37	34.46	FZ	50.31	19.67	No	48.95	35.26	FZ	0.00	24.03	FZ
Turbine	WP51	39.63	35.96	No	66.20	15.59	No	56.39	39.55	No	36.17	79.02	FZ
Turbine	WP52	>100	-	-	97.82	25.57	No	94.42	46.19	No	68.19	72.48	FZ
Turbine	WP53	61.16	48.38	No	28.27	17.53	No	66.37	15.21	No	>100		
Turbine	WP54	>100	-	-	86.42	18.05	No	62.18	30.21	No	55.17	70.83	FZ
Turbine	WP55	>100	-	-	>100	-	-	>100			>100	-	-
Turbine	WP56	>100	-	-	>100	-	-	93.90	22.46	No	>100	-	-
Turbine	WP57	45.03	36.52	No	37.13	16.13	No	>100	-	-	55.64	84.93	FZ
Turbine	WP58	25.88	38.21	FZ	>100	-	-	>100	-	-	29.04	38.12	FZ
Turbine	WP59	67.02	54.63	No	29.26	14.78	No	29.40	11.96	No	75.96	94.27	FZ
Turbine	WP60	>100	-	-	61.87	14.53	No	60.22	13.15	No	>100	-	-
Turbine	WP61	13.19	9.86	No	20.84	10.97	No	71.66	9.74	No	29.24	48.66	FZ
Turbine	WP62	52.28	32.87	No	>100	-	-	>100	-	-	>100	-	-
Turbine	WP63	13.00	56.78	FZ	20.59	55.76	FZ	>100	-	-	14.91	60.95	FZ
Turbine	WP64	54.85	66.10	FZ	48.10	11.43	No	34.37	12.78	No	42.98	9.74	No
Turbine	WP65	>100	-	-	>100	-	-	33.34	35.42	FZ	55.89	14.69	No
Turbine	WP66	>100	-	-	>100	-	-	>100	-	-	>100	-	-
Turbine	WP67	>100	-	-	>100	-	-	>100	-	-	>100	-	-
Turbine	WP68	>100	-	-	47.43	31.47	No	80.72	13.84	No	92.66	13.75	No
Turbine	WP69	44.62	28.89	No	44.67	36.32	No	>100	-	-	>100	-	-
Turbine	WP70	35.75	37.60	FZ	82.22	44.94	No	29.05	58.81	FZ	68.42	12.84	No
Substation		40.44	14.75	No	12	22.47	FZ	>100	-	-	>100	-	-
Switching Station		>100	-	-	0	32.17	FZ	>100	-	-	>100	-	-

		North			East			South			West		
Infrastructure Type	**ID**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**
BESS/Laydown/Batching		43.90	14.75	No	85.60	15.63	No	96.14	28.08	No	4.8	22.00	**FZ**
O&M Option 1		47.49	9.62	No	>100	-	-	>100	-	-	>100	-	-
Compound/O&M Option 2		>100	-	-	>100			10	30.63	**FZ**	41.2	20.07	No
Laydown 1	1	68.78	11.49	No	0	52.14	**FZ**	>100	-	-	>100	-	-
Laydown 2	2	>100	-	-	-	23.44	No	>100	-	-	86.76	24.76	No
Compound		0.00	16.51	**FZ**	6	23.05	**FZ**	>100	-	-	>100	-	-
Batching/Laydown	1	>100	-	-	>100	-	-	>100	-	-	>100	-	-
Batching/Laydown	2	>100	-	-	>100	-	-	>100	-	-	>100	-	-
Batching/Laydown	3	40.35	28.23	No	>100	-	-	>100	-	-	>100	-	-
Batching/Laydown	4	3.30	25.61	**FZ**	0	16.38	**FZ**	0	22.08	**FZ**	2.5	21.67	**FZ**

Table 5.3 BAL and Flame Length Calculations (Access Road and Transmission Line), Method 2 AS3959

		North			East			South			West		
Infrastructure Type	ID*	Distance to Vegetation (m)	Flame Length (m)	Asset located in Flame Zone?	Distance to Vegetation (m)	Flame Length (m)	Asset located in Flame Zone?	Distance to Vegetation (m)	Flame Length (m)	Asset located in Flame Zone?	Distance to Vegetation (m)	Flame Length (m)	Asset located in Flame Zone?
Access Road	1	-	-	-	82.5	35.36	No	-	-	-	>100	-	-
Access Road	2	-	-	-	>100	-	-	-	-	-	>100	-	-
Access Road	3	>100	-	-	-	-	-	>100	-	-	-	-	-
Access Road	4	-	-	-	>100	-	-	-	-	-	50.2	71.02	FZ
Access Road	5	>100	-	-	-	-	-	39.6	36.11	No	-	-	-
Access Road	6	29.1	70.56	FZ	-	-	-	60.8	14.73	No	-	-	-
Access Road	7	-	-	-	>100	-	-	-	-	-	46.3	37.37	No
Access Road	8	-	-	-	65.5	13.87	No	-	-	-	72.1	36.57	No
Access Road	9	-	-	-	55.3	14.88	No	-	-	-	53.5	111.10	FZ
Access Road	10	-	-	-	62.8	14.36	No	-	-	-	57.0	86.69	FZ
Access Road	11	-	-	-	>100	-	-	-	-	-	74.2	81.17	FZ
Access Road	12	-	-	-	>100	-	-	-	-	-	>100	-	-
Access Road	13	-	-	-	70.7	14.16	No	-	-	-	31.4	142.07	FZ
Access Road	14	-	-	-	-	-	-	45.35	24.46	No	71.5	100.67	FZ
Access Road	15	-	-	-	-	-	-	48.8	17.49	No	33.7	79.18	FZ
Access Road	16	-	-	-	-	-	-	57.0	30.35	No	53.6	59.91	FZ
Access Road	17	-	-	-	-	-	-	80.1	18.79	No	7.1	21.44	FZ
Access Road	18	-	-	-	-	-	-	5.7	16.60	FZ	7.7	35.99	FZ
Access Road	19	-	-	-	-	-	-	>100	-	-	>100	--	-
Access Road	20	-	-	-	-	-	-	62.9	26.70	No	33.7	32.39	No
Access Road	21	>100	-	-	>100	-	-	-	-	-	-	-	-
Access Road	22	7.3	66.14	FZ	16.9	17.13	FZ	-	-	-	-	-	-
Access Road	23	-	-	-	-	-	-	88.7	21.55	No	8.2	9.74	FZ
Access Road	24	-	-	-	-	-	-	45.7	10.31	No	61.9	62.33	FZ
Access Road	25	41.6	62.25	FZ	68.7	10.98	No	-	-	-	-	-	-

		North			East			South			West		
Infrastructure Type	**ID***	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**
Access Road	26	64.1	28.76	No	>100	-	-	-	-	-	-	-	-
Access Road	27	>100	-	-	>100	-	-	-	-	-	-	-	-
Access Road	28	>100	-	-	>100	-	-	-	-	-	-	-	-
Access Road	29	36.1	12.28	No	34.2	14.19	No	-	-	-	-	-	-
Access Road	30	55.7	26.26	No	>100	-	-	-	-	-	-	-	-
Access Road	31	-	-	-	-	-	-	29.2	30.02	FZ	24.0	42.99	FZ
Access Road	32	-	-	-	-	-	-	-	-	-	-	-	-
Access Road	33	7.6	12.73	FZ	4.8	51.10	FZ	-	-	-	-	-	-
~~*Access Road*~~	~~*34*~~												
Access Road	35	-	-	-	-	-	-	35.3	26.35	No	33.5	17.42	No
Access Road	36	-	-	-	-	-	-	35.0	38.28	FZ	29.7	14.33	No
~~*Access Road*~~	~~*37*~~												
Access Road	38	-	-	-	-	-	-	22.0	32.31	FZ	>100		
Access Road	39	-	-	-	-	-	-	14.7	39.10	FZ	15.9	50.00	FZ
~~*Access Road*~~	~~*40*~~												
Access Road	41	>100	-	-	46.2	9.74	No	-	-	-	-	-	-
Access Road	42	>100	-	-	85.0	12.32	No	-	-	-	-	-	-
Access Road	43	26.2	62.12	FZ	>100	-	-	-	-	-	-	-	-
Access Road	44	72.3	33.41	No	92.7	11.11	No	-	-	-	-	-	-
Access Road	45	-	-	-	-	-	-	18.6	9.74	No	>100	-	-
Access Road	46	10.6	29.12	FZ	23.0	9.74	No	-	-	-	-	-	-
Access Road	47	9.9	50.96	FZ	89.9	47.48	No	-	-	-	-	-	-
Access Road	48	-	-	-	-	-	-	15.3	9.74	No	11.8	84.11	FZ
Access Road	49	9.4	65.25	FZ	31.3	9.74	No	-	-	-	-	-	-
Access Road	50	-	-	-	-	-	-	18.8	9.74	No	75.5	53.37	No
~~*Access Road*~~	~~*51*~~												

		North			East			South			West		
Infrastructure Type	**ID***	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**
Access Road	52	46.7	60.74	FZ	43.6	9.74	No	-	-	-	-	-	-
Access Road	53	-	-	-	-	-	-	>100	-	-	73.7	44.40	FZ
Access Road	54	-	-	-	-	-	-	31.9	80.07	FZ	63.4	151.46	FZ
Access Road	55	22.1	90.61	FZ	>100	-	-	-	-	-	-	-	-
Access Road	56	7.3	82.60	FZ	20.7	9.86	No	-	-	-	-	-	-
Access Road	57	33.5	82.44	FZ	42.8	72.64	FZ	-	-	-	-	-	-
Access Road	58	20.0	40.60	FZ	5.8	10.25	FZ	-	-	-	-	-	-
Access Road	59	20.6	49.27	FZ	16.8	73.48	FZ	-	-	-	-	-	-
Access Road	60	-	-	-	-	-	-	29.8	90.50	FZ	34.7	83.36	FZ
Access Road	61	25.8	65.68	FZ	14.3	50.10	FZ	-	-	-	-	-	-
Access Road	62	>100	-	-	42.6	69.19	FZ	-	-	-	-	-	-
Access Road	63	-	-	-	-	-	-	48.6	29.35	No	30.9	53.53	FZ
Access Road	64	34.0	63.33	No	26.4	37.48	FZ	-	-	-			
Access Road	65	-	-	-	-	-	-	>100	-	-	27.2	117.88	FZ
Access Road	66	33.7	72.73	FZ	44.7	66.47	FZ	-	-	-			
Access Road	67	-	-	-	-	-	-	>100	-	-	12.5	49.78	FZ
~~*Access Road*~~	~~*68*~~												
Transmission Line	1	25.4	9.80	No	-	-	-	52.2	41.74	No	-	-	-
Transmission Line	2	25.5	10.44	No	-	-	-	25.6	43.73	FZ	-	-	-
Transmission Line	3	54.8	9.74	No	-	-	-	59.2	48.77	No	-	-	-
Transmission Line	4	25.5	9.74	No	-	-	-	25.5	57.93	FZ	-	-	-
Transmission Line	5	39.6	88.63	FZ	-	-	-	47.9	48.63	FZ	-	-	-
Transmission Line	6	>100	-	-	-	-	-	92.0	48.27	No	-	-	-
Transmission Line	7	25.6	43.55	FZ	-	-	-	25.5	56.66	FZ	-	-	-

		North			East			South			West		
Infrastructure Type	**ID***	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**
Transmission Line	8	31.5	68.13	FZ	-	-	-	27.7	65.92	FZ	-	-	-
Transmission Line	9	60.8	9.74	No	-	-	-	68.0	66.51	No	-	-	-
Transmission Line	10	46.5	9.74	No	-	-	-	41.4	75.43	FZ	-	-	-
Transmission Line	11	25.5	8.15	No	-	-	-	28.5	49.20	FZ	-	-	-
Transmission Line	12	25.5	45.80	FZ	-	-	-	25.7	81.46	FZ	-	-	-
Transmission Line	13	>100	-	-	-	-	-	37.9	53.22	FZ	-	-	-
Transmission Line	14	25.5	86.31	FZ	-	-	-	25.5	9.74	No	-	-	-
Transmission Line	15	25.5	87.51	FZ	-	-	-	25.5	9.74	No	-	-	-
Transmission Line	16	25.5	38.92	FZ	-	-	-	25.5	6.46	No	-	-	-
Transmission Line	17	25.5	25.10	No	-	-	-	25.5	35.90	FZ	-	-	-
Transmission Line	18	25.5	10.06	No	-	-	-	25.5	52.33	FZ	-	-	-
Transmission Line	19	25.5	75.31	FZ	-	-	-	25.5	89.84	FZ	-	-	-
Transmission Line	20	25.5	53.34	FZ	-	-	-	26.4	80.15	FZ	-	-	-
Transmission Line	21	25.5	35.93	FZ	-	-	-	25.8	34.08	FZ	-	-	-
Transmission Line	22	91.0	53.92	No	-	-	-	>100	-	-	-	-	-
Transmission Line	23	26.5	14.72	No	-	-	-	25.5	23.26	No	-	-	-
Transmission Line	24	25.5	9.74	No	-	-	-	25.5	71.76	FZ	-	-	-
Transmission Line	25	25.5	9.74	No	-	-	-	25.5	43.20	FZ	-	-	-
Transmission Line	26	25.5	9.74	No	-	-	-	25.5	39.62	FZ	-	-	-
Transmission Line	27	60.3	18.24	No	-	-	-	25.5	12.70	No	-	-	-
Transmission Line	28	25.5	41.64	FZ	-	-	-	25.5	9.74	No	-	-	-

		North			East			South			West		
Infrastructure Type	**ID***	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**
Transmission Line	29	25.5	47.62	FZ	-	-	-	25.5	47.47	FZ	-	-	-
Transmission Line	30	25.5	43.90	FZ	-	-	-	25.5	9.74	No	-	-	-
Transmission Line	31	25.5	9.74	No	-	-	-	28.5	9.74	No	-	-	-
Transmission Line	32	>100	-	-	-	-	-	74.1	6.32	No	-	-	-
Transmission Line	33	25.6	6.32	No	-	-	-	26.2	6.32	No	-	-	-
Transmission Line	34	25.8	54.74	FZ	-	-	-	>100	-	-	-	-	-
Transmission Line	35	25.8	74.46	FZ	-	-	-	25.5	9.74	No	-	-	-
Transmission Line	36	26.5	87.88	FZ	-	-	-	25.5	9.74	No	-	-	-
Transmission Line	37	25.5	61.2	FZ	-	-	-	25.5	9.74	No	-	-	-
Transmission Line	38	>100	-	-	-	-	-	67.2	11.96	No	-	-	-
Transmission Line	39	>100	-	-	-	-	-	>100	-	-	-	-	-
Transmission Line	40	44.5	15.14	No	-	-	-	>100	-	-	-	-	-
Transmission Line	41	48.6	38.93	No	-	-	-	41.1	12.2	No	-	-	-
Transmission Line	42	66.4	9.74	No	-	-	-	50.9	13.29	No	-	-	-
Transmission Line	43	25.5	68.52	FZ	-	-	-	25.5	21.77	No	-	-	-
Transmission Line	44	25.5	51.47	FZ	-	-	-	25.5	6.69	No	-	-	-
Transmission Line	45	25.5	44.31	FZ	-	-	-	>100	-	-	-	-	-
Transmission Line	46	>100	-	-	-	-	-	25.5	48.52	FZ	-	-	-
Transmission Line	47	>100	-	-	-	-	-	91.8	9.74	No	-	-	-
Transmission Line	48	45.5	60.14	FZ	-	-	-	30.2	9.74	No	-	-	-
Transmission Line	49	25.5	74.47	FZ	-	-	-	25.9	9.74	No	-	-	-

		North			East			South			West		
Infrastructure Type	**ID***	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**	**Distance to Vegetation (m)**	**Flame Length (m)**	**Asset located in Flame Zone?**
Transmission Line	50	32.0	87.36	FZ	-	-	-	>100	-	-	-	-	-
Transmission Line	51	>100	-	-	-	-	-	-	-	-	-	-	-
Transmission Line	52	69.5	10.22	No	-	-	-	>100	-	-	-	-	-
Transmission Line	53	25.5	78.51	FZ	-	-	-	>100	-	-	-	-	-
Transmission Line	54	25.5	45.80	FZ	-	-	-	>100	-	-	-	-	-
Transmission Line	55	25.5	9.74	No	-	-	-	28.5	57.57	FZ	-	-	-
Transmission Line	56	25.5	82.25	FZ	-	-	-	25.6	66.50	FZ	-	-	-
Transmission Line	57	62.4	64.39	FZ	-	-	-	>100	-	-	-	-	-
Transmission Line	58	>100	-	-	-	-	-	>100	-	-	-	-	-
Transmission Line	59	53.8	79.26	FZ	-	-	-	79.7	9.90	No	-	-	-
Transmission Line	60	26.9	14.72	No	-	-	-	25.4	22.89	No	-	-	-
Transmission Line	61	78.7	65.27	No	-	-	-	51.7	15.87	No	-	-	-
Transmission Line	62	>100	-	-	-	-	-	50.7	26.68	No	-	-	-

** Refer to Figure C.1 (Appendix C) for the location of each of these points.*

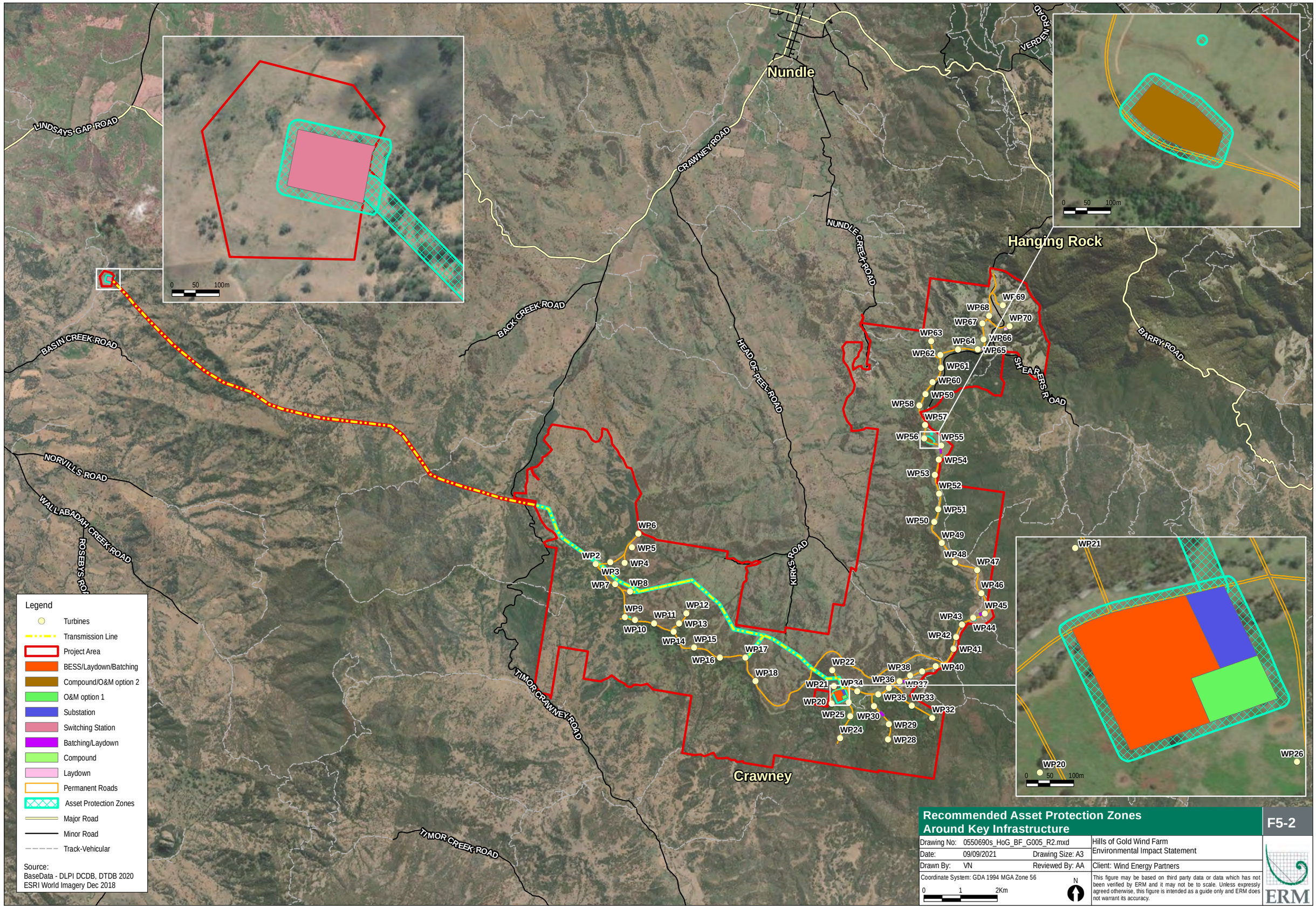
This assessment identifies that 39 of the 65 turbines have the potential for direct flame contact. These assets are all located within the potential flame zone and risk mitigation measures are outlined in Section 6. All turbines will be surrounded by an area of defendable space.

It is also recognised that 40 of 62 transmission line poles (or 65% of the proposed 330 kV transmission line) are located within the flame zone. All poles will be either concrete or galvanised steel poles, and the maintenance of the transmission line easement including reduced fuel loads beneath transmission lines will be the responsibility of the asset owner. The pole locations are based on a concept design and finalised pole location will be subject to detailed design.

The switching station, BESS, substation and the O&M building will all have a minimum 20 m wide asset protection to ensure adequate defendable space around these assets. To ensure that these significant assets are not at risk of direct flame contact, and based on the results of the flame length modelling presented in Table 5.2:

- the substation will have minimum 23m wide APZ to the east and 20m in all other directions;
- the switching station will have a minimum 33m APZ to east and 20m in all other directions;
- the BESS will have a 23m APZ to the west and 20m in all other directions;
- O&M Option 1 will require a minimum 20m wide APZ in all directions; and
- Compound/O&M option 2 will have minimum 21m wide APZ to the south and 20m in all other directions (refer to Figure 5.2).

While it is recognised that key assets that have the potential to influence the spread of fire such as the switching station, substation, BESS and O&M buildings must be located outside of the flame zone. It is also recommended that where possible, the batching plants should also be avoided within the flame zone – this is particularly relevant to Batching/Laydown Area 4 as it is susceptible to direct flame contact in all directions.



Recommended Asset Protection Zones Around Key Infrastructure

F5-2

Drawing No:	0550690s_HoG_BF_G005_R2.mxd		Hills of Gold Wind Farm Environmental Impact Statement
Date:	09/09/2021	Drawing Size: A3	
Drawn By:	VN	Reviewed By: AA	Client: Wind Energy Partners

Coordinate System: GDA 1994 MGA Zone 56

0 1 2Km

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5.4 Firefighter and public safety

The usage of the general area surrounding the Project Area is mostly limited to existing landowners.

The firefighters likely to respond to a bushfire in this area would be volunteers from the NSW RFS and or individual property owners. Based on the locality of the site and the strategic fire advantage that this ridgeline presents, NSW RFS may also work closely with the Fire and Rescue NSW, FCNSW and National Parks in the event of any major fires in this area.

These agencies and groups work together through local bushfire management committees across NSW. Set up under the NSW Rural Fires Act, these committees coordinate fire management planning, prevention and suppression in local areas.

The materials for individual components within the wind farm infrastructure have not yet been finalised, therefore, the flammability and toxicity of burning components have not been determined in detail although this information may form part of the recommended Bushfire Emergency Management and Operations Plan that will be developed prior to construction. The risks to firefighter safety associated with a fire burning the turbines and associated equipment include inhalation of potentially toxic fumes and smoke from any plastic components such as cables (although the main structure of the WTG will be steel or concrete/steel hybrid) or other decomposed products (Allianz Risk Consulting, 2012).

Any volunteer firefighters from the NSW RFS, NSW Fire and Rescue, National Parks, FCNSW or property owners from neighbouring farms attending bushfires in this area may not be trained in structural and electrical firefighting. The Bushfire Emergency Management and Operations Plan will detail appropriate risk control measures that would need to be implemented to safely mitigate potential risks to the health and safety of the firefighters and first responders. At least two copies of the Emergency Management and Operations Plan will be stored in an Emergency Information Cabinet located at the main entrance points and will be accessible to all first responders. Two copies of the Emergency Management and Operations Plan will also be stored within the operations facilities and one at the NSW RFS Liverpool Range District office. This plan will be prepared in consultation with NPWS and will consider the existing fire management regimes within the National Parks estates as detailed within their respective fire management strategies.

As reported by AFAC (2018) wind farms can interfere with local and regional radio transmissions by physical obstruction and radio frequency electromagnetic radiation (Australian Wind Energy Association 2004). The risk of radio communications affecting emergency response operations will be considered in the planning stages of the development however is expected to be manageable.

The combination of dense smoke and hot gases generated by a large fire directly under or near a high voltage power line can create a conductive path that increases the potential for a ‘flashover’. The National Guidelines on Electrical Safety for Emergency Personnel provide critical information relating specifically to fire control near high voltage power lines, including the special conditions that apply to the use of water in fire control activities near power lines. This industry code will be considered in the preparation of the Bushfire Emergency Management and Operations Plan.

The increased risk of arcing in dense smoke has been considered by the Proponent. In terms or arcing potential, the Proponent has advised that the turbines have a detection system that protects them from surges, arcing and other electrical hazards. Arcing would be detected and electrical systems shut off if these persisted over several split seconds.

The majority of the internal power lines are underground however where these are overhead, the Proponent has again confirmed that similar detection systems will be installed to monitor changes over split seconds and within tight bands. Automatic Circuit Breakers at either end of the lines would open to stop transmission of electricity in the event that any arcing is detected.

5.5 Summary of Bushfire Risk Factors

Table 5.4 below presents a summary of bushfire risk factors for the proposed wind farm development.

The risk that a wind farm itself will cause a fire is considered low given appropriate protection measures (AFAC 2018). The proposed upgrade of the internal road network would increase the level of access available to fire fighters along the entire length of this ridgeline (which forms a strategic fire containment line) and would assist to reduce the likelihood of a widespread fire.

It is important to note that the access road is already located within the flame zone and the proposed windfarm assets will not increase this existing hazard. The improved access and additional water sources will be an advantage to both the local RFS and the NPWS for back burning down the slopes in advance of the fire front as was undertaken in 2019 and successfully stopped the Pages Creek Road Fire along this ridgeline. The location of all fire control advantages within the Project Area (water points, helipad, staging area and refuge area) currently mapped on the Ben Halls Gap National Park Fire Management Strategy (refer to Figure 6.1 and Appendix D) will be reviewed and updated in consultation with the NSW RFS and NSW NPWS as part of the recommended Bushfire Emergency Management and Operations Plan.

In the event that a fire does breach any containment lines and threatens the windfarm assets, it is possible that the windfarm infrastructure will sustain direct flame contact and that firefighting will require aerial support. Aerial support was used during the 2109/2020 fires and would not be the result of the windfarm itself although it is recognised that the windfarm would result in additional assets that would need to be protected. Consultation with RFS has confirmed that as the WTG towers are made from non-combustible material and do not present a significance risk, efforts would be concentrated on defending those assets that could contribute to widespread fire. It is therefore important that key assets such as the switching station, substation, BESS and O&M buildings are all located outside of the flame zone and have adequate defendable space all sides.

It is also important to note that there are residential dwellings on rural properties scattered throughout the landscape that may be at risk from fire and the steep, rugged topography within the adjacent National Parks Estate is considered to present an additional existing hazard that will also be considered in the Bushfire Emergency Management and Operations Plan.

Table 5.4 Summary of Bushfire Risk Factors

Risk Factor	Description of Risk	Analysis of the Risk *	Potential to Mitigate/Reduce Impact
Loss of Life	Populated Area	The Hanging Rock RFS modelled a fire starting near Nundle Sawmill and on a reasonable day the fire would take approximately 2 hours and 15 minutes to reach Hanging Rock Village - on a day with severe conditions it would only take minutes to reach the village (Brain Tomalin pers. comm). This noted to be an existing hazard and is referred to here to recognise that bushfire is a key concern for the local community and the risk to life should not be discounted. Natural ignitions such as lightning strikes are likely and historically common across the region. Human induced ignitions (both accidental and arson) are also known to occur. The risk of fire starting as a result of a lightning strike is actually reduced by the presence of wind turbines. A built-in lightning protection system safely dissipates the electricity from the blades or the nacelle into the ground. Wind turbines also have a variety of on-board control systems specifically designed to mitigate the risk of fire. Each wind turbine is connected to a control centre which constantly monitors the wind turbine and shuts down the turbines if there is a risk of overheating. Turbines also automatically shut down if they are close to functioning outside their design conditions such as wind speeds greater than 25 m/s or if electrical surges are detected. The risk that wind farm itself will cause a fire or increase the risk already present in the region is minimal (AFAC 2018). Wind farms are an infrastructure development that should be considered by fire and land management agencies through the preparation of incident action plans for the suppression of bushfires in their vicinity. These considerations are routine and wind farms are not expected to present elevated risks to operations compared to other electrical infrastructure (AFAC 2018).	■ The Project will be controlled by a remote supervisory control and data acquisition (SCADA) from a control room located within the permanent site operations and maintenance facility. The SCADA system will allow remote operation of all WTGs with the ability to shut-down individual or all WTGs if required. ■ Site access points will be constructed as the first stage of development and the final design of access roads will enable safe access and egress for residents attempting to leave the area at the same time that emergency service personnel are arriving to undertake firefighting operations. ■ Key assets such as the switching station, substation, BESS and O&M buildings are all located outside of the flame zone and will have adequate defendable space all sides. ■ Despite the mitigation measures and treatments that are put in place it is noted that some bushfire risk will always remain and it is important that a Bushfire Emergency Management and Operations Plan is prepared in conjunction with relevant stakeholders, including local fire services, adjoining property owners and employees.

Risk Factor	Description of Risk	Analysis of the Risk *	Potential to Mitigate/Reduce Impact
	Aerial Fire Fighters	Fire suppression aircraft only operate in areas where there is no smoke and during daylight hours (CFA 2015). Wind turbines, similar to high voltage transmission lines, are part of the landscape and would be considered in the incident action plan, thus not resulting in any increased risk to aerial fire fighters. The NSW RFS and Australasian Fire and Emergency Services Council (AFAC) have worked together to develop a national position on wind turbines (AFAC 2018). This position paper concludes that wind farms are not expected to adversely affect fire behaviour in their vicinity. Local wind speeds and direction are already highly variable across landscapes affected by turbulence from ridgelines, tall trees and buildings. Any risk of wake turbulence from wind turbines influencing fire behaviour will be mitigated through the shutting down of wind turbines in a bushfire event. . Sufficient planning for access roads and the increased APZ around key assets will reduce the risk of wind farm ignitions spreading beyond the property and reduce the risk of external fire impacting wind farm infrastructure. As reported by AFAC (2018), the bushfire at the Waterloo Wind Farm demonstrated that if conditions are clear and wind turbines are turned off, wind turbines are clearly visible from aircraft and are not likely to constrain aerial firefighting operations (Clean Energy Council 2017). However, during this event transmission infrastructure, meteorological towers and guy-ropes were difficult to see; this infrastructure does have potential to limit the effectiveness of aerial firefighting operations. As noted above, all of the windfarm infrastructure including the transmission lines will need to be considered in any incident action plan and as outlined within the Hills of Gold Wind Farm Aviation Impact Assessment (Aviation Projects, 2020), further consultation will be held with RFS and WEP to ensure that appropriate mitigation methods are in place, so that in the event of a	■ NSW RFS would be provided with maps and GPS coordinates of the final wind turbine layout and identification information for individual wind turbine sites for their internal response planning. ■ Further consultation with NSW NPWS and NSW RFS and the proponent to ensure that appropriate mitigation methods are in place, so that in the event of a bushfire in the area, pilots are aware of the turbine locations and can respond appropriately; ■ Liaise with the Civil Aviation Safety Authority (CASA) and the RAAF Aeronautical Information Service, which maintains a database of structures on behalf of CASA. ■ Turbines will be painted white/light grey for increased visibility. ■ Monitoring masts are to be recorded in the Tall Structures Database maintained by Air Services Australia (Civil Aviation Safety Authority 2018). ■ Install visible markers (such as orange balls) on all masts to minimise risks during aerial firefighting operations. These will also be installed on transmission lines where they span long distances between valleys.

Risk Factor	Description of Risk	Analysis of the Risk *	Potential to Mitigate/Reduce Impact
		bushfire in the area, pilots are aware of the turbine locations and can respond appropriately. In the unlikely event that a fire did spread from the wind farm to surrounding properties, the turbines would not limit aerial firefighting capabilities on other properties in the surrounding area.	
	Firefighter	The firefighters likely to respond to a bushfire in this area would be volunteers from the NSW RFS and or individual property owners. Brigades from NSW Fire and Rescue and National Parks could also respond. As evidenced during the recent fires, the track along the ridgeline is used as a strategic containment line and allows the response agencies to back burn ahead of the fire. The proposed upgrade of the internal road network would increase the level of access available to fire fighters along the entire length of this ridgeline (which forms a strategic fire containment line) and would assist to reduce the likelihood of a widespread fire. In the event that a fire does breach any containment lines and threatens the windfarm assets, it is likely that firefighting will require aerial support. Aerial support was used during the 2109/2020 fires and use of this vital resource would not be the result of the windfarm itself although it is recognised that the windfarm would result in additional assets that would need to be protected. As reported by AFAC (2018) wind farms can interfere with local and regional radio transmissions by physical obstruction and radio frequency electromagnetic radiation (Australian Wind Energy Association 2004). This has been considered in the Hills of Gold Windfarm EMI Study (Lawrence Derrick and Associates, 2020) and communications is not expected to be affected.	■ The Bushfire Emergency Management and Operations Plan will detail appropriate risk control measures that would need to be implemented to safely mitigate potential risks to the health and safety of the firefighters and first responders. ■ At least two copies of the Emergency Management and Operations Plan will be stored in an Emergency Information Cabinet located at the main entrance point and will be accessible to all first responders. Two copies of the Emergency Management and Operations Plan will also be stored within the operations facilities and one at the NSW RFS Liverpool Range District office. ■ Site access points will be constructed as the first stage of development and the final design of access roads will enable safe access and egress for residents attempting to leave the area at the same time that emergency service personnel are arriving to undertake firefighting operations.

Risk Factor	Description of Risk	Analysis of the Risk *	Potential to Mitigate/Reduce Impact
			■ The location of all fire control advantages within the Project Area (water points, helipad, staging area and refuge area) currently mapped on the Ben Halls Gap National Park Fire Management Strategy (refer to Figure 6.1 and Appendix D) will be reviewed and updated in consultation with the NSW RFS and NSW NPWS as part of the recommended Bushfire Emergency Management and Operations Plan. ■ The Bushfire Emergency Management and Operations Plan include a detail site plan identifying, using GPS coordinates, each turbine tower location.
	Workers and Visitors	All employees and visitors involved in the operation and maintenance of the wind farm will be routinely trained. Construction and maintenance staff will also be trained in the basic first response firefighting techniques and appropriate communication and firefighting equipment will be maintained onsite. Provided that appropriate firefighting equipment, training in initial response and water supplies are maintained onsite the likelihood of fire adversely impacting the safety of site personnel is very low although the potential consequences are recognised as being major.	■ Develop and strictly implement safe working and emergency response procedures for all work tasks. ■ Provide and maintain firefighting equipment capable of controlling and suppressing small initial outbreaks of fire. As a minimum, these will be located on the outside of the switching station, substation, BESS and O&M buildings.
Damage to infrastructure within the Project Area	Extensive and widespread loss of infrastructure	45 of the 65 turbines have the potential for direct flame contact. These assets are all located within the potential flame zone. Wind turbine monitoring technology is utilised to ensure that electrical, mechanical and hydraulic systems are functioning correctly and to isolate equipment if operating thresholds such as temperature or blade speed are	The risk will be avoided to some infrastructure by: ■ the substation will have minimum 23m wide APZ to the east and 20m in all other directions;

Risk Factor	Description of Risk	Analysis of the Risk *	Potential to Mitigate/Reduce Impact
		reached. Wind turbines are a relatively passive technology that use few flammable materials and together with the maintenance of an adequate defendable space results in a low risk of damage to the turbines in the event of a bushfire within the surrounding lands. The substations and compounds are also constructed of non-flammable materials. To account for the steep slopes, an increased APZ of 20 m will be established on all sides of the substation, switching station, BESS and O&M Buildings. This will be increased where required to ensure that these key assets are located outside of the flame zone. It is also recognised that 40 of 62 transmission line poles (or 65% of the proposed 330 kV transmission line) is located within the flame zone. All poles will be either concrete or galvanised steel poles, and the maintenance of the transmission line easement including reduced fuel loads beneath transmission lines will be the responsibility of the asset owner. The design and layout of the wind farm will assist in reducing the risk of fire and isolating any issues. In the unlikely event of a widespread fire some external assistance may be required to recover in the short term.	■ the switching station will have a minimum 33m APZ to east and 20m in all other directions; ■ the BESS will have a 23m APZ to the west and 20m in all other directions; ■ O&M Option 1 will require a minimum 20m wide APZ in all directions; and ■ Compound/O&M option 2 will have minimum 21m wide APZ to the south and 20m in all other directions. ■ The risk can be reduced to the remaining infrastructure by: ■ a minimum 10 m APZ is to be established around each wind monitoring masts; ■ each WTG will be mounted on a concrete foundation (approximately 25 m in diameter) located on a cleared hardstand area; ■ the proposed 330 kV transmission line will use concrete or galvanised steel poles; ■ the maintenance of the transmission line easement including reduced fuel loads beneath transmission lines will be the responsibility of the asset owner;

Risk Factor	Description of Risk	Analysis of the Risk *	Potential to Mitigate/Reduce Impact
			■ construction and maintenance staff should be trained in the basic first response firefighting techniques; ■ provide and maintain firefighting equipment capable of controlling and suppressing small initial outbreaks of fire; ■ ensure adequate access to water for NSW RFS and firefighting crews and provide static water supplies and ■ provide all weather access for heavy fire fighting vehicles.
Damage to surrounding properties	Extensive and widespread loss of infrastructure and or property	Wind farm projects generally require upgrades to existing road infrastructure, increasing the accessibility of farms to emergency vehicles should a bushfire break out in the vicinity of the wind farm. As outlined by AFAC (2018) and considered during project design, appropriately planned access roads can increase the ability of fire and land management agencies to successfully undertake firefighting operations by allowing increased accessibility for emergency vehicles. Access roads and other infrastructure can also reduce the likelihood of fire moving through or leaving the property and can act as an effective firebreak in many circumstances. Site access points will be constructed as the first stage of development and the final design of access roads will enable safe access and egress for residents attempting to leave the area at the same time that emergency service personnel are arriving to undertake firefighting operations. Site access points will be maintained for the life of the project and include appropriate signs throughout the wind farm to assist emergency response crews determine track names, location and turbines etc.	■ construction and maintenance staff should be trained in the basic first response fire-fighting techniques; ■ provide and maintain fire-fighting equipment capable of controlling and suppressing small initial outbreaks of fire. As a minimum, these will be located on the outside of the switching station, substation, BESS and O&M buildings; ■ ensure adequate access to water for NSW RFS and fire-fighting crews and provide static water supplies; and ■ provide all weather access for heavy fire fighting vehicles.

Risk Factor	Description of Risk	Analysis of the Risk *	Potential to Mitigate/Reduce Impact
		In the unlikely event that a fire did spread from the wind farm to surrounding properties, the turbines would not limit aerial firefighting capabilities on other properties in the surrounding area.	
	Localised damage to infrastructure and or property	The risk that the wind farm itself will cause a fire is minimal (AFAC 2018). The proposed upgrade of the internal road network would increase the level of access available to fire fighters along the entire length of this ridgeline (which forms a strategic fire containment line) and would assist to reduce the likelihood of a widespread fire. Localised damage is unlikely to require external assistance to recover in the short-term. In the unlikely event that a fire did spread from the wind farm to surrounding properties, the turbines would not limit aerial firefighting capabilities on other properties in the surrounding area.	■ Provide and maintain firefighting equipment capable of controlling and suppressing small initial outbreaks of fire.
Damage to ecological values/assets	Threatened species and ecological communities	The risk that wind farm itself will cause a fire is minimal (AFAC 2018). The proposed upgrade of the internal road network would increase the level of access available to fire fighters along the entire length of this ridgeline (which forms a strategic fire containment line) and would assist to reduce the likelihood of a widespread fire. The wind farm is also unlikely to increase the frequency of fires across the landscape and so will not increase the fire related impacts to threatened species and ecological values.	■ Provide and maintain firefighting equipment capable of controlling and suppressing small initial outbreaks of fire. ■ Ensure that operators are aware of location of threatened flora records to assist in managing fire in these areas.

** Despite the mitigation measures and treatments that are put in place, it is noted that some bushfire risk will always remain and that some of the infrastructure may be subject to direct flame contact. The absence of any identified hazard or asset on the Project site should not be interpreted as a guarantee that such hazards or impacts do not exist.*

6. MITIGATION STRATEGIES

Consideration is given to whether the proposed wind farm will result in people congregating in large numbers. The operation of the proposed wind farm is considered to be a low intensity use in terms of the number of people on site at any one time, with only 31 full time staff onsite during the operational phase. However, there could be up to 174 people onsite during construction phase over a period of up to 24 months. Although the construction period does not pertain to the expected end use of the Project Area, the number of people who could be within the Project Area at one time does warrant consideration in terms of providing adequate defendable space and access/egress as the first stage of construction (prior to the installation of any wind turbine or related infrastructure). The proposed road upgrades including the transverse track and logging track will support more options to evacuate within the local area. An alternate emergency access point to the Project Area is also considered via Head of Peel Road. This access point will remain accessible for use in the event of emergency only and will not be used by Project related traffic.

Mitigation strategies are guided by the following factors that contribute to bushfire risk:

- fuels, weather, topography and predicted fire behaviour including the calculated flame length;
- suppression resources (air and ground), access (roads, tracks) and water supply; and
- values and assets.

Mitigation will be a combination of complementary strategies, all of which are required to provide the best possible protection outcome for the wind farm and the community.

6.1 Asset Protection Zone

An Asset Protection Zone (APZ) is typically designed to separate a vulnerable asset from the bushfire hazard (vegetation/fuel). APZs do not eliminate the fire risk, but may lower it to an extent where fire control is more feasible or damage to the asset is reduced or eliminated.

Understanding the value and limitations of APZ is important, as is the understanding that bushfires attack built assets by either flame contact, radiant heat or burning debris. An APZ can be used to lower or eliminate the bushfire attack from flame contact and radiant heat around the perimeter of the wind farm and all built assets, but under strong winds or during a major fire event burning debris can result in a fire breaching an APZ and flame length could exceed 100 m in the event of a severe fire event running up the steep slopes and valleys surrounding the development. Radiant heat levels impacting these assets could be up to 100 kW/m^2.

Despite the limitations of any APZ:

- a minimum 10 m APZ is to be established around each monitoring masts (PBP, 2019). A 10 m wide APZ is also consistent with the requirements of the Victorian CFA renewable energy guidelines (CFA 2018);
- each WTG will be mounted on a concrete foundation (approximately 25 m in diameter) located on a cleared hardstand area; and
- to account for the steep slopes, an increased APZ of 20 m will be established on all sides of the substation, switching station, BESS and O&M Buildings. This will be increased where required to ensure that these key assets are located outside of the flame zone. As these assets would be the focus of any firefighting activities, it is important that they are surrounded by adequate defendable space.

The specifications recommended for the APZ are as follows:

- APZ will not extend beyond the property boundary or rely on actions being undertaken by adjacent landowners. This includes the neighbouring National Parks estates;
- mineral earth fire break i.e. dirt or gravel;
- no trees and shrubs planted within the APZ; and
- where possible, increase the distance between the trees and the APZ.

There will be no expectation of additional hazard reduction or other works on neighbouring lands including National Parks and Nature Reserves.

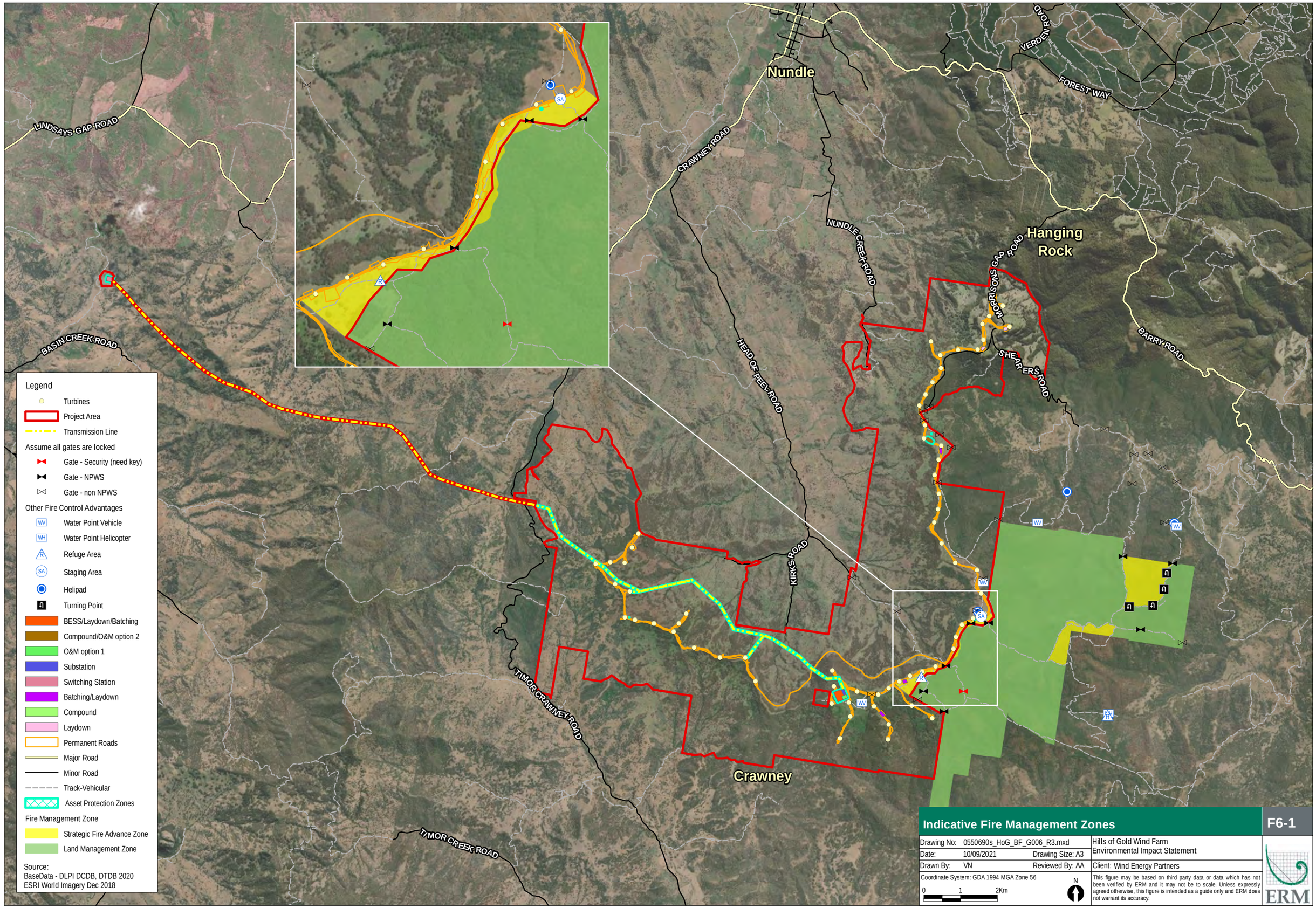
6.2 Strategic Fire Advantage Zones

While the objective of APZs is the protection of human life and property, the Strategic Fire Advantage Zones (SFAZ) have been identified to reduce fire intensity and spread across the landscape.

As evidenced during the recent fires, the existing track along the ridgeline is used as a strategic containment line and allows the response agencies to back burn ahead of the fire. Specifically the National Parks' land located to the east of WTG40 to WTG44 is mapped within the Ben Halls Gap National Park Fire Management Strategy as a Land Management Zone, with Strategic Fire Advantage Zones mapped approximately 2-4 km east of the WTG (refer to Appendix D).

This SFAZ has been extended along the eastern side of the access road to provide a large, more accessible area to back burn down the slope in the event of a major fire within the adjacent National Park. This area will be maintained with an overall reduce fuel load. This may also present an opportunity (in co-ordination with the NSW RFS and NSW NPWS) to explore additional options and integrate Indigenous land and fire management practices.

The location of all fire control advantages within the Project Area (water points, helipad, staging area and refuge area) currently mapped on the Ben Halls Gap National Park Fire Management Strategy (refer to Figure 6.1 and Appendix D) will also be reviewed and updated in consultation with the NSW RFS and NSW NPWS as part of the recommended Bushfire Emergency Management and Operations Plan. Again, there will be no expectation of additional hazard reduction or other works on neighbouring lands including National Parks and Nature Reserves.



Indicative Fire Management Zones

F6-1

Drawing No:	0550690s_HoG_BF_G006_R3.mxd		Hills of Gold Wind Farm Environmental Impact Statement
Date:	10/09/2021	Drawing Size: A3	
Drawn By:	VN	Reviewed By: AA	Client: Wind Energy Partners

Coordinate System: GDA 1994 MGA Zone 56

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6.3 Wind Farm Construction

As considered in Section 3.3, human induced climate change is influencing the frequency and severity of dangerous bushfire conditions in Australia including an earlier start to the bushfire season with dangerous weather conditions occurring significantly earlier in spring than they used to. With this is mind, the following measures are recommended to be implement during the entire period of construction:

- the APZ and access road will be constructed prior to the installation of any wind turbine or related infrastructure;
- ensure appropriate bunding in areas where there is potential for flammable fuels and oils to leak and create bushfires or other environmental risks;
- install appropriate signs to assist emergency response crews determine track names, location and turbines etc;
- ensure that appropriate permits have been issued for work during the Fire Danger Period, and that any conditions on permits are adhered to;
- adhere to restrictions on Total Fire Ban or days of high fire danger;
- suitable firefighting equipment (specific requirements to be confirmed in consultation with NSW RFS) is present onsite;
- carry fire extinguishers or firefighting equipment in vehicles;
- carry emergency communications equipment;
- where practicable, site vehicles during the construction phase will have diesel engines and/or will use the site access roads (if available) to minimise the likelihood of igniting dry grass;
- restrict smoking to prescribed areas, and provide suitable ash and butt disposal facilities;
- all plant, vehicles and earth moving machinery are cleaned of any accumulated flammable material (e.g. vegetation); and
- on days when Very High fire danger or worse is forecast, the “fires near me’ app is to be checked hourly for the occurrence of any fires likely to threaten the site.

6.4 Wind Farm Operation

Fuel Reduction

It is recommended that vegetation fuels throughout the wind farm are maintained in a minimal condition by grazing, or with additional slashing or mowing if required. This will minimise the radiant heat exposure to wind farm components and reduce the risk of a fire spreading beyond the wind farm. If grazing or slashing is not possible under the WTG other lower risk ground cover should be considered e.g. gravel or a non-curing ground cover and/or a very low above ground biomass.

Days of Very High or Worse Fire Danger

Fire Danger Ratings give you an indication of the consequences of a fire, if one was to start. The higher the fire danger, the more dangerous the conditions. These forecasts are updated daily during the fire danger season and are available on the NSW RFS website (http://www.rfs.nsw.gov.au/fire-information/fdr-and-tobans) and the BOM website (http://www.bom.gov.au/nsw/forecasts/fire-danger-ratings.shtml).

To reduce the risk of fires damaging or destroying life, property and the environment the NSW RFS Commissioner may also declare a Total Fire Ban (TOBAN). In a Total Fire Ban no fire may be lit in the open and all fire permits are suspended. No general purpose welding, grinding, soldering or gas cutting can be done in the open.

Emergency Management and Operations Plan

Given the possible toxicity of smoke from burning wind farm infrastructure, firefighters, farm workers and neighbours should avoid working downwind of any fire burning within the wind farm.

An Emergency Management and Operations Plan should be prepared for the wind farm that provides the following:

- a detail site plan identifying, using GPS coordinates, each turbine tower location;
- wind turbines are shut down immediately during emergency operations – where possible, blades should be stopped in the 'Y' or 'rabbit ear' position, as this positioning allows for the maximum airspace for aircraft to manoeuvre underneath the blades and removes one of the blades as a potential obstacle;
- protocols should be explicit about what party has the authority to direct turbine shut-down procedures;
- control and coordination arrangements for emergency response (eg evacuation procedures, emergency assembly areas and procedures for response to hazards);
- location of all fire control advantages within the Project Area (access road, gates, water points, helipad, staging area and refuge area);
- agreed roles and responsibilities of onsite personnel (eg equipment isolation, liaison, evacuation management);
- up-to-date contact details of site personnel and any relevant offsite personnel who could provide technical support during an emergency;
- a manifest (and safety data sheets) for any battery, diesel or other dangerous goods storage/handling, including the class identification, quantity, type (bulk or packaged) and location. Appropriate material (including absorbent, neutralisers, equipment and personal protective equipment) for the clean-up of spills is to be provided and available onsite;
- clearly states work health safety risks and procedures to be followed by firefighters, including personal protective clothing;
- minimum level of respiratory protection;
- minimum evacuation zone distances;
- activation of water spray/foam systems and any other response/protection measures; and
- any other risk control measures required to be followed by firefighters.

The Emergency Management and Operations Plan will be prepared with consideration of Australian Standard/ISO 31000 Risk management principles and guidelines and Australian Standard 3745: Planning for emergencies in facilities.

Two copies of the Emergency Management and Operations Plan should be permanently stored in a prominent 'Emergency Information Cabinet' to be located at each vehicle entrance point to the wind farm, external to any security fence or locked gate, and a copy provided to local emergency responders. Two copies of the Emergency Management and Operations Plan will also be stored within the operations facilities and one at the NSW RFS Liverpool Range District office.

The Emergency Information Cabinets will be clearly visible, installed at a height of 1.2 m - 1.5 m and accessible by all emergency services.

A schedule for ongoing site familiarisation to account for changing personnel, site infrastructure and hazards should be developed in conjunction with the NSW RFS as well as the NPWS and FCNSW.

6.5 Access Roads and Road Network

Site access points will be constructed as the first stage of development and the final design of access roads will enable safe access and egress for residents attempting to leave the area at the same time that emergency service personnel are arriving to undertake firefighting operations.

Site access points will be maintained for the life of the Project and include appropriate signs throughout the wind farm to assist emergency response crews determine track names, location of turbines and location of any locked gates. A preliminary figure showing gates along Morrison's Gap Road and other key Fire Control Advantages as outlined within the Ben Halls Gap National Park Fire Management Strategy (2005) is provided in Figure 6.1.

All access roads will be upgraded to provide sufficient width and other dimensions to ensure safe unobstructed access and allow firefighting crews to operate equipment around the vehicle. Dead-end roads should be avoided. However, where they are present, they will incorporate a sufficient turn-around area to minimise the need for vehicles to make multipoint turns. As a minimum, and to enable access for RFS all roads will be maintained to the minimum standards as outlined within the NSW RFS Fire Trail Standards and the NSW RFS Fire Trail Design, Construction and Maintenance Manual (refer to Appendix B).

This includes:

- the trafficable surface has a width of four (4) metres except for short constrictions to 3.5 metres for no more than 30 metres in length where an obstruction cannot be reasonably avoided or removed;
- curves have a minimum inner radius of six (6) metres. The minimum distance between inner and outer curves is six (6) metres;
- trail surfaces and crossing structures are capable of carrying vehicles with a gross vehicle mass of 15 tonnes and an axle load of nine (9) tonnes;
- the maximum grade of a trail is not more than 15 degrees. Any localised sections of road with steeper grades will be designed to meet performance criteria in consultation with the NSW RFS and clearly sign posted to ensure that the roads provide for traction and safe working angles within the physical operational capability of the firefighting vehicles;
- the cross fall of the trail surface is not more than six (6) degrees;
- drainage structures, feature crossings, or other significant changes in the grade of the trail are in accordance with the NSW RFS Fire Trail Design, Construction and Maintenance Manual;
- a minimum vertical clearance of four (4) metres is provided above the surface of the trafficable surface clear of obstructions;
- capacity for passing is provided every 250 metres; and
- a turning area is provided at the termination of a trail and every 500 metres.

Where practicable site vehicles during the construction phase will have diesel engines and/or will use the site access roads (if available) to minimise the likelihood of igniting dry grass.

6.6 Water Storage

Water supply should be designed to provide filling points for fire tanker units near the wind farm entrance and at the O&M Compounds. A minimum combined storage of 50,000 litres is recommended for the site, based on refilling an approximate of six tanker units (4,000 litres) twice each. Noting that the final requirement will be confirmed by NSW RFS prior to the commencement of construction.

The large dam on Nycooma (31° 37.781'S 151° 8.476'E) was used as a water supply for both vehicles and aircraft during the 2019/2020 bushfire season. As the wind farm development aims to increase the accessibility of the ridgeline to fire fighters and improve strategic fire advantages that already exist, access to water will be maintained such that existing water resources will remain available at all times to support firefighting activities. The requirement for any additional open water supplies (i.e large dams) to be provided along the ridgeline will be confirmed in consultation with NSW RFS. A preliminary figure showing Fire Control Advantages as outlined within the Ben Halls Gap National Park Fire Management Strategy (2005) is provided in Figure 6.1 as a basis for ongoing discussions.

It is important that the locations of these additional water supply points (if required) are carefully considered as they require a catchment area to ensure they remain full during the summer months yet they also need to be near the top of the hill rather than in a valley because it takes a lot of power to lift. Extremely hot conditions also exacerbate the lifting difficulty for aircraft. Helicopters also require an obstacle-free area on approach and departure from a water point. This varies with wind direction and has been considered in the aviation report.

6.7 Total Fire Bans

It is important to be aware of operations that may be carried out on days of total Fire Ban and any prohibited activities or exemptions that are notified by the Commissioner of the NSW RFS under section 99 of the Rural Fires Act 1997.

Under Section 63 of the Rural Fires Act 1997 it is the responsibility of the landowner to limit the ignition and prevent the spread of fires from the property. On days declared Total Fire Ban you cannot light, maintain or use a fire in the open, or carry out any activity in the open that has the potential for a fire to develop. General purpose hot works (such as welding, grinding or gas cutting or any activity that produces a spark or flame) are not to be done in the open.

The NSW RFS strongly recommends the landowner reconsider activities such as using a tractor or slashing, to help reduce the chance of a fire.

Fire permits are also suspended on days of total fire ban. Permits may resume after the Total Fire Ban is lifted, as long as the permit hasn't expired. The NSW RFS Commissioner is responsible for exemptions to Total Fire Bans. These exemptions are detailed in the NSW Government Gazette each time a Total Fire Ban is declared under the Rural Fires Act 1997 Section 99.

6.8 Summary of Recommended Mitigation Strategies

Table 6.1 summarises the bushfire mitigation strategies and recommendations made in this document.

Table 6.1 Summary of Recommended Mitigation Strategies

Mitigation Strategy	Action	Timing
Asset Protection Zone (APZ)	Despite the limitations of any APZ: ■ a minimum 10 m APZ is to be established around each wind monitoring masts; ■ each WTG will be mounted on a concrete foundation (approximately 25 m in diameter) located on a cleared hardstand area; and ■ an increased APZ of 20 m should be established around the O&M buildings, BESS, substation and switching station. This will be increased as required to ensure that these assets are located outside of the flame zone. The specifications recommended for the APZ are as follows: ■ APZ will not extend beyond the property boundary or rely on actions being undertaken by adjacent landowners. This includes the neighbouring National Parks' estates; ■ mineral earth fire break i.e. dirt or gravel; ■ no trees and shrubs planted within the APZ; and ■ where possible, increase the distance between the trees and the APZ.	The APZ and perimeter road will be constructed as the first stage of development, and maintained for the life of the Project.
Strategic Fire Advantage Zone (SFAZ)	An existing SFAZ has already been established within the adjacent National Park as currently mapped on the Ben Halls Gap National Park Fire Management Strategy (dated 2005). This will be extended along the eastern side of the access road to provide a larger, more accessible area to back burn down the slope in the event of a major fire within the adjacent National Park. This area will be maintained (within the bounds of the Project Area only) with an overall reduce fuel load. This may also present an opportunity (in co-ordination with the NSW RFS and NSW NPWS) to explore additional options and integrate Indigenous land and fire management practices.	Maintained for the life of the Project.
Flame zone	■ The O&M buildings, BESS, substation and switching station will be located outside of the flame zone. ■ Where possible, other infrastructure such as a batching plant should be avoided within the Laydown Area 4.	During design phase of the Project.
Monitoring masts	■ Monitoring masts are to be recorded in the Tall Structures Database maintained by Air Services Australia (Civil Aviation Safety Authority 2018). ■ Install visible markers (such as orange balls) on all masts to minimise risks during aerial firefighting operations. Aviation Projects (2020) has confirmed that the Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft.	Prior to construction. Maintained for the life of the Project.

Mitigation Strategy	Action	Timing
Wind farm construction	The following measures are recommended to be implement during the entire period of construction: ■ Any additional water supplies required (i.e on Nycooma) must be installed and accessible prior to commencing construction; ■ the APZ and perimeter road will be constructed in advance of each development stage; ■ appropriate bunding will be put in place in areas where there is potential for flammable fuels and oils to leak and create bushfires or other environmental risks; ■ appropriate signs will be installed to assist emergency response crews determine track names, location and turbines etc; ■ any necessary permits will be obtained for work during first danger periods; ■ adhere to restrictions on Total Fire Bans or days of high fire danger will be taken into account in operations; ■ suitable firefighting equipment (specific requirements to be confirmed in consultation with NSW RFS) will be present onsite; ■ fire extinguishers or firefighting equipment will be carried in vehicles where practicable; ■ emergency communications equipment will be carried where practicable; ■ where practicable, all site vehicles during the construction phase will have diesel engines and will use the site access roads to minimise the likelihood of igniting dry grass; ■ smoking will be restricted to prescribed areas, and suitable ash and butt disposal facilities will be provided; ■ all plant, vehicles and earth moving machinery will be cleaned of any accumulated flammable material (e.g. vegetation); and ■ on days when Very High fire danger or worse is forecast, relevant fire information will be checked regularly for the occurrence of any fires likely to threaten the site.	During Construction.
Access roads and road network	Site access points will be constructed as the first stage of development and the final design of access roads will enable safe access and egress for residents attempting to leave the area at the same time that emergency service personnel are arriving to undertake firefighting operations. Site access points will be maintained for the life of the Project and include appropriate signs throughout the wind farm to assist emergency response crews determine track names, location of turbines and location of any locked gates. Roads shall provide sufficient width and other dimensions to ensure safe unobstructed access and allow firefighting crews to operate equipment around the vehicle. Dead-end roads should be avoided. However, where they are present, they will incorporate a sufficient turn-around area to minimise the need for vehicles to make multipoint turns. As a minimum, and to enable access for NSW RFS all roads will be maintained to the following minimum standards outlined within the NSW RFS Fire Trail Standards and the NSW RFS Fire Trail Design, Construction and Maintenance Manual (refer to Appendix B).	During construction and operation.

Mitigation Strategy	Action	Timing
	Where practicable, all site vehicles during the construction phase will have diesel engines and/or will use the site access roads (where available) to minimise the likelihood of igniting dry grass. In the unlikely event that a fire did spread from the wind farm to surrounding properties, the turbines would not limit aerial fire-fighting capabilities on other properties in the surrounding area.	
During operation	■ The Project will be controlled by a remote supervisory control and data acquisition (SCADA) from a control room located within the permanent site operations and maintenance facility. The SCADA system will allow remote operation of all WTGs with the ability to shut-down individual or all WTGs if required. ■ NSW RFS will be provided with maps and GPS coordinates of the final wind turbine layout and identification information for individual wind turbine sites for their internal response planning. ■ Liaise with the Civil Aviation Safety Authority (CASA) and the RAAF Aeronautical Information Service will be consulted. ■ Safe working and emergency response procedures for all work tasks will be developed and implemented. ■ Maintenance staff will be trained in the basic first response firefighting techniques. ■ Firefighting equipment will be provided and maintained capable of controlling and suppressing small initial outbreaks of fire. As a minimum, these will be located on the outside of the switching station, substation, BESS and O&M buildings.	During operation.
Firefighter safety	Emergency Response Plan prepared and stored at 'Emergency Information Cabinet' at main entrance to the windfarm and provided to local emergency responders. The ERP will include: ■ a detail site plan identifying, using GPS coordinates, each turbine tower location; ■ a safe method of shutting down and isolating the WTG if required (noting that the turbines automatically shut down if they are close to functioning outside their design conditions); ■ control and coordination arrangements for emergency response (eg evacuation procedures, emergency assembly areas and procedures for response to hazards); ■ agreed roles and responsibilities of onsite personnel (eg equipment isolation, liaison, evacuation management); ■ up-to-date contact details of site personnel and any relevant off-site personnel who could provide technical support during an emergency; ■ a manifest (and safety data sheets) for any battery, diesel or other dangerous goods storage/handling, including the class identification, quantity, type (bulk or packaged) and location. Appropriate material (including absorbent, neutralisers, equipment and personal protective equipment) for the clean-up of spills is to be provided and available onsite;	ERP to be developed and approved by both NSW RFS and NSW Fire and Rescue prior to construction.

Mitigation Strategy	Action	Timing
	■ clearly states work health safety risks and procedures to be followed by firefighters, including personal protective clothing; ■ minimum level of respiratory protection; ■ minimum evacuation zone distances; ■ activation of water spray/foam systems and any other response/protection measures; and ■ any other risk control measures required to be followed by firefighters. A schedule for ongoing site familiarisation to account for changing personnel, site infrastructure and hazards should be developed in conjunction with the local RFS.	
Transmission lines	Parts of the transmission line have been mapped within the flame zone. For the safe operation of the transmission line, certain activities will be restricted within the easement such as planting and growing trees, construction of buildings, or erection of antennae or masts. While it has not be confirmed how the easement will be formally registered, for the purposes of this bushfire risk assessment, key responsibilities and management measures will been applied in accordance with the TransGrid Bushfire Risk Management Plan and ISSC3 Guide for the Management of Vegetation in the Vicinity of Electricity Assets which requires assets to be maintained to minimise the risk of fire ignition and to ensure that vegetation clearance are maintained. Visible markers (such as orange balls) will be installed on transmission lines where they span long distances between valleys to minimise risks during aerial firefighting operations. Aviation Projects (2020) has confirmed that the Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft. If obstacle lights are required to be installed, a lighting plan would be developed according to the relevant requirements published in Manual of Standards Part 139—Aerodromes.	Maintained for life of the Project.
Water storage	Water supply should be designed to provide filling points for fire tanker units near the windfarm entrance. A storage of 50,000 litres is recommended, based on refilling six tanker units (4,000 litres) twice each although the required capacity will be confirmed in consultation with RFS. As the wind farm development aims to increase the accessibility of the ridgeline to fire fighters and improve strategic fire advantages that already exist, it is recommended that additional open water supplies (ie large dams) are also provided along the ridgeline to aid in the control of any fire within local area. If water access is to be limited due to impacts of construction on the existing Nycooma Dam currently used as a source of firefighting water, a viable alternate source of local water should be made available to RFS for emergency firefighting. If required, this must be installed and accessible prior to commencing construction.	Considered during Project design. Maintained for life of the Project.

7. CONCLUSION

The risk that the wind farm itself will cause a fire is minimal (AFAC 2018) although it is recognised that the proposed development is located within a bushfire prone landscape, and that despite the mitigation measures and treatments that are put in place, bushfire risk will always remain. It is also recognised that some of the proposed wind farm infrastructure, including WTG, the transmission line and the main access road will be located within the flame zone. It is therefore important that a Bushfire Emergency Management and Operations Plan is prepared in conjunction with relevant stakeholders, including NSW RFS, NSW Fire and Rescue, NPWS, FCNSW, adjoining property owners and employees.

It is also important to note that the access road is already located within the flame zone and the proposed windfarm assets will not increase this existing hazard. The improved access and additional water sources will be an advantage to both the local RFS and the NPWS for back burning down the slopes in advance of the fire front as was undertaken in 2019 and successfully stopped the Pages Creek Road Fire along this ridgeline.

In the event that a fire does breach any containment lines and threatens the windfarm assets, it is possible that the windfarm infrastructure will sustain direct flame contact and that firefighting will require aerial support. Aerial support was used during the 2109/2020 fires and would not be the result of the windfarm itself although it is recognised that the windfarm would result in additional assets that would need to be protected. Consultation with NSW RFS has confirmed that as the WTG towers are made from non-combustible material and do not present a significance risk, efforts would be concentrated on defending those assets that could contribute to widespread fire. It is therefore important that key assets such as the switching station, substation, BESS and O&M buildings are all located outside of the flame zone and have adequate defendable space all sides.

The detailed mitigation measures outlined in the bushfire risk assessment have been developed in consultation with key stakeholders including NSW RFS and NPWS to ensure that the windfarm development does not present any increased risk of widespread fire across the landscape. These mitigation measures will be applied for the life of the project.

It is also important to note that there are residential dwellings on rural properties scattered throughout the landscape that may be at risk from fire and the steep, rugged topography within the adjacent National Parks Estate is considered to present an additional existing hazard that will also be considered in the Bushfire Emergency Management and Operations Plan.

Important Note:

Despite the mitigation measures and treatments that are put in place, it is noted that some bushfire risk will always remain and that some of the infrastructure may be subject to direct flame contact. The absence of any identified hazard or asset on the Project site should not be interpreted as a guarantee that such hazards or impacts do not exist. It is also important that a Bushfire Emergency Management and Operations Plan is prepared prior to the commencement of any construction works in conjunction with relevant stakeholders, including local fire services, NSW RFS, NSW Fire and Rescue, NPWS, FCNSW, adjoining property owners and employees.

Important Disclaimer:

Any representation, statement of opinion, or advice expressed or implied in the bushfire assessment will be made in good faith on the basis that ERM employees and / or agents are not liable (whether by reason of negligence, lack of care or any other reason) to any person, company or their agents for any damage or loss whatsoever which has occurred or may occur in relation to that person taking (or not taking) action in respect of any representation, statement or advice provided within the bushfire assessment.

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APPENDIX A KEY STAKEHOLDER REVIEW OF DRAFT REPORT

From: Alan Bawden
To: Joanne Woodhouse
Subject: RE: Hills Of Gold Windfarm
Date: Wednesday, 7 October 2020 1:58:49 PM
Attachments: image002.png
image003.png

Thanks for the follow up Joanne

The points below are succinct and reflect the approach to address bush fire risk associated with the development.

Regards

Alan Bawden
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PREPARE.ACT.SURVIVE

From: Joanne Woodhouse <Joanne.Woodhouse@erm.com>
Sent: Saturday, 3 October 2020 9:18 PM
To: Alan Bawden <Alan.Bawden@rfs.nsw.gov.au>
Cc: Amanda Antcliff <Amanda.Antcliff@erm.com>
Subject: FW: Hills Of Gold Windfarm

Hi Alan

Thank you for returning my call on Wednesday. Our discussion was extremely helpful in understanding your position in regards to the results of our flame length calculations.

I just wanted to send a quick email to confirm the main points of our discussion as follows:

- The Tamworth Regional Council Bushfire Prone Land mapping identifies the Project Area as bushfire prone land and compliance with Planning for Bushfire Protection (PBP) 2019 and Standards for Asset Protection have been considered.
- The Project Area is located along the upper ridgeline. These ridgelines and plateaus are flanked by very steep rugged terrain, and a mixture of cleared farmland and dry sclerophyll forests within the adjacent National Parks. This is noted to be an existing hazard and is not directly influenced by the proposed wind farm development.
- The NPWS and NSW RFS used the ridgeline as a containment line and were able to back burn in advance of the fire front last season. This action successfully stopped the Pages Creek Road Fire and reinforces that this ridgeline is strategically important in terms of ongoing bushfire mitigation and co-ordinated access arrangements. The Project will aim to upgrade the existing access as well as provide additional water supply points along the ridgeline. This will continue to be managed as a SFAZ.

- The risk that wind farm itself will cause a fire is minimal.
- While the Planning for Bushfire Protection (PBP) Guidelines (NSW RFS 2019) specifies an asset protection zone of 10 m for windfarm assets, given the steep slopes and existing fire history within the adjacent National Parks estates, flame length modelling has also been undertaken (as per Method 2 calculations within Appendix B of AS3959) and as requested in the RFS agency comments attached to the SEARs.
- This assessment identifies that a number of the turbines as well as part of the access road and transmission line have the potential for direct flame contact. Based on our discussions, the turbines are not considered a key risk in terms of either ignition or spreading fire across the landscape. We therefore need to identify those turbines at risk of direct flame contact and then provide mitigation measures including non-combustible steel construction, remote operation of all WTGs with the ability to shut-down individual or all WTGs if required and an area of defendable space around the base of each turbine.
- Based on our discussions yesterday, as the turbines do not present a significant risk, firefighting efforts would be concentrated on defending those assets that could contribute to widespread fire. Key assets that have the potential to influence the spread of fire such as the switching station, substation, BESS and O&M buildings are to be located outside of the flame zone.
- In the event that a fire does breach any containment lines and threatens the windfarm assets, it is possible that the windfarm infrastructure will sustain direct flame contact and that fire fighting will require aerial support. Again you were able to confirm that firefighting efforts would be concentrated on defending those assets that could contribute to widespread fire and the provision of a defendable space around the switching station, substation, BESS and O&M buildings must be provided.
- Preparation of the Bushfire Emergency Management and Operations Plan will also be a key recommendation.

Thankyou again for your time and I look forward to receiving any additional comment or advice as the assessment progresses.

Regards,

Joanne Woodhouse
Principal Consultant

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APPENDIX B NSW RFS FIRE TRAIL STANDARDS

NSW GOVERNMENT

NSW RURAL FIRE SERVICE

NSW RFS
FIRE TRAIL STANDARDS

Contents

STATEMENT

NSW RFS FIRE TRAIL STANDARD 2016 V1.0, PRINTED 2016, 2018
NSW RFS FIRE TRAIL STANDARD 2016, V1.1, PRINTED JUNE 2019.
INCLUDES CORRECTION TO LAT/LONG FORMAT FROM 'DDM' TO 'DD' FORMAT.

1. Introduction

1.1 Background

Bush fires have been a natural part of the landscape for many thousands of years. As communities have developed and properties and towns have been established, the risk of bush fires impacting on communities has increased. Throughout NSW there are approximately 1.3 million properties on bush fire prone land.

Firefighters rely on public roads, trails and other tracks on public and private land to access the landscape to prevent and contain bush fires. Fire trails exist for the purpose of providing access to respond to bush fires, and it is critical to identify and maintain an effective network of accessible trails.

Historically, decisions regarding the establishment and maintenance of fire trails have rested with land managers guided by a cooperative framework established by the NSW Bush Fire Coordinating Committee (BFCC). A need for a different approach was identified to achieve a more consistent and strategic outcome across both public and private lands.

The NSW Government is establishing a more integrated and strategic network of fire trails and access arrangements to improve accessibility for firefighters during bush fires and hazard reduction burns.

Amendments to the *Rural Fires Act 1997*, through the *Rural Fires Amendment (Fire Trails) Act 2016,* provide a legislative basis for the establishment and maintenance of the enhanced network of fire trails.

The *Rural Fires Amendment (Fire Trails) Act 2016* provides for the NSW RFS Commissioner to make *Fire Trail Standards* that (without limitation) may set out:

- classification, length, width, gradient, signage, construction standards and maintenance of fire trails, and
- the structure and form of Fire Access and Fire Trail (FAFT) plans and Treatment Registers prepared by local Bush Fire Management Committees (BFMC).

1.2 Purpose

This document constitutes the *Fire Trail Standards* made by the NSW RFS Commissioner pursuant to section 62K of the *Rural Fires Act 1997*.

These Standards establish the requirements to achieve an integrated and strategic fire access and fire trail network. The Standards set out design and construction requirements for identified fire trails in NSW, and prescribe the structure of the FAFT plan and associated Treatment Registers to be prepared by BFMCs.

The Standards are to be used by organisations across NSW responsible for undertaking fire access and fire trail planning, and land managers responsible for the design, construction and maintenance of fire trails.

A suite of documents developed by the NSW RFS Commissioner and the NSW BFCC provide supplementary guidance and direction to land managers to assist in the design, construction and maintenance of fire trails on their land, and BFMCs involved in fire trail planning and the preparation of FAFT plans. These include:

- FAFT workshop presentation
- FAFT Plan Instructions
- Maps
- List of current fire trails
- Treatment Register (populated with BFMC fire trails)
- Trail ranking and prioritisation tool.

1.3. Aim

The aim of the Standards is to facilitate the planning and implementation of an integrated and strategic network of fire trails.

1.4 Objectives

The objectives of the Standards are:

- To provide a process to identify an integrated and strategic network of fire trails for the protection of the community and its assets, including environmental and social values;
- To establish a network of strategic fire trails which meet minimum standards and allow standard off- road capable firefighting vehicles to safely and effectively traverse the landscape;
- To ensure fire trails enable a vehicle to be driven safely along the trail without damage to the vehicle due to overhanging vegetation, built structures, rough trail surface or other physical impediments;
- To ensure fire trails are of an expected standard that is known and understood by firefighters, can be readily identified including in limited visibility conditions, and are available when required; and,
- To provide a sustainable fire trail network that meets operational requirements, minimises adverse impacts on the environment, and delivers value for money.

1.5 Assumptions

The Standards have been prepared on the basis of the following assumptions:

- The fire trail network will be used by suitably trained and competent firefighters capable of operating in the expected physical environment.
- Firefighting vehicles will meet NSW RFS standard specifications and be driven by licensed and competent drivers in accordance with local procedures.

1.6 Limitations

The Standards have been prepared with regard to the following limitations:

- Fire trails provided for in the Standards are for the purposes of bush fire suppression and other fire management purposes. While it is recognised that fire trails may also be used for other purposes (including other land management and commercial purposes, forming a part of fire breaks, fire containment lines and the like), such uses do not fall within the scope of these Standards.
- While fire trails will be built to a consistent acceptable standard in consideration of operational needs, the safety of firefighters cannot be guaranteed given variability in topography, weather and fire conditions.
- The design and construction standards specified in the Standards cater for standard off-road capable firefighting vehicles currently used in NSW.
- The implementation of a new standard is often challenging and subject to available funding and priorities. The NSW RFS Commissioner and the BFCC acknowledge that a cooperative and incremental approach in implementing this Standard will be required over several years, and the effectiveness of the Standard will be continually monitored to ensure it meets the intent of the legislation.

1.7 Definitions

Expressions defined in 62J of the *Rural Fires Act 1997* apply to the Standards. Definitions are per the NSW RFS Dictionary and apply to the Standards except where otherwise defined in section 62J of the Act. Key terms relevant to the Standards are included below for reference:

Designated fire trail	A fire trail identified by the NSW RFS Commissioner that must be upgraded or established to meet the Standards.
Certified fire trail	A fire trail that has been certified as compliant with the *Fire Trail Standards*.
Registered fire trail	A fire trail, regardless of tenure, that has been certified to meet these Standards and is placed on the Public Register.
Strategic fire trail	A fire trail on any tenure identified by a BFMC during the FAFT planning process, or by the NSW RFS Commissioner, to be of significant value in the suppression or management of fire within the landscape. These trails are placed on the Treatment Register approved by the NSW RFS Commissioner and subsequently designated. These may include multi- purpose trails.
Tactical fire trail	A fire trail on any tenure identified by a BFMC during the FAFT planning process, or by the NSW RFS Commissioner, that should remain open to support the prevention and suppression of fire. These may include multi-purpose trails.
Private land	means that is not public land (section 62J).
Public land	means managed land, unoccupied Crown Land, or land owned or occupied by a public authority. A public authority responsible for any particular land is taken to be occupier of the land for this Part (section 62J).

1.8 What is a fire trail for the purpose of these Standards?

There are a range of access ways across the landscape available for use by firefighters. These include public roads, tracks and trails or other roads used for land management, asset management or recreational purposes.

The purpose of these Standards is to define a network of fire trails for vehicular use identified through the processes established by the Act and deemed necessary for the protection of the community and its assets. These vehicular trails will be identified at a local level by the BFMC and recorded in a FAFT plan and the Treatment Register, or by the NSW RFS Commissioner. The NSW RFS Commissioner may provide guidance relating to the factors to be considered in this process.

While the Standards are principally concerned with fire trails designated and registered under provisions of the Act, it is recognised that other fire trails and access ways will continue to exist and serve an important role in bush fire suppression and fire management. These other fire trails will also be informed by the Standards. All fire trails and access ways will be identified as part of the overall fire access network captured in the FAFT planning process.

1.9 Performance-based approach

The Standards adopt a performance-based approach which allows for flexibility and innovation in the design of fire trails having regard to site-specific opportunities and constraints.

The performance criteria must be satisfied for registered fire trails, and should be achieved for other fire trails. Performance criteria are set out for each requirement and the outcome that needs to be achieved. Meeting the performance criteria is essential to maintain the safety and operational performance of firefighting resources. Compliance with the performance criteria can be achieved in one of two ways:

2. **Acceptable solution** – Acceptable solutions have been specified for each performance criteria and are 'deemed to satisfy'. Materials, components, design factors, and construction methods may be included which, if used, will result in compliance with the performance criteria. It is expected that designated and registered fire trails on the whole will fall into this category; or,
3. **Performance solution** – A performance solution may be proposed where constraints mean compliance with the acceptable solution is not practicable, and it is demonstrated that it otherwise achieves the performance criteria.

The process of demonstrating compliance, including where a performance solution is proposed, is outlined in Chapter 3.

1.10 Environmental approvals

Fire trail works are required to be undertaken in accordance with applicable environmental and other regulatory requirements. A range of environment approval mechanisms exist for fire trails, these include:

- Bush Fire Hazard Reduction Certificate issued in accordance with the Bush Fire Environmental Assessment Code;
- Review of Environmental Factors (REF) under Part 5 of the *Environmental Planning and Assessment Act 1979*;
- Assessment in accordance with the Infrastructure State Environmental Planning Policy (ISEPP); or
- Any other relevant environmental approval methods.

The following applies to the Bush Fire Environmental Assessment Code.

The Bush Fire Environmental Assessment Code 2017* (the *"Code"*) provides a streamlined environmental assessment process for mechanical and burning methods for undertaking bush fire hazard reduction work, including fire trails.

For the purposes of clause 3.8 of the Code, the Code applies to the following works, provided the works are to bring the fire trail into closer compliance with an acceptable solution set out in, or performance solution approved in accordance with, the design and construction requirements set out in Chapter 2 and the work is in accordance with the *NSW RFS Fire Trail Design, Construction and Maintenance Manual* issued by the NSW RFS Commissioner:

- a designated fire trail;
- a registered fire trail;
- a fire trail that constitutes part of the fire trail network within a FAFT plan approved for the area;
- a fire trail shown on the BFMC's fire trail layer and categorised as 'essential' or 'important' as at 1 August 2017 where there is no FAFT plan approved for the area; or
- an existing fire trail identified as a treatment in an approved Bush Fire Risk Management Plan where there is no FAFT plan approved for the area.

For the purposes of clause 3.9 of the Code, the Code applies to works for a vehicular control line, where those works are in accordance with an acceptable solution set out in, or performance solution approved in accordance with, the design and construction requirements set out in Chapter 2 and *NSW RFS Fire Trail Design, Construction and Maintenance Manual* issued by the NSW RFS Commissioner.

*Note: Once approved and Gazetted.

2. Fire Trail Standards

2.1 Classification of fire trails

The Standards provide for the classification of fire trails based on the type of firefighting vehicle required to access an area. Three categories are provided:

- **Category 1**: A fire trail that can be safely traversed by a Category 1 firefighting vehicle.
- **Category 7**: A fire trail that can be safely traversed by a Category 7 firefighting vehicle.
- **Category 9**: A fire trail that can be safely traversed by a Category 9 firefighting vehicle.

Specific requirements have been developed for each category of fire trail. The specifications are based on the engineering details contained in Appendix A.

The category of each fire trail will be identified in the FAFT plan as set out in Chapter 4 and as identified by the NSW RFS Commissioner in the designation and registration of the fire trail.

2.2 Design requirements

Intent of requirements: to provide a functional, strategic network of fire trails which permits access for firefighting vehicles used in NSW in order to support fire management and bush firefighting.

2.2.1 Category 1 Fire Trails

The following performance criteria and acceptable solutions are considered industry best practice and apply to Category 1 Fire Trails:

Table 1: Category 1 Fire Trail requirements

REQUIREMENT	PERFORMANCE CRITERIA	ACCEPTABLE SOLUTIONS
Width	The width of the trail provides for safe, reliable and unobstructed passage by a Category 1 firefighting vehicle within acceptable operational limits.	- The trafficable surface has a width of 4 metres except for short constrictions to 3.5 metres for no more than 30 metres in length where an obstruction cannot be reasonably avoided or removed. - Curves have a minimum inner radius of 6 metres. The minimum distance between inner and outer curves is 6 metres.
Capacity	The construction and formation of the trail is trafficable under all weather conditions (other than due to flood, storm surge or snowfall) for a Category 1 firefighting vehicle.	- Trail surfaces and crossing structures are capable of carrying vehicles with a gross vehicle mass of 15 tonnes and an axle load of 9 tonnes.

REQUIREMENT	PERFORMANCE CRITERIA	ACCEPTABLE SOLUTIONS
Grade and crossfall	The vertical profile of the trail provides for traction and safe working angle within the physical operational capability of a Category 1 firefighting vehicle. *Note: This includes design that does not impede the undercarriage of a vehicle.*	› The maximum grade of a trail is not more than 15 degrees. › The crossfall of the trail surface is not more than 6 degrees. › Drainage structures, feature crossings, or other significant changes in the grade of the trail shall be in accordance with the *NSW RFS Fire Trail Design, Construction and Maintenance Manua*l.
Clearance	A cleared corridor is provided around the trail which permits the unobstructed passage of a Category 1 firefighting vehicle and for a working corridor either side of the vehicle to enable firefighters to exit from, and access equipment in, the vehicle.	› A minimum vertical clearance of 4 metres is provided above the surface of the trafficable surface clear of obstructions.
Passing	The trail provides for two Category 1 firefighting vehicles to pass at appropriate intervals so as to avoid unacceptable delays in operations.	› Capacity for passing is provided every 250 metres comprising: › A widened trafficable surface of at least 6 metres for a length of at least 20 metres; or › A 6 metre wide and 8 metre long area clear of the trafficable surface with a minimum inner curve radius of 6 metres and minimum outer radius of 12 metres; or › A turnaround as provided for in this table.
Turnarounds	The trail provides for a turning manoeuvre for a Category 1 firefighting vehicle to return in the direction from which it came at appropriate intervals and at the termination of a trail.	› A turning area is provided at the termination of a trail and every 500 metres and is achieved by: › An area clear of the trafficable surface 6 metres wide and 8 metres deep, with a minimum inner curve radius of 6 metres and outer minimum radius of 12 metres; or › A turning circle of minimum 22 metre diameter. › A T-junction with each terminating end of the junction being at least 10 metres in length from the intersection of the roads and the inner radius of that intersection being at least 6 metres › A fire trail or road intersection.
Drainage	The fire trail is drained effectively to manage rainfall runoff to prevent damage to the trafficable surface.	› Drainage of the trail is designed and constructed in accordance with the *NSW RFS Fire Trail Design, Construction and Maintenance Manual*.

2.2.2 Category 7 Fire Trails

The following performance criteria and acceptable solutions are considered industry best practice and apply to Category 7 Fire Trails:

Table 2: Category 7 Fire Trail requirements

REQUIREMENT	PERFORMANCE CRITERIA	ACCEPTABLE SOLUTIONS
Width	The width of the trail provides for safe, reliable and unobstructed passage by a Category 7 firefighting vehicle within acceptable operational limits.	› The trafficable surface has a width of 3.5 metres except for short constrictions to 3 metres for no more than 30 metres in length where an obstruction cannot be reasonably avoided or removed. › Curves have a minimum inner radius of 5 metres. The minimum distance between inner and outer curves is 5 metres.
Capacity	The construction and formation of the trail is trafficable under all weather conditions (other than due to flood, storm surge or snowfall) for a Category 7 firefighting vehicle.	› Trail surfaces and crossing structures are capable of carrying vehicles with a gross vehicle mass of 8 tonnes and an axle load of 6 tonnes.
Grade and crossfall	The vertical profile of the trail provides for traction and safe working angle within the physical operational capability of a Category 7 firefighting vehicle. ***Note**: This includes design that does not impede the undercarriage of a vehicle.*	› The maximum grade of a trail is not more than 15 degrees. › The crossfall of the carriageway is not more than 6 degrees. › Drainage structures, feature crossings, or other significant changes in the grade of the trail shall be in accordance with the *NSW RFS Fire Trail Design, Construction and Maintenance Manual*.
Clearance	A cleared corridor is provided around the trail which permits the unobstructed passage of a Category 7 firefighting vehicle and for a working corridor either side of the vehicle to enable firefighters to exit from, and access equipment in, the vehicle.	› A minimum vertical clearance of 3.5 metres is provided above the surface of the trafficable surface clear of obstructions.

REQUIREMENT	PERFORMANCE CRITERIA	ACCEPTABLE SOLUTIONS
Passing	The trail provides for two Category 7 firefighting vehicles to pass at appropriate intervals so as to avoid unacceptable delays in operations.	› Capacity for passing bays are provided every 250 metres comprising: › A widened trafficable surface of at least 5.5 metres for a length of at least 15 metres; or, › A 5.5 metre wide and 6 metre long area clear of the trafficable surface with a minimum inner curve radius of 5 metres and minimum outer radius of 10 metres.
Turnarounds	The trail provides for a turning manoeuvre for a Category 7 firefighting vehicle to return in the direction from which it came at appropriate intervals and at the termination of a trail.	› A turning area is provided at the termination of a trail and every 500 metres and is achieved by: › An area clear of the trafficable surface 5.5 metres wide and 6 metres deep, with a minimum inner curve radius of 5 metres and outer minimum radius of 10 metres; or › Turning circle of minimum 17 metre diameter.
Drainage	The fire trail is drained effectively to manage rainfall runoff to prevent damage to the trafficable surface.	› Drainage of the trail is designed and constructed in accordance with the *NSW RFS Fire Trail Design, Construction and Maintenance Manual*.

2.2.3 Category 9 Fire Trails

The following performance criteria and acceptable solutions requirements are considered industry best practice and apply to Category 9 Fire Trails:

Table 3: Category 9 Fire Trail requirements

REQUIREMENT	PERFORMANCE CRITERIA	ACCEPTABLE SOLUTIONS
Width	The width of the trail provides for safe, reliable and unobstructed passage by a Category 9 firefighting vehicle within acceptable operational limits.	› The trafficable surface has a width of 3 metres except for short constrictions to 2.5 metres for no more than 30 metres in length where an obstruction cannot be reasonably avoided or removed. › Curves have a minimum inner radius of 5 metres. The minimum distance between inner and outer curves is 5 metres.
Capacity	The construction and formation of the trail is trafficable under all weather conditions (other than due to flood, storm surge or snowfall) for a Category 9 firefighting vehicle.	› Trail surfaces and crossing structures are capable of carrying vehicles with a gross vehicle mass of 4 tonnes and an axle load of 2 tonnes.
Grade and crossfall	The vertical profile of the trail provides for traction and safe working angle within the physical operational capability of a Category 9 firefighting vehicle. *Note: This includes design that does not impede the undercarriage of a vehicle.*	› The maximum grade of a trail is not more than 15 degrees. › The crossfall of the trail surface is not more than 6 degrees. › Drainage structures, feature crossings, or other significant changes in the grade of the trail shall be in accordance with the *NSW RFS Fire Trail Design, Construction and Maintenance Manual*.
Clearance	A cleared corridor is provided around the trail which permits the unobstructed passage of a Category 9 firefighting vehicle and for a working corridor either side of the vehicle to enable firefighters to exit from, and access equipment in, the vehicle.	› A minimum vertical clearance of 3 metres is provided above the surface of the trafficable surface clear of obstructions.

REQUIREMENT	PERFORMANCE CRITERIA	ACCEPTABLE SOLUTIONS
Passing	The trail provides for two Category 9 firefighting vehicles to pass at appropriate intervals so as to avoid unacceptable delays in operations.	› Capacity for passing bays are provided every 250 metres comprising: › A widened trafficable surface of at least 5 metres for a length of at least 15 metres; or, › A 5.5 metre wide and 6 metre long area clear of the trafficable surface with a minimum inner curve radius of 5 metres and minimum outer radius of 10 metres.
Turnarounds	The trail provides for a turning manoeuvre for a Category 9 firefighting vehicle to return in the direction from which it came at appropriate intervals and at the termination of a trail.	› A turning area is provided at the termination of a trail and every 500 metres and is achieved by: › An area clear of the trafficable surface 5.5 metres wide and 6 metres deep, with a minimum inner curve radius of 5 metres and outer minimum radius of 10 metres; or › Turning circle of minimum 16 metre diameter.
Drainage	The fire trail is drained effectively to manage rainfall runoff to prevent damage to the trafficable surface.	› Drainage of the trail is designed and constructed in accordance with the *NSW RFS Fire Trail Design, Construction and Maintenance Manual*.

2.3 Construction and maintenance requirements

Fire trails shall be constructed and maintained in accordance the *NSW RFS Fire Trail Design, Construction and Maintenance Manual* issued by the NSW RFS Commissioner.

2.4 Access requirements

Access to fire trails shall not be obstructed to ensure that the fire trail is available for use by firefighting services. Where access to a fire trail is controlled through the installation of a gate or other control mechanism, this shall not unreasonably restrict access to firefighters. Access by firefighters and their representatives shall only be undertaken for the purposes of firefighting and associated activities.

Inappropriate / unauthorised access is not permitted without the knowledge of the land manager.

Any gate or control mechanism installed across a trail shall be operable by a single person without assistance or machinery, and provide a clear area for the passing of a vehicle at least the width of the trafficable surface specified in the relevant acceptable solution specified in Table 1, 2 or 3. This area for passing should be provided within 100 metres of the gate.

Where any securing arrangement to a gate or other control mechanism requires the use of the key for access, the land manager must provide firefighters with access such that firefighting efforts are not hampered or delayed, to the satisfaction of the NSW RFS Commissioner.

The NSW RFS Commissioner will work with major government land managers to identify suitable and efficient access control arrangements to facilitate access to the fire trail network across tenures.

It is acknowledged that fire trails may need to be closed periodically for maintenance and repair purposes. Any periods of closure should be minimised as far as reasonably practicable and local response agencies should be made aware of the closure, intended duration of closure and reopening.

2.5 Signage requirements

Standardised signs should be installed and maintained throughout the fire trail network so that fire trails are easily identified when required for firefighting activities and fire management, including in times of limited visibility. Signs will be required for all fire trails on public land, while signs to be installed on private land will be subject to agreement with the relevant private landowner.

The NSW RFS Commissioner will supply and install standard fire trail signs or approved indicative signage where appropriate for all registered fire trails. Signage will be installed in the first instance on trails where no current signage exists. Where existing signage exists that is clear and performs the required function, it will not require replacement until the sign is no longer functional, at which time it will be replaced by NSW RFS with a sign that meets this Standard.

To maintain consistency and ensure accuracy, the NSW RFS Commissioner will gather signage requirement details from each land manager through the BFMC prior to ordering signage.

2.5.1 Standard fire trail signs

A fire trail should be clearly signposted with standard signs at each entry point to the fire trail.

Fire trail signs will be a metal blade, Class 1 reflective yellow with black lettering, and include:

- NSW RFS* Logo
- Fire trail name (including ‘F/T’ as an abbreviation for ‘fire trail’);
- Latitude and longitude reference of the location of the sign in Degrees Decimal Minutes (DD) format, and;
- The vehicle carrying capacity (1, 7 or 9) in red within red circle as displayed in Appendix B.

Lettering is to be 70mm in height, and a blade is to be no longer than 1200mm. Should a fire trail name not fit on a single blade of this length, the following options are to be considered:

1. compress lettering spacing and retain 70mm height
2. reduce lettering size and print on two lines

Where a sign is to be mounted on a centre pole, blade length may be increased to 1800mm. Signs should consider the use of an anti-graffiti coating.

An illustration of a typical standard sign for a registered fire trail is at Appendix B.

In areas where permanent signage is unsuitable such as areas of high theft or vandalism, the NSW RFS Commissioner may consider the use of temporary signage such a v-frame signage, or other design suitable for use during an incident.

**except where the sign is paid and provided by the land manager. In these circumstances, the land manager may use their logo in place of the NSW RFS.*

2.5.2 Indicative fire trail signs

In circumstances where the use of a standard fire trail sign is not considered suitable, such as on or near private property, the NSW RFS Commissioner may issue and install indicative fire trail signs.

These signs will be a metal blade, Class 1 reflective yellow, and include only the trail Vehicle Carrying Capacity (i.e. 1, 7 or 9) as shown in Appendix B. These signs should consider the use of an anti-graffiti coating.

An illustration of a typical indicative sign for a registered fire trail is at Appendix B.

2.5.3 Installation of fire trail signs on non-registered fire trails

Should a BFMC or land manager wish to install fire trail signs on non-registered fire trails, the sign should use the design in Appendix B with the following alterations:

- all lettering is to be black, including the vehicle carrying capacity
- there must be no circle around the vehicle carrying capacity.

2.5.4 No through trails

All trails with only one entry and exit point (dead ends or to hand tool lines only) must be marked as a "No Through Road". These signs to be Class 1 reflective white with black lettering 70mm in height, and are to be a single blade positioned directly under the fire trail sign.

2.5.5 Bridges

Bridges should be marked and identify load rating. These signs to be Class 1 reflective white with black lettering as per RMS standards, and are to be a single sign positioned appropriately in relation to the bridge.

2.5.6 Standard symbology and other advisory signs

In some circumstances there may be a requirement or benefit in displaying additional information on sign posts. This may include a six (6) figure grid reference.

Standard symbology, in accordance with AFAC Standards, for features considered relevant (such as Water Points, Escape Routes and Helipads) by a BFMC may be included on a Class 1 reflective white single blade. The symbology would be consistent with the colour of the standardised AFAC symbol. An example is provided in Appendix B.

Should the fire trail have any known restrictions, a separate blade shall be provided to identify the restriction. These will be a metal blade, Class 1 reflective white with black lettering.

2.5.7 Fire trail name

Fire trails shall be appropriately named in order to minimise confusion. BFMCs and land managers are required to name the fire trail prior to registration. If already known, use accepted names when formally naming a fire trail. Fire trails should not be referred to as 'unnamed', 'no name', or 'unknown'.

Nominated names should be easy to pronounce, write and spell. Avoid duplication or the use of common names in existence elsewhere within the BFMC's local area.

2.5.8 Other signs

Other signs may be required from time to time by the NSW RFS Commissioner. These may include guide posts for culverts, or signage required to indicate the location of turn-around points or helipads.

The NSW RFS will work with the other agencies to determine additional public safety information signage to be provided as part of, or in conjunction with, fire trail signs as required.

3. Assessment and compliance

Assessments will need to be undertaken at a number of points in this process to determine whether a fire trail complies with the design and construction requirements of the Standard. Assessments shall be focussed on whether the trail complies with the design and construction standards set out in Chapter 2. Where an assessment is undertaken for the purposes of submission to the NSW RFS Commissioner, the assessment will be required to be in the form specified by the NSW RFS Commissioner.

3.1 Performance solutions

Where a performance solution is proposed, the onus is on the land manager to demonstrate compliance with relevant provisions of the Standards.

Performance solutions must be assessed according to one or more of the assessment methods:

- Evidence to support that the use of a material, form of construction, or design meets the performance criteria;
- Verification methods such as a test, inspection, calculation or other method that determines whether a performance solution complies with the relevant performance criteria;
- Comparison with the acceptable solutions using expert judgement.

Performance solutions should be developed in consultation with the relevant stakeholders such as the NSW RFS, engineers, private land owners, and the BFMC before being forwarded to the NSW RFS Commissioner for approval.

3.2 Annual assessment

A public land manager shall provide to the NSW RFS Commissioner annually a statement as to the condition of each designated and registered fire trail on its land, and whether or not each of those trails meet the Standards. The statement must be made in the form as specified by the NSW RFS Commissioner.

Where a fire trail is located on private land, assessment arrangements will be determined and set out in the agreement entered into between the NSW RFS Commissioner and the landowner.

The NSW RFS may undertake inspections of fire trails on both public and private land additional to the annual assessment requirement.

An annual assessment of all other fire trails in a FAFT plan should be undertaken by the responsible agency and provided to the BFMC.

4. Planning

4.1 Fire Access and Fire Trail plan requirements

In order to provide a consistent approach to fire trail planning across NSW, the Act requires BFMCs to prepare a draft FAFT plan for their area. This must be prepared in accordance with requirements set out in these Standards and reviewed and approved by the BFCC.

The FAFT plan will supplement existing fire planning activities undertaken at the local level, such as bush fire risk management planning, and identify the appropriate means of accessing land to prevent, fight, manage or contain bush fires. The process will consider a wide range of factors that will review the adequacy of the access system for firefighting to provide access for the protection of life and property in an area.

A FAFT plan shall:

- Be prepared in accordance with instructions and be in a form specified by the NSW RFS Commissioner;
- Include all trails that form the fire trail network as envisaged in the Standards, along with other access ways; and
- Be prepared with a planning horizon of 5 years.

A FAFT plan shall comprise:

- A map showing:
  - A base layer containing all existing vehicular tracks, trails and roads;
  - The identified fire trail network comprising:
    - All strategic fire trails;
    - All tactical fire trails; and
    - Other fire access ways, such as existing roads, tracks and trails that may be of use for fire management, but do not form part of the fire trail network.
- A schedule of the identified fire trails that constitute the fire trail network detailing:
  - Name
  - Identifier
  - Category (strategic or tactical)
  - Status (registered, designated etc.)
  - Vehicle Carrying Capacity (VCC)
  - Proposed fire trails
  - Current fire trail condition
  - Responsible agency; and
  - Other matters as determined by the NSW RFS Commissioner.

4.2 Fire trail treatment register

A treatment register form should be used to set out a schedule of works for the construction and maintenance of fire trails that constitute the fire trail network.

A treatment register shall be prepared and submitted to the NSW RFS Commissioner for approval:

- Concurrently with the submission of a draft FAFT plan; and
- By 31 May each year.

A treatment register shall:

- Be prepared in accordance with the BFMC instructions and be in a format specified by the NSW RFS Commissioner; and
- Detail planned fire trail works for the nominal five year planning horizon of the FAFT plan to improve the network over time.

5. Document review

The *Fire Trail Standards* may be reviewed and amended by the NSW RFS Commissioner as required. A review must be undertaken before 30 June 2019.

Appendix A

Firefighting vehicle specifications

Category 1 Firefighting vehicle specifications

Length	8200 mm
Width	2400 mm
Mirror length	450mm
Height	3700 mm (including 600 mm for aerials)
Ground clearance	310 mm
Approach angle	35º
Departure angle	25º
Wheelbase	4700 mm
Turning circle – wall to wall	22m diameter
Weight	14200kg
Maximum axle loading	9,000kg

Category 7 Firefighting vehicle specifications

Length	6200mm
Width	2040mm
Mirror length	450mm
Height	3050mm (including 600 mm for aerials)
Ground clearance	230mm
Approach angle	35º
Departure angle	30º
Wheelbase	3395mm
Turning circle – wall to wall	17m diameter
Weight	7500kg
Maximum axle loading	5600kg

Category 9 Firefighting vehicle specifications

Length	5300mm
Width	1750mm
Mirror length	450mm
Height	2600 mm (including 600 mm for aerials)
Ground clearance	220mm
Approach angle	35º
Departure angle	30º
Wheelbase	3180mm
Turning circle – wall to wall	16m diameter
Weight	3700 kg
Maximum axle loading	2000kg

Appendix B

“Certified” Fire Trail Signage

PRIMARY FIRE TRAIL DIRECTIONAL SIGN SINGLE END-MOUNTED POST

- 200mm wide blade with Chevron
- Class 1 yellow reflective with black lettering
- Red circle and vehicle carrying capacity. Circle to be 125mm in diameter
- 70mm Lettering
- Where two lines are required, lettering height may be 60mm
- Max length 900mm
- Lat/ Long (DD format) lettering size to suit –single line
- Logo to be 115mm high

BI-DIRECTIONAL SIGN CENTRE–MOUNTED POST

- 200mm wide blade with chevron at each end
- Class 1 yellow reflective with black lettering
- Red circle and vehicle carrying capacity. Red circle to be 125mm in diameter at either end
- 70mm Lettering
- Where two lines are required, lettering height may be 60mm
- Max length 1200mm
- Lat/ Long (DD format) lettering size to suit -single line

INDICATIVE FIRE TRAIL SIGN FOR USE ON OR NEAR PRIVATE PROPERTY

- 200mm wide blade with chevron
- Class 1 yellow reflective with black lettering
- Red circle and vehicle carrying capacity. Red circle to be 125mm in diameter

“Advisory” Fire Trail Signage

AFAC SYMBOLOGY AND OTHER ADVISORY SIGNS

Attached under yellow blade

- 200mm wide blade with Chevron
- Attached under yellow blade
- 200mm blade with square end
- 70mm Lettering
- Reflective white background
- Black lettering
- AFAC symbology to be 125mm high
- Only AFAC Standard Bush Fire Symbology is to be used

AFAC BUSH FIRE SYMBOLOGY

Helipad

Staging Area

Refuge

Water Point Helicopter

Water Point

Escape Route

“Tactical” Fire Trail Signage

PRIMARY FIRE TRAIL DIRECTIONAL SIGN SINGLE END-MOUNTED POST

- 200mm wide blade with Chevron
- Class 1 yellow reflective with black lettering
- Cat number lettering to be 90mm
- 70mm Lettering
- Where two lines are required, lettering height may be 60mm
- Max length 900mm
- Lat/ Long (DD format) lettering size to suit on single line
- Logo to be 115mm high

BI-DIRECTIONAL SIGN CENTRE MOUNTED POST

- 200mm wide blade with chevron at each end
- Class 1 yellow reflective with black lettering
- Red circle and vehicle carrying capacity. Red circle to be 125mm in diameter at either end
- 70mm Lettering
- Where two lines are required, lettering height may be 60mm
- Max length 1200mm
- Lat/ Long (DD format) lettering size to suit on single line

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APPENDIX C FLAME LENGTH MODEL

		North										East									
		Distance from Infastructure to Vegetation (m)	Vegetation Type within 100m (PCT)	Vegetation Type within 100m	surface fuel load (w)	total fuel load (W)	Slope under the vegetation (degrees)	Slope Direction (upslope or downslope)	rate of spread (R): R = 0.0012 * FDI * w	Rslope= forward rate of spread adjusted for slope (km/h): Rslope = R exp (0.069 slope)	FLAME LENGTH Lf = (13 Rslope + 0.24W)/2 (m)	At risk of direct flame contact ?	Distance from Infastructure to Vegetation (m)	Vegetation Type within 100m (PCT)	Vegetation Type within 100m	surface fuel load (w)	total fuel load (W)	Slope under the vegetation (degrees)	Slope Direction (upslope or downslope)	rate of spread (R): R = 0.0012 * FDI * w	Rslope= forward rate of spread adjusted for slope (km/h): Rslope = R exp (0.069 slope)	FLAME LENGTH Lf = (13 Rslope + 0.24W)/2 (m)	At risk of direct flame contact ?
Turbine	WP2	27.64	1194	Forest	25	35	13.23	downslope	2.40	5.98	43.07	FZ	22.61	1194	Forest	25	35	10.91	downslope	2.40	5.10	37.32	FZ
Turbine	WP3	21.46	1194	Forest	25	35	10.20	upslope	2.40	1.19	11.92	No	27.13	1194	Forest	25	35	12.43	upslope	2.40	1.02	10.81	No
Turbine	WP4	>100											15.90	934	Forest	25	35	21.71	downslope	2.40	10.74	73.99	FZ
Turbine	WP5	>100											>100										
Turbine	WP6	33.49	1194	Forest	25	35	14.42	upslope	2.40	0.89	9.97	No	50.88	1194	Forest	25	35	12.66	upslope	2.40	1.00	10.71	No
Turbine	WP7	>100											>100										
Turbine	WP8	38.13	931	Forest	25	35	23.51	downslope	2.40	12.15	83.19	FZ	41.48	931	Forest	25	35	18.03	downslope	2.40	8.33	58.34	FZ
Turbine	WP9	26.40	1194	Forest	25	35	11.53	downslope	2.40	5.32	38.77	FZ	43.33	931	Forest	25	35	8.52	upslope	2.40	1.33	12.87	No
Turbine	WP10	>100											93.00	931	Forest	25	35	6.89	downslope	2.40	3.86	29.30	No
Turbine	WP11	20.67	934	Forest	25	35	20.21	downslope	2.40	9.68	67.09	FZ	25.30	934	Forest	25	35	13.85	downslope	2.40	6.24	44.77	FZ
Turbine	WP12	34.00	934	Forest	25	35	24.79	downslope	2.40	13.28	90.50	FZ	43.14	954	Forest	25	35	24.26	downslope	2.40	12.80	87.40	FZ
Turbine	WP13	>100											52.31	954	Forest	25	35	10.94	upslope	2.40	1.13	11.53	No
Turbine	WP14	37.02	1194	Forest	25	35	4.34	upslope	2.40	1.78	15.76	No	15.73	1194	Forest	25	35	11.51	upslope	2.40	1.08	11.25	No
Turbine	WP15	16.86	1194	Forest	25	35	16.54	downslope	2.40	7.51	53.04	FZ	60.14	1194	Forest	25	35	11.43	downslope	2.40	5.28	38.53	No
Turbine	WP16	32.24	1194	Forest	25	35	13.50	downslope	2.40	6.09	43.80	FZ	46.11	1194	Forest	25	35	15.00	upslope	2.40	0.85	9.74	No
Turbine	WP17	21.35	1194	Forest	25	35	23.65	downslope	2.40	12.27	83.95	FZ	62.41	934	Forest	25	35	15.00	upslope	2.40	0.85	9.74	No
Turbine	WP18	>100											28.96	934	Forest	25	35	21.34	downslope	2.40	10.46	72.21	FZ
Turbine	WP19	25.65	934	Forest	25	35	23.20	downslope	2.40	11.90	81.53	FZ	36.24	934	Forest	25	35	23.25	downslope	2.40	11.94	81.79	FZ
Turbine	WP20	>100											54.68	934	Forest	25	35	6.77	downslope	2.40	3.83	29.09	No
Turbine	WP21	19.15	1194	Forest	25	35	4.77	downslope	2.40	3.34	25.89	FZ	24.16	1194	Forest	25	35	5.72	downslope	2.40	3.56	27.35	FZ
Turbine	WP22	13.00	1194	Forest	25	35	20.00	downslope	2.40	9.54	66.21	FZ	65.46	1194	Forest	25	35	17.77	downslope	2.40	8.18	57.37	No
Turbine	WP23	62.09	1194	Forest	25	35	8.90	upslope	2.40	1.30	12.64	No	28.53	1194	Forest	25	35	18.01	downslope	2.40	8.31	58.24	FZ
Turbine	WP24	14.78	1194	Forest	25	35	10.17	upslope	2.40	1.19	11.94	No	16.79	1194	Forest	25	35	8.82	upslope	2.40	1.31	12.69	No
Turbine	WP25	>100											97.44	934	Forest	25	35	4.09	downslope	2.40	3.18	24.88	No
Turbine	WP26	>100											>100										
Turbine	WP28	62.69	1194	Forest	25	35	6.05	upslope	2.40	1.58	14.48	No	50.48	1194	Forest	25	35	3.85	upslope	2.40	1.84	16.16	No
Turbine	WP29	55.71	934	Forest	25	35	3.11	upslope	2.40	1.94	16.79	No	43.46	931	Forest	25	35	11.22	downslope	2.40	5.21	38.04	No
Turbine	WP30	29.54	934	Forest	25	35	5.23	downslope	2.40	3.44	26.58	No	12.62	934	Forest	25	35	4.49	downslope	2.40	3.27	25.47	FZ
Turbine	WP32	44.49	1194	Forest	25	35	11.42	upslope	2.40	1.09	11.29	No	19.64	1194	Forest	25	35	13.59	upslope	2.40	0.94	10.31	No
Turbine	WP33	27.40	1194	Forest	25	35	5.57	upslope	2.40	1.63	14.82	No	12.74	1194	Forest	25	35	6.98	downslope	2.40	3.89	29.45	FZ
Turbine	WP34	67.85	1194	Forest	25	35	9.06	upslope	2.40	1.28	12.55	No	15.04	1194	Forest	25	35	5.23	downslope	2.40	3.44	26.58	FZ
Turbine	WP35	>100											>100										
Turbine	WP36	87.95	1194	Forest	25	35	7.96	downslope	2.40	4.16	31.22	No	33.07	1194	Forest	25	35	3.53	downslope	2.40	3.06	24.11	No
Turbine	WP37	78.76	1194	Forest	25	35	12.38	downslope	2.40	5.64	40.85	No	>100										
Turbine	WP38	43.11	1194	Forest	25	35	5.95	downslope	2.40	3.62	27.71	No	>100										
Turbine	WP39	59.08	1194	Forest	25	35	13.83	downslope	2.40	6.23	44.71	No	>100										
Turbine	WP40	25.38	934	Forest	25	35	21.10	downslope	2.40	10.29	71.09	FZ	67.45	934	Forest	25	35	18.30	downslope	2.40	8.49	59.36	No
Turbine	WP41	38.47	934	Forest	25	35	21.16	downslope	2.40	10.34	71.40	FZ	61.87	1194	Forest	25	35	7.99	upslope	2.40	1.38	13.19	No
Turbine	WP42	34.27	1194	Forest	25	35	22.57	downslope	2.40	11.39	78.26	FZ	73.62	1194	Forest	25	35	6.18	upslope	2.40	1.57	14.38	No
Turbine	WP43	51.20	1194	Forest	25	35	14.08	downslope	2.40	6.34	45.41	No	22.00	1194	Forest	25	35	2.64	upslope	2.40	2.00	17.20	No
Turbine	WP44	>100											>100										
Turbine	WP45	>100											>100										
Turbine	WP46	25.56	1194	Forest	25	35	6.35	downslope	2.40	3.72	28.38	FZ	24.50	1194	Forest	25	35	7.20	upslope	2.40	1.46	13.69	No
Turbine	WP47	83.65	433	Woodland	15	25	4.78	downslope	1.44	2.00	16.02	No	93.74	1194	Forest	25	35	5.48	downslope	2.40	3.50	26.97	No
Turbine	WP48	58.33	1194	Forest	25	35	3.05	downslope	2.40	2.96	23.45	No	66.26	1194	Forest	25	35	5.16	upslope	2.40	1.68	15.13	No
Turbine	WP49	>100											17.20	1194	Forest	25	35	1.73	upslope	2.40	2.13	18.04	FZ
Turbine	WP50	75.37	1194	Forest	25	35	9.60	downslope	2.40	4.65	34.46	FZ	50.31	1194	Forest	25	35	0.12	downslope	2.40	2.38	19.67	No
Turbine	WP51	39.63	1194	Forest	25	35	10.30	downslope	2.40	4.89	35.96	No	66.20	1194	Forest	25	35	4.56	upslope	2.40	1.75	15.59	No
Turbine	WP52	>100											97.82	1194	Forest	25	35	4.56	downslope	2.40	3.29	25.57	No
Turbine	WP53	61.16	1194	Forest	25	35	15.09	downslope	2.40	6.80	48.38	No	28.27	1194	Forest	25	35	2.28	upslope	2.40	2.05	17.53	No
Turbine	WP54	>100											86.42	934	Forest	25	35	1.73	upslope	2.40	2.13	18.05	No
Turbine	WP55	>100											>100										
Turbine	WP56	>100											>100										
Turbine	WP57	45.03	1194	Forest	25	35	10.56	downslope	2.40	4.97	36.52	No	37.13	1194	Forest	25	35	3.89	upslope	2.40	1.83	16.13	No
Turbine	WP58	25.88	1194	Forest	25	35	11.30	downslope	2.40	5.23	38.21	FZ	>100										
Turbine	WP59	67.02	1194	Forest	25	35	17.00	downslope	2.40	7.76	54.63	No	29.26	1194	Forest	25	35	5.63	upslope	2.40	1.63	14.78	No
Turbine	WP60	>100											61.87	934	Forest	25	35	5.97	upslope	2.40	1.59	14.53	No
Turbine	WP61	13.19	1194	Forest	25	35	14.68	upslope	2.40	0.87	9.86	No	20.84	1194	Forest	25	35	12.09	upslope	2.40	1.04	10.97	No
Turbine	WP62	52.28	1194	Forest	25	35	8.82	downslope	2.40	4.41	32.87	No	>100										
Turbine	WP63	13.00	1194	Forest	25	35	17.61	downslope	2.40	8.09	56.78	FZ	20.59	1194	Forest	25	35	17.33	downslope	2.40	7.93	55.76	FZ
Turbine	WP64	54.85	1194	Forest	25	35	19.97	downslope	2.40	9.52	66.10	FZ	48.10	1194	Forest	25	35	11.14	upslope	2.40	1.11	11.43	No
Turbine	WP65	>100											>100										
Turbine	WP66	>100											>100										
Turbine	WP67	>100											>100										
Turbine	WP69	44.62	1194	Forest	25	35	6.65	downslope	2.40	3.80	28.89	No	44.67	1194	Forest	25	35	10.47	downslope	2.40	4.94	36.32	No
Turbine	WP70	35.75	1194	Forest	25	35	11.03	downslope	2.40	5.14	37.60	FZ	82.22	1194	Forest	25	35	13.91	downslope	2.40	6.27	44.94	No
Substation		40.44	1194	Forest	25	35	5.67	upslope	2.40	1.62	14.75	No	12	1194	Forest	25	35	2.29	downslope	2.40	2.81	22.47	FZ
Switching Station		>100											0	541	Forest	25	35	8.46	downslope	2.40	4.30	32.17	FZ
BESS/Laydown/Batching		43.90	1194	Forest	25	35	5.67	upslope	2.40	1.62	14.75	No	85.60	1194	Forest	25	35	4.51	upslope	2.40	1.76	15.63	No
O&M Option 1		47.49	1194	Forest	25	35	15.31	upslope	2.40	0.83	9.62	No	>100										
Compound/O&M option 2		>100											>100										
Laydown	1	68.78	1194	Forest	25	35	11.03	upslope	2.40	1.12	11.49	No	0	931	Forest	25	35	16.27	downslope	2.40	7.38	52.14	FZ
Laydown	2	>100											54.53	931	Forest	25	35	3.04	downslope	2.40	2.96	23.44	No
Compound		0.00	526	Forest	25	35	3.43	upslope	2.40	1.89	16.51	FZ	6	1194	Forest	25	35	2.74	upslope	2.40	2.90	23.05	FZ
Batching/Laydown	1	>100											>100										
Batching/Laydown	2	>100											>100										
Batching/Laydown	3	40.35	1194	Forest	25	35	6.26	downslope	2.40	3.70	28.23	FZ	>100										
Batching/Laydown	4	3.30	934	Forest	25	35	4.59	downslope	2.40	3.29	25.61	FZ	0	934	Forest	25	35	3.59	upslope	2.40	1.87	16.38	FZ

		South										West									
		Distance from Infastructure to Vegetation (m)	Vegetation Type within 100m (PCT)	Vegetation Type within 100m	surface fuel load (w)	total fuel load (W)	Slope under the vegetation (degrees)	Slope Direction (upslope or downslope)	rate of spread (R): R = 0.0012 * FDI * w	Rslope= forward rate of spread adjusted for slope (km/h): Rslope = R exp (0.069 slope)	FLAME LENGTH Lf = (13 Rslope + 0.24W)/2 (m)	At risk of direct flame contact ?	Distance from Infastructure to Vegetation (m)	Vegetation Type within 100m (PCT)	Vegetation Type within 100m	surface fuel load (w)	total fuel load (W)	Slope under the vegetation (degrees)	Slope Direction (upslope or downslope)	rate of spread (R): R = 0.0012 * FDI * w	Rslope= forward rate of spread adjusted for slope (km/h): Rslope = R exp (0.069 slope)	FLAME LENGTH Lf = (13 Rslope + 0.24W)/2 (m)	At risk of direct flame contact ?
Turbine	WP2	58.22	1194	Forest	25	35	12.72	upslope	2.40	1.00	10.68	No	36.581646	1194	Forest	25	35	17.07	downslope	2.40	7.79	54.85	FZ
Turbine	WP3	67.76	934	Forest	25	35	20.46	downslope	2.40	9.85	68.23	FZ	49.831584	1194	Forest	25	35	14.93	upslope	2.40	0.86	9.77	No
Turbine	WP4	15.49	934	Forest	25	35	22.48	downslope	2.40	11.32	77.80	FZ	72.884408	507	Woodland	15.00	25.00	15.00	upslope	1.44	0.51	6.32	No
Turbine	WP5	43.29	1194	Forest	25	35	13.14	upslope	2.40	0.97	10.50	No	43.074533	1194	Forest	25	35	8.43	upslope	2.40	1.34	12.92	No
Turbine	WP6	48.74	1194	Forest	25	35	18.03	downslope	2.40	8.33	58.32	FZ	26.55425	1194	Forest	25	35	24.86	downslope	2.40	13.34	90.93	FZ
Turbine	WP7	33.17	1194	Forest	25	35	17.65	downslope	2.40	8.11	56.92	FZ	35.92	1194	Forest	25	35	14.06	downslope	2.40	6.33	45.36	FZ
Turbine	WP8	61.51	934	Forest	25	35	15.00	upslope	2.40	0.85	9.74	No	69.31	931	Forest	25	35	16.39	downslope	2.40	7.44	52.53	No
Turbine	WP9	35.03	931	Forest	25	35	15.78	downslope	2.40	7.13	50.53	FZ	22.88	1194	Forest	25	35	11.44	downslope	2.40	5.29	38.56	FZ
Turbine	WP10	66.42	931	Forest	25	35	15.64	downslope	2.40	7.06	50.09	No	73.82	931	Forest	25	35	8.33	downslope	2.40	4.26	31.92	No
Turbine	WP11	34.98	931	Forest	25	35	20.71	downslope	2.40	10.02	69.32	FZ	25.94	934	Forest	25	35	17.94	upslope	2.40	0.70	8.72	No
Turbine	WP12	50.27	1194	Forest	25	35	15.00	upslope	2.40	0.85	9.74	No	22.27	934	Forest	25	35	24.79	downslope	2.40	13.28	90.50	FZ
Turbine	WP13	52.95	954	Forest	25	35	6.94	upslope	2.40	1.49	13.86	No	98.72	934	Forest	25	35	14.96	upslope	2.40	0.85	9.76	No
Turbine	WP14	34.90	1194	Forest	25	35	15.68	downslope	2.40	7.08	50.21	FZ	57.28	931	Forest	25	35	9.83	downslope	2.40	4.73	34.93	No
Turbine	WP15	35.47	1194	Forest	25	35	12.12	upslope	2.40	1.04	10.96	No	11.85	1194	Forest	25	35	11.26	downslope	2.40	5.22	38.13	FZ
Turbine	WP16	18.92	1194	Forest	25	35	21.73	downslope	2.40	10.75	74.07	FZ	16.07	1194	Forest	25	35	15.00	upslope	2.40	0.85	9.74	No
Turbine	WP17	75.07	934	Forest	25	35	9.12	upslope	2.40	1.28	12.51	No	55.51	1194	Forest	25	35	18.21	downslope	2.40	8.43	59.00	No
Turbine	WP18	38.55	1194	Forest	25	35	19.17	downslope	2.40	9.01	62.76	FZ	31.43	1194	Forest	25	35	23.82	downslope	2.40	12.42	84.91	FZ
Turbine	WP19	>100											33.45	934	Forest	25	35	18.87	downslope	2.40	8.83	61.57	FZ
Turbine	WP20	23.37	1194	Forest	25	35	6.04	downslope	2.40	3.64	27.86	No	23.40	1194	Forest	25	35	2.46	downslope	2.40	2.84	22.69	No
Turbine	WP21	16.86	1194	Forest	25	35	5.93	upslope	2.40	1.59	14.56	No	15.97	1194	Forest	25	35	7.52	downslope	2.40	4.03	30.41	FZ
Turbine	WP22	25.13	1194	Forest	25	35	10.73	upslope	2.40	1.14	11.64	No	13.43	1194	Forest	25	35	24.15	downslope	2.40	12.71	86.79	FZ
Turbine	WP23	13.00	1194	Forest	25	35	22.73	downslope	2.40	11.52	79.06	FZ	24.62	1194	Forest	25	35	24.48	downslope	2.40	13.00	88.67	FZ
Turbine	WP24	20.62	1194	Forest	25	35	5.47	downslope	2.40	3.50	26.96	FZ	27.86	1194	Forest	25	35	16.38	downslope	2.40	7.43	52.49	FZ
Turbine	WP25	93.27	934	Forest	25	35	4.58	downslope	2.40	3.29	25.60	No	>100										
Turbine	WP26	>100											>100										
Turbine	WP28	79.90	1194	Forest	25	35	9.45	downslope	2.40	4.61	34.15	No	>100										
Turbine	WP29	12.72	934	Forest	25	35	5.31	upslope	2.40	1.66	15.01	FZ	27.18	934	Forest	25	35	1.90	upslope	2.40	2.11	17.89	No
Turbine	WP30	12.63	934	Forest	25	35	3.28	upslope	2.40	1.91	16.64	FZ	33.95	934	Forest	25	35	3.58	upslope	2.40	1.88	16.39	No
Turbine	WP32	16.79	1194	Forest	25	35	7.92	upslope	2.40	1.39	13.23	No	35.69	1194	Forest	25	35	8.14	downslope	2.40	4.21	31.55	No
Turbine	WP33	13.57	1194	Forest	25	35	20.24	downslope	2.40	9.70	67.24	FZ	35.99	931	Forest	25	35	10.96	downslope	2.40	5.11	37.43	FZ
Turbine	WP34	16.49	1194	Forest	25	35	8.90	downslope	2.40	4.44	33.03	FZ	19.02	1194	Forest	25	35	5.95	upslope	2.40	1.59	14.55	No
Turbine	WP35	>100											>100										
Turbine	WP36	34.46	1194	Forest	25	35	2.51	downslope	2.40	2.85	22.75	No	67.36	1194	Forest	25	35	7.54	downslope	2.40	4.04	30.44	No
Turbine	WP37	>100											>100										
Turbine	WP38	>100											57.91	1194	Forest	25	35	4.48	downslope	2.40	3.27	25.45	No
Turbine	WP39	>100											98.01	1194	Forest	25	35	3.94	downslope	2.40	3.15	24.67	No
Turbine	WP40	99.47	934	Forest	25	35	13.82	upslope	2.40	0.93	10.21	No	41.86	934	Forest	25	35	17.74	downslope	2.40	8.16	57.26	FZ
Turbine	WP41	51.76	934	Forest	25	35	14.57	upslope	2.40	0.88	9.91	No	29.15	934	Forest	25	35	24.12	downslope	2.40	12.68	86.60	FZ
Turbine	WP42	43.44	1194	Forest	25	35	17.39	downslope	2.40	7.97	56.00	FZ	28.57	1194	Forest	25	35	24.87	downslope	2.40	13.35	90.97	FZ
Turbine	WP43	13.00	1194	Forest	25	35	4.79	downslope	2.40	3.34	25.91	FZ	13.48	1194	Forest	25	35	15.10	downslope	2.40	6.80	48.42	FZ
Turbine	WP44	>100											95.29	1194	Forest	25	35	8.12	downslope	2.40	4.20	31.52	No
Turbine	WP45	>100											>100										
Turbine	WP46	40.04	1194	Forest	25	35	7.65	upslope	2.40	1.42	13.40	No	46.15	1194	Forest	25	35	6.78	downslope	2.40	3.83	29.11	No
Turbine	WP47	>100											>100										
Turbine	WP48	37.74	1194	Forest	25	35	11.98	downslope	2.40	5.49	39.86	FZ	41.23	1194	Forest	25	35	8.38	downslope	2.40	4.28	32.01	No
Turbine	WP49	23.66	1194	Forest	25	35	6.37	downslope	2.40	3.72	28.40	FZ	36.57	1194	Forest	25	35	13.49	downslope	2.40	6.09	43.78	FZ
Turbine	WP50	48.95	1195	Forest	25	35	9.98	upslope	2.40	4.78	35.26	FZ	0.00	1195	Forest	26	35	2.91	downslope	2.50	3.05	24.03	FZ
Turbine	WP51	56.39	1194	Forest	25	35	11.86	downslope	2.40	5.44	39.55	No	36.17	1194	Forest	25	35	22.72	downslope	2.40	11.51	79.02	FZ
Turbine	WP52	94.42	1194	Forest	25	35	14.35	downslope	2.40	6.46	46.19	No	68.19	1194	Forest	25	35	21.40	downslope	2.40	10.50	72.48	FZ
Turbine	WP53	66.37	1194	Forest	25	35	5.05	upslope	2.40	1.69	15.21	No	>100										
Turbine	WP54	62.18	1194	Forest	25	35	7.41	downslope	2.40	4.00	30.21	No	55.17	1194	Forest	25	35	21.04	downslope	2.40	10.25	70.83	FZ
Turbine	WP55	>100											>100										
Turbine	WP56	93.90	1194	Forest	25	35	2.28	downslope	2.40	2.81	22.46	No	>100										
Turbine	WP57	>100											55.64	1194	Forest	25	35	23.82	downslope	2.40	12.42	84.93	FZ
Turbine	WP58	>100											29.04	1194	Forest	25	35	11.26	downslope	2.40	5.22	38.12	FZ
Turbine	WP59	29.40	1194	Forest	25	35	10.11	upslope	2.40	1.19	11.96	No	75.96	1194	Forest	25	35	25.41	downslope	2.40	13.86	94.27	FZ
Turbine	WP60	60.22	934	Forest	25	35	8.06	upslope	2.40	1.38	13.15	No	>100										
Turbine	WP61	71.66	1194	Forest	25	35	15.00	upslope	2.40	0.85	9.74	No	29.24	1194	Forest	25	35	15.18	downslope	2.40	6.84	48.66	FZ
Turbine	WP62	>100											>100										
Turbine	WP63	>100											14.91	1194	Forest	25	35	18.72	downslope	2.40	8.73	60.95	FZ
Turbine	WP64	34.37	1194	Forest	25	35	8.66	upslope	2.40	1.32	12.78	No	42.98	1194	Forest	25	35	15.00	upslope	2.40	0.85	9.74	No
Turbine	WP65	33.34	1194	Forest	25	35	10.05	downslope	2.40	4.80	35.42	FZ	55.89	1194	Forest	25	35	5.75	upslope	2.40	1.61	14.69	No
Turbine	WP66	>100											>100										
Turbine	WP67	>100											>100										
Turbine	WP69	>100											>100										
Turbine	WP70	29.05	931	Forest	25	35	18.16	downslope	2.40	8.40	58.81	FZ	68.42	931	Forest	25	35	8.56	upslope	2.40	1.33	12.84	No
Substation		>100											>100										
Switching Station		>100											>100										
BESS		96.14	934	Forest	25	35	6.17	downslope	2.40	3.67	28.08	No	4.8	1194	Forest	25	35	1.91	downslope	2.40	2.74	22.00	FZ
O&M		>100											>100										
Compound/O&M option 2		10	1194	Forest	25	35	7.64	downslope	2.40	4.07	30.63	FZ	41.2	1194	Forest	25	35	0.25	upslope	2.40	2.44	20.07	No
Laydown	1	>100											>100										
Laydown	2	>100											86.76	1194	Forest	25	35	4	upslope	2.40	3.16	24.76	No
Compound		>100											>100										
Batching/Laydown	1	>100											>100										
Batching/Laydown	2	>100											>100										
Batching/Laydown	3	>100											>100										
Batching/Laydown	4	0	934	Forest	25	35	1.98	downslope	2.40	2.75	22.08	FZ	2.5	934	Forest	25	35	1.64	downslope	2.40	2.69	21.67	FZ

		North											South									
Infastructure Type	ID	Distance from Infastructure to Vegetation (m)	Vegetation Type within 100m (PCT)	Vegetation Type within 100m	surface fuel load (w)	total fuel load (W)	Slope under the vegetation (degrees)	Slope Direction (upslope or downslope)	rate of spread (R): R = 0.0012 * FDI * w	Rslope= forward rate of spread adjusted for slope (km/h): Rslope = R exp (0.069 slope)	FLAME LENGTH Lf = (13 Rslope + 0.24W)/2 (m)	Is the infastructure located within the Flame Zone?	Distance from Infastructure to Vegetation (m)	Vegetation Type within 100m (PCT)	Vegetation Type within 100m	surface fuel load (w)	total fuel load (W)	Slope under the vegetation (degrees)	Slope Direction (upslope or downslope)	rate of spread (R): R = 0.0012 * FDI * w	Rslope= forward rate of spread adjusted for slope (km/h): Rslope = R exp (0.069 slope)	FLAME LENGTH Lf = (13 Rslope + 0.24W)/2 (m)	Is the infastructure located within the Flame Zone?
Access Road	23																					
Access Road	1																					
Access Road	2																					
Access Road	3	>100											>100									
Access Road	4																					
Access Road	5	>100											39.6	1194	Forest	25	35	10.4	downslope	2.40	4.91	36.11	No
Access Road	6	29.1	1194	Forest	25	35	21.0	downslope	2.40	10.21	70.56	FZ	60.8	1194	Forest	25	35	5.7	upslope	2.40	1.62	14.73	No
Access Road	7																					
Access Road	8																					
Access Road	9																					
Access Road	10																					
Access Road	11																					
Access Road	12																					
Access Road	13																					
Access Road	14																					
Access Road	15																					
Access Road	16																					
Access Road	17																					
Access Road	18																					
Access Road	19																					
Access Road	20																					
Access Road	21	>100											>100									
Access Road	22	7.3	1194	Forest	25	35	20.0	downslope	2.40	9.53	66.14	FZ	16.9	1194	Forest	25	35	2.7	upslope	2.40	1.99	17.13	FZ
Access Road	24																					
Access Road	25	41.6	1194	Forest	25	35	19.0	downslope	2.40	8.93	62.25	FZ	68.7	931	Forest	25	35	12.1	upslope	2.40	1.04	10.98	No
Access Road	26	64.1	1194	Forest	25	35	6.6	downslope	2.40	3.78	28.76	No	>100										
Access Road	27	>100											>100										
Access Road	28	>100											>100										
Access Road	29	36.1	1194	Forest	25	35	9.5	upslope	2.40	1.24	12.28	No	34.2	1194	Forest	25	35	6.5	upslope	2.40	1.54	14.19	No
Access Road	30	55.7	1194	Forest	25	35	5.0	downslope	2.40	3.39	26.26	No	>100										
Access Road	31																					
Access Road	32																					
Access Road	33	7.6	1194	Forest	25	35	8.7	upslope	2.40	1.31	12.73	FZ	4.8	1194	Forest	25	35	16.0	downslope	2.40	7.22	51.10	FZ
Access Road	35																					
Access Road	36																					
Access Road	38																					
Access Road	39																					
Access Road	41	>100											46.2	934	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No
Access Road	42	>100											85.0	540	Forest	25	35	9.5	upslope	2.40	1.25	12.32	No
Access Road	43	26.2	540	Forest	25	35	19.0	downslope	2.40	8.91	62.12	FZ	>100										
Access Road	44	72.3	540	Forest	25	35	9.1	downslope	2.40	4.49	33.41	No	92.7	540	Forest	25	35	11.8	upslope	2.40	1.06	11.11	No
Access Road	45																					
Access Road	46	10.6	540	Forest	25	35	6.8	downslope	2.40	3.83	29.12	FZ	23.0	526	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No
Access Road	47	9.9	526	Forest	25	35	15.9	downslope	2.40	7.19	50.96	FZ	89.9	526	Forest	25	35	14.8	downslope	2.40	6.66	47.48	No
Access Road	48																					
Access Road	49	9.4	526	Forest	25	35	19.8	downslope	2.40	9.39	65.25	FZ	31.3	526	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No
Access Road	50																					
Access Road	52	46.7	540	Forest	25	35	18.7	downslope	2.40	8.70	60.74		43.6	934	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No
Access Road	53																					
Access Road	54																					
Access Road	55	22.1	1194	Forest	25	35	24.8	downslope	2.40	13.29	90.61	FZ	>100										
Access Road	56	7.3	1194	Forest	25	35	23.4	downslope	2.40	12.06	82.60	FZ	20.7	1194	Forest	25	35	14.7	upslope	2.40	0.87	9.86	No
Access Road	57	33.5	1194	Forest	25	35	23.4	downslope	2.40	12.04	82.44	FZ	42.8	1194	Forest	25	35	21.4	downslope	2.40	10.53	72.64	FZ
Access Road	58	20.0	1194	Forest	25	35	12.3	downslope	2.40	5.60	40.60	FZ	5.8	1194	Forest	25	35	13.7	upslope	2.40	0.93	10.25	FZ
Access Road	59	20.6	1194	Forest	25	35	15.4	downslope	2.40	6.93	49.27	FZ	16.8	1194	Forest	25	35	21.6	downslope	2.40	10.66	73.48	FZ
Access Road	60																					
Access Road	61	25.8	934	Forest	25	35	19.9	downslope	2.40	9.46	65.68	FZ	14.3	931	Forest	25	35	15.6	downslope	2.40	7.06	50.10	FZ
Access Road	62	>100											42.6	931	Forest	25	35	20.7	downslope	2.40	10.00	69.19	FZ
Access Road	63																					
Access Road	64	34.0	931	Forest	25	35	19.3	downslope	2.40	9.10	63.33	No	26.4	1194	Forest	25	35	11.0	downslope	2.40	5.12	37.48	FZ
Access Road	65																					
Access Road	66	33.7	1194	Forest	25	35	21.4	downslope	2.40	10.54	72.73	FZ	44.7	934	Forest	25	35	20.1	downslope	2.40	9.58	66.47	FZ
Access Road	67																					
Transmission Line	1	25.4	541	Forest	25	35	14.8	upslope	2.40	0.86	9.80	No	52.2	541	Forest	25	35	12.7	downslope	2.40	5.78	41.74	No
Transmission Line	2	25.5	540	Forest	25	35	13.3	upslope	2.40	0.96	10.44	No	25.6	540	Forest	25	35	13.5	downslope	2.40	6.08	43.73	FZ
Transmission Line	3	54.8	540	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No	59.2	540	Forest	25	35	15.2	downslope	2.40	6.86	48.77	No
Transmission Line	4	25.5	540	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No	25.5	540	Forest	25	35	17.9	downslope	2.40	8.27	57.93	FZ
Transmission Line	5	39.6	540	Forest	25	35	24.5	downslope	2.40	12.99	88.63	FZ	47.9	540	Forest	25	35	15.2	downslope	2.40	6.83	48.63	FZ
Transmission Line	6	>100											92.0	540	Forest	25	35	15.1	downslope	2.40	6.78	48.27	No
Transmission Line	7	25.6	540	Forest	25	35	13.4	downslope	2.40	6.05	43.55	FZ	25.5	540	Forest	25	35	17.6	downslope	2.40	8.07	56.66	FZ
Transmission Line	8	31.5	540	Forest	25	35	20.4	downslope	2.40	9.83	68.13	FZ	27.7	540	Forest	25	35	19.9	downslope	2.40	9.50	65.92	FZ
Transmission Line	9	60.8	541	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No	68.0	541	Forest	25	35	20.1	downslope	2.40	9.59	66.51	No
Transmission Line	10	46.5	541	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No	41.4	540	Forest	25	35	22.0	downslope	2.40	10.96	75.43	FZ
Transmission Line	11	25.5	541	Forest	25	35	19.9	upslope	2.40	0.61	8.15	No	28.5	541	Forest	25	35	15.4	downslope	2.40	6.92	49.20	FZ
Transmission Line	12	25.5	541	Forest	25	35	14.2	downslope	2.40	6.40	45.80	FZ	25.7	541	Forest	25	35	23.2	downslope	2.40	11.89	81.46	FZ
Transmission Line	13	>100											37.9	599	Woodland	15	25	24.3	downslope	1.44	7.73	53.22	FZ
Transmission Line	14	25.5	540	Forest	25	35	24.1	downslope	2.40	12.63	86.31	FZ	25.5	540	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No
Transmission Line	15	25.5	540	Forest	25	35	24.3	downslope	2.40	12.82	87.51	FZ	25.5	540	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No
Transmission Line	16	25.5	492	Woodland	15	25	19.5	downslope	1.44	5.53	38.92	FZ	25.5	492	Woodland	15	25	14.4	upslope	1.44	0.53	6.46	No
Transmission Line	17	25.5	492	Woodland	15	25	12.5	downslope	1.44	3.40	25.10	No	25.5	492	Woodland	15	25	18.2	downslope	1.44	5.06	35.90	FZ
Transmission Line	18	25.5	540	Forest	25	35	14.2	upslope	2.40	0.90	10.06	No	25.5	540	Forest	25	35	16.3	downslope	2.40	7.41	52.33	FZ
Transmission Line	19	25.5	540	Forest	25	35	22.0	downslope	2.40	10.94	75.31	FZ	25.5	540	Forest	25	35	24.7	downslope	2.40	13.18	89.84	FZ
Transmission Line	20	25.5	490	Woodland	15	25	24.4	downslope	1.44	7.75	53.34	FZ	26.4	540	Forest	25	35	22.9	downslope	2.40	11.69	80.15	FZ
Transmission Line	21	25.5	490	Woodland	15	25	18.2	downslope	1.44	5.07	35.93	FZ	25.8	490	Woodland	15	25	17.4	downslope	1.44	4.78	34.08	FZ
Transmission Line	22	91.0	540	Forest	25	35	16.8	downslope	2.40	7.65	53.92	No	>100										
Transmission Line	23	26.5	540	Forest	25	35	5.7	upslope	2.40	1.62	14.72	No	25.5	540	Forest	25	35	2.9	downslope	2.40	2.93	23.26	No
Transmission Line	24	25.5	540	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No	25.5	540	Forest	25	35	21.2	downslope	2.40	10.39	71.76	FZ
Transmission Line	25	25.5	540	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No	25.5	540	Forest	25	35	13.3	downslope	2.40	6.00	43.20	FZ
Transmission Line	26	25.5	540	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No	25.5	540	Forest	25	35	11.9	downslope	2.40	5.45	39.62	FZ
Transmission Line	27	60.3	486	Woodland	15	25	7.1	downslope	1.44	2.34	18.24	No	25.5	540	Forest	25	35	8.8	upslope	2.40	1.31	12.70	No
Transmission Line	28	25.5	541	Forest	25	35	12.7	downslope	2.40	5.76	41.64	FZ	25.5	541	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No
Transmission Line	29	25.5	540	Forest	25	35	14.8	downslope	2.40	6.68	47.62	FZ	25.5	540	Forest	25	35	14.8	downslope	2.40	6.66	47.47	FZ
Transmission Line	30	25.5	540	Forest	25	35	13.5	downslope	2.40	6.11	43.90	FZ	25.5	540	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No
Transmission Line	31	25.5	541	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No	28.5	541	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No
Transmission Line	32	>100											74.1	599	Woodland	15	25	15.0	upslope	1.44	0.51	6.32	No
Transmission Line	33	25.6	599	Woodland	15	25	15.0	upslope	1.44	0.51	6.32	No	26.2	599	Woodland	15	25	15.0	upslope	1.44	0.51	6.32	No
Transmission Line	34	25.8	599	Woodland	15	25	24.8	downslope	1.44	7.96	54.74	FZ	>100										
Transmission Line	35	25.8	540	Forest	25	35	21.8	downslope	2.40	10.81	74.46	FZ	25.5	540	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No
Transmission Line	36	26.5	1194	Forest	25	35	24.3	downslope	2.40	12.87	87.88	FZ	25.5	1194	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No
Transmission Line	37	25.5	1194	Forest	25	35	18.8	downslope	2.40	8.77	61.20	FZ	25.5	1194	Forest	25	35	11.9	upslope	2.40	1.06	11.08	No
Transmission Line	38	>100											67.2	1194	Forest	25	35	10.1	upslope	2.40	1.19	11.96	No
Transmission Line	39	>100											>100										
Transmission Line	40	44.5	931	Forest	25	35	5.1	upslope	2.40	1.68	15.14	No	>100										
Transmission Line	41	48.6	934	Forest	25	35	11.6	downslope	2.40	5.34	38.93	No	41.1	931	Forest	25	35	9.7	upslope	2.40	1.23	12.20	No
Transmission Line	42	66.4	934	Forest	25	35	14.4	downslope	2.40	6.48	46.33	No	50.9	541	Forest	25	35	7.8	upslope	2.40	1.40	13.29	No
Transmission Line	43	25.5	541	Forest	25	35	14.6	downslope	2.40	6.57	46.92	FZ	25.5	541	Forest	25	35	1.7	downslope	2.40	2.70	21.77	No
Transmission Line	44	25.5	486	Forest	25	35	5.7	downslope	2.40	3.56	27.32	FZ	25.5	486	Woodland	15	25	13.5	upslope	1.44	0.57	6.69	No
Transmission Line	45	25.5	540	Forest	25	35	13.7	downslope	2.40	6.17	44.31	FZ	>100										
Transmission Line	46	>100											25.5	540	Forest	25	35	15.1	downslope	2.40	6.82	48.52	FZ
Transmission Line	47	>100											91.8	540	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No
Transmission Line	48	45.5	540	Forest	25	35	18.5	downslope	2.40	8.61	60.14	FZ	30.2	540	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No
Transmission Line	49	25.5	540	Forest	25	35	21.8	downslope	2.40	10.81	74.47	FZ	25.9	540	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No
Transmission Line	50	32.0	541	Forest	25	35	24.3	downslope	2.40	12.79	87.36	FZ	>100										
Transmission Line	51	>100											>100										
Transmission Line	52	69.5	540	Forest	25	35	13.8	upslope	2.40	0.93	10.22	No	>100										
Transmission Line	53	25.5	540	Forest	25	35	22.6	downslope	2.40	11.43	78.51	FZ	>100										
Transmission Line	54	25.5	540	Forest	25	35	14.2	downslope	2.40	6.40	45.80	FZ	>100										
Transmission Line	55	25.5	540	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No	28.5	540	Forest	25	35	17.8	downslope	2.40	8.21	57.57	FZ
Transmission Line	56	25.5	540	Forest	25	35	23.3	downslope	2.40	12.01	82.25	FZ	25.6	540	Forest	25	35	20.1	downslope	2.40	9.58	66.50	FZ
Transmission Line	57	62.4	540	Forest	25	35	19.6	downslope	2.40	9.26	64.39	FZ	>100										
Transmission Line	58	>100											>100										
Transmission Line	59	53.8	540	Forest	25	35	22.8	downslope	2.40	11.55	79.26	FZ	79.7	540	Forest	25	35	14.6	upslope	2.40	0.88	9.90	No
Transmission Line	60	26.9	1194	Forest	25	35	5.7	upslope	2.40	1.62	14.72	No	25.4	1194	Forest	25	35	2.6	downslope	2.40	2.88	22.89	No
Transmission Line	61	78.7	1194	Forest	25	35	19.8	downslope	2.40	9.40	65.27	No	51.7	1194	Forest	25	35	4.2	upslope	2.40	1.80	15.87	No
Transmission Line	62	>100											50.7	1194	Forest	25	35	5.3	downslope	2.40	3.46	26.68	No

		East											West									
Infastructure Type	ID	Distance from Infastructure to Vegetation (m)	Vegetation Type within 100m (PCT)	Vegetation Type within 100m	surface fuel load (w)	total fuel load (W)	Slope under the vegetation (degrees)	Slope Direction (upslope or downslope)	rate of spread (R): R = 0.0012 * FDI * w	Rslope= forward rate of spread adjusted for slope (km/h): Rslope = R exp (0.069 slope)	FLAME LENGTH Lf = (13 Rslope + 0.24W)/2 (m)	Is the infastructure located within the Flame Zone?	Distance from Infastructure to Vegetation (m)	Vegetation Type within 100m (PCT)	Vegetation Type within 100m	surface fuel load (w)	total fuel load (W)	Slope under the vegetation (degrees)	Slope Direction (upslope or downslope)	rate of spread (R): R = 0.0012 * FDI * w	Rslope= forward rate of spread adjusted for slope (km/h): Rslope = R exp (0.069 slope)	FLAME LENGTH Lf = (13 Rslope + 0.24W)/2 (m)	Is the infastructure located within the Flame Zone?
Access Road	23	88.7	1194	Forest	25	35	1.5	downslope	2.40	2.67	21.55	No	8.2	1194	Forest	25	35	15.0	upslope	2.40	0.85	9.74	FZ
Access Road	1	82.5	1194	Forest	25	35	10.0	downslope	2.40	4.79	35.36	No	>100										
Access Road	2	>100											>100										
Access Road	3																						
Access Road	4	>100											50.2	1194	Forest	25	35	21.1	downslope	2.40	10.28	71.02	FZ
Access Road	5																						
Access Road	6																						
Access Road	7	>100											46.3	1194	Forest	25	35	10.9	downslope	2.40	5.10	37.37	No
Access Road	8	65.5	1194	Forest	25	35	6.9	upslope	2.40	1.49	13.87	No	72.1	1194	Forest	25	35	10.6	downslope	2.40	4.98	36.57	No
Access Road	9	55.3	1194	Forest	25	35	5.5	upslope	2.40	1.64	14.88	No	53.5	1194	Forest	25	35	27.9	downslope	2.40	16.45	111.10	FZ
Access Road	10	62.8	927	Forest	25	35	6.2	upslope	2.40	1.56	14.36	No	57.0	1194	Forest	25	35	24.1	downslope	2.40	12.69	86.69	FZ
Access Road	11	>100											74.2	1194	Forest	25	35	23.1	downslope	2.40	11.84	81.17	FZ
Access Road	12	>100											>100										
Access Road	13	70.7	1194	Forest	25	35	6.5	upslope	2.40	1.53	14.16	No	31.4	1194	Forest	25	35	31.6	downslope	2.40	21.21	142.07	FZ
Access Road	14	45.35	1194	Forest	25	35	3.79	downslope	2.40	3.12	24.46	No	71.5	1194	Forest	25	35	26.4	downslope	2.40	14.84	100.67	FZ
Access Road	15	48.8	1194	Forest	25	35	2.32	upslope	2.40	2.04	17.49	No	33.7	1194	Forest	25	35	22.8	downslope	2.40	11.53	79.18	FZ
Access Road	16	57.0	1194	Forest	25	35	7.5	downslope	2.40	4.02	30.35	No	53.6	1194	Forest	25	35	18.4	downslope	2.40	8.57	59.91	FZ
Access Road	17	80.1	1194	Forest	25	35	1.0	upslope	2.40	2.24	18.79	No	7.1	1194	Forest	25	35	1.4	downslope	2.40	2.65	21.44	FZ
Access Road	18	5.7	1194	Forest	25	35	3.3	upslope	2.40	1.91	16.60	FZ	7.7	1194	Forest	25	35	10.3	downslope	2.40	4.89	35.99	FZ
Access Road	19	>100											>100										
Access Road	20	62.9	1194	Forest	25	35	5.3	downslope	2.40	3.46	26.70	No	33.7	1194	Forest	25	35	8.6	downslope	2.40	4.34	32.39	No
Access Road	21																						
Access Road	22																						
Access Road	24	45.7	1194	Forest	25	35	13.6	upslope	2.40	0.94	10.31	No	61.9	934	Forest	25	35	19.1	downslope	2.40	8.94	62.33	FZ
Access Road	25																						
Access Road	26																						
Access Road	27																						
Access Road	28																						
Access Road	29																						
Access Road	30																						
Access Road	31	29.2	1194	Forest	25	35	7.3	downslope	2.40	3.97	30.02	FZ	24.0	1194	Forest	25	35	13.2	downslope	2.40	5.97	42.99	FZ
Access Road	32																						
Access Road	33																						
Access Road	35	35.3	934	Forest	25	35	5.1	downslope	2.40	3.41	26.35	No	33.5	934	Forest	25	35	2.4	upslope	2.40	2.03	17.42	No
Access Road	36	35.0	1194	Forest	25	35	11.3	downslope	2.40	5.24	38.28	FZ	29.7	934	Forest	25	35	6.3	upslope	2.40	1.56	14.33	No
Access Road	38	22.0	931	Forest	25	35	8.5	downslope	2.40	4.33	32.31	FZ	>100										
Access Road	39	14.7	1194	Forest	25	35	11.7	downslope	2.40	5.37	39.10	FZ	15.9	1194	Forest	25	35	15.6	downslope	2.40	7.05	50.00	FZ
Access Road	41																						
Access Road	42																						
Access Road	43																						
Access Road	44																						
Access Road	45	18.6	540	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No	>100										
Access Road	46																						
Access Road	47																						
Access Road	48	15.3	526	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No	11.8	540	Forest	25	35	23.7	downslope	2.40	12.29	84.11	FZ
Access Road	49																						
Access Road	50	18.8	1194	Forest	25	35	15.0	upslope	2.40	0.85	9.74	No	75.5	526	Forest	25	35	16.6	downslope	2.40	7.56	53.37	No
Access Road	52																						
Access Road	53	>100											73.7	934	Forest	25	35	13.7	downslope	2.40	6.19	44.40	FZ
Access Road	54	31.9	934	Forest	25	35	22.9	downslope	2.40	11.67	80.07	FZ	63.4	1194	Forest	25	35	32.5	downslope	2.40	22.65	151.46	FZ
Access Road	55																						
Access Road	56																						
Access Road	57																						
Access Road	58																						
Access Road	59																						
Access Road	60	29.8	1194	Forest	25	35	24.8	downslope	2.40	13.28	90.50	FZ	34.7	934	Forest	25	35	23.5	downslope	2.40	12.18	83.36	FZ
Access Road	61																						
Access Road	62																						
Access Road	63	48.6	934	Forest	25	35	6.9	downslope	2.40	3.87	29.35	No	30.9	1194	Forest	25	35	16.7	downslope	2.40	7.59	53.53	FZ
Access Road	64																						
Access Road	65	>100											27.2	1194	Forest	25	35	28.8	downslope	2.40	17.49	117.88	FZ
Access Road	66																						
Access Road	67	>100											12.5	1194	Forest	25	35	15.5	downslope	2.40	7.01	49.78	FZ
Transmission Line	1																						
Transmission Line	2																						
Transmission Line	3																						
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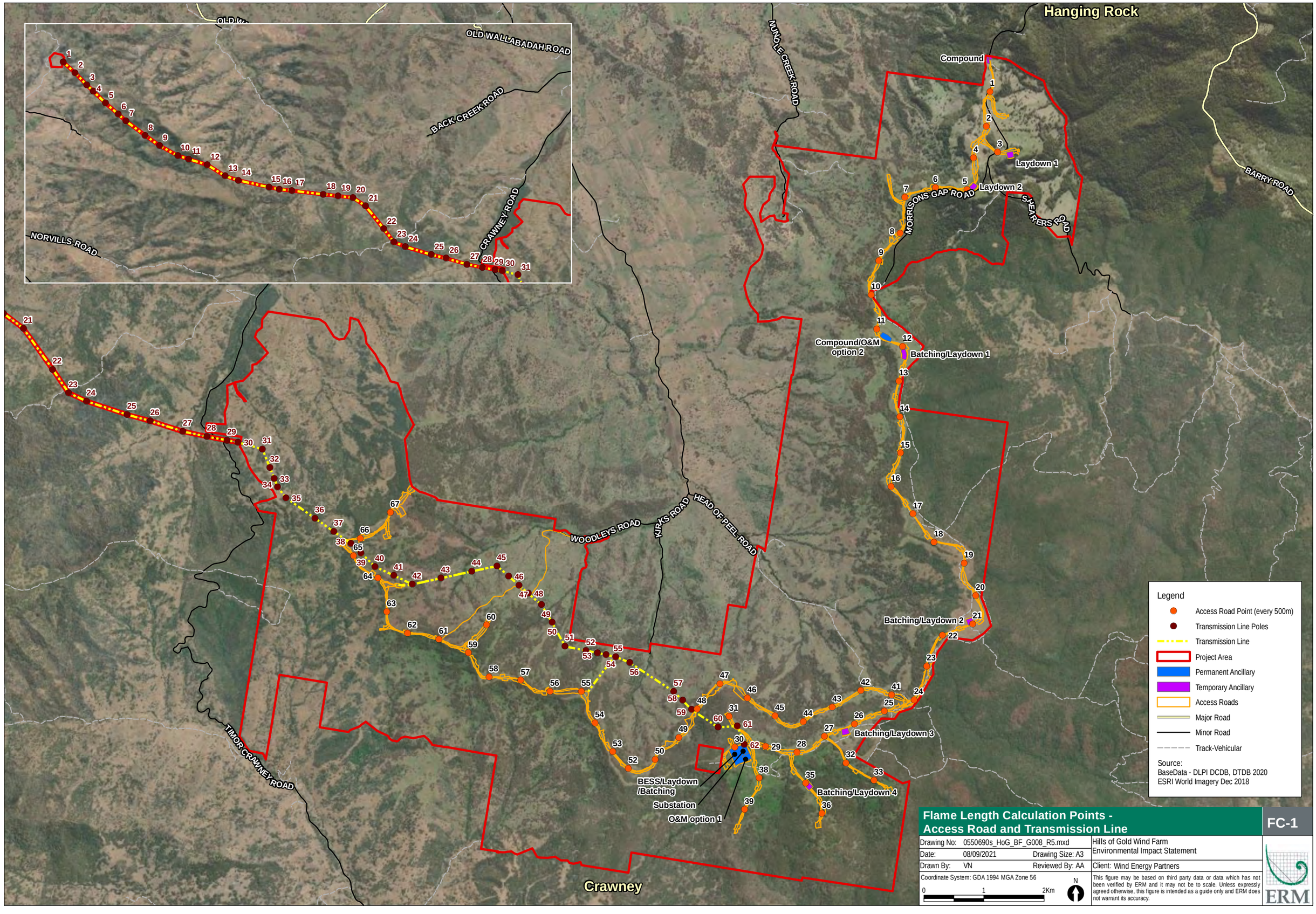

Flame Length Calculation Points - Access Road and Transmission Line

FC-1

Drawing No:	0550690s_HoG_BF_G008_R5.mxd		Hills of Gold Wind Farm Environmental Impact Statement
Date:	08/09/2021	Drawing Size: A3	
Drawn By:	VN	Reviewed By: AA	Client: Wind Energy Partners

Coordinate System: GDA 1994 MGA Zone 56

0 1 2Km

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ERM

APPENDIX D BEN HALLS GAP AND CRAWNEY PASS NATIONAL PARK FIRE MANAGEMENT STRATEGIES

Hunter Region
Ben Halls Gap National Park
Fire Management Strategy (Type 2)
2005
Sheet 1 of 1

This strategy should be used in conjunction with aerial photography and field reconnaissance during incidents and the development of incident action plans.

Published by the Department of Environment and Conservation (NSW), June, 2006.
Contact: NSW National Parks and Wildlife Service, Hunter Region, Locked Bag 99, Nelson bay DC, NSW 2315.
ISBN: 1 74137 823 0 **DEC Number: 2006/59** **Last Updated: 13/03/07**

Department of Environment and Conservation (NSW)

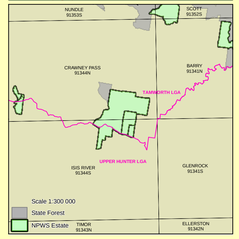
This strategy is a relevant Plan under Section 38 (4) and Section 44 (3) of Rural Fires Act 1997.

Endorsed by: **Date:** / /

Director Northern, Parks & Wildlife Division

Locality

Index
1:25 000 Topographic Map Sheets and Local Government Areas

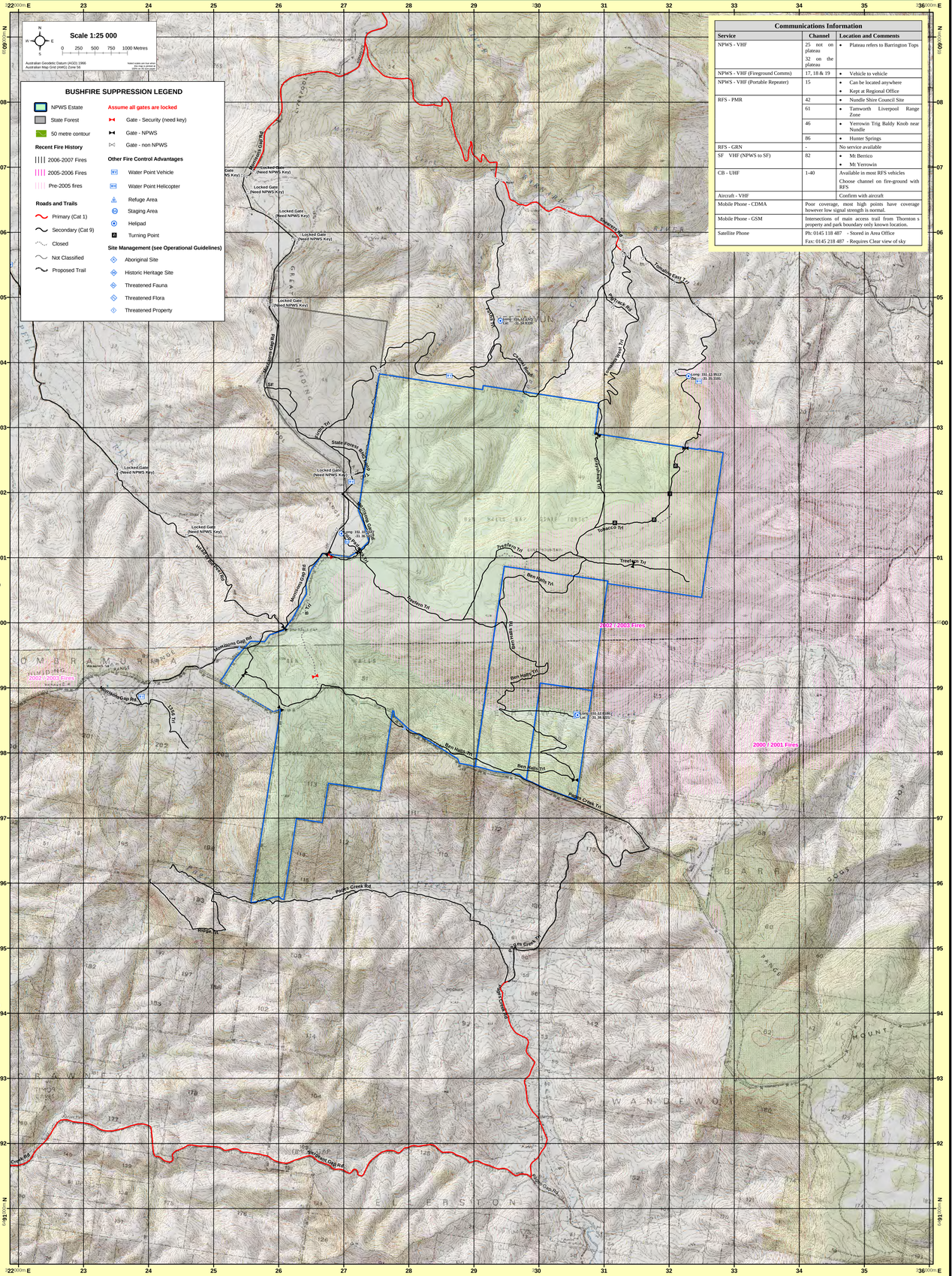


Operational Guidelines (continued)

Refer to current Fire Management Manual (updated annually) .
Brief all personnel involved in suppression operations on the following issues:

General	Guidelines
Earthmoving Equipment (NPWS FMM 4.2.20 & 4.3)	• Earthmoving equipment may only be used with the prior consent of a senior NPWS officer, and then only if the probability of its success is high. • Earthmoving equipment must be always guided and supervised by an experienced officer, and accompanied by a support vehicle. When engaged in direct or parallel attack this vehicle must be a fire/fighting vehicle. • Containment lines constructed by earthmoving equipment should consider the protection of drainage features, observe the Threatened Species and Cultural Heritage Operational Guidelines, and be surveyed, where possible, to identify unknown cultural heritage sites. • Earthmoving equipment must be washed down, where practicable, prior to it entering the park and surrounding properties due to the sensitivity of the area to *Phytopthora cinnamomi* and weed invasion.
Fire Advantage Recording	• All fire advantages used during wildfire suppression operations must be mapped as part of fire suppression final task checklist and where relevant added to the database.
Rehabilitation (NPWS FMM 5.1)	• Containment lines should be stabilised and rehabilitated as part of the wildfire suppression operation.
Smoke Management (NPWS FMM 3.4)	• The potential impacts of smoke and possible mitigation tactics must be considered when planning for wildfire suppression and prescribed burning operations. • There are no local public roads within 3km of the park.
Visitor Management (NPWS FMM 3.6 & 4.13)	• The reserve may be closed to the public during periods of extreme fire danger or during wildfire suppression operations.

Bushfire Suppression



Contact Information

Agency	Position / Location	Phone
NPWS	Hunter Region Duty Officer / After Hours	0429 144 880 016 301161 - Ask for Hunter Region Duty Officer -(during fire season only)
	Upper Hunter Area Manager	6540 2306 / 0429 144 876
	Fire Management Officer	4984 8206 / 0429 144 870
	Regional Operations Coordinator	4984 8212 / 0429 144 872
	Upper Hunter Area Office	6540 2300 / (fax) 6545 9475
	Hunter Region Office	4984 8200 / (fax) 4981 5913
RFS	Liverpool Range Zone Fire Control Tamworth Zone Fire Control Officer	6747 1493 / (fax) 6747 1489 24hr number 18000 811 66 67627641
NSW Fire Brigade	Emergency Newcastle Fire Brigades (24hr)	000 4929 7177 / (fax) 4927 2580
SES	Emergency Upper Hunter Division Murrurundi Unit Tamworth	000 6546 6080 / (fax) 6572 2312 67620711
Police	Emergency Nundle Station	000 6769 3344 (Diverts if unattended)
Ambulance	Emergency Bookings	000 131 233
Hospital	Murrurundi (Community Health) Tamworth Base Hospital	6546 6106 67677700
DOP	Newcastle	4929 4346 / (fax) 4929 6364 0412 258320 (AH)
DPI - Forests	Hunter Region Office Maitland Walcha Management Area	4931 6666 / (fax) 4927 8030 6777 2511 / (fax) 6777 2179
Council	Nundle Shire Council	6769 3205 / (fax) 6769 3114
Local Aboriginal Land Council	Wanaruah (Muswellbrook) Nungaroo (Quirindi)	6543 1288 / 6543 1962 6746 2356 / (fax) 6746 2670

Operational Guidelines

Refer to current Fire Management Manual (updated annually).
Brief all personnel involved in suppression operations on the following issues:

Resource	Guidelines
Aboriginal Cultural Heritage Site Management (NPWS FMM 4.11)	
A1	• As far as possible protect site from fire. • Do not cut down trees. • Use of foams, wetting agents & retardant is acceptable.
A2	• As far as possible protect site from fire. • Avoid ground disturbance including handtools, dozers. • Avoid water bombing which may cause ground disturbance.
A3	• Avoid ground disturbance including handtools, dozers. • Avoid water bombing which may cause ground disturbance. • Site may be burnt by wildfire, backburn, prescribed burn.
Historic Heritage Management (NPWS FMM 4.10)	**RCHMS: Regional Cultural Heritage Management Strategy.* • *In areas where the asset may be in or close to a water body, wetland or swamp, no foam or retardant is to be used.* • *Earth-moving machinery is to be used around, rather than over/through assets.*
HS1	• High RCHMS* priority. • Avoid fire, including wildfire, backburning & HR. • Avoid all water bombing activities.
HS2	• High RCHMS* priority. • Avoid fire, including wildfire, backburning & HR.
HS3	• High or low RCHMS* priority. • Heritage site unlikely to be effected by fire. • Danger to any fire crew activity. Avoid site at all costs.

Operational Guidelines (continued)

Refer to current Fire Management Manual (updated annually).
Brief all personnel involved in suppression operations on the following issues:

Resource	Guidelines
Historic Heritage Management (NPWS FMM 4.10)	**RCHMS: Regional Cultural Heritage Management Strategy.* • *In areas where the asset may be in or close to a water body, wetland or swamp, no foam or retardant is to be used.* • *Earth-moving machinery is to be used around, rather than over/through assets.*
HS4	• Low RCHMS* priority. • Avoid fire, including wildfire, backburning & HR. • Avoid all water bombing activities.
HS5	• Low RCHMS* priority. • Avoid fire, including wildfire, backburning & HR.
HS6	• High or low RCHMS* priority. • Heritage site unlikely to be effected by fire. • Avoid use of earth moving machinery.
HS7	• High or low RCHMS* priority. • Heritage site unlikely to be effected by fire. • Avoid use of earth moving machinery. • Avoid all water bombing activities.
Threatened Fauna Management (NPWS FMM 4.12 & 5.2)	
FA1	• Protect large and hollow bearing trees.
FA2	• Protect large and hollow bearing trees. • Avoid interfire intervals of < 10 yrs. • Avoid high intensity fires that consume tree canopies and fallen logs.
FA3	• Avoid interfire intervals of < 10 yrs.
FA4	• Habitat unlikely to be effected by fire. • Avoid use of earth moving machinery in wetland habitats. • Avoid use of retardant and foam in wetland habitats.
FA5	• Habitat unlikely to be effected by fire. • Avoid use of earth moving machinery in dune habitats.
FA6	• Avoid fire, including wildfire, backburning & HR, as far as possible in wetland habitat. • Avoid use of earth moving machinery in wetland habitats. • Avoid use of retardant and foam in wetland habitats.
FA7	• Avoid high intensity fires that consume tree canopies and fallen logs.
FA8	• Avoid fire, including wildfire, backburning & HR, as far as possible. • Avoid use of earth moving machinery.
Threatened Flora Management (NPWS FMM 4.12)	
FL1	• Avoid interfire intervals of < 10 yrs. • Avoid the use of earthmoving machinery. • Avoid the use of retardant.
FL2	• Avoid fire, including wildfire, backburn, HR, as far as possible. • Avoid the use of earthmoving machinery. • Avoid the use of retardant.
FL3	• Avoid high intensity fire. • Avoid interfire intervals <10 years, effect unknown. • Avoid the use of earth moving machinery.
FL4	• Avoid summer fire. • Avoid high intensity fire. • Avoid earth moving machinery.
FL5	• Avoid low intensity fire. • Avoid interfire intervals of < 5 yrs. • Avoid earth moving machinery. • Avoid the use of retardant.
Threatened Property	• Where possible property owners with assets at risk from a wildfire event should be kept informed regarding the progress of the fire; and asked for an assessment of their current level of asset protection preparedness. • There are very few assets near the reserve, however there are fences along most private property/reserve boundaries. These should be prepared to avoid damage when undertaking fire suppression activities.

Operational Guidelines (continued)

Refer to current Fire Management Manual (updated annually)
Brief all personnel involved in suppression operations on the following issues:

General	Guidelines
Aerial Water Bombing (NPWS FMM 4.4 / NSW Fire Agencies Aviation SOPs O2-4 / NPWS Guidelines for Effective Aircraft Management)	• The use of bombing aircraft should support containment operations by aggressively attacking hotspots and spot-overs. • The use of bombing aircraft without the support of ground based suppression crews should be limited to very specific circumstances. • Where practicable foam should be used to increase the effectiveness of the water. • Ground crews must be alerted to water bombing operations. • Fire retardant Phos Chek should not be used in heathland areas or swamps.
Aerial Ignition (NPWS FMM 4.2.20 & 4.4 / NSW Fire Agencies Aviation SOPs O2-4 / NPWS Guidelines for Effective Aircraft Management)	• Aerial ignition may be used during back-burning or fuel reduction operations where practicable, but only with the prior consent of a senior NPWS officer. • Utilise incendiaries to rapidly progress back-burns down slope where required.
Backburning (NPWS FMM 4.8)	• Temperature and humidity trends must be monitored carefully to determine the safest times to implement back-burns. Generally on steeper slopes, when the FDI is Very High or greater, backburning should commence when the humidity begins to rise in the late afternoon or early evening. This is particularly important on sideslope areas in and around the park as the high elevation and steep long runs will increase spotting distance. With a lower FDI backburning may be safely undertaken during the day. Backburning may be undertaken on the more gentle slopes of the plateau in the higher fire danger parts of the day. • Where practicable, clear a 1m radius around dead and fibrous barked trees adjacent to containment lines prior to backburning, or wet down these trees as part of the backburn ignition. • Avoid ignition of backburns at the bottom of slopes where a long and intense up slope burn is likely.
Command & Control (NPWS FMM 4.2)	• The first combatant agency on site may assume control of the fire, but then must ensure the relevant land management agency is notified promptly. • On the arrival of other combatant agencies, the initial incident controller will consult with the relevant land management agency in regard to the ongoing command, control and incident management team requirements as per the relevant BFMC Plan of Operations.
Fire Suppression Chemicals (NPWS FMM 4.2.20 & 4.9)	• Wetting and foaming agents (surfactants) are permitted for use in wildfire suppression. • The use of fire retardant is only permitted with the prior consent of the senior NPWS officer, and should not be used in rainforest, watercourses, dams, swamps and heathlands. • Exclude the use of surfactants and retardants within 50m of rainforest, watercourses, dams, heathlands and swamps and EECs. • Areas where fire suppression chemicals are used must be mapped and the used products name recorded.
Containment Lines (NPWS FMM 2.2 & 3.9)	• Construction of new containment lines should be avoided, where practicable, except where they can be constructed with minimal environmental impact. New containment lines require the prior consent of a senior NPWS officer. • Containment lines should not be constructed or maintained in or within 200m upstream of the of the Sphagnum Moss EECs within the park. • Where practicable, containment lines should be stabilised and rehabilitated as part of the wildfire suppression operation. • All containment lines not required for other purposes should be closed at the cessation of the incident. • All personnel involved in containment line construction should be provided with information on both natural and cultural heritage sites in the location to minimise the potential of damage.

Strategy Information

Fire Season Information	
Wildfires	• Due to high elevations and the associated temperate climatic conditions usually the potential for a large fire event is greatest between October and December. This period may extend into January/ February in more severe years.
Prescribed Burning (NPWS Fire Management Manual 4.7)	• General season is Autumn to late Winter. Burning is possible in early Spring.

Suppression Strategies	
Current FDR	**Forecast FDR**
Low - Mod	Low - Mod	• Undertake direct, parallel or indirect attack along existing containment lines.
Low - Mod	= > High	• Where practicable consider maximising the fire area in accordance with the requirements of any proposed prescribed burns. • In order to minimise the fire area and secure the flanks as soon as possible, undertake direct, parallel or indirect attack along the closest containment lines. • Pay particular attention to the flank on the next predicted down wind side.
High	All	• Identify and survey backup control lines. • Construct new control lines if necessary to minimise the time to contain the fire. • Undertake indirect attack along existing or newly constructed containment lines.
All	All	• Secure and deepen containment lines along the newly predicted downwind side of the fire. • Containment to the plateau will reduce the fire fighting effort. • If applicable consider broader than normal containment strategies to avoid wasted effort and high risk of failure. • Ensure there is sufficient time to secure containment lines prior to the fire impacting upon them; otherwise fall back to the next potential line.

Vegetation

Status of Fire Thresholds

Fire Thresholds	
Overburnt	Fire thresholds have been exceeded. • *Protect from fire as far as possible.*
Vulnerable	The area will be Overburnt if it burns this year. • *Protect from fire as far as possible.*
Recently Burnt	Time since fire is less than the optimal interval, but before that it was within threshold. • *Avoid fires if possible.*
Within Threshold	Fire history is within the threshold for vegetation in this area. • *A burn is neither required nor should one necessarily be avoided.*
Almost Underburnt	The area is close to its threshold and may become underburnt with the absence of fire. • *A prescribed burn may be advantageous. Consider allowing unplanned fires to burn.*
Underburnt	Fire frequency is below fire thresholds in the area. • *A prescribed burn may be advantageous. Consider allowing unplanned fires to burn.*
Unknown	Insufficient data to determine fire threshold.

NB. Fire thresholds are defined for vegetation communities to conserve biodiversity

Risk Management Information

Fire Management Zones	
Asset Protection Zones	The objective of **APZ**s is the protection of humn life and property. This will have precedence over guidelines for the management of biodiversity. Maintain Overall Fuel Hazard at Moderate or below.
Strategic Fire Advantage Zones	The objective of **SFAZ**s is to reduce fire intensity across lager areas. Maintain Overall Fuel Hazard at High or below, however adherence to guidelines for biodiversity will take precedence where practical.
Land Management Zones	The objective of **LMZ**s is to conserve biodiversity and protect cultural heritage. Manage fire consistent with fire thresholds.

Hunter Region
Crawney Pass National Park & Wallabadah Nature Reserve
Fire Management Strategy (Type 2) 2009

Sheet 1 of 1

This strategy should be used in conjunction with aerial photography and field reconnaissance during incidents and the development of incident action plans.

Published by the Department of Environment and Climate Change (NSW), *February 2009*.
Contact: NSW National Parks and Wildlife Service, *Hunter Region locked bag 99 Nelson Bay DC 2315*
ISBN: *978 1 741226546* **DECC Number:** *2007/542* **Last Updated:** *17/04/09*

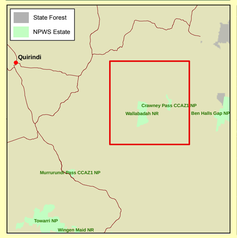
Department of Environment and Climate Change (NSW)

This strategy is a relevant Plan under Section 38 (4) and Section 44 (3) of Rural Fires Act 1997.

Endorsed by: **Date:** / /

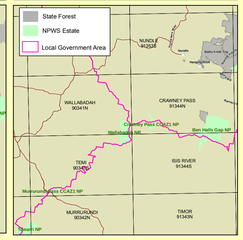
Director Northern, Parks & Wildlife Group

Locality



Index

1:25 000 Topographic Map Sheets and Local Government Areas



Contact Information

Agency	Position / Location	Phone
NPWS	Hunter Region Duty Officer (24hr)	0429 144880
	Upper Hunter Area Manager	65402306 / 0429144876
	Fire Management Officer	4984 8206 / 0429 144870
	Regional Operations Coordinator	4984 8212 / 0429 144872
	Upper Hunter Area Office	65402300 / (fax) 65459475
	Hunter Regional Office	4984 8200 / (fax) 4981 5913
RFS	Liverpool Range Fire Control Centre	0267471493 (24hr)
		1800 081166
	Tamworth Fire control Centre	67627641 (24hr)
NSW Fire Brigade	Emergency	000
	Newcastle Communications (24hr)	4929 7177 / (fax) 4927 2580
SES	Emergency	000
	Scone	65453300 / (fax) 65452160
Police	Emergency	000
	Scone	6544 0199 / (fax) 65453190
	Murrurundi	6546 6144
	Nundle	6769 3344
Ambulance	Emergency	000
	Bookings	131 233
Hospital	Scone	65402100
	Muswellbrook	65422000
	Murrurundi (no emergency section)	65469000
DPI - Forests	Hunter Region Office Maitland	4931 6519 / (fax) 4933 0772
		0429 491 868
Council	Upper Hunter Shire	65493700 / (fax) 65452671
	Liverpool Plains	65453696 (Ah)
	Tamworth Regional	
Local Aboriginal Land Council	Wanaruah	65431288
	Nungaroo	67462356 / (fax) 67462670

Operational Guidelines

Refer to Current Fire Management Manual (updated annually)
Brief all personnel involved in suppression operations on the following issues:

Resource	Guidelines
Aboriginal Cultural Heritage Site Management	
A1	☐ As far as possible protect site from fire. ☐ Do not cut down trees. ☐ Use of foams, wetting agents & retardant is acceptable.
A2	☐ As far as possible protect site from fire. ☐ Avoid ground disturbance including handtools, dozers. ☐ Avoid water bombing which may cause ground disturbance.
A3	☐ Avoid ground disturbance including handtools, dozers. ☐ Avoid water bombing which may cause ground disturbance. ☐ Site may be burnt by wildfire, backburn, prescribed burn.
Historic Heritage Management	☐ **HCHMS:* Regional Cultural Heritage Management Strategy. ☐ In areas where the asset may be in or close to a water body, wetland or swamp, no foam or retardant is to be used. ☐ Earth-moving machinery is to be used around, rather than over/through assets.
HS1	☐ High RCHMS* priority. ☐ Avoid fire, including wildfire, backburning & PB. ☐ Avoid all water bombing activities.

Operational Guidelines (continued)

Refer to Current Fire Management Manual (updated annually)
Brief all personnel involved in suppression operations on the following issues:

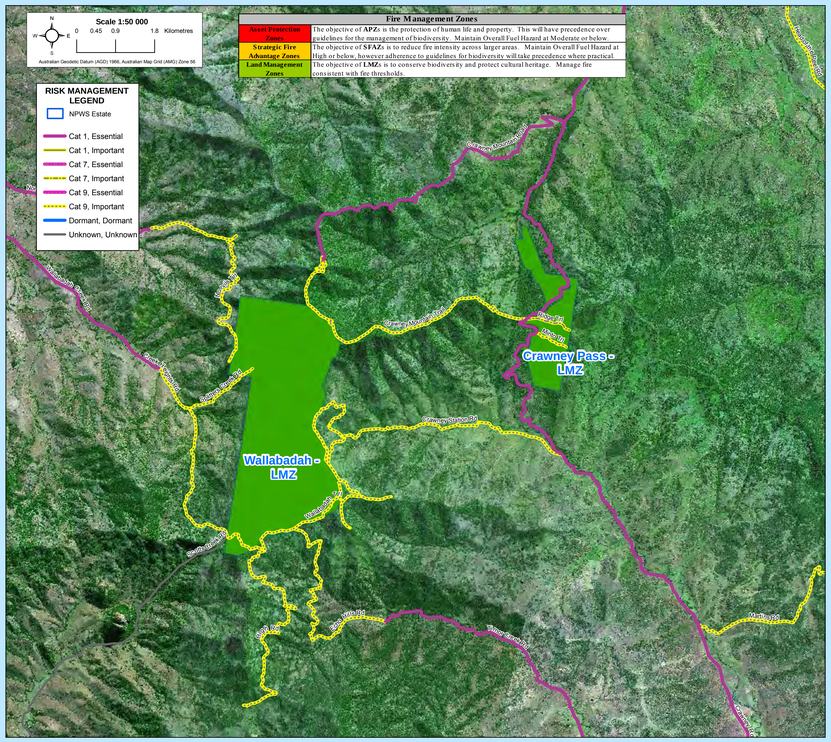
Resource	Guidelines
Historic Heritage Management (continued)	☐ **RCHMS:* Regional Cultural Heritage Management Strategy. ☐ In areas where the asset may be in or close to a water body, wetland or swamp, no foam or retardant is to be used. ☐ Earth-moving machinery is to be used around, rather than over/through assets.
HS2	☐ High RCHMS* priority. ☐ Avoid fire, including wildfire, backburning & PB.
HS3	☐ High or low RCHMS* priority. ☐ Heritage site unlikely to be effected by fire. ☐ Danger to any fire crew activity. Avoid site at all costs.
HS4	☐ Low RCHMS* priority. ☐ Avoid fire, including wildfire, backburning & PB. ☐ Avoid all water bombing activities.
HS5	☐ Low RCHMS* priority. ☐ Avoid fire, including wildfire, backburning & PB.
HS6	☐ High or low RCHMS* priority. ☐ Heritage site unlikely to be effected by fire. ☐ Avoid use of earth moving machinery.
HS7	☐ High or low RCHMS* priority. ☐ Heritage site unlikely to be effected by fire. ☐ Avoid use of earth moving machinery. ☐ Avoid all water bombing activities.
Threatened Fauna Management	
FA1	☐ Protect large and hollow bearing trees.
FA2	☐ Protect large and hollow bearing trees. ☐ Avoid interfire intervals of < 10 yrs. ☐ Avoid high intensity fires that consume tree canopies and fallen logs.
FA3	☐ Avoid interfire intervals of < 10 yrs.
FA4	☐ Habitat unlikely to be effected by fire. ☐ Avoid use of earth moving machinery in wetland habitats. ☐ Avoid use of retardant and foam in wetland habitats.
FA5	☐ Habitat unlikely to be effected by fire. ☐ Avoid use of earth moving machinery in dune habitats.
FA6	☐ Avoid fire, including wildfire, backburning & HR, as far as possible in wetland habitat. ☐ Avoid use of earth moving machinery in wetland habitats. ☐ Avoid use of retardant and foam in wetland habitats.
FA7	☐ Avoid high intensity fires that consume tree canopies and fallen logs.
FA8	☐ Avoid fire, including wildfire, backburning & HR, as far as possible. ☐ Avoid use of earth moving machinery.
Threatened Flora Management	
FL1	☐ Avoid interfire intervals of< 10 yrs. ☐ Avoid the use of earthmoving machinery. ☐ Avoid the use of retardant.
FL2	☐ Avoid fire, including wildfire, backburn, prescribed burning, as far as possible. ☐ Avoid the use of earthmoving machinery. ☐ Avoid the use of retardant.
FL3	☐ Avoid high intensity fire. ☐ Avoid interfire intervals <10 years, effect unknown. ☐ Avoid the use of earth moving machinery.
FL4	☐ Avoid summer fire. ☐ Avid high intensity fire. ☐ Avoid earth moving machinery.
FL5	☐ Avoid low intensity fire. ☐ Avoid interfire intervals of < 5 yrs. ☐ Avoid earth moving machinery. ☐ Avoid the use of retardant.

Operational Guidelines (continued)

Refer to Current Fire Management Manual (updated annually)
Brief all personnel involved in suppression operations on the following issues:

Threatened Property	☐ Where possible property owners with assets at risk from a wildfire event should be kept informed regarding the progress of the fire; and asked for an assessment of their current level of asset protection preparedness.
General	**Guidelines**
Aerial Water Bombing (NPWS FMM / NSW Fire Agencies Aviation SOPs O2 / NPWS Guidelines for Effective Aircraft Management)	☐ The use of bombing aircraft should support containment operations by aggressively attacking hotspots and spot-overs. ☐ The use of bombing aircraft without the support of ground based suppression crews should be limited to very specific circumstances. ☐ Where practicable foam should be used to increase the effectiveness of the water. ☐ Ground crews must be alerted to water bombing operations. ☐ Take note of powerlines
Aerial Ignition (NPWS FMM / NSW Fire Agencies Aviation SOPs O2-4 / NPWS Guidelines for Effective Aircraft Management)	☐ Aerial ignition may be used during back-burning or fuel reduction operations where practicable, but only with the prior consent of a senior NPWS officer. ☐ Utilise incendiaries to rapidly progress back-burns down slope where required. ☐ Take note of powerlines
Backburning (NPWS FMM)	☐ Temperature and humidity trends must be monitored carefully to determine the safest times to implement back-burns. Generally, when the FDI is Very High or greater, backburning should commence when the humidity begins to rise in the late afternoon or early evening. With a lower FDI backburning may be safely undertaken during the day. ☐ Where practicable, clear a 1m radius around dead and fibrous barked trees adjacent to containment lines prior to backburning, or wet down these trees as part of the backburn ignition. ☐ Avoid ignition of backburns at the bottom of slopes where a long and intense up slope burn is likely. ☐ Brief all involved personnel on the location of cultural sites and threatened species prior to backburning, and adhere to the above guidelines.
Command & Control (NPWS FMM)	☐ The first combatant agency on site may assume control of the fire, but then must ensure the relevant land management agency is notified promptly. ☐ On the arrival of other combatant agencies, the initial incident controller will consult with regard to the ongoing command, control and incident management team requirements as per the relevant BFMC Plan of Operations.
Containment Lines (NPWS FMM)	☐ Construction of new containment lines should be avoided, where practicable, except where they can be constructed with minimal environmental impact. New containment lines require the prior consent of a senior NPWS officer. ☐ Where practicable, containment lines should be stabilised and rehabilitated as part of the wildfire suppression operation. ☐ All containment lines not required for other purposes should be closed and rehabilitated at the cessation of the incident. ☐ All personnel involved in containment line construction should be briefed on both natural and cultural heritage sites in the location.
Smoke Management (NPWS FMM)	☐ The potential impacts of smoke and possible mitigation tactics must be considered when planning for wildfire suppression and prescribed burning operations. ☐ If smoke becomes a hazard on local roads or highways, the police and relevant media must be notified. ☐ Smoke management must be in accordance with relevant RTA traffic management guidelines.

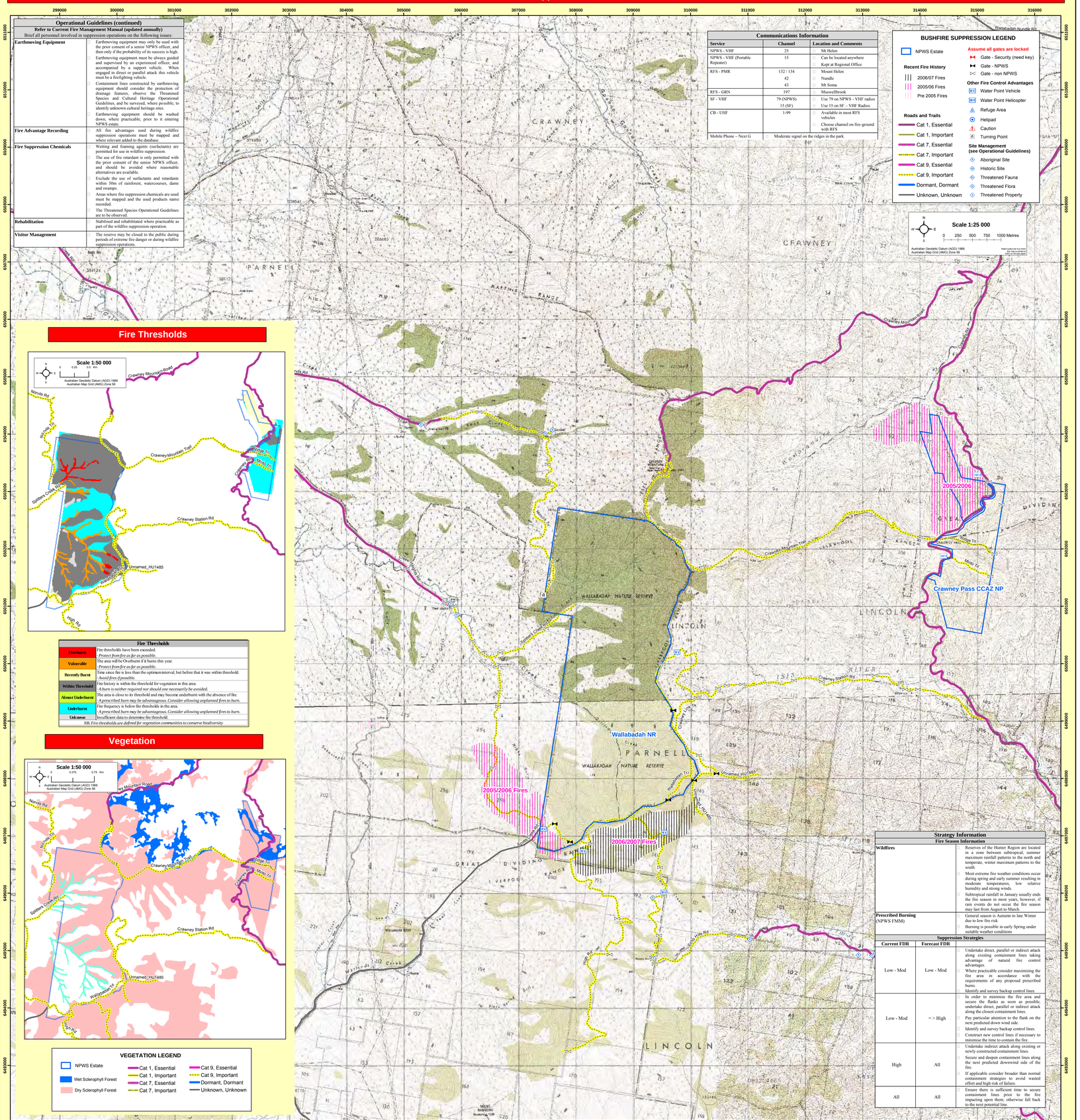
Risk Management Information



Fire Management Zones

Asset Protection Zones	The objective of **APZs** is the protection of human life and property. This will have precedence over guidelines for the management of biodiversity. Maintain Overall Fuel Hazard at Moderate or below.
Strategic Fire Advantage Zones	The objective of **SFAZs** is to reduce fire intensity across larger areas. Maintain Overall Fuel Hazard at High or below, however adherence to guidelines for biodiversity will take precedence where practical.
Land Management Zones	The objective of **LMZs** is to conserve biodiversity and protect cultural heritage. Manage fire consistent with fire thresholds.

Bushfire Suppression



Operational Guidelines (continued)

Refer to Current Fire Management Manual (updated annually)
Brief all personnel involved in suppression operations on the following issues:

Earthmoving Equipment	☐ Earthmoving equipment may only be used with the prior consent of a senior NPWS officer, and then only if the probability of its success is high. ☐ Earthmoving equipment must be always guided and supervised by an experienced officer, and accompanied by a support vehicle. When engaged in direct or parallel attack this vehicle must be a firefighting vehicle. ☐ Containment lines constructed by earthmoving equipment should consider the protection of drainage features, observe the Threatened Species and Cultural Heritage Operational Guidelines, and be surveyed, where possible, to identify unknown cultural heritage sites. ☐ Earthmoving equipment should be washed down, where practicable, prior to it entering NPWS estate.
Fire Advantage Recording	☐ All fire advantages used during wildfire suppression operations must be mapped and where relevant added to the database.
Fire Suppression Chemicals	☐ Wetting and foaming agents (surfactants) are permitted for use in wildfire suppression. ☐ The use of fire retardant is only permitted with the prior consent of the senior NPWS officer, and should be avoided where reasonable alternatives are available. ☐ Exclude the use of surfactants and retardants within 50m of rainforest, watercourses, dams and swamps. ☐ Areas where fire suppression chemicals are used must be mapped and the used products name recorded. ☐ The Threatened Species Operational Guidelines are to be observed.
Rehabilitation	☐ Stabilised and rehabilitated where practicable as part of the wildfire suppression operation.
Visitor Management	☐ The reserve may be closed to the public during periods of extreme fire danger or during wildfire suppression operations.

Communications Information

Service	Channel	Location and Comments
NPWS - VHF	25	☐ Mt Helen
NPWS - VHF (Portable Repeater)	15	☐ Can be located anywhere ☐ Kept at Regional Office
RFS - PMR	132 / 134	☐ Mount Helen
	42	☐ Nundle
	43	☐ Mt Soma
RFS - GRN	197	☐ Muswellbrook
SF - VHF	79 (NPWS)	☐ Use 79 on NPWS - VHF radios
	15 (SF)	☐ Use 15 on SF – VHF Radios
CB - UHF	1-99	☐ Available in most RFS vehicles ☐ Choose channel on fire-ground with RFS
Mobile Phone – Next G		☐ Moderate signal on the ridges in the park.

BUSHFIRE SUPPRESSION LEGEND

NPWS Estate

Recent Fire History
2006/07 Fires
2005/06 Fires
Pre 2005 Fires

Roads and Trails
Cat 1, Essential
Cat 1, Important
Cat 7, Essential
Cat 7, Important
Cat 9, Essential
Cat 9, Important
Dormant, Dormant
Unknown, Unknown

Assume all gates are locked
Gate - Security (need key)
Gate - NPWS
Gate - non NPWS

Other Fire Control Advantages
Water Point Vehicle
Water Point Helicopter
Refuge Area
Helipad
Caution
Turning Point

Site Management (see Operational Guidelines)
Aboriginal Site
Historic Site
Threatened Fauna
Threatened Flora
Threatened Property

Scale 1:25 000
0 250 500 750 1000 Metres
Australian Geodetic Datum (AGD) 1966
Australian Map Grid (AMG) Zone 56

Fire Thresholds

Fire Thresholds	
Overburnt	Fire thresholds have been exceeded. *Protect from fire as far as possible.*
Vulnerable	The area will be Overburnt if it burns this year. *Protect from fire as far as possible.*
Recently Burnt	Time since fire is less than the optimum interval, but before that it was within threshold. *Avoid fires if possible.*
Within Threshold	Fire history is within the threshold for vegetation in this area. *A burn is neither required nor should one necessarily be avoided.*
Almost Underburnt	The area is close to its threshold and may become underburnt with the absence of fire. *A prescribed burn may be advantageous. Consider allowing unplanned fires to burn.*
Underburnt	Fire frequency is below fire thresholds in the area. *A prescribed burn may be advantageous. Consider allowing unplanned fires to burn.*
Unknown	Insufficient data to determine fire threshold.
NB. Fire thresholds are defined for vegetation communities to conserve biodiversity	

Vegetation

Strategy Information

Fire Season Information

Wildfires	☐ Reserves of the Hunter Region are located in a zone between subtropical, summer maximum rainfall patterns to the north and temperate, winter maximum patterns to the south. ☐ Most extreme fire weather conditions occur during spring and early summer resulting in moderate temperatures, low relative humidity and strong winds. ☐ Subtropical rainfall in January usually ends the fire season in most years, however, if rain events do not occur the fire season may last from August to March.
Prescribed Burning (NPWS FMM)	☐ General season is Autumn to late Winter due to low fire risk ☐ Burning is possible in early Spring under suitable weather conditions

Suppression Strategies

Current FDR	Forecast FDR	
Low - Mod	Low - Mod	☐ Undertake direct, parallel or indirect attack along existing containment lines taking advantage of natural fire control advantages. ☐ Where practicable consider maximising the fire area in accordance with the requirements of any proposed prescribed burns. ☐ Identify and survey backup control lines.
Low - Mod	= > High	☐ In order to minimise the fire area and secure the flanks as soon as possible, undertake direct, parallel or indirect attack along the closest containment lines. ☐ Pay particular attention to the flank on the next predicted down wind side. ☐ Identify and survey backup control lines. ☐ Construct new control lines if necessary to minimise the time to contain the fire.
High	All	☐ Undertake indirect attack along existing or newly constructed containment lines. ☐ Secure and deepen containment lines along the next predicted downwind side of the fire. ☐ If applicable consider broader than normal containment strategies to avoid wasted effort and high risk of failure.
All	All	☐ Ensure there is sufficient time to secure containment lines prior to the fire impacting upon them; otherwise fall back to the next potential line.

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