Appendix O. Bushfire assessment

Shoalhaven Hydro Expansion Project - Main Works Environmental Impact Statement

SSI-10033

Origin Energy Eraring Pty Ltd

November 2022

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Shoalhaven Hydro Expansion Project - Main Works

Bushfire assessment

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Executive summary

Origin Energy Eraring Pty Ltd (Origin) proposes to develop the Shoalhaven Hydro Expansion Project, to construct and operate a new pumped hydro power station on and under the land between the Fitzroy Falls Reservoir and Lake Yarrunga (the Project). The Project is located within the Wingecarribee and Shoalhaven Local Government Areas in New South Wales.

This assessment forms part of the Environmental Impact Statement for the Project, which has been prepared under Division 5.2 of the *Environmental Planning and Assessment Act 1979*. This assessment has been prepared to address the Secretary's Environmental Assessment Requirements relating to public safety associated with bushfire risks and will assist the Minister for Planning to make a determination on whether or not to approve the Project.

The Project is to be carried out in the Wingecarribee and Shoalhaven Local Government Areas, located within a heavily vegetated area that is classified as bushfire prone land. Most of the vegetation surrounding the Project area is Category 1 high bush fire risk vegetation under the *Planning for Bushfire Protection 2019* mapping. There are some lower risk areas associated with rainforest (Category 2) and cleared areas (Category 3).

Historical fire weather

Bushfires occur frequently in the landscape surrounding the Project area. Sixty bushfires are recorded to have occurred within 10 km of the Project area since 1975. Five of these fires have impacted the Project area. Prescribed burns are also a common occurrence with an average of over 167 hectares being burnt per year within 10 km of the Project since 1975.

The area experiences a warm temperate climate with warm and relatively wet summers and cooler and drier winters. Although the climate is relatively mild, days with maximum temperatures exceeding 40°C occur occasionally between the months of October and March, inclusive. The generally mild climate typically moderates fire weather conditions. The bushfire season generally runs between October and March but may commence several months earlier under dry conditions. Highly elevated fire weather conditions may occur during this period, particularly on days with north-easterly or easterly winds, high temperatures and low humidity. Days with severe fire danger ratings or greater occur about four times each year, on average. The frequency of such days is projected to increase in response to projected climate change over the operating life of the Project.

Projected fire weather

Climate change modelling undertaken for this assessment (under the high emissions RCP8.5 scenario) suggests that the main projected changes in climate for the region are an increased temperature and decreased cool season rainfall. With warmer and drier conditions, bushfire fuel availability is expected to be slightly greater at the commencement of the fire danger period (October) than is currently the case. Combined, these projections indicate that bushfire weather will become harsher. The average Forest Fire Danger Index is projected to increase slightly. Days with dangerous fire weather conditions are projected to become more frequent and occur through more months of the year. Days with severe Fire Danger Ratings are projected to occur between September and April by about 2050 under the high emissions Representative Concentration Pathway (RCP) 8.5 scenario. Catastrophic fire weather conditions could occur from October to March compared with only March, November, and December historically.

Fire management zoning

Bushfire management arrangements for the Project region are described in the Morton National Park Fire Management Strategy (2006) and the Shoalhaven Bushfire Management Committee's Bushfire Risk Management Plan (2018).

These documents identify the Kangaroo Valley Power Station as well as the Bendeela pondage area and associated infrastructure as Strategic Fire Advantage Zones. These zones are strategically placed and managed to provide an advantage for fire fighters in containing and suppressing wildfires. Fire frequency may occur towards the lower thresholds necessary to conserve biodiversity.

Bushfire attack level assessment

Should vegetation in the vicinity of the Project area be ignited in a bushfire, it would potentially expose Project infrastructure to flames, radiant heat and embers. The level of exposure to bushfire (bushfire attack level) can be calculated using the method outlined in the *Planning for Bushfire Protection 2019* in conjunction with *Australian Standard 3959:2018 Construction of building in bushfire prone areas.* The setbacks for different bushfire attack levels were calculated from the edge of the construction footprint surrounding the Kangaroo Valley Power Station. This is the only area where new infrastructure is proposed that is considered necessary to manage the radiant heat exposure

Bushfire risk scenarios

Two bushfire scenarios that may affect the Project have been identified by this assessment:

- Scenario 1 Off-site ignition: A fire ignites in or burns into the vegetation surrounding the Project area on a day of elevated fire danger. Under such conditions, embers and smoke carry towards/into the Project area and infrastructure and any personnel present would potentially be exposed to flames and radiant heat
- Scenario 2 On-site ignition: Electrical equipment failure or hot works associated with the Project results in fire ignition within the Project area. Fire escapes into surrounding vegetation. This fire may be contained and remain small or spread under high-risk conditions in the following days. Appropriate measures must be in place to mitigate the bushfire risks from and to the Project, particularly those associated with these scenarios.

Potential impacts

The potential bush fire related impacts considered in association with the Project include:

- Fire ignition
- Landscape fire
- Presence of Project infrastructure could affect suppression efforts for landscape fires
- Presence of Project infrastructure may affect bushfire fuel management.

Bushfire protection measures

The main bushfire protection measures that have application to construction and operation of the Project are:

- *Asset Protection Zones (APZ):* provide a buffer zone between a bushfire hazard and buildings or other structures. APZ are managed to minimise fuel loads and reduce radiant heat levels, flame, ember, and smoke attack. They help to provide a defendable space for firefighters and other emergency services personnel responding to a fire event and reduce opportunities for any fire igniting on site to escape to surrounding areas.
- *Siting and construction of sensitive infrastructure:* buildings and other infrastructure and any hazardous material storage areas with sensitivity to radiant heat exposure will generally be provided with an Asset Protection Zone and where possible constructed in accordance with the relevant Bushfire Attack Level as per the *National Construction Code* and *Planning for Bushfire Protection 2019.* Where such construction is not possible due to conflicts with infrastructure function, design will aim to maximise the resilience of the infrastructure to bushfire where practicable.
- *Access roads:* which provide safe operational access to and within the Project area for emergency services personnel. Access roads will also provide safe egress for site personnel in case of a bushfire or other emergency.
- *Fire water supply:* access to water for fire suppression and/or protection of structures or equipment located on site will be provided.
- *Emergency and evacuation planning* would be addressed with other hazards as part of the contractor's and operator's site emergency management planning.

It is recommended that Asset Protection Zones are implemented to safeguard fire sensitive infrastructure. The final location of infrastructure will be determined during the detailed design process. Design will aim to maximise the resilience of all infrastructure to bushfire where practicable.

Contents

Appendices

Tables

Figures

Glossary and terms

Term	Definition
°C	Degrees centigrade
%	Per cent
ABS	Australian Bureau of Statistics
APZ	Asset Protection Zone
BAL	Bushfire Attack Level
BFMCs	Bush Fire Management Committees
BPL	Bushfire prone land
CMIP5	Coupled Model Intercomparison Project Phase 5
CMIP6	Coupled Model Intercomparison Project Phase 6
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act 1979*
ERP	Emergency Response Plan
Existing scheme	The existing Shoalhaven Pumped Hydro Energy Storage Scheme (owned and operated by Origin).
F&R NSW	Fire and Rescue NSW
FDR	Fire danger rating
FEA	Fire exclusion area
FFDI	Forest Fire Danger Index
ha	Hectares
HMZ	Heritage Management Zone
hr	Hour
IPCC	International Panel on Climate Change
ISSC	The NSW Electricity Industry Safety Steering Committee
Kangaroo Valley construction footprint	the construction footprint surrounding the Kangaroo Valley Power Station
Km	Kilometres
LGAs	Local government areas
Lower scheme	The Lower Scheme refers to works carried out at Kangaroo Valley portal, tail race portal, Laydown Area 7 and spoil emplacement area and traffic between portals and storage/spoil sites.
m	Metres
ML	Megalitres
mm	Millimetre
MW	Megawatt
MNP Fire Management Strategy	Morton National Park Fire Management Strategy 2006
NCC	National Construction Code
NEM	National Energy Market
NPWS	NSW National Parks and Wildlife Service
NSW	New South Wales
Origin	Origin Energy Eraring Pty Ltd

Term	Definition
PBP	Planning for Bushfire Protection 2019
Penstock	A water transfer pipeline and associated infrastructure also referred to as a pipeline
Project	Shoalhaven Hydro Expansion Project
RCP	Representative Concentration Pathways
RFS	Rural Fire Service
SBFMC BFRMP	Shoalhaven Bushfire Management Committee's Bushfire Risk Management Plan
SEARs	Secretary's Environmental Assessment Requirements
SFAZ	Strategic Fire Asset Zone
TOBANs	Total fire bans
Upper Scheme	The Upper Scheme refers to works carried out above Kangaroo Valley portal revolving around site access improvements, upper laydown works, pipeline installation and shaft boring.

1. Introduction

1.1 Project overview

Origin Energy Eraring Ltd (Origin) proposes to develop the Shoalhaven Hydro Expansion Project, to construct and operate a new pumped hydro power station on and under the land between the Fitzroy Falls Reservoir and Lake Yarrunga (the Project). The Project would draw on Origin's existing water allocations to pump water up from Lake Yarrunga consuming energy when it is in less demand. Energy would then be generated through the return of water from Fitzroy Falls Reservoir to Lake Yarrunga when demand for energy increases.

The Project would involve almost doubling the electricity generation capacity of the existing scheme, providing an approximate additional 235 megawatts (MW) of generation capacity. The operation of the scheme would respond to the needs of the National Energy Market (NEM) and involving up to one pumping and generation cycle per day. Each generation cycle is anticipated to involve up to 8 hours of generation and 16 hours of pumping, each of which could be divided into shorter durations to best satisfy the needs of the NEM.

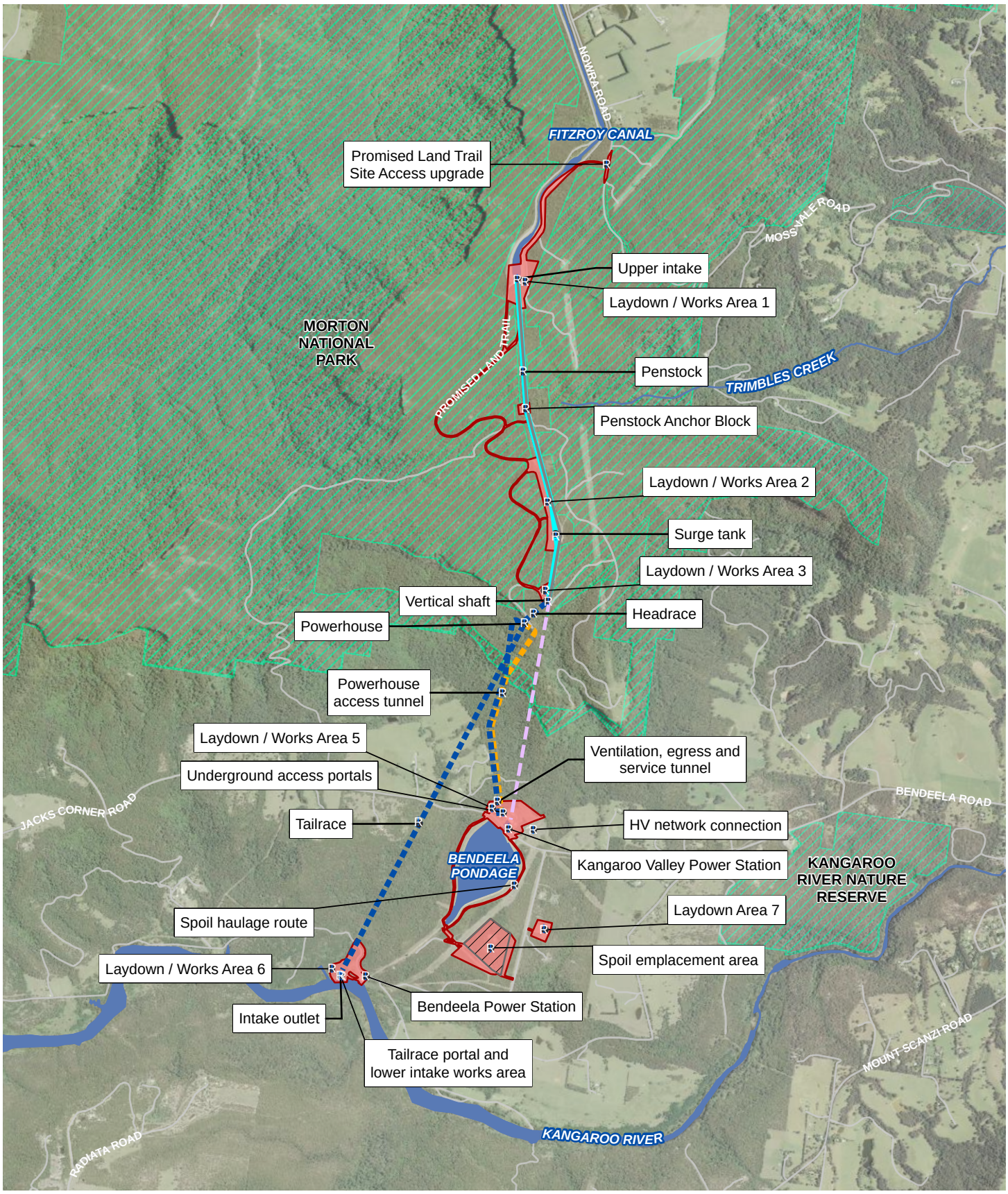
The Project is located in the New South Wales (NSW) Southern Highlands, approximately 150 kilometres (km) southeast of Sydney. An indicative Project layout based on the current reference design is provided in **Figure 1-1** and consists of the construction and operation of:

- Upper scheme components (Upper Scheme) including:
  - Connection to existing upper intake control structure at the southern end of the Fitzroy Canal
  - A surface penstock (water transfer pipeline and associated infrastructure) from the existing Fitzroy Canal control structure to the vicinity of the Existing Scheme surge tank
  - A new surge tank adjacent to the Existing Scheme surge tank
  - A further section of surface penstock, adjacent to the Existing Scheme, from the new surge tank to the high pressure shaft
- Underground works including:
  - Vertical shaft and headrace tunnel connecting to the southern end of Upper Scheme surface penstock to an underground power station
  - An underground power station cavern housing a transformer, reversible motor generator and pump turbine capable of supplying a nominal 235 MW of hydroelectric power
  - Associated access tunnel and multipurpose (egress, ventilation and services) tunnel with an entrance in the vicinity of the existing Kangaroo Valley Power Station
  - A tailrace tunnel, including an underground surge chamber located just downstream of the underground power station, terminating west of the existing Bendeela Power Station on Lake Yarrunga
- Lower scheme surface components (Lower Scheme) including:
  - Lower intake /outlet structure west of the Bendeela Power Station connected to the tailrace tunnel
  - Spoil emplacement facility east of Bendeela Pondage
  - High voltage network connection to existing Kangaroo Valley substation
  - Operational surface infrastructure including administration building, water treatment infrastructure and ventilation building.

The Project would also require ancillary works which may include the carrying out of works to upgrade or construct access roads, spoil disposal sites, utilities infrastructure, construction compounds and construction power and water supply.

The Shoalhaven Hydro Expansion Project essentially duplicates the existing scheme and as such, the Project does not propose any new water storages or connections between waterbodies that have not already been utilised for the existing scheme. In addition, no transmission line augmentations are required to receive or distribute electricity from the existing Kangaroo Valley Power Station substation.

A full Project description is provided in Chapter 3 of the Environmental Impact Statement (EIS).



Legend

- Points of interest
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Project area
- Spoil site
- Waterway
- Road
- NPWS Reserve
- Waterbody

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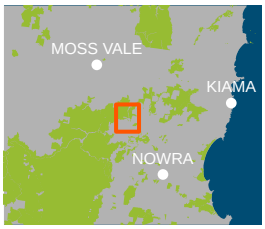

Data sources

Jacobs 2022
Department of Planning and Environment 2022
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Figure 1-1 Indicative Project layout

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1.2 Project location

The Project location as shown in **Figure 1-2** occurs in the Wingecarribee and Shoalhaven Local Government Areas (LGAs). Access to the upper portion of the Project on the plateau, for penstock, surge tank and vertical shaft construction would be via the Promised Land Trail. The Promised Land Trail is accessed from Moss Vale Road and traverses both WaterNSW land and the Morton National Park and was constructed as part of the original scheme. Access to the lower portion of the Project within Kangaroo Valley would be via Bendeela Road from Moss Vale Road in the vicinity of the townships of Kangaroo Valley and Barrengarry.

The Project is in close proximity to:

- The existing Shoalhaven Pumped Hydro Energy Storage Scheme (the existing scheme), which was commissioned in 1977 and is currently used to generate electricity and pumping facilities
- The Morton and Budawang National Parks, which comprises an area of over 194,193 ha on the eastern escarpment of the Southern Tablelands
- The Bendeela Recreation Area, located on the northern bank of Lake Yarrunga directly to the east of the Bendeela Power Station and consists of a popular, serviced campground operated by WaterNSW on WaterNSW land
- Communities and townships within the zone of influence of the Project, including Barrengarry, Kangaroo Valley, Fitzroy Falls, Wildes Meadow and Avoca. Surrounding landholdings are rural in nature and include isolated dwellings to the east and west of the Project and accessed off Bendeela Road and Jacks Corner Road some supporting holiday type uses (retreats and wedding venues)
- The Scots Collage Glengarry Campus, which is located approximately 500 m to the west of the proposed outlet works.

1.3 Secretary's Environmental Assessment Requirements

This assessment forms part of the EIS for the Project. The EIS has been prepared under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This assessment has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) relating to bushfire risks and will assist the Minister for Planning to make a determination on whether or not to approve the Project.

Table 1-1 outlines the SEARs relevant to this assessment along with a reference to where these are addressed.

Table 1-1. SEAR relevant to bushfire risk

Secretary's requirement	What is addressed in this report
Public Safety – including an assessment of the risks to public safety, paying particular attention to bushfire and flooding risks, emergency egress and evacuation, and the handling and use of any dangerous goods	Assessment of bushfire risks is provided in this report. Refer to separate reports for assessment of other public safety risks.

1.4 Structure of this report

The structure and content of this report are outlined in **Table 1-2**.

Table 1-2. Structure and content

Chapter	Description
Chapter 1 Introduction	Outlines key elements of the Project, SEARs and the purpose of this report (this Chapter).
Chapter 2 Policy and planning setting	Provides an outline of the statutory context, including applicable legislation and planning policies.
Chapter 3 Bushfire risk factors	Provides an analysis of potential bushfire risk factors (i.e. existing conditions) to the Project.
Chapter 4 Potential bushfire impacts	Consideration of the potential impacts and risks associated with the Project.
Chapter 5 Bushfire protection measures	Provides a recommendation of potential bushfire protection measures to address bushfire impacts/risk of the Project.

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Legend

- Points of interest
- Project area
- Project location
- NPWS Reserve
- State Forest

0 5 10 km

1:300,000 at A4

GDA2020 MGA Zone 56

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Data sources

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Figure 1-2 Project location

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2. Legislative and policy context

Legislation applicable to the bushfire management of this Project is outlined in this section.

2.1 State legislation

2.1.1 Work Health and Safety Act 2011

The *NSW Work Health and Safety Act 2011* (and Commonwealth legislation, the *Cth Work Health and Safety Act 2011*) provides a framework for protection of the health and safety of people at work, and those who may be affected by such work. Under the Act, employers have the primary responsibility to ensure (so far as reasonably practicable) the safety of workers, and the general public, at a workplace. This includes ensuring, so far as reasonably practicable, from bushfire-related risks during construction and operation of the Project.

2.1.2 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) restricts the granting of development consent on bushfire-prone land (BPL) unless the proposed development conforms with the requirements of *Planning for Bush Fire Protection* (PBP) (NSW RFS, 2019). Critical state significant infrastructure (such as this Project) does not require development consent under Part 5 of the Act and therefore is not subject to this requirement. However, the SEARs issued by the Secretary for this Project require an assessment of public safety risks with particular attention to bushfire risk. The application of PBP is nevertheless considered in this assessment as detailed in **Section 2.2.1**.

Local government area Bush Fire Management Committees (BFMCs) maintain and update maps of BPL in their regions.

2.1.3 Rural Fires Act 1997

The objectives of the *Rural Fires Act 1997* are to prevent bushfires and protect people, built assets and natural assets from fire damage. The Act provides for the designation of Neighbourhood Safer Places, where people may find shelter from a bushfire. It also provides for the designation and maintenance of fire trails.

The Act states that it is the duty of public authorities, landowners, and occupiers to take all notified and practical steps to prevent bushfire ignition and minimise spread on their land. Trees that are reasonably necessary for protection of threatened species may be retained in fire breaks. Permits are required to light fires for bushfire fuel hazard reduction or to clear fire breaks. The Act reiterates that certain instruments under the EP&A Act, *National Parks and Wildlife Act 1974, Local Government Act 1993, Biodiversity Conservation Act 2016* and the *Local Land Services Act 2013* do not apply when responding to fire emergencies.

The Act declares the bushfire danger period to run from October to March (inclusive), which can be modified by the NSW Rural Fire Service (RFS). Total fire bans (TOBANs) may be issued by the Minister in the interests of public safety.

2.1.4 NSW Electricity Supply Act 1995

The *Electricity Supply Act 1995* operates to promote the efficient and environmentally responsible production and use of electricity as well as the delivery of a safe and reliable supply of electricity. The Act provides network operators powers that are necessary to enable them to construct, operate, repair, and maintain their electricity works. The Act promotes and encourages the safety of persons and property in relation to the generation, transmission, distribution and use of electricity. In addition, the Act ensures that any significant disruption to the supply of electricity in an emergency is managed effectively.

The Act is supplemented by the *Electricity Supply (Safety and Network Management) Regulation 2014*. The regulations state that Network Operators must take all reasonable steps to ensure that the design, construction, commissioning, operation and decommissioning of its network are safe and refer to *AS 5577 Electricity Network Safety Management Systems* to define the fundamental principles to be considered in the development of a Network Safety Management System. This includes, amongst other things, to manage the risk of bush fire. The NSW Electricity Industry Safety Steering Committee (ISSC) provides *ISSC 3 Guide for the Management of Vegetation in the Vicinity of Electricity Assets* (November 2016), which provides a set of requirements for the management of the

risks, including bush fire, associated with the impact of vegetation on Electricity Assets in the Distribution Network for the benefit of public safety, community amenity and electricity supply reliability.

2.2 Regulatory policies/relevant guidelines

2.2.1 Planning for Bush Fire Protection 2019

The SEARs (as per **Section 1.3**) mandate that the EIS assesses bushfire related public safety risks. While not mandated by the SEARs, PBP seeks to provide for human safety (including of fire responders) during bushfire events and to minimise the effects of bushfires on property; while considering development potential, site characteristics and environmental protection and as such has been adopted as a guide to undertaking this assessment. Achievement of these objectives is underpinned by several principles:

- Control the types of development permissible in bushfire prone areas
- Minimise the impact of radiant heat and direct flame contact by separating development from bushfire hazards
- Minimise the vulnerability of buildings to ignition and fire spread from flames, radiation, and embers
- Enable appropriate access and egress for the public and firefighters
- Provide adequate water supplies for bushfire suppression operations
- Focus on property preparedness, including emergency planning and property maintenance requirements
- Facilitate the maintenance of Asset Protection Zones (APZs), fire trails, access for firefighting and on-site equipment for fire suppression.

2.2.2 Guide for Bush Fire Prone Land Mapping

The identification of BPL in NSW is required under the EP&A Act, including a requirement for and guidance for the preparation of a bush fire prone land map identifying vegetation within LGAs that has the potential to support a bush fire. The bush fire prone land map is the trigger for the consideration of bush fire protection measures for new development (measures are detailed in *Planning for Bush Fire Protection* (RFS, 2019) and include reference to AS 3959-2018– *Construction of buildings in bush fire prone area*s). Guidance for identification and mapping of BPL is provided in the *Guide for Bush Fire Prone Land Mapping* (RFS, 2015).

The *Guide for Bush Fire Prone Land Mapping*, in conjunction with PBP, is designed to identify if an area can support a bushfire or is subject to bushfire attack based on the presence and type of vegetation fuel sources. The mapping is the responsibility of local government area/rural fire district-based BFMCs. BPL mapping is typically published by the respective BFMC and the maps and metadata are developed according to guidance provided by NSW RFS (2015). BPL mapping for the state is available from the NSW Government data portal, www.data.nsw.gov.au.

BPL assessments are based on allocation of the vegetation present into one of four categories, as follows:

- *Category 1:* which includes areas of forest, woodland, heath, forested wetland, and timber plantation. Highest risk category
- *Category 2:* rainforests and "lower risk vegetation parcels". These parcels contain remnant vegetation that is limited in its connectivity to larger areas and land parcels with land management practices that actively reduce bushfire risk (and are subject to a bushfire plan or similar). Category 2 vegetation has lower bushfire risk than category 1 and 3 vegetation
- *Category 3:* which includes grasslands, freshwater wetlands, semi-arid woodlands, alpine complex and arid shrublands. Moderate risk category
- *Exclusion:* Areas of vegetation less than 1 ha and greater than 100 m separation from category 1, 2 or 3 vegetation; small patches or strips of remnant vegetation; managed grasslands; agricultural cropland; gardens; and mangroves are not mapped as bushfire prone.

BPL is defined as land with category 1, 2 or 3 vegetation and land within 100 metres (m) of category 1 or within 30 m of category 2 or 3 vegetation.

3. Bushfire risk factors

3.1 Bushfire weather

3.1.1 Historical bushfire weather

The Project area experiences a warm temperate climate. Summers are warm and partly cloudy and wet while the winters are short, cooler, and relatively wet (**Figure 3-1**). Average daily maximum temperatures range between 16°C in July and 26°C in January. Temperatures in excess of 40°C have been recorded in the months between November and March. The hottest recorded temperature is 45.6°C (December 2019). Average minimum temperatures range between 6.3°C in July and 16.2°C in January. Below zero conditions have been recorded between July and August, with the lowest recorded temperature being -0.9°C (August 2002).

Average annual rainfall is 939 mm. Annual rainfall (2000-2021) has ranged between 577 mm (2019) and 1673 mm (2020). The highest recorded daily rainfall total is 208 mm (August 2015).

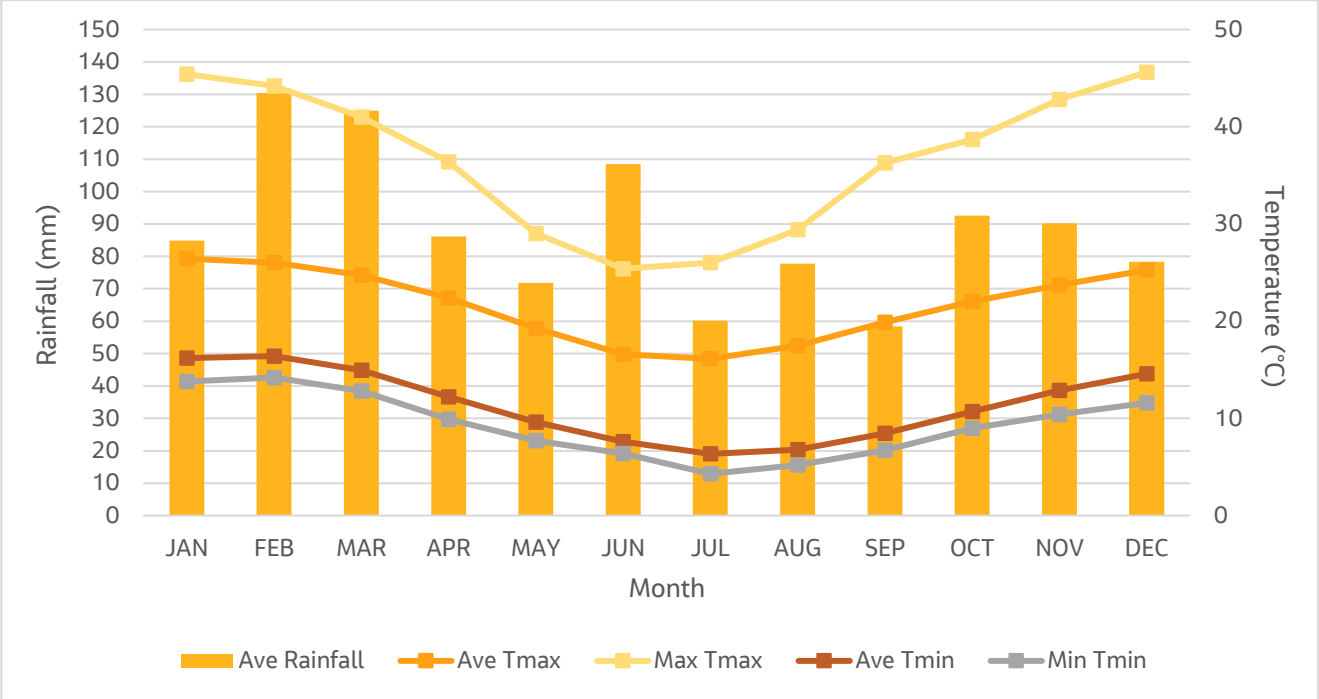


Figure 3-1. Average monthly rainfall, average daily maximum (Tmax) and minimum (Tmin) temperatures, maximum (Max Tmax) and minimum (Min Tmin) recorded temperatures (Bureau of Meteorology 1955-2021, Nowra Ran Air weather stations: 068076, 068072)

Average monthly fire danger ratings (FDR) (**Figure 3-2**) are in the low to moderate range between April and November (Forest Fire Danger Index [FFDI] ≤12) and high throughout the remainder of the year **(Figure 3-3**). Days of very high FDR or greater (FFDI ≥25) may occur in any month. Days with catastrophic fire danger (FFDI>100) have been recorded in March, November and December (only once in each month). Days in the extreme fire danger range (FFDI 75-100) have been recorded in each month between October and March.

Total Fire Bans (TOBANs) are declared by the NSW RFS. During TOBANs, potential human sources of ignition are prohibited or restricted to reduce the risk of bushfires igniting during or (rarely) immediately preceding a period of dangerous fire weather. FDR on TOBAN days is typically very high or greater.

The bushfire season generally runs between October and March. The Project area is identified as having a 1:50 year FFDI of 100 in PBP; which PBP states is the FFDI to be used for development assessment purposes.

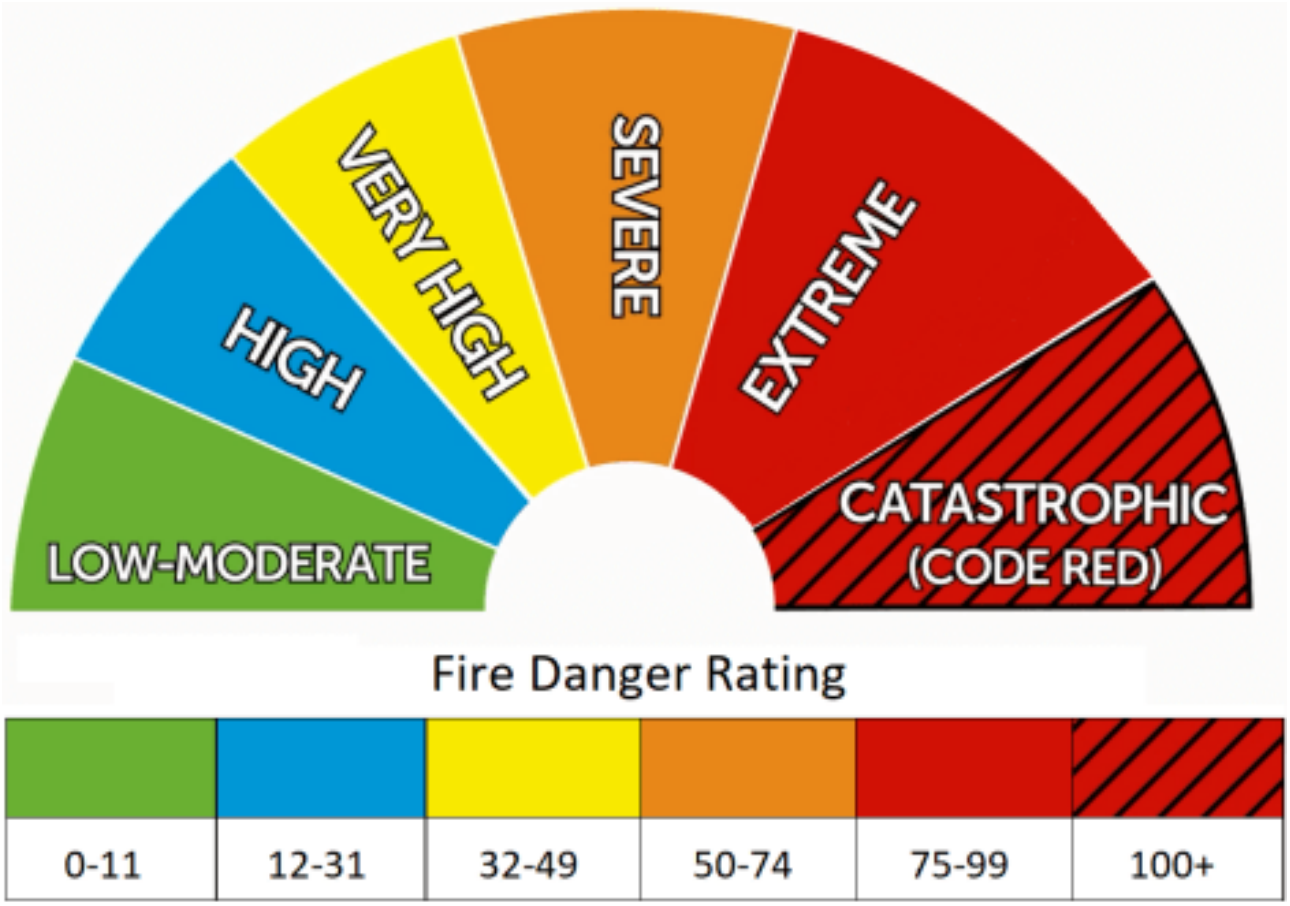
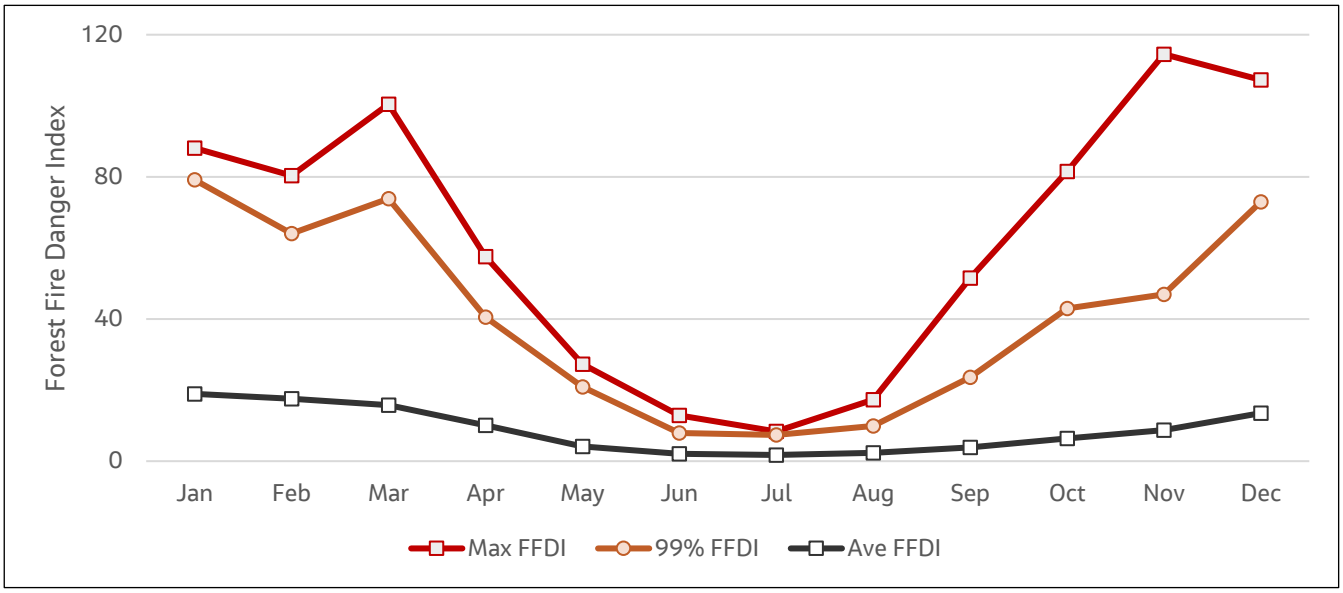
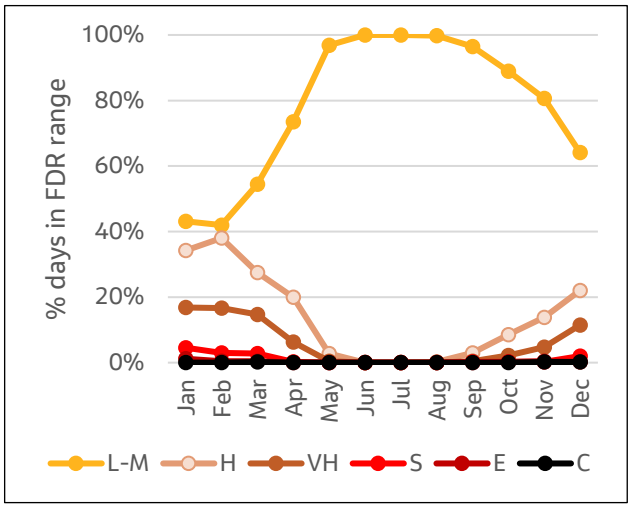


Figure 3-2. Fire Danger Rating and Forest Fire Danger Index (CSIRO, 2020)[1]

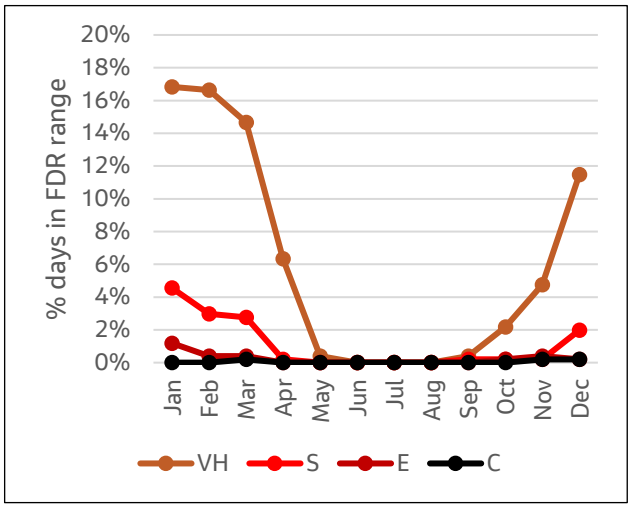
[1] This system is currently being replaced with the Australian Fire Danger Rating System as of September 1st 2022. The new national system is based on eight fire behaviours to produce more accurate, consistent and timely fire information. The new system will replace the six categories used here with four categories based on a new parameter called the Fire Behaviour Index (https://www.afac.com.au/initiative/afdrs). The original FDR system was utilised for this report as the new system had not been incorporated into commercial models at the time of writing.



a) Monthly values of maximum FFDI, 99th percentile of daily maximum FFDI and average daily FFDI.



b) Percentage of days with maximum daily FFDI in each fire danger rating scale (low-moderate: L-M; high: H; very high: VH)



c) Percentage of days with maximum daily FFDI in each fire danger rating scale (severe: S; extreme: E; catastrophic: C)

Figure 3-3. Estimated FFDI and fire danger rating (FDR) values for Shoalhaven (Nowra Ran Air weather stations: 068076, 068072), based on records for 1989-2021.

3.1.2 Climate change projections for bushfire

The Project is anticipated to have a service life of approximately 100 years and should therefore be resilient to projected fire weather and other climatic conditions in the 2050s and beyond. Climate projections indicate bushfire weather in the region is very likely to become harsher over the coming decades (Dowdy *et al.*, 2015).

Climate projections for 2050 were generated for the Project area, based on the mean model results for all CMIP5[2] models with projections for rainfall and temperature for RCP8.5[3] (high emissions scenario); as made available through SimCLIM[4]. Change factors to 2050 for each of these weather parameters were applied to the 1980-2010 data for BoM stations 068076 and 68072 (Nowra Ran Air weather stations).

Climate models suggest that the main projected changes in climate for the region under the RCP8.5 scenario are for:

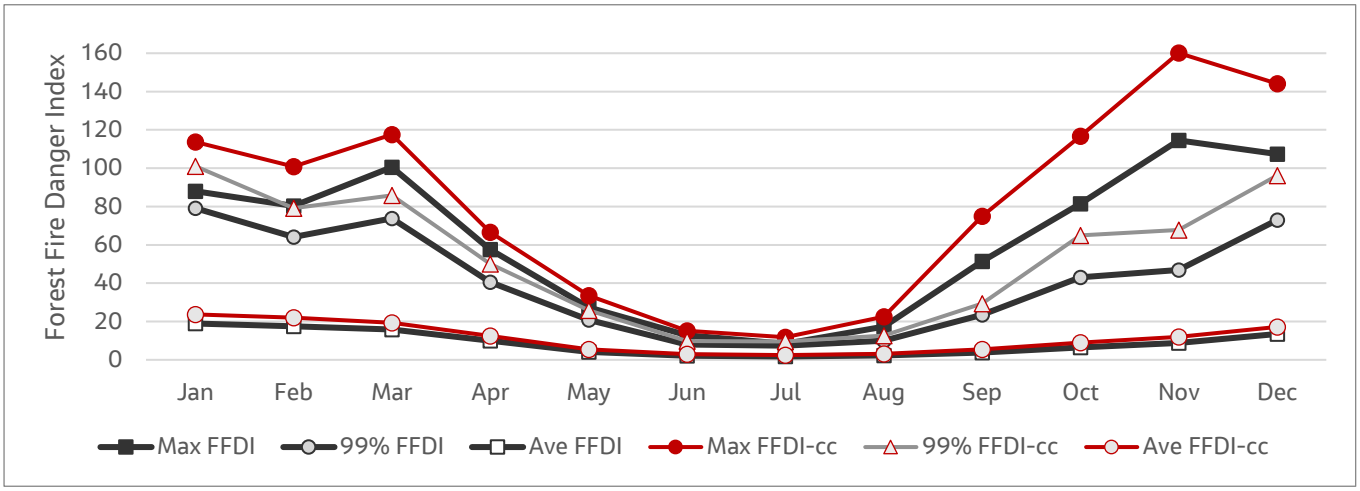
- **Increased temperature:** temperatures are projected to increase throughout the year, with annual average maximum temperatures approximately 1.9°C warmer by 2050. Annual maximum temperatures are projected to increase by 2°C by 2050. Days experiencing temperatures above 35°C are estimated to increase from 10 to 17 per year
- **Decreased cool season rainfall**: average summer and winter rainfall are projected to decrease slightly from 138 mm to 135 mm and 127 mm respectively. Spring rainfall (prior to the commencement of bushfire season) is projected to decrease from 174 mm to 140 mm by 2050.

With warmer and drier conditions, bushfire fuel availability is expected to be slightly greater at the commencement of the fire danger period (October) than is currently the case. Combined, these projections indicate that bushfire weather will become harsher. Average FFDI is projected to increase slightly (**Figure 3-4**: **Table 3-1**). Days with dangerous fire weather conditions are projected to become more frequent and occur through more months of the year. Days with severe FDR are projected to occur between September and April by about 2050 under the high emissions RCP8.5 scenario. Catastrophic fire weather conditions (under maximum potential FFDI results) could occur from October to March compared with only March, November, and December historically (**Figure 3-3**).

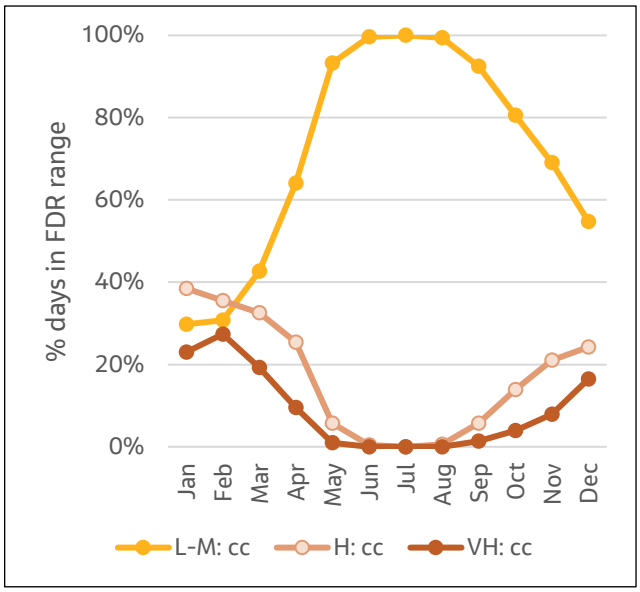
[2] CMIP5: Coupled Model Intercomparison Project Phase 5. This refers to the collaborative framework resulting in a collection of models for climate change. They were used in the International Panel on Climate Change's (IPCC's) Fifth Assessment Report. CMIP5 modelling was utilised for this Report, as the findings from the IPCC's Sixth Assessment Report have not been integrated into commercial models.

[3] Population and economic growth, technological change including reliance on fossil fuels, and political and social changes will all have substantial effects on greenhouse gas emissions and accumulation in the atmosphere. To account for this uncertainty, the Intergovernmental Panel on Climate Change (IPCC) developed four Representative Concentration Pathways (RCPs) to illustrate four different scenarios for global human activity and development over the coming century, and the resulting effect on global climate. The four RCPs are distillations of a large volume of future scenarios discussed in the scientific literature, chosen by a multi-disciplinary team of experts to form the basis of the Fifth Assessment Report (IPCC, 2014). RCP8.5 represents a scenario in which emissions continue to rise rapidly through most of the century. This is driven by continued population and economic growth, without a transition to low-carbon technologies (business as usual).

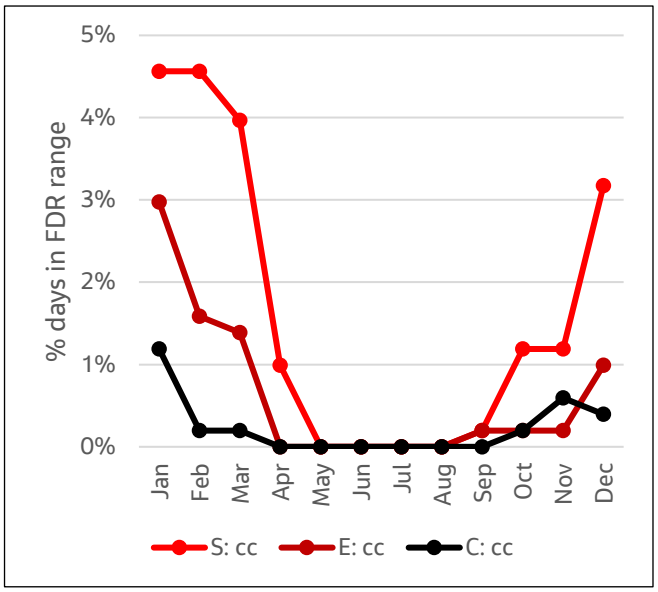
[4] https://www. https://www.climsystems.com/



a). Monthly values of 99th percentile of daily maximum FFDI and average daily FFDI – historically (black) and projected for 2050 under RCP8.5 (red).



b). Percentage of days with maximum daily FFDI in each FDR scale (low-moderate: L-M; high: H; very high: VH) projected for 2050 under RCP8.



c). Percentage of days with maximum daily FFDI in each FDR scale (severe: S; extreme: E; catastrophic: C) projected for 2050 under RCP8.5

Figure 3-4. Estimated FFDI and fire danger rating (FDR) values for Shoalhaven (Nowra Ran Air weather stations: 068076, 068072), based on records for 1989-2021 and climate change projections for 2050 RCP8.5.

Table 3-1. Current and projected fire danger index[1], indicative fire behaviour and average occurrence at the Project area

FDR	Fire behaviour guidance	Average number of days / year	
		Current	2050
Low-moderate FDI<12	There is some potential for fires and those that occur will normally stop (meteorological conditions allowing) at roads, tracks and watercourses. Fires that occur can generally be extinguished by the use of hand operated water sprays and fire beaters.	286	261
High FDI 12-24	Fires are capable of spreading rapidly, particularly in the absence of preventative measures and may require additional work effort to be extinguished.	52	62
Very high FDI 25-50	Fires are capable of spreading rapidly, with or without preventative measures. Fire containment may require significant effort and the use of earthmoving equipment and/or backburning.	22	33
Severe FDI 51-74	Fires are capable of being uncontrollable, unpredictable and extremely fast moving. They will NOT be contained without extensive effort on established fire lines with adequate personnel and equipment (this may include water bombing aircraft).	4	6
Extreme FDI 75-100		<1	2
Catastrophic FDI>100	Fires are capable of being uncontrollable, unpredictable, and extremely fast moving, and will NOT be contained without extensive effort on very large established fire trails with extensive personnel and equipment (this will include water bombing aircraft).	<1	<1

3.2 Topography

The Project is located within mountainous terrain (**Figure 3-5**; **Table 3-2**). The landscape includes the Fitzroy Falls Plateau, below which is the Fitzroy Falls Escarpments leading down to the Kangaroo Valley (Office of Environment and Heritage, 2017). The highest point of the site is Barrengarry Mountain with an elevation of 685 m above sea level (asl) It is part of a plateau (> 600m asl) that extends north-east towards the Fitzroy Falls Reservoir. The Reservoir feeds into the Fitzroy Canal which ends at the Laydown / Works Area 1. As per the name, the Kangaroo Valley Power Station is located in the Kangaroo Valley at the southern base of the escarpment up to the plateau. The Kangaroo Valley Power Station is located at 185 m above sea level and sits adjacent to the Bendeela Pondage area. Kings Creek bounds the Project area to the west and is a tributary to the Kangaroo River. The Bendeela Power Station is located adjacent the Kangaroo River/ Lake Yarrunga at an elevation of approximately 85 m above sea level. Smaller creeks and drainage lines such as Trimbles Creek and Nelsons Creek extend across the Project area.

The landscape adjacent the Project area displays a similar pattern of plateau, escarpment and valley. The Yarrunga Creek runs from the north-east to southwest adjacent the Project area, with escarpment either side of the valley the creek is within. Beyond this to the northwest is a large area of forested plateau forming part of the Morton National Park which then extends to the grazing lands of the Moss Vale Highlands. To the east of the Project area is more forested escarpment and areas of the Kangaroo Valley which becomes increasing cleared of forest around the townships of Kangaroo Valley and Barrengarry. To the west and south is deeply dissected forested land of the Great Dividing Range, similar to that within the Project area.

Table 3-2. Slope classes surrounding the Project area

Slope class	Percentage of land within 500 m of Project area	Percentage of land within 10 km of Project area
0° to <5°	41%	38%
5° to <10°	25%	22%
10° to <20°	24%	24%
20° to <30°	8%	11%
≥30°	2%	5%

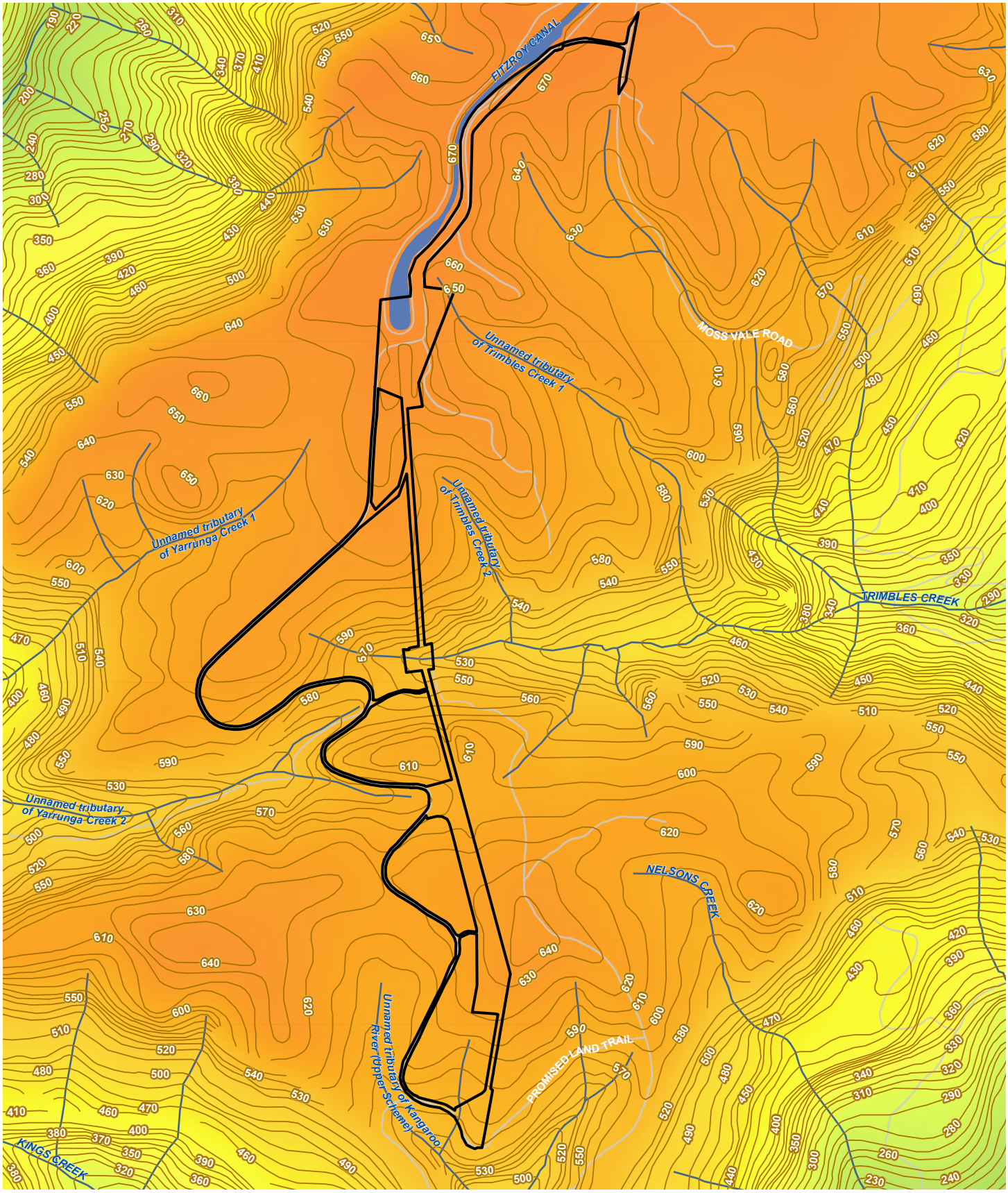
3.3 Vegetation

The Project area is surrounded by forests of the Morton National Park and WaterNSW restricted entry land. Vegetation formations as per mapping by DPE (2022a) within 10km of the Project area are presented in **Figure 3-6**. The mapping indicates 76% of the surrounding landscape is comprised of native vegetation (**Figure 3-6**). The plateau areas generally support dry sclerophyll forest and the escarpments wet sclerophyll forest and rainforest. The majority of the vegetation surrounding the Project construction footprint is composed of dry sclerophyll forest (**Figure 3-6**). The valleys have a mixture of dry and wet sclerophyll forest. To the north is the Moss Vale Highlands which is predominantly cleared and supports grazing pastures (mapped as not native vegetation). To the east, around the townships of Kangaroo Valley and Barrengarry are also large areas of cleared land that support pasture for grazing.

Table 3-3. Vegetation formations within 10 km of the Project area (DPE 2022)

Vegetation Formation	Percentage of area
Dry Sclerophyll Forests	30
Wet Sclerophyll Forests	30
Not native vegetation	24
Rainforests	12
Forested Wetlands	2
Freshwater Wetlands	1
Heathlands	1
Grassy Woodlands	0
Unattributed	0

These vegetation formations are reflected in the BPL mapping (**Figure 3-7**). Within the Project area most vegetation is Category 1 high bush fire risk vegetation. There are some lower risk areas associated with rainforest (Category 2) and cleared areas (Category 3).



Legend

- Project area
- Contour 10m
- Waterway
- Road

Elevation

900 m

0

0 0.3 0.6 km

1:16,000 at A4

GDA2020 MGA Zone 56

N

Data sourcesa

Jacobs 2022
Department of Planning and Environment 2022
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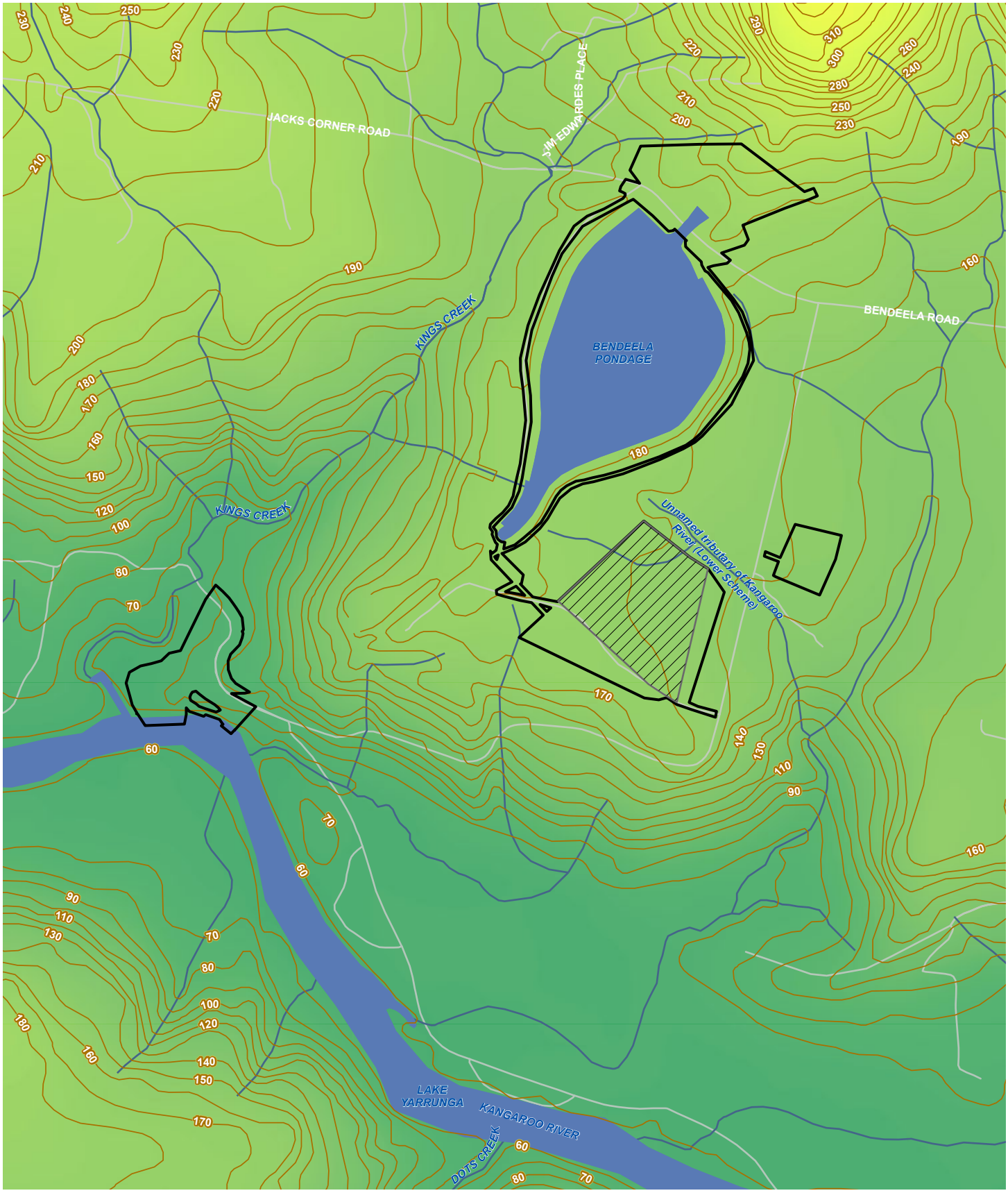
Figure 3-5a Topography surrounding the project - Upper Scheme (Plateau)

Date: 10/26/2022 Path: \\ausyd0vs01\GISProj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_Bushfire Management.aprx
Created by : JB | QA by : HK



Legend

- Project area
- Spoil site
- Contour 10m
- Waterway
- Road

Elevation

900 m

0

0 0.3 0.5 km

1:12,500 at A4

GDA2020 MGA Zone 56

Data sourcesb

Jacobs 2022
Department of Planning and Environment 2022
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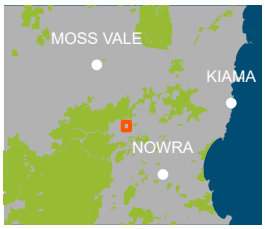
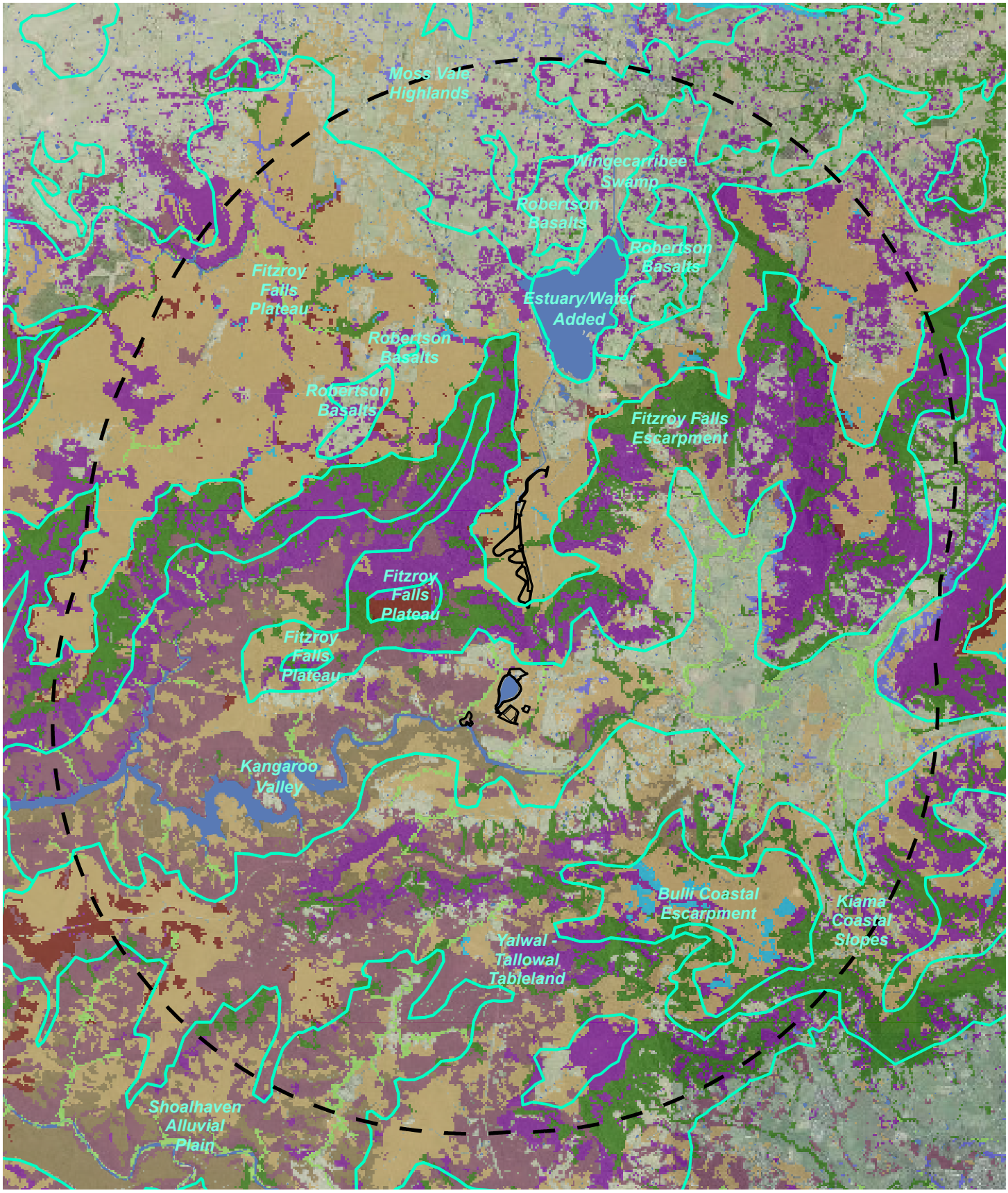


Figure 3-5b Topography surrounding the project - Lower Scheme (Kangaroo Valley)

Date: 10/26/2022 Path: \\ausyd0vs01\GISProj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_Bushfire Management.aprx
Created by : JB | QA by : HK



Legend

- Project a
- Spoil site
- 10km Study area
- Mitchell Landscapes

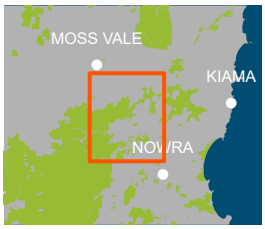
Vegetation formations

- Dry Sclerophyll Forests (Shrub/ grass sub-formation)
- Dry Sclerophyll Forests (Shrubby sub-formation)
- Forested Wetlands
- Freshwater Wetlands
- Grassy Woodlands
- Heathlands
- Not native vegetation
- Rainforests
- Wet Sclerophyll Forests (Grassy sub-formation)
- Wet Sclerophyll Forests (Shrubby sub-formation)
- Waterbody

0 2 4 km

1:128,715 at A4

GDA2020 MGA Zone 56



Data sources

Jacobs 2022
Department of Planning and Environment 2022
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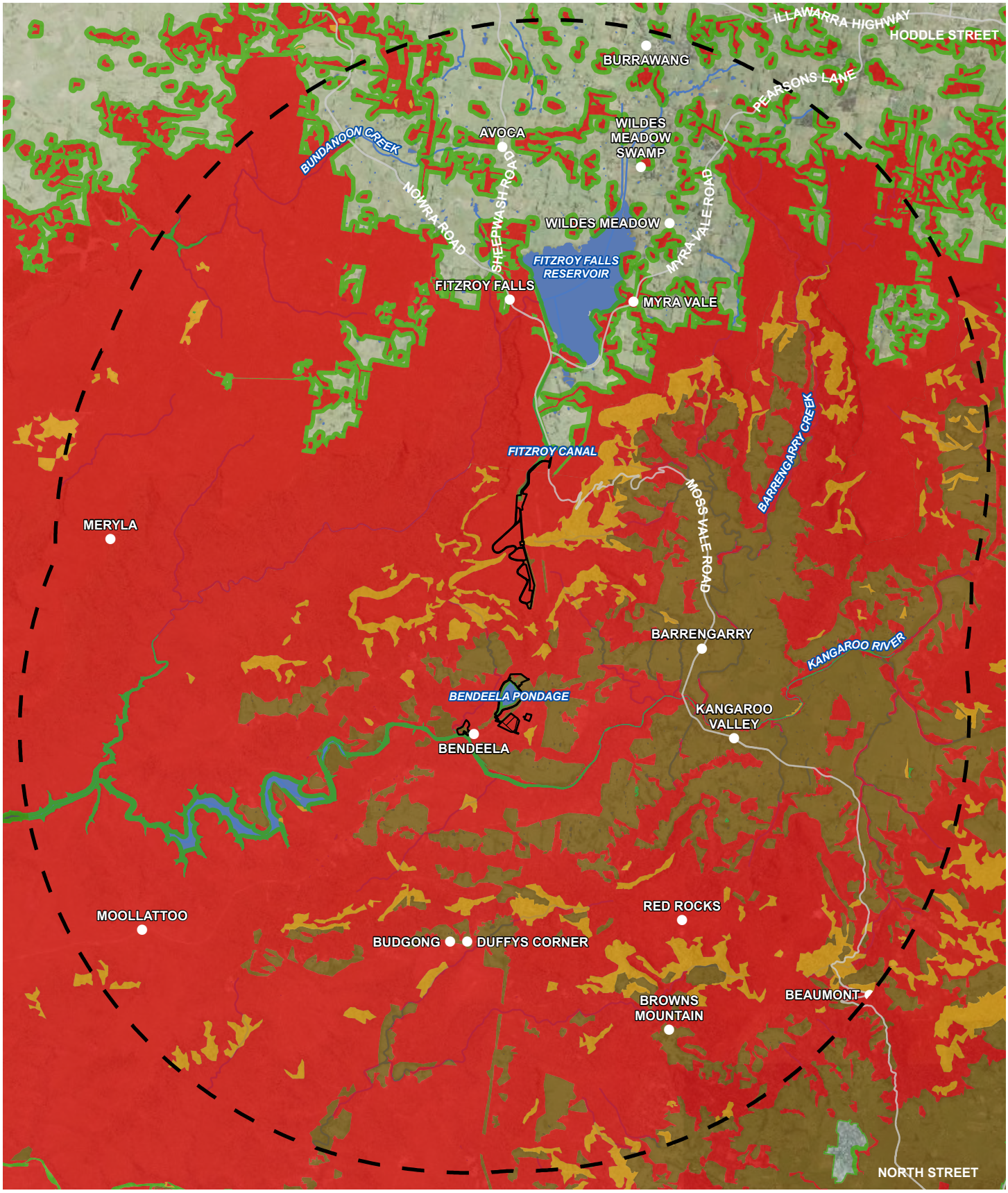
Figure 3-6 Vegetation formations surrounding the Project

Date: 10/25/2022 Path: \\ausyd0vs01\GISProj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_Bushfire Management.aprx
Created by : JB | QA by : HK



Legend

- Project area
- Spoil site
- 10km Study area
- Road
- Waterways
- Waterbody

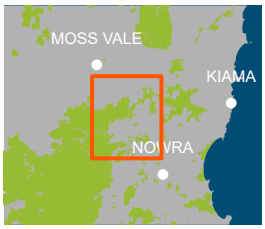
Bush Fire Prone Land

- Vegetation Category 1
- Vegetation Category 2
- Vegetation Category 3
- Vegetation Buffer

0 2 4 km

1:120,000 at A4

GDA2020 MGA Zone 56



Data sources

Jacobs 2022
Department of Planning and Environment 2022
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Figure 3-7 Bushfire prone land mapping for the area surrounding the Project

Date: 16/08/2022 Path: \\ausyd0vs01\gisproj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_Bushfire Management.aprx
Created by : JB | QA by : CC

3.4 Fire history

3.4.1 Bushfire history

Bushfires occur frequently in the landscape surrounding the Project area (**Figure 3-8**). Sixty bushfires are recorded to have occurred within 10 km of the Project area since 1975 in the NSW National Parks and Wildlife Service (NPWS) fire history layer (DPE 2022b). Five of these fires have impacted the Project area. Other fires (most likely smaller fires on private land) may have occurred within the 10 km investigation area over that period but have not been recorded in the fire history dataset.

Bushfires that have occurred within the 10 km landscape surrounding the Project area have ranged in size (within the 10 km areas) up to 17,333 ha (**Figure 3-8**). The average size of wildfires within the 10km area is approximately 876 ha. Significant wildfires in which over 10,000 ha of the 10km area was burnt occurred in 1964, 1982, and 2019. The 2019 bushfires burned over 14,000 ha of the 10km area and impacted the Bendeela Power Station, however only fencing was damaged. The highest recorded occurrence of wildfires in the area surrounding the Project was nine in 2019.

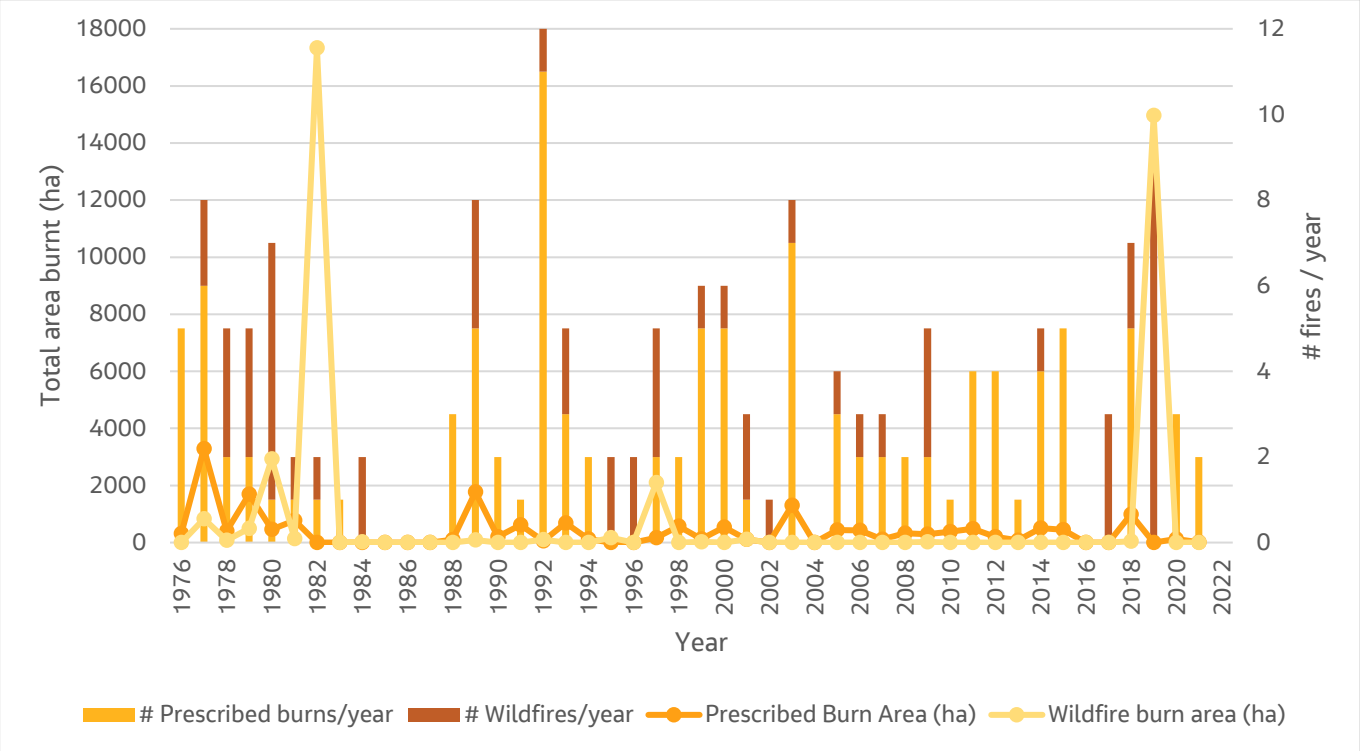


Figure 3-8. History of wildfires and prescribed burns occurring in Project area and surrounding 10km [Total burnt area per year (ha); Count of fires per year]

3.4.2 Prescribed burn history

Prescribed burning is used to manage ecological values and the bush fire fuel hazard in forested areas in the landscape. An average of over 167 ha of land in the 10 km investigation area has been subject to prescribed burning each year since 1975. The recorded area of prescribed burning per year has ranged between approximately 10 ha in 2021 to over 1700 ha in 1989 (**Figure 3-8**). The highest count of prescribed burns per year was 11 in 1992, however only 56 ha was burnt by prescribed burns in that year.

3.5 Fire management zoning

Bushfire management arrangements for the region in which the Project is located are described in the Morton National Park Fire Management Strategy (2006) (MNP Fire Management Strategy) as well as the Shoalhaven Bushfire Management Committee's Bushfire Risk Management Plan (SBFMC BFRMP) (SBFMC, 2018).

The SBFMC BFRMP is a strategic document that identifies community assets at risk within the Shoalhaven LGA and sets out a five-year program of coordinated multi-agency treatments to reduce the risk of bush fire to the assets. Treatments may include such things as hazard reduction burning, grazing, community education, fire trail maintenance and establishing community fireguard groups (SBFMC, 2018).

The MNP Fire Management Strategy provides strategic assistance for fire management activities within the reserve. These guidelines are framed by cooperative arrangements with fire authorities, NPWS strategies for fire management, reserve management plans, neighbours and other site-specific issues that need to be considered.

The MNP Fire Management Strategy identified that the Project and surrounding area encompasses several types of fire management zones (**Figure 3-9**), including:

- *Asset Protection Zone* (APZ): Within these areas the focus is on protection of life and adjoining higher risk assets. Bushfire fuels are managed towards lower levels and fire may be more frequent than desirable to conserve biodiversity
- *Fire Exclusion Ara* (FEA): Where fire should not be introduced and excluded where possible
- *Strategic Fire Advantage Zones* (SFAZ): These zones are strategically placed and managed to provide an advantage for fire fighters in containing and suppressing wildfires. Fire frequency may occur towards the lower thresholds necessary to conserve biodiversity
- *Heritage Management Zones* (HMZ): Within these zones, fire is managed towards a range of intensities and frequencies required in order to conserve natural processes (biodiversity) and cultural assets. Fire authorities continue to aim at containing wildfires in these areas.

Both the MNP Fire Management Strategy (2006) and the SBFMC BFRMP (2018) identifies Kangaroo Valley Power Station as a SFAZ (**Figure 3-9**). The SBFMC BFRMP also identifies the Bendeela pondage area and associated infrastructure as a SFAZ.

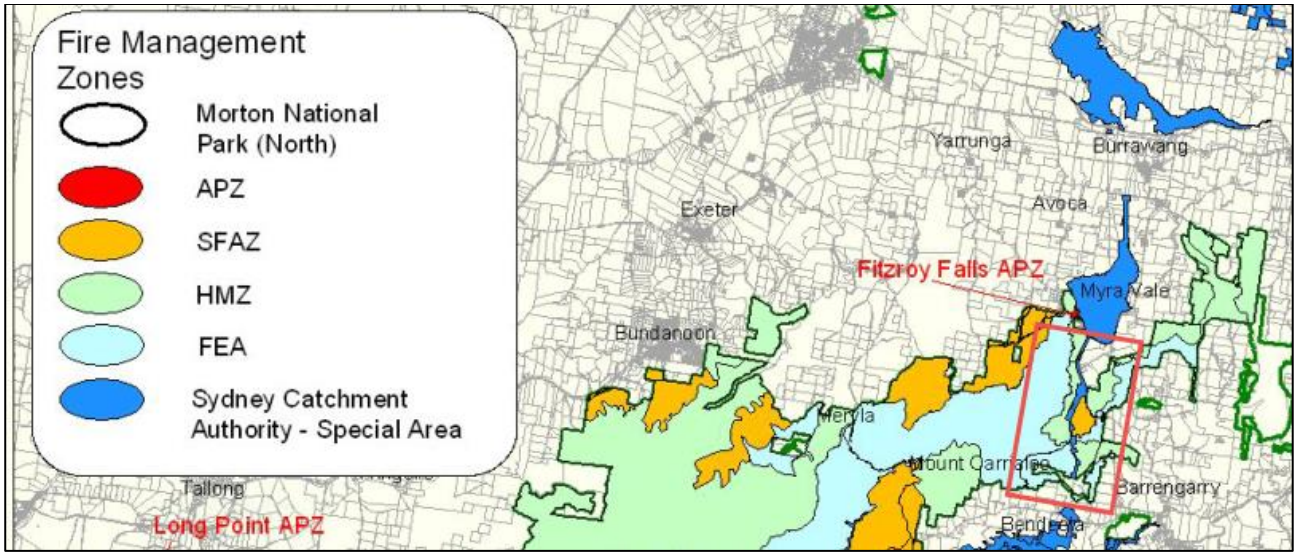


Figure 3-9. Fire management zones under the MNP Fire Management Strategy (2006) [Project area in RED]

More recently, the NPWS identified fire management zones for Morton National Park (**Figure 3-10**). The NPWS zoning is different to the zoning under the MNP Fire Management Strategy (**Figure 3-9**). Although the NPWS zoning identifies a similar SFAZ (**Figure 3-10**), it does not identify the Sydney Catchment Authority – Special Area (**Figure 3-9**). In addition, the HMZ and FEA identified under the MNP Fire Management Strategy (**Figure 3-9**) are combined into a Land Management Zone under the NPWS zoning (**Figure 3-10**).

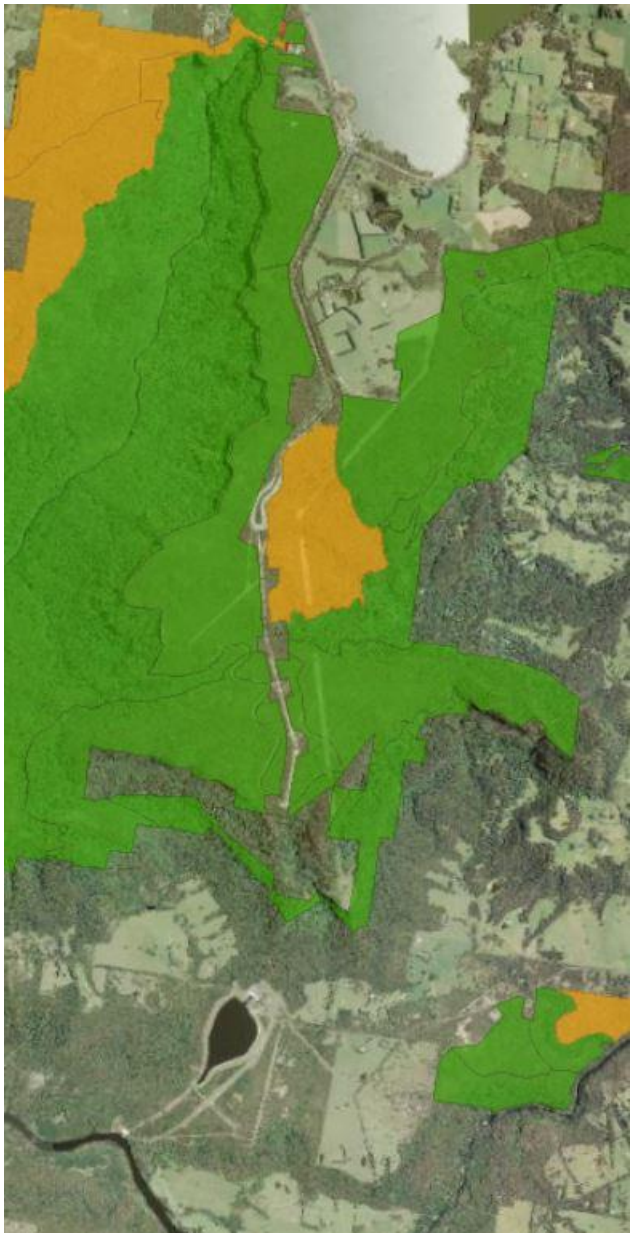


Figure 3-10. Fire management zoning along the pipeline corridor [yellow = SFAZ, green = LMZ] (NPWS, 2022)

3.6 Existing bush fire safety management

The current site management and bushfire safety provisions in place for the facility are located within the Shoalhaven Scheme Bushfire Plan (SHS-HSE-PLS-003) (Origin, 2021) (the Plan). The Plan applies to all personnel working on the Shoalhaven Scheme Assets and is focused solely on bushfire issues only and should be read in conjunction with the Emergency Response Plan (SHS-HSE-ERP-001) (ERP). The existing management strategies within the Plan have been outlined so that this risk assessment and proposed measures are understood in the context of and do not conflict with existing management.

The preparedness strategies developed under the Plan (**Table 3-4**, **Table 3-5**) include:

- APZs
- Establishing and maintaining fire control lines
- Fuel load assessment
- Fuel load reduction program
- Identification and monitoring of water supplies.

Table 3-4: Existing bushfire management strategies (Origin, 2021)

Management strategy	Asset	Management Approach				
		Aim	Specification	Management	Monitoring	Priority
APZ	Kangaroo Valley Station Bendeela Station	To provide a fuel free zone around the Shoalhaven Scheme assets during the fire season	Grass and pasture to be <10cm height prior to the fire season commencing in October each year and maintained to this level until the end of the season at the end of March	Mechanical, herbicide spraying or grazing fuel hazard reduction	Commence monitoring in July, then monthly monitoring to the end of the fire season. Monitoring requirements to be managed through ERP	Very High
Fire control lines	APZs surrounding Kangaroo Valley Station and Bendeela Station	To provide a fuel reduced zone around the primary operational areas. To establish fuel reduced control line areas to reduce the rate of spread and the intensity of fires	Fuel free zones	The fence line around the APZ to have one metre chemical Fire Control Line	Control Lines to be completed by July and then monthly monitoring to the end of the fire season. Monitoring requirements to be managed through ERP	
Fuel Load Reduction	All infrastructure located in vegetated areas	To reduce available fuel loads within the Shoalhaven Scheme sites estate	Fuel free zones within the Shoalhaven Scheme sites Managed grass and wooded bushland within the Shoalhaven Scheme landholdings	**Management prior to & during fire season:** ▪ Inspect/Relocate/Dispose stored equipment or materials that present as a potential fuel load (pallets, timber etc.) ▪ Inspect/Clean station building gutters. ▪ Inspect/Clean station spoon drains ▪ Maintain/Control stations/easements grassed areas <100mm length (Mowing) ▪ Maintain/Control station batter vegetation growth (herbicide spraying) ▪ Inspect/Clean dry vegetation build up in General Water Tank yards and tanks. ▪ Inspect/Clear high voltage power line easements ▪ Inspect/Store all flammables (fuels, oils, packaging, supplies etc.) inside suitable containment structures/buildings Work requirements to be managed through Maintenance Management System	Commence monitoring in August, then monthly monitoring to the end of the fire season. Monitoring requirements to be managed through Maintenance Management System	

The Plan identifies existing water supply options at the Project area of which may be utilised during a bushfire event (**Table 3-5**).

Table 3-5: Existing water supply and use during bushfire events (Origin, 2021)

Water Supply	Volume	Fire Water Management
General Water Tanks	KV 1 x 134kL available for fire fighting BN 1 x 134kL and 1 x 50kL available for fire fighting	▪ Primary water supply utilised by Shoalhaven Scheme internal fire system – hydrants, hose reels and sprinkler systems ▪ Capacity of the tanks only allow 50 minutes of hydrant firefighting capability ▪ Management of water supply during a bushfire event: ▪ Bendeela General Water Tanks: Water is supplied to the tank by a 4" pipe fed from the Bendeela Pondage via the Bendeela Station Penstock ▪ Kangaroo Valley General Water Tank: Water is taken from the Bendeela Pondage and supplied to the tank via 2 x General Water Pumps located in the Kangaroo Valley Pump Room ▪ Water Supply from the tanks cannot be utilised for the filling of RFS and Fire & Rescue NSW firefighting vehicles. This is because this water storage is the key storage for containing any on-site fire and is prioritised for this use. See 'Bendeela Pondage' and 'Lake Yarrunga' below ▪ Continual monitoring of tank storages is required if Kangaroo Valley or Bendeela Stations hydrants are being used to wet down the Shoalhaven Scheme Assets in preparation for a bush fire event. This water supply must be maintained as far as possible for use in fire control as required within the Shoalhaven Scheme sites & facilities ▪ The Bendeela Pondage (tank water supply source) has an operating storage range of 70ML to 870ML.
Bendeela Pondage	100-870 mega-litre pond	Management prior to & during fire season: ▪ Bendeela Pondage is located on the south-west boundary of the Kangaroo Valley Station. The water is the lower waterway for the Kangaroo Valley station and has an operational storage of 70ML (MOL) to 870ML (TOL). Bendeela Pondage management during bushfire event: ▪ This water could be utilised in a fire event to fill the RFS & Fire & Rescue (F&R) NSW vehicles. ▪ The water in the pondage should be communicated to and made freely available to the RFS & F&R NSW in any bush fire event (internal or external) ▪ RFS Truck fill point located Work with RFS/F&R NSW to ID pick up point/s of the pondage. This allows 24hr access for the RFS to fill their trucks when required. Filling rate is one thousand litres a minute.
Lake Yarrunga	>85 giga-litre Lake	Management prior to & during fire season: ▪ Lake Yarrunga is located on the south-west boundary of the Bendeela Valley Station. The water is the lower waterway for the Bendeela station and has an operational storage of >35,000ML. Bendeela Pondage management during bushfire event: ▪ This water could be utilised in a fire event to fill the RFS & Fire & Rescue NSW vehicles ▪ The water in the lake should be communicated to and made freely available to the RFS & Fire & Rescue NSW in any bush fire event (internal or external) ▪ RFS Truck fill point located Work with RFS/F&R NSW to ID pick up point/s of the lake. This allows 24hr access for the RFS to fill their trucks when required. Filling rate is one thousand litres a minute.

The Plan also outlines existing bushfire prevention strategies to minimise the impact of bushfire events on the Project area and assets (Table 3-6).

Table 3-6: Existing bushfire prevention management strategies (Origin, 2021)

Factors Affecting Ignition Risk	Action to Minimise Ignition Risk
Employees, contractors and consultants	▪ Maintain high level of employee/contractor awareness (e.g. toolbox talks) of bush fire risks and prevention strategies ▪ Consider the risk of fire when developing risk assessments for outside/remote site work ▪ Availability of fire suppression equipment and management actions during a bush fire event.
Smoking	▪ Shoalhaven Scheme Smoking Policy is to be adhered to at all times.
Fencing, stock management, other land management activities	▪ Maintain communications with community/neighbours, where appropriate ▪ Consideration of fire in risk assessments.
Lightning strike	▪ Survey surrounding areas for ignitions immediately after dry storms have passed through.
Hot Work	▪ Should hot work be occurring during Total Fire Ban Days for essential repairs and maintenance works activities, conditions within the relevant Schedule must be met and the local NSW Rural Fire Service District Office or nearest Fire & Rescue Station notified ▪ Job Safety Environmental Analysis to include buffer zones, firefighting equipment available in the work area ▪ All works carried out by Origin or Origin representatives on land owned by Origin to utilise approved hot work methodologies ▪ Continual use of hot work permits within the power station ▪ All hot work activities outside of the workshops, strictly follow Hot Work Permit requirements especially to have a spotter and a fire extinguisher within work zone ▪ Maintain high level of employee awareness (e.g. toolbox talks) ▪ Ensure adequate buffer zone between activities and fuel source ▪ In all work areas, hot work activities on Extreme or Catastrophic Fire Danger Days should be avoided.
Machinery	▪ Maintain high level of employee awareness (e.g. toolbox talks) ▪ Ensure adequate buffer zone between activities and fuel source ▪ Ensure all plant or equipment have spark arrestors and are operating without causing backfiring etc ▪ Fire Danger Ratings and Total Fire Ban Days are to be observed and adhered to with regards to using machinery ▪ Only undertake grass slashing/control works during low fire danger periods within the Bush Fire Danger Period.
Arson	▪ Report any act of deliberate fire lighting, or suspicion of deliberate fire lighting, to the NSW Police Force, Fire and Rescue NSW and RFS and assist in any investigation.
Vehicle Access	▪ Only diesel-powered vehicles to be used to access Shoalhaven Scheme remote sites and easements during the Bush Fire Danger period.

3.7 Bushfire scenarios

The landscape around the Project has the potential to support extreme bushfire behaviour, as evidenced by the 2019-20 fires. The topography is complex, mountainous and steep with gorges and valleys that can funnel wind and fire. Fuel loads associated with wet and dry sclerophyll forests and rainforest are contiguous over large areas. During days with elevated fire weather these factors contribute to a landscape that can support extreme fire behaviour including the potential for fire-storm activity associated with atmosphere-coupled fires (e.g. McRae and Sharples 2011). High bushfire risk weather conditions are most frequently associated with hot dry north-westerly winds. These conditions can be followed by a strong south-westerly change, turning the north-east flank of the fire into a long head fire.

Two bushfire scenarios that may affect the Project have been identified:

- *Scenario 1 Off-site ignition:* A fire ignites in or burns into the vegetation surrounding the Project area on a day of elevated fire danger. Under such conditions, embers and smoke carry towards/into the Project area and infrastructure and any personnel present would potentially be exposed to flames and radiant heat.
- *Scenario 2 On-site ignition:* Electrical equipment failure or hot works associated with the Project results in fire ignition within the Project area. Fire escapes into surrounding vegetation. This fire may be contained and remain small or spread under high risk conditions in the following days.

4. Potential bushfire impacts

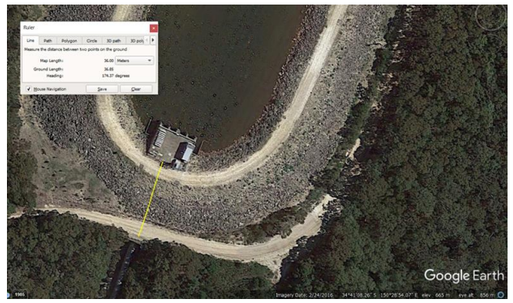
4.1 Project Infrastructure

Project infrastructure is detailed in **Table 4-2**, including identification of existing, newly proposed or upgraded infrastructure. There is capacity within the current scheme that will be utilised. **Table 4-2** also identifies vulnerability of Project infrastructure to bushfire; consequence of infrastructure failure due to bushfire; and. assumptions with regard to future management and potential bushfire protection measures. The indicative key to understand the ratings used for vulnerability to bushfire and consequence of failure is provided in **Table 4-1**.

Table 4-1. Indicative key to vulnerability and consequence rating

Rating	Vulnerability to bushfire	Consequences of failure
Low	Unlikely to be affected by bushfire, or if so only minor impacts.	▪ Facility shut down unlikely ▪ No impact to human safety ▪ Fire behaviour unaffected.
Medium	May be affected by bushfire but repair likely to be straightforward.	▪ Material damage may result in facility shutdown ▪ Fire behaviour may be exacerbated ▪ Significant impact to human safety unlikely.
High	Likely to be affected by bushfire and function significantly affected but repair possible.	▪ Material damage likely to result in facility shutdown ▪ Fire behaviour likely to be exacerbated ▪ Significant impact to human safety likely.
Very High	Likely to be affected by bushfire and replacement required.	▪ Fire behaviour likely to be exacerbated ▪ Almost certain to significantly impact human safety.

Table 4-2. Project Infrastructure

Infrastructure	Existing / proposed /upgrade	Location/ description	Vulnerability to bushfire impact (likelihood of failure)	Consequence of failure due to bushfire	Assumptions and recommended mitigation
Upper scheme					
Connection to upper intake control structure at the southern end of the Fitzroy Canal	Existing with additional duplicate electrical, control and mechanical plant added as part for the new facility	Southern end of Fitzroy Canal 	Low Steel and concrete construction, very small inventory of combustibles contained within building or equipment, electronic equipment is contained within besser block building. Minimum 35m+ non- combustible zone surrounding infrastructure Power to intake is via overhead line that is vulnerable to bushfire; however there is a DC battery backup within the besser block building to provide an additional level of protection against loss of power; loss of power or damage to electrical equipment at the upper intake does not prevent safe and controlled shut down of the facility. Control cables to the intake are buried. Primary shutdown and isolation of the hydro plant are via the main inlet valves and turbine discharge valves within the hydro plants.	The consequence of a credible failure is considered Low. Loss of water, the volume would be dependent on where a failure occurred. The station would likely not operate while repairs are made. However repairs are likely to be minor with no exotic materials required or specialist plant and equipment to acquire. Full rupture of the pipeline causing a large scale water discharge event is not considered to be a credible consequence of failure due to bushfire.	Non-combustible zone associated with canal will be maintained. No specific protection required.
Surface Pipeline	Proposed immediately west of existing penstock	Surface penstock from the existing Fitzroy Canal control structure to headrace shaft	Low Penstock is substantially steel and concrete construction. Robustly designed expansion joints in the penstock, and pipeline footing sliding joints allow lateral movement to avoid damage from expansion that could result from a fire scenario. The expansion joint is a pipe in pipe design with no exposure of joint packing to fire. The pipeline steel varies along the alignment from 13 to 21mm thick. The thicker sections are at low points where internal water pressures are higher. The pipeline is filled with water presenting a heat sink. Due to the surge tank being located in the penstock alignment pressure increase due to thermal expansion of water (from radiant heat) cannot physically exceed the design pressure of the pipeline. The surge tank is a 15m open top tank design and there are no isolation valves in the alignment. Vulnerability to structural failure due to falling trees is considered low due to the pipe wall thickness and inherent strength of the steel pipe. The existing Kangaroo Valley Penstock (which the new penstock is a duplicate design) was exposed to a bushfire in 2019 with negligible damage reported. This penstock has been in operation since the late 1970's.	The consequence of a credible failure is considered low. Loss of water, the volume would be dependent on where a failure occurred. Full rupture of the pipeline causing a large scale water discharge event is not considered to be a credible consequence of failure due to bushfire.	No specific protection required.
Surge Tank	Proposed in the vicinity west of the existing surge tank	A new surge tank adjacent to the existing scheme surge tank. 	Low The surge tank is a concrete foundation and steel construction open top tank approximately 15m diameter and 40m high. It is located at the highest point in the alignment. The structure does not contain any combustible materials. The surge tank contains a large volume of water at least 1/3 up the elevation of the tank when the facility is shut down. This would act to dissipate heat and decrease vulnerability of the structure to damage. Minor electrical equipment is located on the tower and this is not critical to the safe and controlled shutdown of the Facility. There are also ladders and platforms for safe access.	Low A credible damage mode is localised bucking on the tank walls due to high radiant heat exposure. This damage is only considered credible above the water level that equalises when the facility is shutdown. Failure of the surge tank is not considered a credible failure mode due to bushfire. Localised buckling and minor damage may not render the surge tank inoperable; however repairs may need to be undertaken in due course. Repair would not require any exotic materials or unusual methods, but would likely require cranage and may take up to a week, where the Facility was un-operational. Given that damage may not render the facility inoperable, the repairs would be scheduled for low electricity market impact times.	No specific protection required.

Infrastructure	Existing / proposed /upgrade	Location/ description	Vulnerability to bushfire impact (likelihood of failure)	Consequence of failure due to bushfire	Assumptions and recommended mitigation
Lower Scheme surface components					
Lower intake	Proposed	Lower intake /outlet structure west of the Bendeela Power Station connected to the tailrace tunnel.	Low Concrete and steel construction, non- combustible. There is no pressure on the gates. There is no equipment at the lower intake for the safe shutdown of the plant. The structure is 10m below the surrounding surface so it is not likely to be exposed to the full force of the fire.	Low Plant is unable to operate while repairs are made. Likely to be short term ~1 week.	No specific protection required.
Leachate treatment facility	Proposed	To be constructed in the spoil emplacement area, east of Bendeela Pondage.	Medium Non-combustible construction materials. Small bunded facility to treat leachate from the spoil stockpile. Bushfire may cause damage to the dosing system. Small amount of chemicals will be stored for pH correction.	Low: If the leachate treatment facility is damaged, that can be closed off while repairs are made. Small amount of chemicals unlikely to contribute to a significant fire or spill to environment.	No specific protection required.
High voltage network connection	Proposed	From ventilation and power evacuation tunnel to existing Kangaroo Valley substation.	Low. Current base case is that this connection is buried in a covered conduit.	Medium Loss of power export capability. Electricity will be tripped off by the network operator if a fault were to occur in that line.	Connection is to be buried. No other specific protection required.
Kangaroo Valley Power Station	Existing	Existing building over underground power station cut into foot of escarpment and surrounded by hardstand and smaller demountable type buildings. An additional four staff will be accommodated in the building due to the Project. The facility will be remotely operable so that staff can vacate the facility if necessary and function maintained. 	Medium The station is of concrete construction. There is chance of damage to exterior equipment such as transformers and auxiliary buildings such as spare parts storage. Low chance of damage to power station internals. The station has a Bushfire Management Plan and was defended from bushfires in 2019. Transformer deluge system can be activated to protect the transformers.	Medium Loss of equipment. Station downtime to source and replace damaged equipment. The generator step up transformers are filled with mineral oil (approximately 100,000L in total) – in the unlikely event of ignition this fuel could result in a substantial fire. There is also a small amount of diesel storage for the emergency generator.	No proposed works associated with station. Station has existing Bushfire Management Plan and will continue to be managed in accordance with it and updated as required.
Kangaroo Valley Power Station administration building	Existing	Within Kangaroo Valley Power Station.	Low There is no new administration building proposed at the surface for the new underground station. The new station will be operated from the existing Kangaroo Valley Power Station admin building. The existing admin building is located inside the concrete underground power station. All connections from the new underground station to the existing Kangaroo Valley Power Station admin building, such as communication cables, will all be underground.	Very High The administration building will not include any critical or non-replicated systems for safe shutdown of the new power station. The facility will be capable of remote management and hence occupation of this building is not critical to site operation. In a bushfire event, it is expected that only those directly involved in defending against the fire would be at site. The admin building as part of the main underground power station has underground areas that are used for shelter in place.	No proposed works or change in used associated with existing building. Existing emergency management planning in place to continue to operate and updated as required.

Infrastructure	Existing / proposed /upgrade	Location/ description	Vulnerability to bushfire impact (likelihood of failure)	Consequence of failure due to bushfire	Assumptions and recommended mitigation
Kangaroo Valley Station switchyard	Existing	Existing secured switchyard containing connection equipment into which the Project intends to connect. No expansion proposed to the overall footprint. Additional equipment being installed into one switchyard bay. The switchyard was originally designed for an expansion. Existing bushfire plan should not need to be modified.	Medium Cables, current transformers, circuit breakers, isolators, switches and other electrical equipment vulnerable to bushfire (radiant heat and flames). However typically replacement equipment is readily available in the market.	Medium Loss of power export capability for all stations. The switchyard is automatically isolated from the network by the network operator in the event of a fault. Low amount of combustible fuel to sustain fire.	No change in operation of switchyard. Management to continue in accordance with existing BMP. ISSC 3 Guidelines also apply.
Kangaroo Valley Power Station ventilation building	Proposed	Approximate footprint of 25 by 25 m adjacent to Kangaroo Valley Power Station.	Medium Fire resistant building materials will be used for the building cladding, frame and roof. It may be vulnerable to ember attack due to large air intakes, but some shutters may be installed that could be closed during bushfire. Air filters for the ventilation building shall be located in relation to outdoor air intakes so that entering ignition sources, such as burning embers, cannot be deposited on the filters as specified in Clause 2.6.2 of AS 1668.1. The system would also be shut down in the event of a bushfire. The new power station surface infrastructure includes 2 x 144kL fire water storage tanks and hydrants that could be used for this structure.	Medium Critical to safe operations underground. Loss of surface ventilation equipment would make underground station inoperable, however may be able to continue unmanned operation or use temporary ventilation equipment while repairs are undertaken. Low amount of combustible fuel to sustain fire.	Building to be constructed with fire resistant materials but may not be possible to be fully constructed in accordance with AS3959 due to ventilation requirements.
Kangaroo Valley Power Station water treatment infrastructure	Proposed	Adjacent to Kangaroo Valley Power Station.	Medium Fire resistant building materials will be used for the main water treatment building. Small inventory of combustibles contained within building or equipment. Some non-critical infrastructure such as pipes or instruments are likely to be external to the building and may be vulnerable. The new power station surface infrastructure includes 2 x 144kL fire water storage tanks and hydrants that could be used for this structure.	Medium No uncontrolled release of untreated water to the environment is expected. The water treatment infrastructure could be shut off in the event of a bush fire. If damage occurred, some interruption to operation of the underground station is likely however a temporary solution is likely to be available while repairs are undertaken. Low amount of combustible fuel/chemicals to sustain fire.	Building could be constructed in accordance with AS3959.
Bendeela Power Station	Existing	Northern bank of lake Yarrunga at southern extent of existing scheme. 	Medium Chance of damage to exterior equipment such as the spare transformer, spare parts or transmission cables. Low chance of damage to power station internals. The power station is constructed of concrete with a steel roof. Hardstand area provides ~10m non-combustible zone on two sides of the station. The existing power station has a bushfire plan and was defended against a bushfire in 2019. The generator step up transformer has a deluge system that could be activated in the event of a bushfire and is enclosed on 3 sides with concrete walls.	Medium Loss of equipment. Station downtime to source and replace damaged equipment. The in-service transformer and spare transformer each contain approximately 30,000L of mineral oil - in the unlikely event of failure this fuel could result in a substantial fire. There is also a small amount of diesel stored for the emergency generator. There is a new replacement transformer stored in the carpark. However, this transformer is filled with non-combustible Midel 7131 ester oil. It is not expected that any person will be present at the station in the event of a bushfire, unless to actively defend it. However it is suitable for shelter in place if required. Personnel only need to access station for maintenance and are not required to be in attendance for its operation.	No proposed works or change in operation associated with existing power station.

Infrastructure	Existing / proposed /upgrade	Location/ description	Vulnerability to bushfire impact (likelihood of failure)	Consequence of failure due to bushfire	Assumptions and recommended mitigation
Lower intake outlet	Existing	Adjacent (approx. 100m) Bendeela Power Station on north bank of Lake Yarrunga.	Low Concrete and steel construction. No combustible materials. No exposed safety critical electrical equipment. The lower intake/outlet is surrounded on its two longer sides by the concrete power station building on one side and Lake Yarrunga on the other.	Low The lower outlet is not under pressure and does not contain equipment for the safe shutdown of the plant. If some equipment was damaged in a bush fire then the station may not be able to operate while the repairs were made.	No specific protection required.
Underground works					
Vertical shaft and headrace tunnel	Proposed	Connected to the southern extent of Upper Scheme surface pipeline to an underground power station.	Low Underground services, not vulnerable to bushfire subject to essential surface services being protected. Ember attack and smoke not likely to be of concern as facility to be shut down in the event of a bushfire, including shut down of ventilation system. Tunnel opening (portal) is to be fenced but not sealed so smoke and embers may enter at start of 1,100 m tunnel to power station, however only expected to travel limited distance underground from tunnel opening and no combustible or vulnerable features impacted. Embers not expected to pass through air filtration system, smoke could pass through but system shutdown would prevent significant ingress of smoke into the cavern.	Low Failure due to bushfire associated with surface services and no impact to underground services. It is not expected that any person will be underground in the event of a bushfire as the facility can be remotely operated and the cavern would be evacuated until a bushfire risk has passed.PA system is available to communicate to workers across the facility including in underground areas to enable evacuation. Personnel only need to use the access tunnel and cavern for maintenance and are not required to be in attendance at site for facility operation.	Facility shutdown in event of bushfire and no damage to underground features.
Underground power station cavern	Proposed	Houses a transformer, reversible generator and pump capable of supplying approximately 235 MW of hydroelectric power.			
Access tunnel, ventilation shaft and power evacuation tunnel	Proposed	Connecting the underground power station cavern to the vicinity of the existing Kangaroo Valley Power Station. The portal is of non-combustible concrete construction. It will have a boom gate or similar to stop access but cannot be sealed.			
Tailrace tunnel	Proposed	Connecting underground power station to the Lower Intake/Outlet on Lake Yarrunga including underground surge chamber.			

4.2 Bushfire attack level assessment

Should vegetation in the vicinity of the Project area be ignited in a bushfire, it would potentially expose Project infrastructure to flames, radiant heat and embers. The level of exposure to bushfire (bushfire attack level (BAL)) can be calculated using the method outlined in the PBP in conjunction with AS3959:2018 *Construction of building in bushfire prone areas* (Standard Australia, 2018). Kangaroo Valley Power Station construction footprint

The setbacks for different BALs were calculated from the edge of the construction footprint surrounding the Kangaroo Valley Power Station (Kangaroo Valley construction footprint). This is the only area where new infrastructure is proposed that is considered necessary to manage the radiant heat exposure (as per **Table 4-2**). This method was undertaken to demonstrate the potential exposure that may occur and to consider potential setbacks for infrastructure within this area. **Table 4-3** provides the results of the BAL assessment for the Kangaroo Valley Power Station construction footprint. This assessment was conducted on the assumption that, if necessary, vegetation clearing will occur within the Kangaroo Valley Power Station construction footprint.

Table 4-3. Bushfire attack level assessment for Kangaroo Valley power station construction footprint (assumes no classified vegetation within construction footprint)

Component	Kangaroo Valley Construction Footprint						
Footprint perimeter aspect	**Northern perimeter**		**Western perimeter**	**South-western perimeter**	**North-eastern perimeter**		**South-eastern perimeter**
Risk scenario	Fire travels southward downhill until it reaches the gully (tributary to Kings Creek) adjacent to the northern perimeter	From gully fire travels uphill approximately 30-40m into north-east of the site	Fire travels easterly parallel to Jacks Corner Road	South of Jacks Corner Road fire travels uphill from Kings Creek towards the crest that extends from the south-west corner of site	Fire travels south-west downhill to site	Fire travels westerly to north-westerly across the uphill to site	Fire travels north-westerly uphill through fragmented vegetation
FDI	100						
Vegetation type	Forest[5]						
Distance to vegetation (m)	0		0	0	0		60
Slope (up/down)	Upslope	Downslope	Downslope	Downslope	Upslope	Downslope	Downslope
Slope (°)	-16	5-10[1]	6	15-20[3]	-18	3	5
BAL40 setback (m)	18	28	28	46	18	28	22
BAL29 setback (m)	24	36	36	56	24	36	29
BAL19 setback (m)	33	49	49	73	33	49	40
BAL12.5 setback (m)	45[2]	65[2]	65	92	45[2]	65[2]	54[4]

1. Given the very short run (30-40 m) into the site across this slope, the effective slope is considered less than the maximum slope measured.

2. Where there are multiple assessments for the one direction the largest setback is required.

3. To account for the complex topography a slope of 15-20° has been assigned for this area. Considerations include: short (30-40 m) slopes >20° either further than 100 m from the site boundary or not perpendicular with the site, such that a flame would not be directed toward the site; and the potential for convergence of multiple flame fronts on the ridgeline, although again the slope topography would not direct the flame toward the site.

4. Classified vegetation in this direction is greater than 54 m from the construction footprint so effectively no set-back required.

5. Forest classification is based on DPE (2022a) and Jacobs (2022)

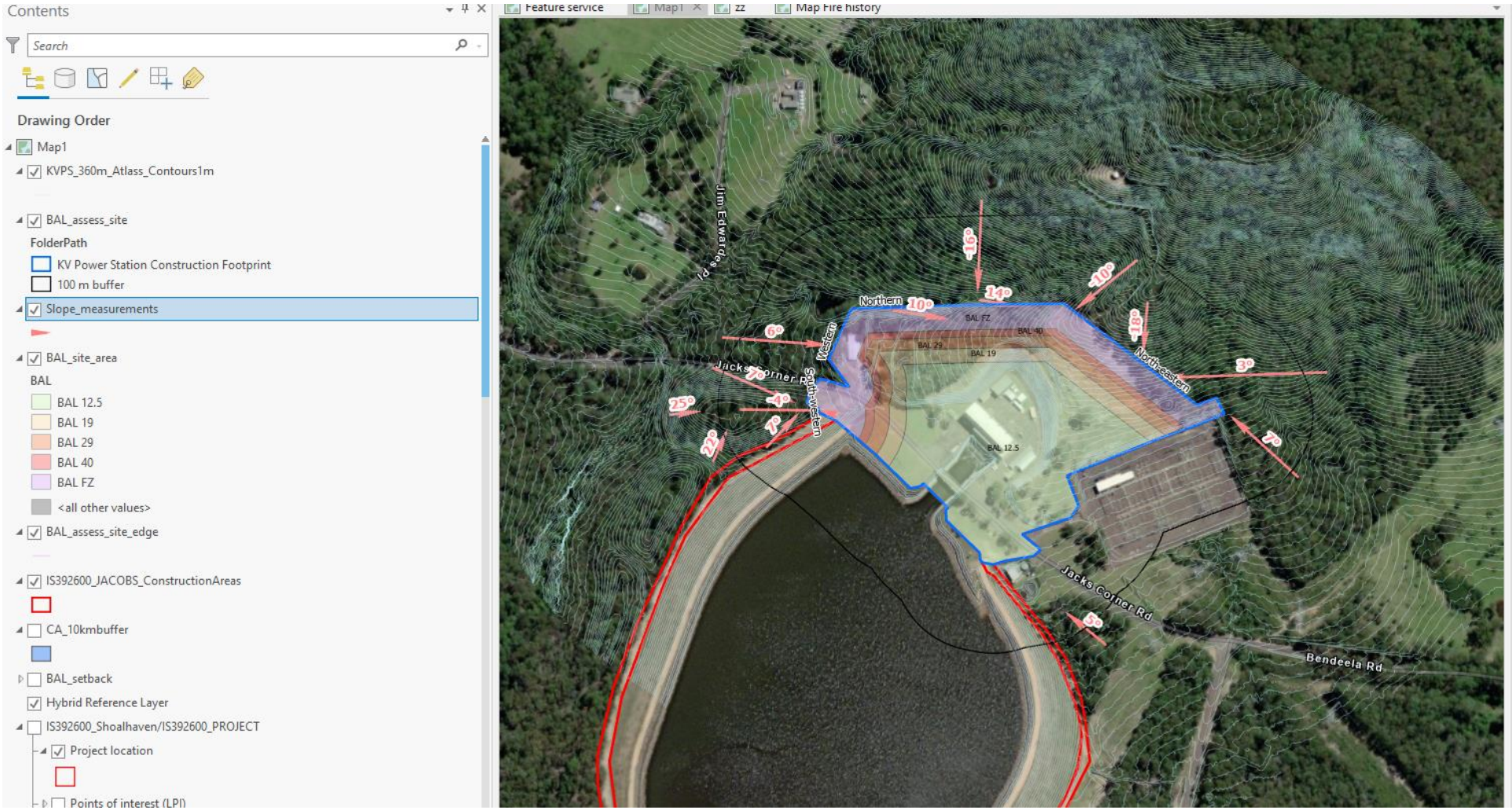


Figure 4-1. Bushfire attack level assessment for Kangaroo Valley Power Station construction footprint
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4.3 Overview of potential impacts

The potential bush fire related impacts considered in association with the Project include:

- **Fire ignition***:* there are several potential ways by which construction and / or operation of the Project could ignite a fire that escapes beyond the immediate vicinity of the Project and affect people, property, land uses, the environment and / or heritage features. These include:
  - Hot works: activities with potential to create a spark or generate hot particles (e.g., use of angle grinder, welding
  - Off-road vehicle use or parking in areas where potential bushfire fuels make contact with hot parts of vehicles
  - Lightning strike on infrastructure
  - Failure of infrastructure results in ignition (e.g. explosive failure of transformer, arcing from a conductor)
  - Other miscellaneous activity, such as ignition from storing hazardous materials (i.e. diesel fuel, chemicals, explosives etc), personnel smoking or miscellaneous equipment failure used by construction or maintenance staff.
- **Landscape fire:** a fire burning through the landscape could impact the Project and construction or maintenance personnel
- **Presence of Project infrastructure could affect suppression efforts for landscape fires:** the presence of infrastructure associated with the Project is unlikely to impair fire responses. It is unlikely to limit access or exacerbate fire behaviour leading to a fire spreading to a greater extent than may otherwise have been the case, with larger or more severe impacts (refer to **Table 4-2**).
- **Presence of Project infrastructure may affect bushfire fuel management**: planned burning in forests will not be constrained by the presence of the proposed infrastructure, and hence the Project will not lead to an increase in accumulation of bushfire fuels.

5. Bushfire protection measures

Bushfire protection measures have been developed for construction and operational phases of the Project, based on guidance from PBP (RFS, 2019a) and future consultation with RFS. This includes the consideration of performance criteria and proposed solutions. Adoption of the measures described here is expected to reduce, to an acceptable level, both the risk of bushfire ignition by construction and/or operation of the assets and the risk that bushfires in the landscape pose to the assets.

It is recommended that the Water NSW and RFS be consulted in the finalisation of the bushfire protection measures such that bushfire risks to the Project area and any impacts to habitat values are balanced.

The main bushfire protection measures that have application to construction and operation of the Project are:

- *APZ:* provide a buffer zone between a bushfire hazard and buildings or other structures. APZ are managed to minimise fuel loads and reduce radiant heat levels, flame, ember, and smoke attack. They help to provide a defendable space for firefighters and other emergency services personnel responding to a fire event and reduce opportunities for any fire igniting on site to escape to surrounding areas.
- *Siting and construction of sensitive infrastructure:* buildings and other infrastructure and any hazardous material storage areas with sensitivity to radiant heat and/or ember exposure will generally be provided with APZ and where possible constructed in accordance with the relevant BAL as per the National Construction Code (NCC) and PBP. Where such construction is not possible due to conflicts with infrastructure function, design will aim to maximise the resilience of the infrastructure to bushfire where practicable (e.g. where does not impact function). *Access roads:* which provide safe operational access to and within the Project area for emergency services personnel. Access roads will also provide safe egress for site personnel in case of a bushfire or other emergency.
- *Fire water supply:* access to water for fire suppression and/or protection of structures or equipment located on site will be provided.
- *Emergency and evacuation planning* would be addressed with other hazards as part of the contractor's and operator's site emergency management planning.

5.1 Asset Protection Zones and construction standards for sensitive buildings and infrastructure

APZ provide a low fuel hazard buffer between buildings (or other structures) and a bushfire hazard. They create a space to help manage the flame, radiant heat and ember exposure of the structures and any emergency service personnel or other persons in place. They typically require the removal of native overstorey vegetation and regular maintenance of the grasses or other understorey vegetation. Performance criteria and proposed solutions for APZ and construction standards are provided in **Table 5-1** and **Table 5-2**.

It is recommended that APZ are implemented to safeguard fire sensitive infrastructure. The extent of the APZ required in the vicinity of the Kangaroo Valley Power Station construction footprint is detailed in the BAL assessment and associated map in **Section 4.2**. The final location of infrastructure is not yet available and will be determined during the detailed design process. The management standards for the APZ follow PBP and are provided in **Appendix A**. Vegetation clearances around existing electrical assets are to be managed in accordance ISSC3 *Guide for Managing Vegetation in the Vicinity of Electrical Assets* (note there are no proposed assets that fall under the remit of this guideline).

Design should aim to maximise the resilience of all infrastructure to bushfire where practicable. While APZ to provide BAL-19 should be applied to proposed buildings within the Kangaroo Valley Power Station construction footprint, where practicable (i.e. does not prevent building function) they should be constructed in accordance with BAL-FZ of the NCC and as modified by section 7.5 of PBP. Given the utilitarian nature of these buildings it is considered BAL-FZ construction is generally in accordance with how they are normally constructed. Vulnerable features such as fuel, pumps and generators should be placed in areas of lower risk and provided shielding and ember proofing.

Table 5-1. Performance criteria and proposed solutions for Asset Protection Zones

Considered performance criteria	Proposed solution
▪ APZs are provided commensurate with the construction of the buildings and infrastructure ▪ A defendable space is provided.	▪ APZ provided for sensitive Project infrastructure where practicable ▪ APZ maintained around Kangaroo Valley Power Station and APZ for BAL-19 maintained for proposed buildings (ventilation building and water treatment building).
▪ APZs are managed and maintained to prevent the spread of a fire.	▪ APZs are managed in accordance with the requirements of Appendix 4 of PBP.
▪ The APZ is provided in perpetuity ▪ APZ maintenance is practical, soil stability is not compromised and the potential for crown fires is minimised.	▪ APZs are wholly within the boundaries of the development site ▪ APZ are located on lands with a slope less than 18 degrees.

Table 5-2. Performance criteria and proposed solutions for Construction Standards

Considered performance criteria	Proposed solution
▪ Proposed buildings can withstand bush fire attack in the form of embers, radiant heat and flame contact.	▪ Where practicable (i.e. does not prevent building function) buildings constructed in accordance with BAL-FZ of the NCC and as modified by section 7.5 of PBP.
▪ Infrastructure is designed and constructed for resilience to bushfire so that risk is reduced as low as reasonably practicable.	▪ Design and construction of all infrastructure maximises resilience to bushfire where practicable (i.e. Does not conflict with function) ▪ Surface fuel stores, hazardous material, generators and pumps to be located within APZ and shielded from radiant heat associated with bushfire, including other secondary fuel sources and provided with ember proof enclosures.
▪ Proposed fences and gates are designed to minimise the spread of bush fire.	▪ Fencing and gates to be constructed of non-combustible material only.
▪ Location and design of gas services will not lead to ignition of surrounding bushland or the fabric of building.	▪ No gas services are proposed.
▪ Location of electricity services limits the possibility of ignition of surrounding bush land or the fabric of buildings.	▪ Any new electrical transmission lines are underground ▪ No new overhead electrical transmission lines proposed ▪ Vegetation clearance for existing transmission lines and other electrical assets managed in accordance ISSC3 *Guide for Managing Vegetation in the Vicinity of Electrical Assets.*

5.2 Vehicle access

5.2.1 Existing access

There is access to the site associated with the existing scheme including:

- The lower scheme is accessed from Bendeela Road/Jacks Corner Road and access includes:
  - Access roads to Kangaroo Valley Power Station and Bendeela Power Station
  - Numerous maintenance tracks such as around Bendeela Pondage
- The Upper Scheme is accessed through Moss Vale Road/Nowra Road
  - Promised Land Trail/McPhails Fire trail provides access to some parts of the Upper Scheme

Not all infrastructure is accessible by vehicle (e.g. along pipelines) and some foot access is required.

5.2.2 Proposed access

The existing access network will largely meet the requirements for the Project, proposed access / access upgrades include:

- Powerhouse access tunnel approximately 1,800 m in length inclined at about 1 in 10. This tunnel is anticipated to have internal dimensions of up to 8 m in diameter and be configured to allow delivery vehicles to turn-around below ground. It is anticipated that the access tunnel would be connected to the Bendeela Road/Jacks Corner Road west of the existing Kangaroo Valley Power Station
- Promised Land Trail/McPhails Firetrail may require some upgrades to facilitate site access during construction. Post construction these fire trails will continue to be managed by NPWS. Any upgrade works will be done in consultation with NPWS.

Table 5-3 provides performance criteria and proposed solutions for the access associated with the Project.

Table 5-3. Performance criteria and proposed solutions for access

Considered performance criteria	Proposed solution
Firefighting vehicles are provided with safe, all-weather access to structures and hazard vegetation.	▪ Access roads (excludes fire trails and maintenance tracks) are two-wheel drive, all-weather roads.
The capacity of access roads is adequate for firefighting vehicles.	▪ The capacity of road surfaces and any bridges/causeways is sufficient to carry fully loaded firefighting vehicles (up to 23 tonnes), bridges and causeways are to clearly indicate load rating.
Firefighting vehicles can access and exit safely.	▪ Access roads (excludes fire trails and maintenance tracks) meet the following standards: - Minimum 4m carriageway width - Passing bays are provided every 200m that are 20m long by 2m wide, making a minimum trafficable width of 6m, at the passing bay - a minimum vertical clearance of 4m to any overhanging obstructions, including tree branches - A suitable turning area in accordance with Appendix 3 of PBP must be provided for any dead-end roads - curves have a minimum inner radius of 6m and are minimal in number to allow for rapid access and egress - The minimum distance between inner and outer curves is 6m; the crossfall is not more than 10 degrees - maximum grades for sealed roads do not exceed 15 degrees and not more than 10 degrees for unsealed roads ▪ Upgrades to fire trails will meet the requirements of the NSW RFS *Fire trail standards* and the NSW RFS *Fire trail design, construction and maintenance manual*.

5.3 Water for firefighting

Table 5-4 provides performance criteria and proposed solutions for water for firefighting. It includes consideration of the emergency water access for firefighting vehicles at Fitzroy Falls Reservoir, Bendeela Pondage and Lake Yaurrunga. In addition, a static supply for use in the vicinity of the Kangaroo Valley Power Station and the underground access tunnel portal is proposed.

Table 5-4. Performance criteria and proposed solutions for water supply

Considered performance criteria	Proposed solution
An adequate water supply is provided for firefighting purposes.	▪ Fitzroy Falls Reservoir, Bendeela pondage and Lake Yarrunga provide potential static water supplies, access and, if necessary, fittings to be confirmed in agreement with RFS including consideration that: - Firefighting vehicles are provided with safe, all-weather access and where necessary, a suitable turning area provided - Adequate signage is provided to direct firefighting vehicles to specified re-fill locations.
	▪ Two 144 kL fire water tanks are provided within the Kangaroo Valley construction footprint that meets the following requirements: - A connection for firefighting purposes is located within the IPA or non-hazard side and away from the structure; 65mm Storz outlet with a ball valve is fitted to the outlet - Ball valve and pipes are adequate for water flow and are metal - Supply pipes from tank to ball valve have the same bore size to ensure flow volume - A hardened ground surface for truck access is supplied within 4m; - Underground tanks have an access hole of 200mm to allow tankers to refill direct from the tank - Above-ground tanks are manufactured from concrete or metal - Raised tanks have their stands constructed from non-combustible material or bush fire-resisting timber (see appendix f of AS 3959) - Unobstructed access can be provided at all times - Underground tanks are clearly marked - Tanks on the hazard side of a building are provided with adequate shielding for the protection of firefighters - All exposed water pipes external to the building are metal, including any fittings - A pump is provided, and is a minimum 5hp or 3kW petrol or diesel-powered pump, and shielded against bush fire attack; a hose and reel for firefighting connected to the pump shall be 19mm internal diameter - Fire hose reels are constructed in accordance with AS/NZS 1221:1997, and installed in accordance with the relevant clauses of as 2441:2005 - Hydrants are located outside of parking reserves and road carriageways to ensure accessibility for fire suppression - Hydrants are provided in accordance with the relevant clauses of as 2419.1:2005 - *Fire hydrant installations system design, installation and commissioning.*

5.4 Emergency management during operation

Site and emergency management planning is required to manage the risk of a fire to personnel, infrastructure and the risk of infrastructure exacerbating fire behaviour or making conditions unsafe and also manage the risk of operations creating an ignition source that could lead to a potential bush fire. **Table 5-5** provides performance criteria and proposed solutions for emergency management during operations.

Table 5-5. Performance criteria and proposed solutions for emergency management during operations

Considered performance criteria	Proposed solution
▪ A bushfire emergency and evacuation management plan is prepared.	▪ A bushfire emergency management and evacuation plan is prepared by the operator consistent with the RFS publication: *A guide to developing a bush fire emergency management and evacuation plan*, and AS 3745:2010; and includes: - Daily readiness and preparation for bushfire: including awareness of forecast fire weather conditions, monitoring fire incidence and bushfire warnings in the landscape - The effective management or shutdown of the facility during a bushfire to reduce the risk of exacerbating fire behaviour or increasing risk to fire fighters - Remote operation of site in the event of potential bushfire - The risk of ignition and fire spread from operations is managed to an acceptable level including considering risks associated with: · Infrastructure · Hazardous materials · Use of a flame · Hot works (activities that generate sparks, heat or hot material) · Vehicles (e.g. Ignition from exhaust systems) · On-site fire response capability · Vegetation management.

5.5 Bushfire protection measures during construction

Construction activities may present a different risk profile to those during Project operation due to the larger number of personnel and activities taking place on site. During this time risks of landscape fire to construction personnel and of on-site ignitions escaping from the site into the surrounding landscape may be elevated. A specific emergency management plan to manage risks during construction is required. **Table 5-6** provides performance criteria and proposed solutions for emergency management to be confirmed as part of detailed design.

Table 5-6. Performance criteria and proposed solutions for emergency management during operations

Considered performance criteria	Proposed solution
A bushfire emergency and evacuation management plan is prepared.	▪ A Bush Fire Emergency Management and Evacuation Plan is prepared for Project construction consistent with the RFS publication: *A Guide to Developing a Bush Fire Emergency Management and Evacuation Plan*, and the AS 3745:2010; and includes: - Daily readiness and preparation for bushfire: including awareness of forecast fire weather conditions, monitoring fire incidence and bushfire warnings in the landscape - The effective management or shutdown of the site during a bushfire to reduce the risk of exacerbating fire behaviour or increasing risk to fire fighters - The risk of ignition and fire spread from construction is managed to an acceptable level including considering: · Infrastructure · Hazardous materials

Considered performance criteria	Proposed solution
	• Use of a flame • Hot works (activities that generate sparks, heat or hot material) • Vehicles and plant (e.g. Ignition from exhaust systems) • On-site fire response capability: water supply, hand tools, etc, • Vegetation management at construction sites and laydown areas.

5.6 Potential environmental impacts of proposed bushfire protection measures

Potential environmental impacts of the proposed bushfire protection measures are largely confined to the clearing and ongoing management of vegetation within the Project area. Potential impacts to biodiversity, Aboriginal cultural heritage and non-Aboriginal heritage, from clearing of vegetation is assessed separately in **Appendix F** of the EIS (Biodiversity development assessment report), **Appendix G** of the EIS (Aboriginal cultural heritage assessment report) and **Appendix H** (Historical heritage impact assessment), respectively. Given the existing vegetation management associated with the facility, there is considered to be minimal impact to biodiversity associated with bush fire protection measures. No new roads are proposed for the purposed of bush fire protection.

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Appendix A. APZ management standards

Inner Protection Areas

Trees

- Tree canopy cover should be less than 15% at maturity
- Trees at maturity should not touch or overhang the building
- Lower limbs should be removed up to a height of 2m above the ground
- Tree canopies should be separated by 2 to 5m
- Preference should be given to smooth barked and evergreen trees.

Shrubs

- Create large discontinuities or gaps in the vegetation to slow down or break the progress of fire towards buildings should be provided
- Shrubs should not be located under trees
- Shrubs should not form more than 10% ground cover
- Clumps of shrubs should be separated from exposed windows and doors by a distance of at least twice the height of the vegetation.

Grass

- Grass should be kept mown (as a guide grass should be kept to no more than 100mm in
- Height)
- Leaves and vegetation debris should be removed.

Outer Protection Areas (15 m maximum)

Trees

- Tree canopy cover should be less than 30%
- Canopies should be separated by 2 to 5m.

Shrubs

- Shrubs should not form a continuous canopy
- Shrubs should form no more than 20% of ground cover.

Grass

- Grass should be kept mown to a height of less than 100mm
- Leaf and other debris should be removed.