APPENDIX V

BUSHFIRE RISK AND HAZARD ASSESSMENT


Bushfire risk and hazard assessment

Exploratory Works for Snowy 2.0

Prepared for Snowy Hydro Limited
July 2017




snowy 2.0

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Bushfire Risk and Fuel Assessment

Exploratory Works for Snowy 2.0

Prepared for Snowy Hydro | 13 July 2018

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Final

Report Bushfire Risk and Hazard Assessment | Prepared for Snowy Hydro | 13 July 2018

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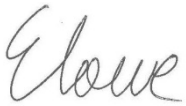
Signature		Signature	
Date	13 July 2018	Date	13 July 2018

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1 Introduction

1.1 The project

Snowy Hydro Limited (Snowy Hydro) proposes to develop Snowy 2.0, a large scale pumped hydro-electric storage and generation project which would increase hydro-electric capacity within the existing Snowy Mountains Hydro-electric Scheme (Snowy Scheme). This would be achieved by establishing a new underground hydro-electric power station that would increase the generation capacity of the Snowy Scheme by almost 50%, providing an additional 2,000 megawatts (MW) generating capacity, and providing approximately 350,000 megawatt hours (MWh) of storage available to the National Electricity Market (NEM) at any one time, which is critical to ensuring system security as Australia transitions to a decarbonised NEM. Snowy 2.0 will link the existing Tantangara and Talbingo reservoirs within the Snowy Scheme through a series of underground tunnels and hydro-electric power station.

Snowy 2.0 has been declared to be State significant infrastructure and critical State significant infrastructure (CSSI) by the NSW Minister for Planning under the provisions of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and is defined in Clause 9 of Schedule 5 of the *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP). Separate applications and environmental impact statements (EIS) for different phases of Snowy 2.0 are being submitted under Part 5, Division 5.2 of the EP&A Act. This technical assessment has been prepared to support an EIS for Exploratory Works to undertake investigative works to gather important technical and environmental information for the main Snowy 2.0 project. The main project will be subject of a separate application and EIS next year.

1.2 Project overview

The purpose of Exploratory Works for Snowy 2.0 is primarily to gain a greater understanding of the conditions at the proposed location of the power station, approximately 850 metres (m) below ground level. Understanding factors such as rock conditions (such as stress conditions) and ground temperature is essential to inform decisions about the precise location of the power station cavern and confirm the cavern construction methods.

Exploratory Works comprises:

- an exploratory tunnel to the site of the underground power station for Snowy 2.0;
- horizontal and other test drilling, investigations and analysis in situ at the proposed cavern location and associated areas, and around the portal construction pad, access roads and excavated rock management areas all within the disturbance footprint;
- a portal construction pad for the exploratory tunnel;
- an accommodation camp for the Exploratory Works construction workforce;
- road works and upgrades providing access and haulage routes during Exploratory Works;
- barge access infrastructure, to enable access and transport by barge on Talbingo reservoir;
- excavated rock management, including subaqueous placement within Talbingo Reservoir;
- services infrastructure such as diesel-generated power, water and communications; and

- post-construction revegetation and rehabilitation, management and monitoring.

1.3 Location of Exploratory Works

Snowy 2.0 and Exploratory Works are within the Australian Alps, in southern NSW. The regional location of Exploratory Works is shown on Figure 1.1. Snowy 2.0 is within both the Snowy Valleys and Snowy Monaro Regional local government areas (LGAs), however Exploratory Works is entirely within the Snowy Valleys LGA. The majority of Snowy 2.0 and Exploratory Works are within Kosciuszko National Park (KNP). The area in which Exploratory Works will be undertaken is referred to herein as the project area, and includes all of the surface and subsurface elements further discussed in Section 2.1.

Exploratory Works is predominantly in the Ravine region of the KNP. This region is between Talbingo Reservoir to the north-west and the Snowy Mountains Highway to the east, which connects Adaminaby and Cooma in the south-east to Talbingo and Tumut to the north-west of the KNP. Talbingo Reservoir is an existing reservoir that forms part of the Snowy Scheme. The reservoir, approximately 50 kilometres (km) north-west of Adaminaby and approximately 30 km east-north-east of Tumbarumba, is popular for recreational activities such as boating, fishing, water skiing and canoeing.

The nearest large towns to Exploratory Works are Cooma and Tumut. Cooma is approximately one hour and forty five minutes drive (95 km) south-east of Lobs Hole. Tumut is approximately half an hour (45 km) north of Talbingo. There are several communities and townships near the project area including Talbingo, Tumbarumba, Batlow, Cabramurra and Adaminaby. Talbingo and Cabramurra were built for the original Snowy Scheme workers and their families. Adaminaby was relocated to alongside the Snowy Mountains Highway from its original location (now known as Old Adaminaby) in 1957 due to the construction of Lake Eucumbene. Talbingo and Adaminaby provide a base for users of the Selwyn Snow Resort in winter. Cabramurra was modernised and rebuilt in the early 1970s and is owned and operated by Snowy Hydro. It is still used to accommodate Snowy Scheme employees and contractors. Properties within Talbingo are now predominantly privately owned. Snowy Hydro now only owns 21 properties within the town.

Other attractions and places of interest in the vicinity of the project area include Selwyn Snow Resort, the Yarrangobilly Caves complex and Kiandra. Kiandra has special significance as the first place in Australia where recreational skiing was undertaken and is also an old gold rush town.

The project area is shown on Figure 1.2 and comprises:

- **Lobs Hole:** Lobs Hole will accommodate the excavated rock emplacement areas, an accommodation camp as well as associated infrastructure, roads and laydown areas close to the portal of the exploratory tunnel and portal construction pad at a site east of the Yarrangobilly River;

- **Talbingo Reservoir:** installation of barge access infrastructure near the existing Talbingo Spillway, at the northern end of the Talbingo Reservoir, and also at Middle Bay, at the southern end of the reservoir, near the Lobs Hole facilities, and installation of a submarine cable from the Tumut 3 power station to Middle Bay, providing communications to the portal construction pad and accommodation camp. A program of subaqueous rock placement is also proposed;

- **Mine Trail Road** will be upgraded and extended to allow the transport of excavated rock from the exploratory tunnel to sites at Lobs Hole that will be used to manage excavated material, as well as for the transport of machinery and construction equipment and for the use of general construction traffic; and

- several sections of **Lobs Hole Ravine Road** will be upgraded in a manner that protects the identified environmental constraints present near the current alignment.

The project is described in more detail in Chapter 2.

1.4 Proponent

Snowy Hydro is the proponent for Exploratory Works. Snowy Hydro is an integrated energy business – generating energy, providing price risk management products for wholesale customers and delivering energy to homes and businesses. Snowy Hydro is the fourth largest energy retailer in the NEM and is Australia's leading provider of peak, renewable energy.

1.5 Assessment guidelines and requirements

This Bush Fire Risk and Hazard Assessment (BFRHA) has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) for the Exploratory Works, issued first on 17 May 2018 and revised on 20 June 2018, as well as relevant governmental assessment requirements, guidelines and policies.

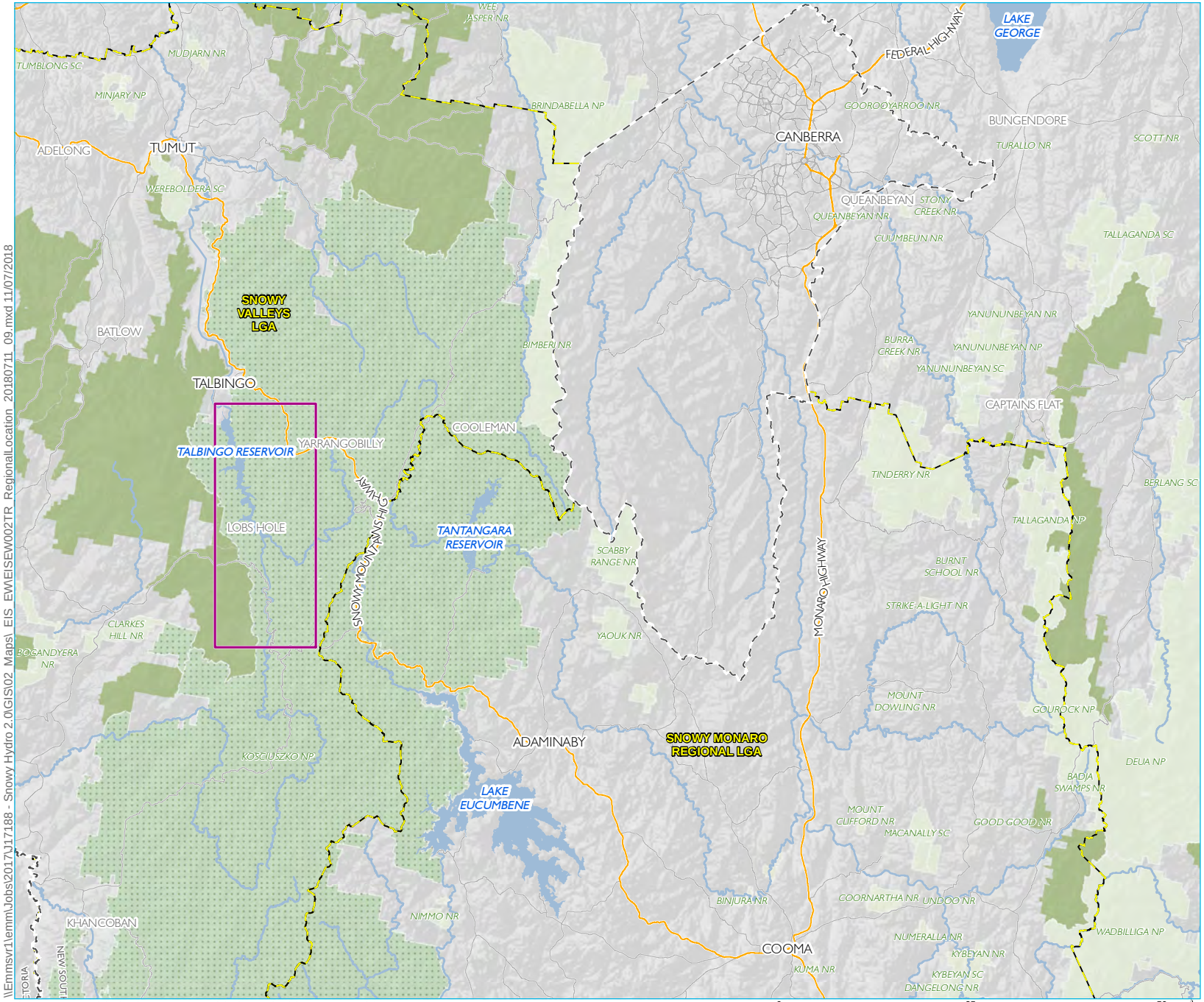
The SEARs must be addressed within the EIS. Table 1.1 lists the matters relevant to this BFRHA and where they are addressed in this report.

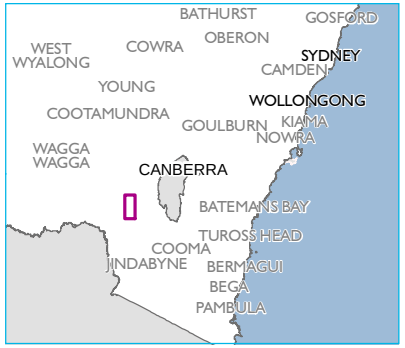
Table 1.1 Relevant matters raised in SEARs

Requirement	Section addressed
The EIS must assess public safety, including an assessment of the risks to public safety, paying particular attention to bush fire risks, emergency egress and evacuation, and the handling of dangerous goods.	Bush fire risks – Sections 3, 4, 5, 6 and 7. Emergency egress and evacuation (bush fire emergency) – Sections 5, 6 and 7. The handling of dangerous goods (bush fire risk) – Section 3 and 5.

To inform preparation of the SEARs, the Department of Planning and Environment (DPE) invited relevant government agencies to advise on matters to be addressed in the EIS. These matters were taken into account by the Secretary for DPE when preparing the SEARs.

The following provides detail on the relevant legislation, planning documents and codes, as related to this BFRHA.





KEY

- Exploratory Works project area
- Main road
- Local road
- Watercourse
- Waterbodies
- Kosciuszko National Park
- NPWS reserve
- State forest
- Local government area boundary
- State boundary

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Source: EMM (2018); Snowy Hydro (2018); DFSI (2017); LPMA (2011)

Regional location of Snowy 2.0 and Exploratory Works

Snowy 2.0
Bushfire Risk and Hazard Assessment
Exploratory Works
Figure 1.1

Source: EMM (2018); Snowy Hydro (2018); SMEC (2018); Robert Bird (2018); DFSI (2017); LPMA (2011)

0 2.5 5 km

N

GDA 1994 MGA Zone 55

KEY

- Exploratory tunnel
- Access road upgrade
- Access road extension
- Communications cable
- Main road
- Local road
- Major watercourse
- On land rock management
- Subaqueous excavated rock placement
- Disturbance footprint
- Avoidance footprint

Exploratory Works project area

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Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 1.2

snowy 2.0 EMM

1.5.1 National Parks and Wildlife Act 1974

The overall management of the KNP is prescribed by objectives stated in the *National Parks and Wildlife Act 1974* (NPWS Act). It is a requirement under the NPWS Act that no operations and actions are to be undertaken which are contrary to the Plan of Management (PoM). The *Kosciuszko National Park Plan of Management* (NPWS, 2006) (KNP PoM) states as an overarching principle: "Maintain or improve the condition of the natural and cultural values that together make the Park a special place."

The KNP PoM further states the following specific fire management objectives:

- Fire management is aimed at ensuring:
  - no human life is lost or person injured as a result of fire;
  - infrastructure within and beyond the boundaries of the KNP is not damaged from fire;
  - important natural features, especially alpine areas, restricted, rare or endemic plant or animal communities and species, and karst systems, are protected from detrimental impacts associated with fire;
  - a natural diversity of vegetation communities and age classes is promoted;
  - fire does not contribute to catchment instability and water quality problems;
  - sites and features of cultural significance are protected from fire; and
  - wilderness quality and scenic amenity are retained;
- fire suppression and protection operations are undertaken in ways that minimise adverse effects on the values of the KNP;
- fire detection and access infrastructure and operations permit rapid suppression of fire;
- prescribed burning is strategic in nature and undertaken in ways that minimise associated adverse effects;
- the incidence of unplanned fires ignited from human causes in the KNP is minimised;
- fire management decision-making is informed by the results of relevant research; and
- fire management is strategically coordinated across the greater landscape and multiple land tenures and involves the community.

This BFRHA considers the KNP PoM, where relevant to the Exploratory Works.

1.5.2 Rural Fires Act 1997

The objectives of the *NSW Rural Fires Act 1997* (RF Act) is to:

- prevent, mitigate and suppress bush and other fires in NSW;
- co-ordinate bush fire fighting and bush fire prevention throughout the State;

- protect people from injury or death and property from damage as a result of bush fires; and
- protect the environment.

The RF Act places emphasis on cooperative fire management and wildfire suppression planning between the various organisations involved in fire management. With respect to the Exploratory Works, the NSW National Parks and Wildlife Service (NPWS) is the local authority responsible for fire management in the KNP, while the NSW RFS is the local authority responsible for fire management for that part of the Exploratory Works proposed for the northern end of Talbingo Reservoir (within the Snowy Valleys Council LGA). As the local authorities under the RF Act, these organisations share responsibilities to undertake appropriate measures to prevent fire from entering or leaving their estates.

It is also noted that under section 63 of the RF Act, owners and occupiers of land have a duty to take practicable steps to prevent the occurrence of bush fires on, and to minimise the danger of the spread of bush fires on or from that land.

Part 3, division 4 of the RF Act stipulates that the Bush Fire Coordinating Committee (BFCC) must constitute a Bush Fire Management Committee (BFMC) for each area in NSW that is subject to the risk of bush fires. Each BFMC is required to prepare and submit to the BFCC a draft Bush Fire Risk Management Plan (BFRMP), a strategic document that identifies community assets at risk and sets out a five year program of coordinated multi-agency (including the NSW RFS and the NPWS) treatments to reduce the risk of bush fire to the assets identified. The Exploratory Works occurs within the Riverina Highlands BFMC area and adjacent to the Snowy Monaro BFMC area.

Under the RF Act and as a fire authority, the NPWS is required to implement the provisions of Bush Fire Management Plans. The *Kosciuszko National Park Fire Management Strategy 2008-2013* (NPWS 2008) (KNP FMS) has been prepared in accordance with the policies and procedures detailed in the NPWS *Fire Management Manual* (NPWS 2006a), the *State Incident Plan* (NPWS, 2006b) and the KNP PoM.

This BFRHA incorporates the procedures detailed in the Riverina Highlands BFRMP and the KNP FMS, where relevant to the Exploratory Works.

1.5.3 Environmental Planning and Assessment Act 1979

Snowy 2.0 has been declared to be Critical State Significant Infrastructure (CSSI) by the NSW Minister for Planning under the provisions of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

Under the EP&A Act, the provisions of *Planning for Bush Fire Protection* (PBP), as set out by NSW Rural Fire Service (NSW RFS) (2006) and described further within the following section, apply to all development on land which is mapped as being bush fire prone or if the development is potentially exposed to a bush fire threat. If a development of a type not specifically addressed in the PBP is proposed in a bush fire prone area, the NSW RFS will determine which standards apply to that development.

Under Section 5.23(1) of the EP&A Act, CSSI projects are exempt from requiring a bush fire safety authority (BFSA). However, given the scale of many CSSI projects, the requirements of PBP should be applied as appropriate, and consultation with the NSW RFS is encouraged. Even where comments are sought at the strategic planning stage of a project, further consultation with the NSW RFS may be required at subsequent stages of project development. In the case of the Exploratory Works assessed in this EIS, a bush fire community refuge is proposed. Once the design and location of the bush fire community refuge is finalised, consultation with DPE and the NSW RFS may identify the need for a BFSA. This BFRHA has been prepared to address the aims and objectives of PBP, should a referral to the RFS be required.

1.5.4 Planning for Bush Fire Protection 2006

Planning for Bush Fire Protection (NSW RFS 2006) (PBP) is a planning document to link responsible planning and development control with the protection of life, property and the environment.

The aim of PBP is to use the NSW development assessment system to provide for the protection of human life (including fire-fighters) and to minimise impacts on property from the threat of bush fire, while having due regard to development potential, onsite amenity and protection of the environment.

The objectives of PBP are as follows:

- afford occupants of any building adequate protection from exposure to a bush fire;
- provide for a defendable space to be located around buildings;
- provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition;
- ensure that safe operational access and egress for emergency service personnel and residents (staff, contractors and visitors) is available;
- provide for ongoing management and maintenance of bush fire protection measures, including fuel loads in the asset protection zone (APZ); and
- ensure that utility services are adequate to meet needs of fire fighters (and others assisting in bush fire fighting).

PBP provides an assessment framework for the potential impacts of bush fire upon the proposed assets and establishes six key bushfire protection measures that are to be addressed and collectively form an effective mitigation strategy in order to reduce the impacts of bush fire. These six key bush fire protection measures are:

- the provision of clear separation of buildings and bush fire hazard, in the form of a fuel-reduced Asset Protection Zone (APZ);
- construction standard and design;
- appropriate access standards for residents, fire fighters, emergency service workers and those involved in evacuation;
- adequate water supply and pressure;
- emergency management arrangements for fire protection and/or evacuation; and
- suitable landscaping, to limit fire spreading to a building.

The proposed mitigation measures as per PBP, as appropriate to the Exploratory Works, are discussed within this BFRHA.

1.5.5 National Construction Code

The National Construction Code (NCC) provides the minimum necessary requirements for safety, health, amenity and sustainability in the design and construction of new buildings throughout Australia.

The NCC is a performance based code which comprises the *Building Code of Australia* (BCA) as Volumes 1 and 2 and the *Plumbing Code of Australia* as Volume 3.

The NCC contains performance requirements and Deemed-to-Satisfy provisions relating to the construction of buildings in bush fire prone areas. These provisions apply to Class 1, 2, 3 and 4 and some Class 10 and Special Fire Protection Purpose (SFPP) buildings.

For the purposes of the BFRHA and in keeping with PBP, the Exploratory Works will be considered 'other development': that is, development which is not an 'integrated development' such as residential/rural residential subdivision, residential infill or special fire protection purpose. For Class 5, 6, 7, 8 and 10 buildings (which include offices, factories, warehouses and other commercial or industrial facilities) as defined by the BCA, the BCA does not provide for any bush fire specific performance requirements. Therefore, the A*ustralian Standard 3959 -2009 Construction of Buildings in Bushfire-prone Areas* (AS 3959 - 2009) (the bush fire construction standards), does not apply as a set of 'deemed to satisfy' provisions, and only the aim and objectives of the PBP apply.

The accommodation camp for the Exploratory Works is defined as long-term accommodation (exceeding 6 weeks in duration) and to satisfy the objectives of PBP, an acceptable solution would be to provide an APZ as for residential subdivision to prevent flame contact and ignition of external building materials. As such, the accommodation camp will need to comply with the specific requirements of PBP for APZs and the bush fire construction standards for residential subdivisions.

The KNP FMS (NPWS 2008) confirms that for new developments, excluding the resort areas defined in the State Environmental Planning Policy (SEPP) (Kosciuszko National Park Alpine Resorts) 2007, NPWS will apply the same standards (PBP and appropriate building standards as specified in the bushfire construction standards (AS 3959 – 2009) and the BCA) to any new developments in the KNP.

1.6 Purpose of this report

This BFRHA supports the EIS for the Exploratory Works. It considers the bush fire hazard associated with the proposed Exploratory Works and documents the methods and results, the initiatives built into the project design to avoid and minimise bush fire impacts, and the mitigation and management required to address residual impacts not able to be avoided.

1.7 Objective and scope

The SEARs for the Exploratory Works identify bush fire risks, in particular to public safety, as a key issue that must be considered and addressed as part of the EIS. As the Exploratory Works occur on bush fire prone land and is development that is potentially exposed to a bush fire threat, this BFRHA has been prepared in accordance with the NSW RFS *Planning for Bush Fire Protection* (2006). The BFRHA has been undertaken to demonstrate compliance with the aim and objectives of *Planning for Bush Fire Protection* (PBP) and the specific objectives and performance criteria for the land uses proposed. This BFRHA has also been undertaken to consider and incorporate the procedures detailed in the *Kosciuszko National Park Fire Management Strategy 2008-2013* (NPWS 2008), where relevant to the Exploratory Works.

2 Project description

2.1 Overview

Exploratory Works comprises construction associated with geotechnical exploration for the underground power station for Snowy 2.0. The Exploratory Works elements are shown on Figure 2.1 and involve:

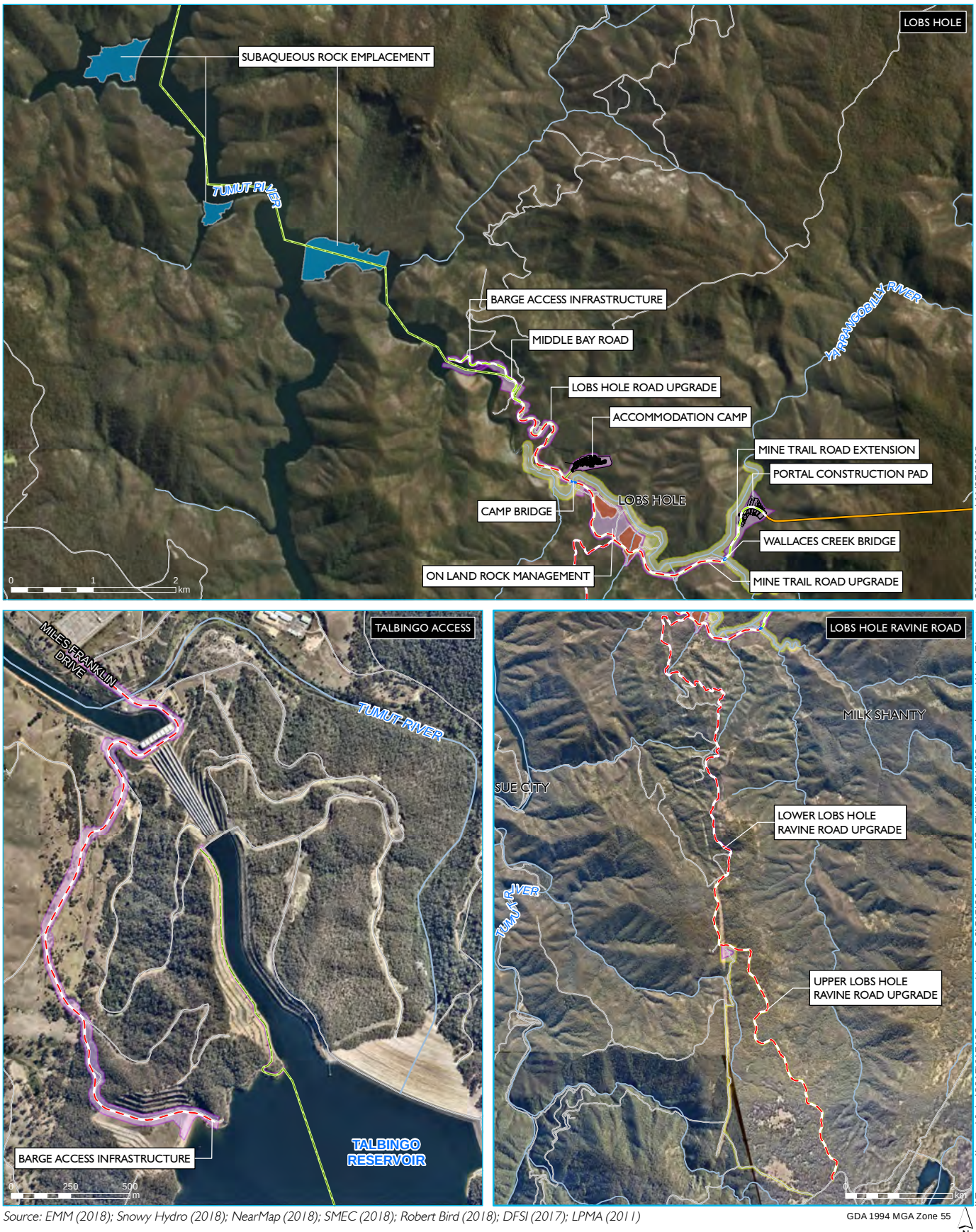
- establishment of an exploratory tunnel to the site of the underground power station for Snowy 2.0;
- horizontal and other test drilling, investigations and analysis in situ at the proposed cavern location and associated areas, and around the portal construction pad, access roads and excavated rock management areas all within the disturbance footprint;
- establishment of a portal construction pad for the exploratory tunnel;
- establishment of an accommodation camp for the Exploratory Works construction workforce;
- road works and upgrades providing access and haulage routes during Exploratory Works;
- establishment of barge access infrastructure, to enable access and transport by barge on Talbingo reservoir;
- excavated rock management, including subaqueous placement within Talbingo Reservoir;
- establishment of services infrastructure such as diesel-generated power, water and communications; and
- post-construction revegetation and rehabilitation, management and monitoring.

2.2 Exploratory tunnel

An exploratory tunnel of approximately 3.1 km is proposed to provide early access to the location of the largest cavern for the underground power station. This will enable exploratory drilling and help optimise the location of the cavern which, in turn, will optimise the design of Snowy 2.0.

The exploratory tunnel is proposed in the north-east section of Lobs Hole and will extend in an east-west direction with the portal construction pad to be outside the western end of the tunnel at a site east of the Yarrangobilly River, as shown on Figure 2.2.

The location of the proposed exploratory tunnel and portal construction pad is shown in Figure 2.2. The exploratory tunnel will be excavated by drill and blast methods and have an 8 x 8 m D-Shaped cross section, as shown on Figure 2.3.



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Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); Robert Bird (2018); DFSI (2017); LPMA (2011)

GDA 1994 MGA Zone 55

N

KEY

- Exploratory tunnel
- Access road upgrade
- Access road extension
- Permanent bridge
- Portal construction pad and accommodation camp conceptual layout
- Communications cable
- Local road or track
- Watercourse
- On land rock management
- Subaqueous rock emplacement area
- Disturbance footprint
- Avoidance footprint

Exploratory Works elements

Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 2.1

snowy 2.0 EMM

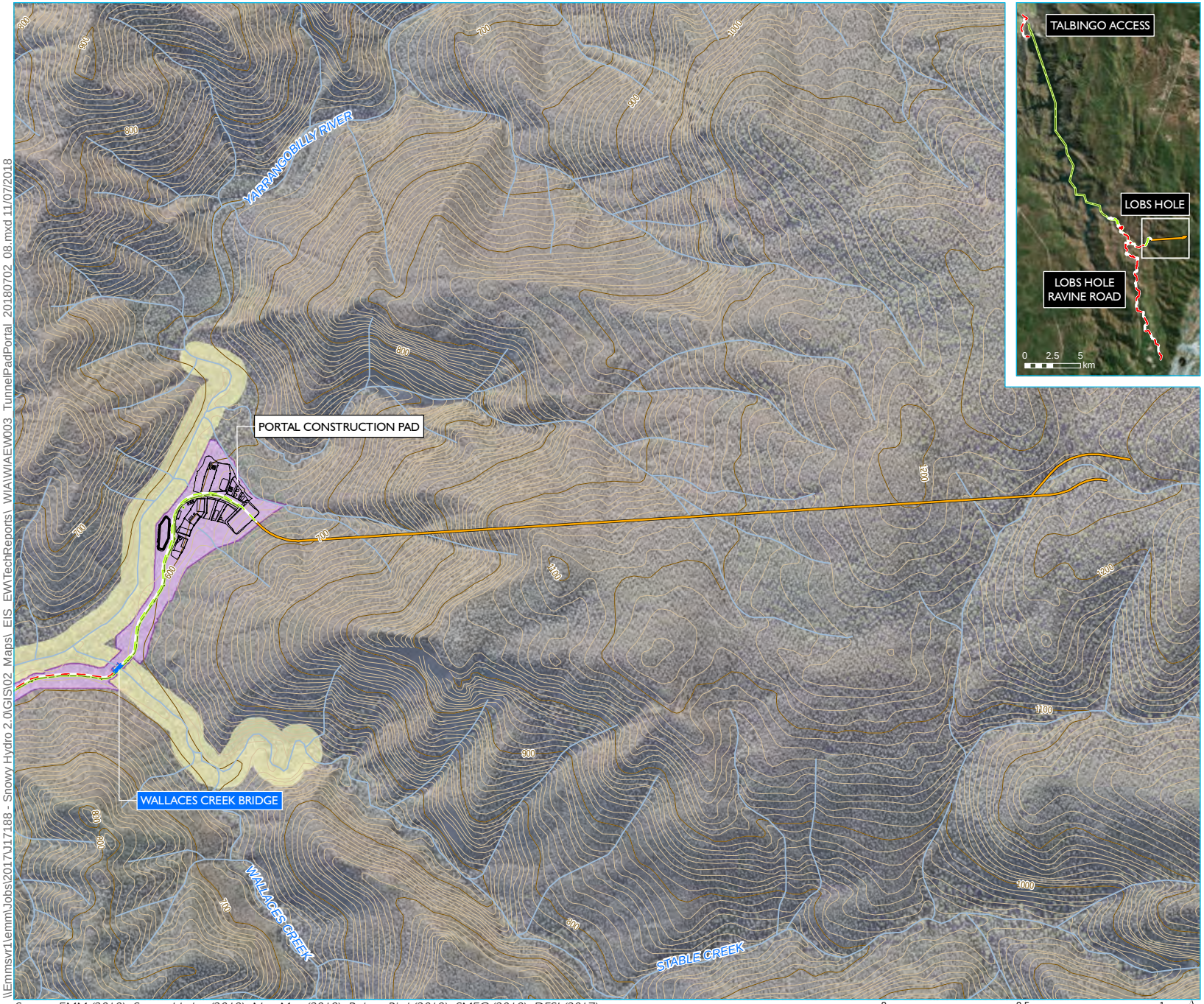
The drill and blast excavation process will be repeated cyclically throughout the tunnelling works, involving:

- marking up and drilling blast holes in a predetermined pattern in the working face of the tunnel;
- loading the blast holes with explosives, attaching detonators and connecting the holes into a blast sequence, and detonating the blast;
- ventilating the tunnel to remove blast fumes and dust;
- removing blasted rock;
- scaling and wash down of the tunnel roof and walls to remove loosened pieces of rock;
- geological mapping of the exposed rock faces and classification of the conditions to determine suitable ground support systems for installation;
- installing ground support; and
- advancing construction ventilation ducting and other utilities including power, water, compressed air and communications.

The exploratory tunnel will be shotcrete-lined with permanent anchor support, and incorporate a groundwater management system. The exploratory tunnel shape and dimensions are designed to allow two-lane traffic for the removal of excavated material, along with additional space for ventilation and drainage of groundwater inflows. Groundwater intersected during tunnelling will be contained and transferred to the portal for treatment and management. Areas identified during forward probing with the potential for high groundwater flows may require management through a detailed grouting program or similar.

The tunnel portal will be established at the western end of the exploratory tunnel and provide access and utilities to the exploratory tunnel during construction. The portal will house power, communications, ventilation and water infrastructure. The portal will also provide a safe and stable entrance to the exploratory tunnel.

It is anticipated that the exploratory tunnel will be adapted for multiple functions during construction of the subsequent stages of the Snowy 2.0 project. The exploratory tunnel will also eventually be utilized to form the main access tunnel (MAT) to the underground power station during the operational phase of Snowy 2.0, should it proceed.



KEY

- Access road upgrade
- Access road extension
- Portal construction pad conceptual layout
- Exploratory tunnel
- Permanent bridge
- Communications cable
- Watercourse
- Contour (10m)
- Contour (100m)
- Disturbance footprint
- Avoidance footprint

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Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); Robert Bird (2018); SMEC (2018); DFSI (2017)

0 0.5 1 km

GDA 1994 MGA Zone 55

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Exploratory tunnel location

Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 2.2

snowy2.0 EMM

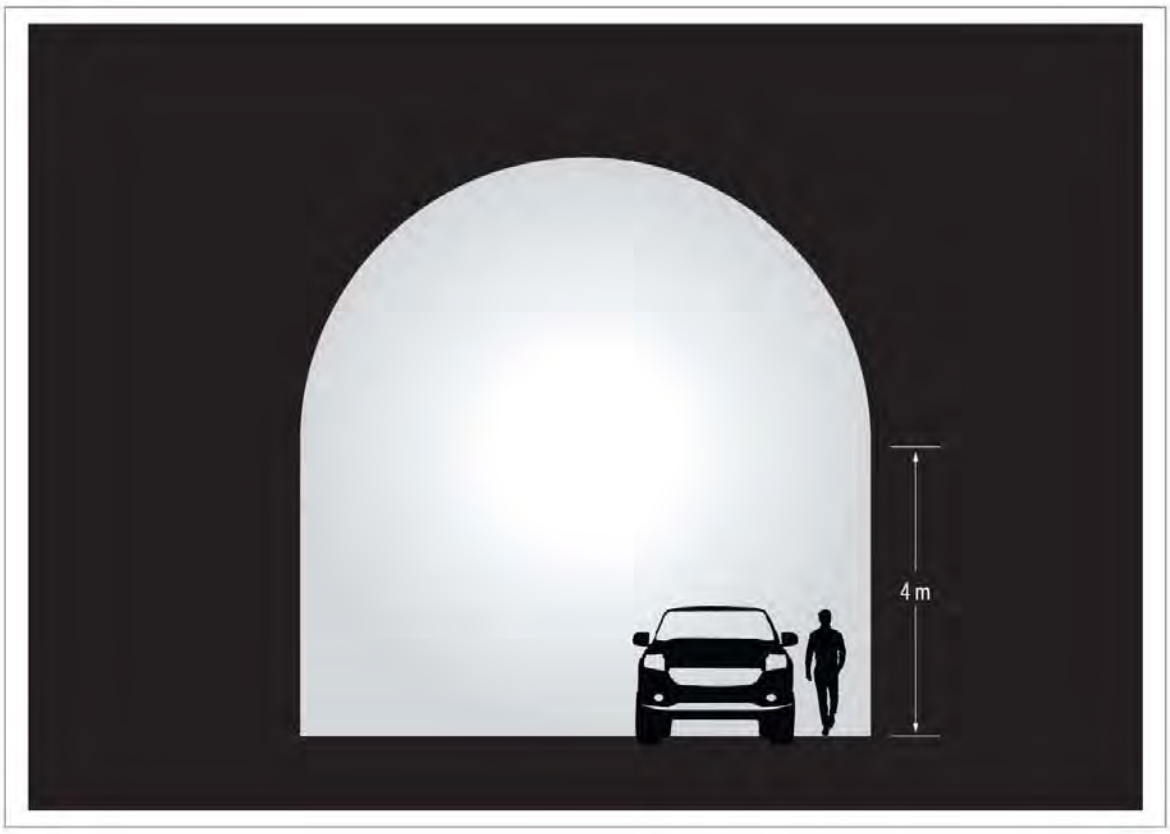
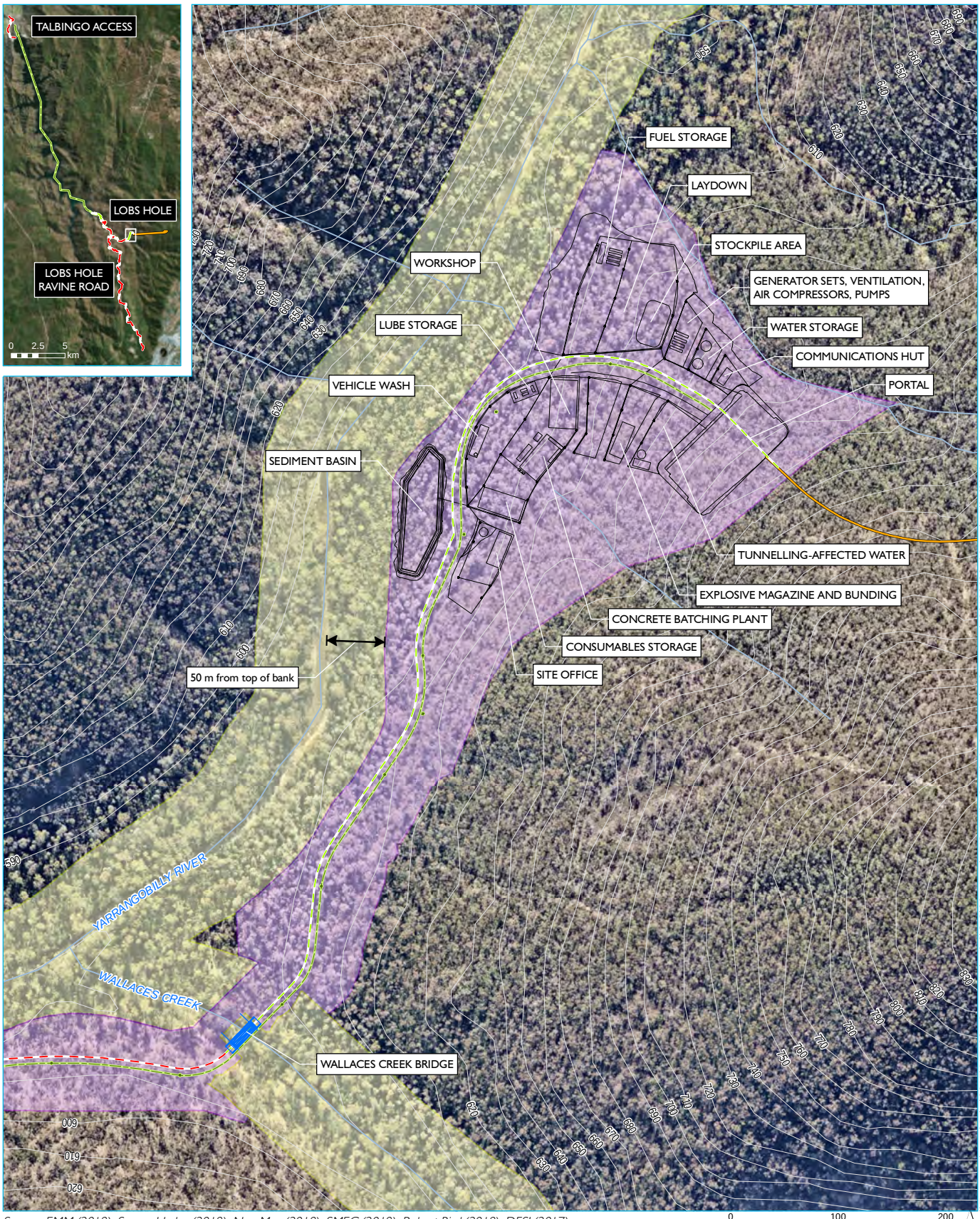


Figure 2.3 Exploratory tunnel indicative cross section

2.3 Portal construction pad

A portal construction pad for the exploratory tunnel will provide a secure area for construction activities. Infrastructure at the portal construction pad, shown in Figure 2.4, will primarily support tunnelling activities and include a concrete batching plant and associated stockpiles, site offices, maintenance workshops, construction support infrastructure, car parking, equipment laydown areas. Stockpile areas will allow for around two to three months supply of concrete aggregate and sand for the concrete batching plant to ensure that the construction schedule for the proposed access road works do not interfere with the exploratory tunnel excavation schedule. A temporary excavated rock stockpile area is also required to stockpile material excavated during tunnel construction prior to its transfer to the larger excavated material emplacement areas.

The portal construction pad will be at the western end of the exploratory tunnel. The portal construction pad will be excavated to provide a level construction area with a near vertical face for the construction of the portal and tunnelling. The area required for the portal construction pad is approximately 100,000 m^2.



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Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); Robert Bird (2018); DFSI (2017)

0 100 200 m
GDA 1994 MGA Zone 55

N

KEY

- Access road upgrade
- Access road extension
- Permanent bridge
- Portal construction pad conceptual layout
- Exploratory tunnel
- Communications cable
- Watercourse
- Contour (10m)
- Disturbance footprint
- Avoidance footprint

Conceptual layout – portal construction pad

Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 2.4

2.4 Excavated rock management

It is estimated that approximately 750,000 m^3 of bulked materials will be excavated, mostly from the exploratory tunnel and portal construction pad with additional quantities from road upgrade works. Subject to geochemical testing of the rock material, excavated rock will be placed either on land or subaqueously within Talbingo Reservoir.

2.4.1 On land placement

Excavated materials will be placed in one of two rock emplacement areas at Lobs Hole as shown on Figure 2.5.

The strategy for excavated rock management is for excavated material to be emplaced at two areas with the final placement of excavated material to be determined at a later date.

Consultation with NPWS throughout the design process has identified an opportunity for the eastern emplacement area to form a permanent landform that enables greater recreational use of Lobs Hole following the completion of Snowy 2.0's construction. It is envisaged that the excavated rock emplacement area will provide, in the long-term, a relatively flat final landform suitable for camping and basic recreational facilities to be confirmed in consultation with NPWS.

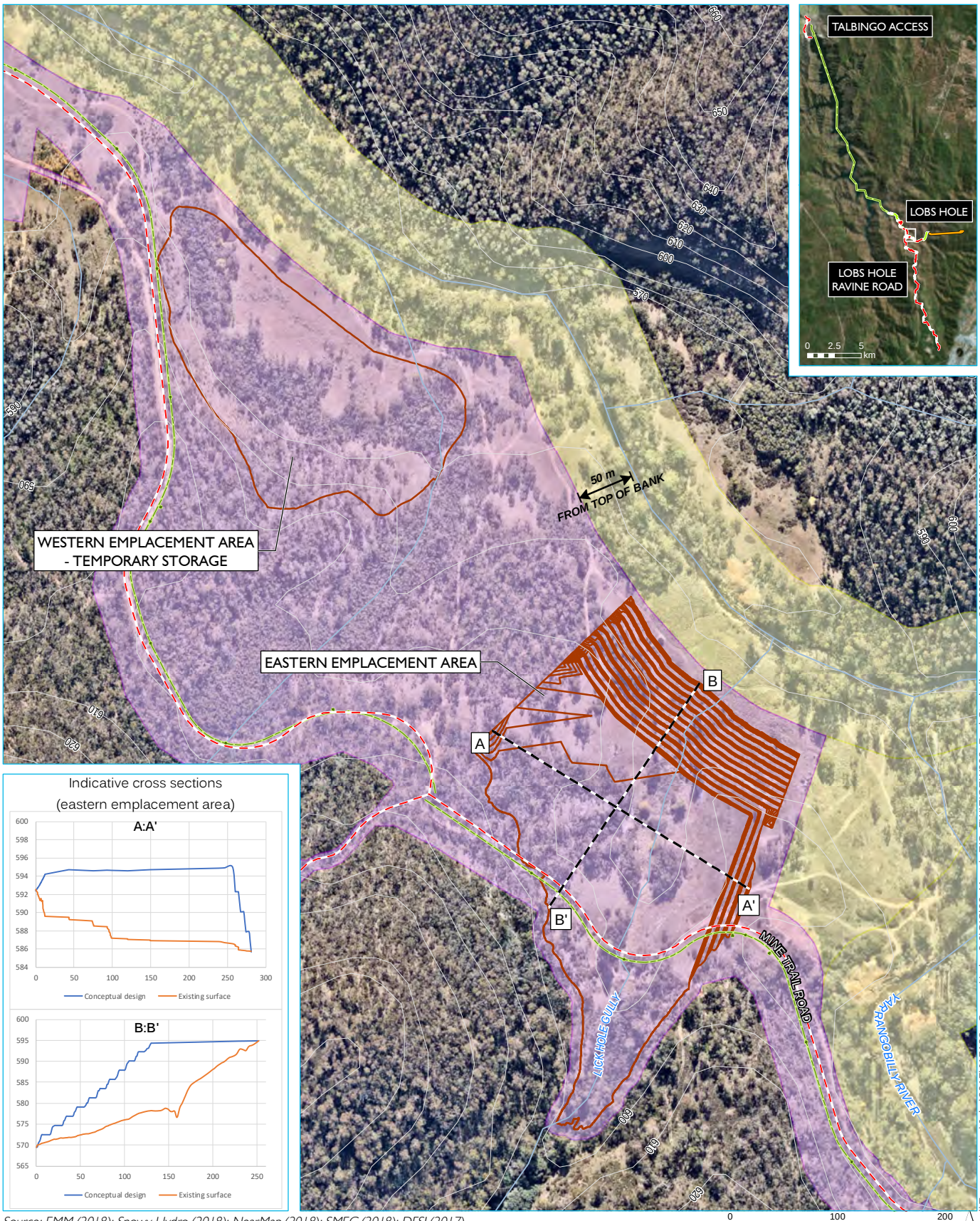
The eastern emplacement area has a capacity of up to 600,000 m^3 of material. It will be approximately 25 m maximum depth and will be benched down to the northern edge of the emplacement which is setback 50 m from the Yarrangobilly River.

The western emplacement area will be used to store excavated material should it not be able to be placed within the eastern emplacement area. It is envisaged this emplacement area will be used to store excavated materials suitable for re-use within the construction of Exploratory Works or for use by NPWS in KNP maintenance activities. All remaining material placed in this emplacement area will be removed following the completion of Exploratory Works.

The guiding principles for the design, construction method and management of emplacement areas undertaken for Exploratory Works have been as follows:

- reducing potential for acid rock drainage from the excavated rock emplacement area entering the Yarrangobilly River or forming groundwater recharge;
- avoid known environmental constraints; and
- manage existing surface water flows from Lick Hole Gully.

The design and management of the emplacement areas have not yet been finalised due to the need for further investigations to determine the likely geochemical characteristics of the excavated material. Following further investigation and prior to construction of Exploratory Works a management plan will be prepared and implemented.



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Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); DFSI (2017)

KEY

- Cross-section
- Exploratory tunnel
- Access road upgrade
- Access road extension
- Communications cable
- On land rock management
- Watercourse
- Contour (10m)
- Disturbance footprint
- Avoidance footprint

Conceptual layout – excavated material emplacement areas

Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 2.5

2.4.2 Subaqueous placement

An intial program for the placement of excavated rock within Talbingo Reservoir also forms part of Exploratory Works. The program will be implemented in an appropriate section of Talbingo Reservoir in accordance with a detailed management plan based on an engineering method informed through the materials' geochemistry and reservoir's characteristics. The purpose of the program is to confirm the suitability of the emplacement method for future excavated rock material from the construction of Snowy 2.0, should it proceed.

The rock for subaqueous placement will be taken from the excavated rock emplacement areas as described above. Testing of the rock would be conducted during excavation to assess geochemical properties. Any rock assessed as unsuitable for subaqueous placement based on the prior geochemical and leachability testing would be separately stockpiled and not used in the program. Suitable (ie non-reactive material) would be transported and loaded to barge, for placement at the deposition area. Suitable placement locations have been identified for Exploratory Works and are shown indicatively on Figure 2.6.

All placement within the reservoir would occur within silt curtains and would be subject to a detailed monitoring regime including survey monitoring of pre-placement and post-placement bathymetry, local and remote background water quality monitoring during placement with a structured management response to monitoring results in the event of an exceedance of established triggers. The management, mitigation and monitoring measures would be refined following the ongoing investigations.

2.5 Accommodation camp

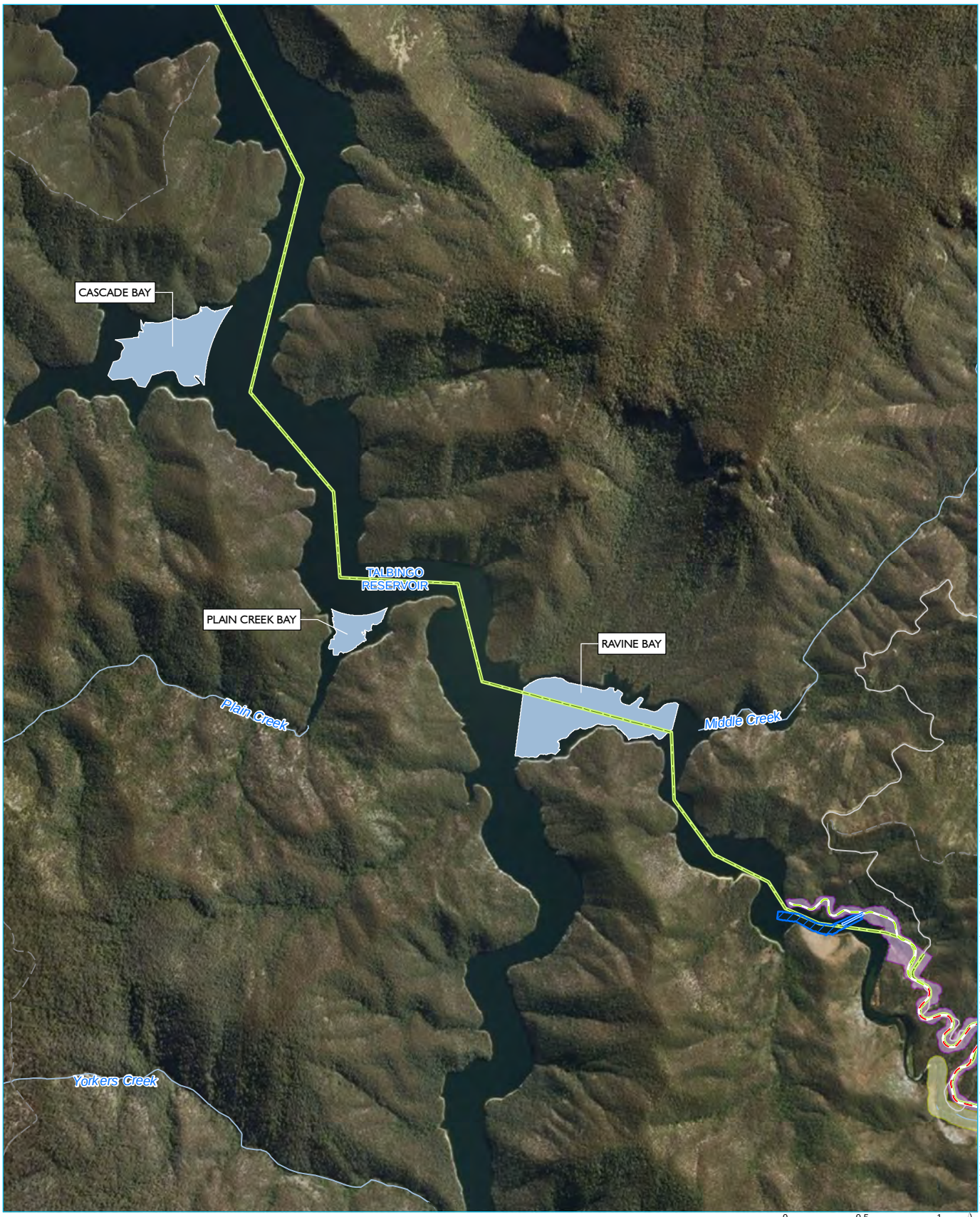
An accommodation camp is proposed to provide accommodation and supporting services for workers in close proximity to the exploratory tunnel. The accommodation camp layout is shown on Figure 2.7 and includes ensuite rooms surrounding central facilities including a kitchen, tavern, gym, admin office, laundry, maintenance building, sewage and water treatment plants and parking that will service the Exploratory Works workforce. The accommodation camp access road will connect to the north side of Lobs Hole Road at Lobs Hole. The conceptual layout of the accommodation camp is shown on Figure 2.7.

2.6 Road and access provisions

Existing road and access will need to be upgraded to a suitable standard to:

- provide for the transport of excavated rock material between the exploratory tunnel and the excavated rock emplacement areas;
- accommodate the transport of oversized loads as required; and
- facilitate the safe movement of plant, equipment, materials and construction staff to the portal construction pad.

Given the topographic constraints of the area, the standard of the existing roads and the environmental values associated with KNP, the option of barging larger and oversized loads to the site is available. This is discussed further at Section 2.7.



Source: EMM (2018); Snowy Hydro (2018); ESRI (2018); SMEC (2018); DFSI (2018); GA (2017); LPMA (2011)

0 0.5 1 km
GDA 1994 MGA Zone 55

N

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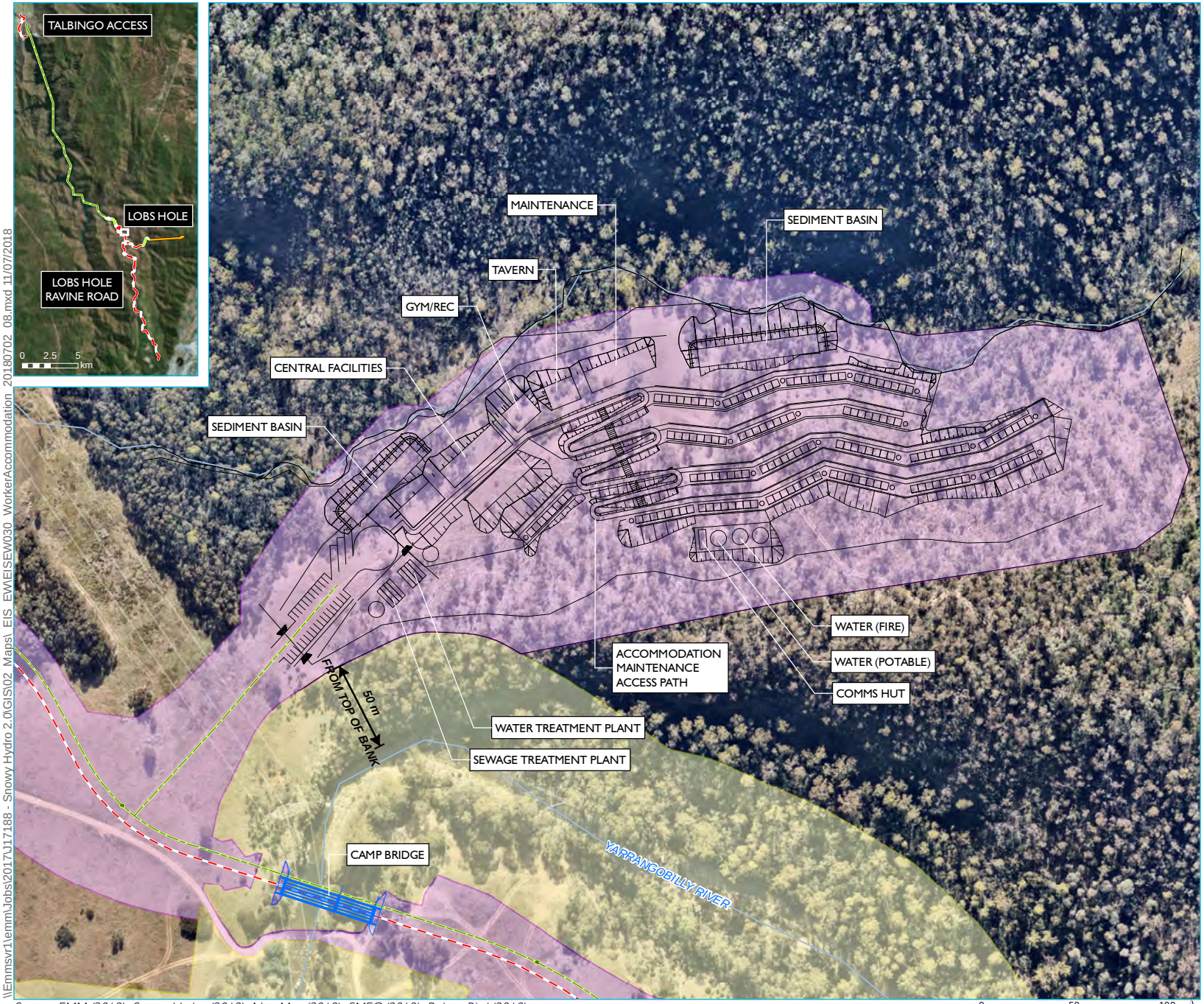
KEY

- Access road upgrade
- Access road extension
- Communications cable
- Subaqueous rock emplacement
- Major watercourse
- Local road
- Track
- Middle Bay barge access
- Disturbance area - barge infrastructure
- Disturbance footprint
- Avoidance footprint

Subaqueous excavated rock placement

Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 2.6

snowy 2.0 EMM



KEY

- Exploratory tunnel
- Access road upgrade
- Access road extension
- Permanent bridge
- Accommodation camp conceptual layout
- Communications cable
- Watercourse
- Disturbance footprint
- Avoidance footprint

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Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); Robert Bird (2018)

Conceptual layout – accommodation camp

Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 2.7

2.6.1 Access road works

The access road upgrades will be designed based on access for a truck and dog trailer. The proposed road works are shown in Figure 2.8 and described in Table 2.1. It is expected that the majority of materials and equipment will travel along the Snowy Mountains Highway, Link Road and Lobs Hole Ravine Road, with some required to travel on Miles Franklin Drive via Talbingo to Talbingo Dam Wall and be transferred via a barge to site. The primary haul routes for construction material on site are provided in Figure 2.9. Where existing roads are replaced by new access roads or road upgrades, the existing roads will be removed and rehabilitated in line with the rehabilitation strategy for Exploratory Works.

Table 2.1 Access road works summary

Roadwork area	Overview
Upper Lobs Hole Ravine Road upgrade	Minor upgrades to 7.5 km section of existing road. Only single lane access will be provided. No cut and fill earthworks or vegetation clearing will be undertaken.
Lower Lobs Hole Ravine Road upgrade	Upgrades to 6 km section of existing road involving cut and fill earthworks in some sections. Only single lane access will be provided.
Lobs Hole Road upgrade	Upgrade to 7.3 km section of existing road providing two-way access.
Mine Trail Road upgrade	Upgrade to 2.2 km section of existing track to two-way access.
Mine Trail Road extension	Establishment of a new two-way road providing access to the exploratory tunnel portal.
Middle Bay Road	Establishment of a new two-way road to the proposed Middle Bay barge ramp.
Spillway Road	Upgrade of a 3 km section of existing road to provide two-way access to the proposed Spillway barge ramp.

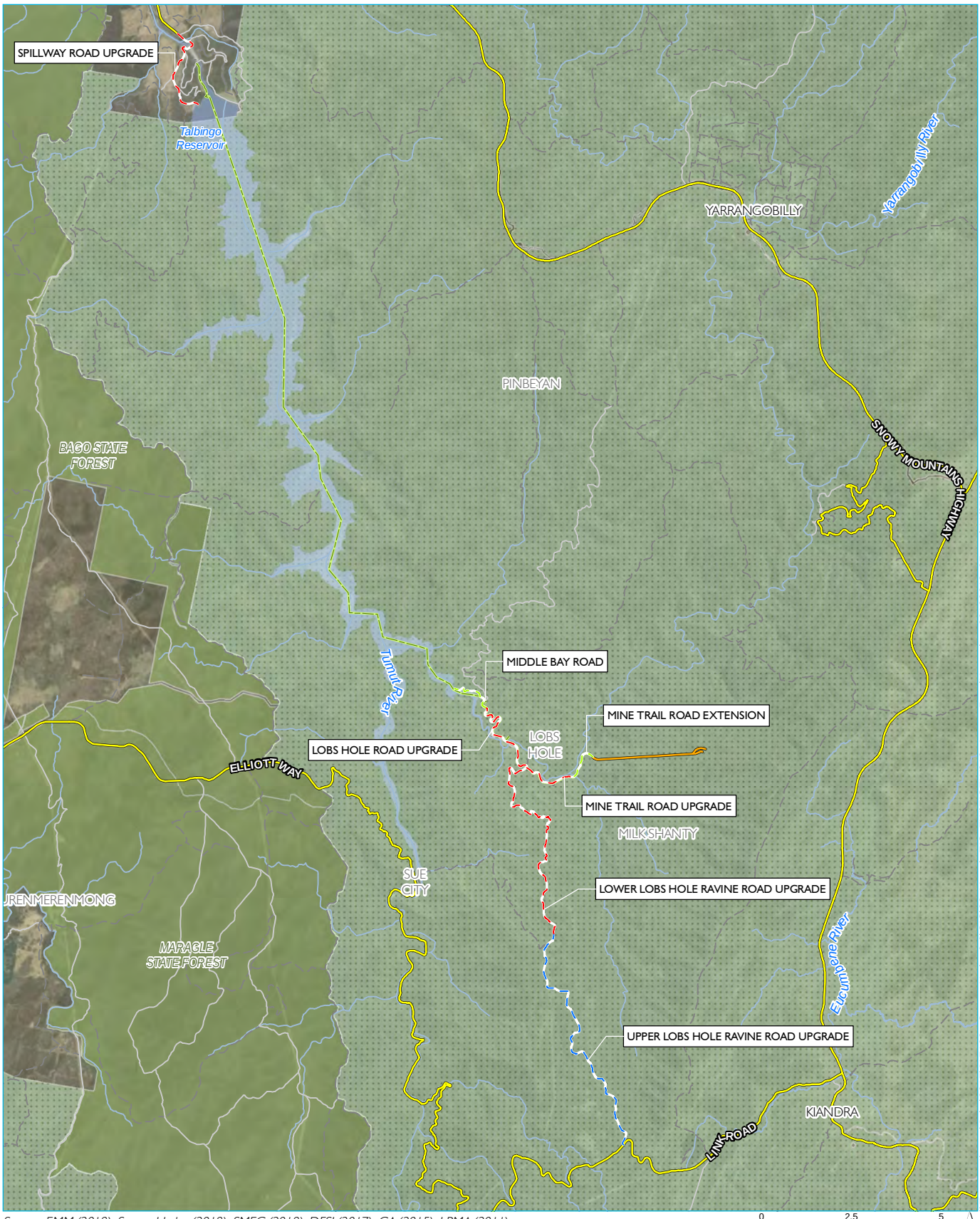
While no cut and fill earthworks or vegetation clearing is proposed along Upper Lobs Hole Ravine Road, a laydown area is proposed within and adjacent to the existing transmission line easement. This area will be used to store materials required for the road works to the lower section of Lobs Hole Ravine Road.

2.6.2 Watercourse crossings

Bridge construction will be required at two locations as described in Table 2.2. The locations of proposed bridge works are shown in Figure 2.9.

Table 2.2 Watercourse crossing summary

Bridge works area	Overview
Camp bridge	An existing crossing on Yarrangobilly River will be used as a temporary crossing while a new permanent bridge is built as part of Lobs Hole Road upgrade. The existing crossing will require the crossing level to be raised with rocks to facilitate vehicle passage. The rocks used to raise the crossing level will be removed and the crossing no longer used once the permanent bridge has been constructed. The new bridge (Camp Bridge) will be a permanent crossing and used for both Exploratory Works and Snowy 2.0 main works, should it proceed.
Wallaces Creek bridge	Establishment of a new permanent bridge at Wallaces Creek as part of the Mine Trail Road extension. Establishment of this bridge will require an initial temporary pre-fabricated 'Bailey bridge' to be constructed, which will be removed before the end of Exploratory Works.



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Source: EMM (2018); Snowy Hydro (2018); SMEC (2018); DFSI (2017); GA (2015); LPMA (2011)

0 2.5 5 km
GDA 1994 MGA Zone 55

N

KEY

- Access road upgrade - without widening
- Access road upgrade - with widening
- Access road extension
- Exploratory tunnel
- Communications cable
- Main road
- Local road
- Vehicular track
- Perennial watercourse
- Scheme storage
- Kosciuszko National Park
- State forest

Access road upgrades and establishment

Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 2.8

KEY

- Access road upgrade
- Access road extension
- Permanent bridge
- Exploratory tunnel
- Portal construction pad and accommodation camp conceptual layout
- Communications cable
- Excavated rock haul route
- Watercourse
- On land rock management
- Middle Bay barge access
- Disturbance footprint
- Avoidance footprint

\\Emmsvr1\emm\Jobs\2017\117188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS EWEISEW005 ExcavatedRockHaulRoute 20180702 10.mxd 11/07/2018

Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); Robert Bird (2018); DFSI (2017)

Excavated material haul route

Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 2.9

The design for permanent bridges at both crossings will consist of steel girders with a composite deck. This is the most common type of permanent bridge constructed in and around the existing Snowy Scheme. Lightweight steel girders are easy to transport and will therefore allow for efficiencies in the construction schedule and permit the use of smaller-scale lifting equipment at the construction site.

2.7 Barge access infrastructure

To provide an alternative to road access, a barge option is proposed, not only for bulky and heavy equipments but for materials and also in case of emergency. During Exploratory Works, barges will be loaded at the northern barge ramp (Talbingo barge ramp), travel about 18 km along Talbingo Reservoir and be unloaded at the southern barge ramp (Middle Bay barge ramp) before returning to the north. Some loads may also be transported in the reverse direction.

Barge access infrastructure will comprise two dedicated barge ramps at Middle Bay and Talbingo Spillway, with a slope of approximately 1 vertical to 10 horizontal (1V: 10H) at each location. A navigation channel is also required adjacent to the Middle Bay barge ramp. Construction will involve:

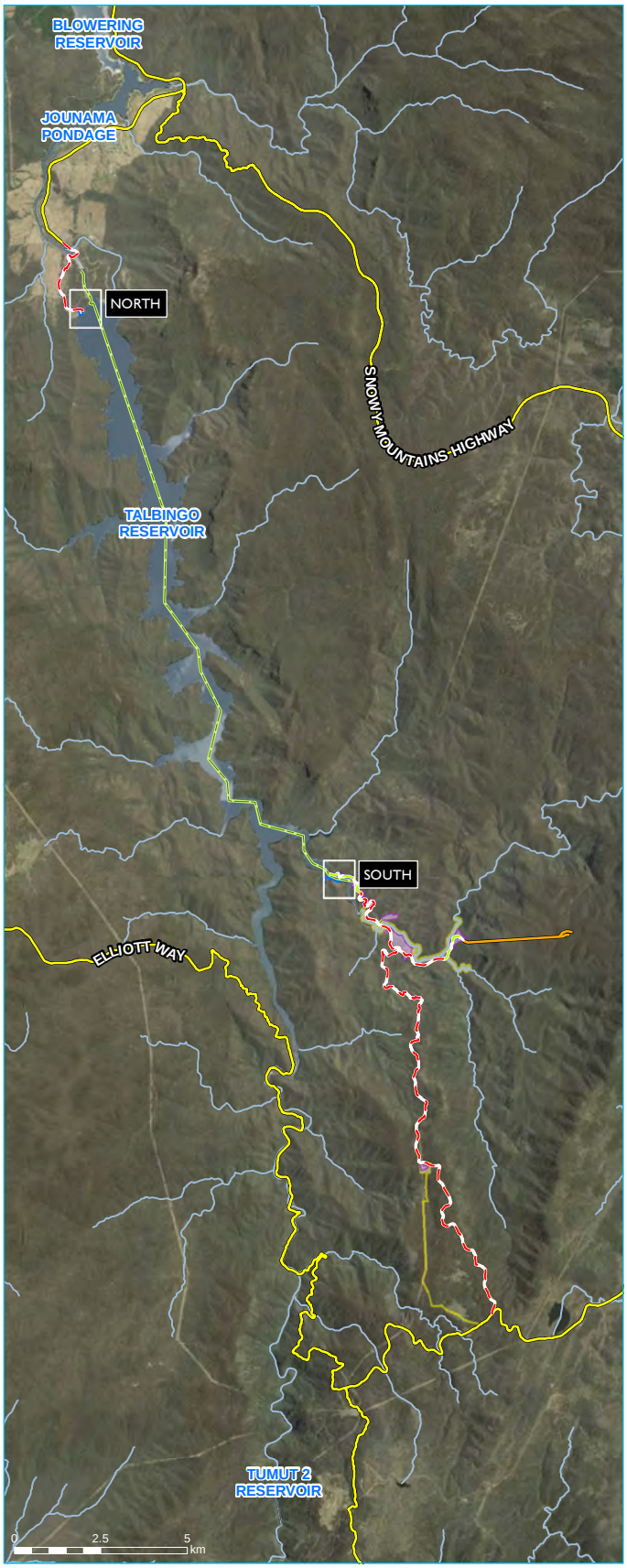
- geophysical and geotechnical investigation of the barge access area to inform detailed design;
- site establishment and excavation of barge access area;
- installation of precast concrete panels at the ramp location;
- installation of bollards for mooring lines;
- removal of trees and debris to establish a navigation channel allowing barge access; and
- minor dredging to allow barge access at the reservoir minimum operating level.

To facilitate construction, laydown areas are proposed adjacent to the Middle Bay barge ramp and adjacent to the water inlet pipeline. Laydown will also be used within the footprint of the Talbingo barge ramp.

Dredged material will be placed as part of the subaqueous placement program or within one of the designated on land rock emplacement areas. The infrastructure proposed for the Talbingo Spillway barge ramp and Middle Bay barge ramp is provided in Figure 2.10.

2.8 Services and infrastructure

Exploratory Works will require additional power and communication infrastructure. Water services are also needed and include a water services pipeline and water and waste water (sewage) treatment facilities. A summary of services required is provided at Table 2.3.



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Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); DFSI (2017); LPMA (2011)

GDA 1994 MGA Zone 55

N

KEY

- Exploratory tunnel
- Access road upgrade
- Access road extension
- Communications cable
- Main road
- Local road or track
- Perennial watercourse
- Middle Bay barge access
- Disturbance area - barge infrastructure
- Disturbance footprint
- Avoidance footprint

Barge access locations

Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 2.10

Table 2.3 Summary of services and infrastructure

Services infrastructure	Description
Power	Power will be provided at the portal construction pad and accommodation camp by diesel generators, with fuel storage provided at the portal construction pad.
Communication	Communication will be provided via fibre optic link. The fibre optic service has been designed to incorporate a submarine cable from Tumut 3 power station across Talbingo Reservoir to Middle Bay, and then via a buried conduit within the access roads to the accommodation camp and the portal construction pad.
Water and waste water (sewage)	A water services pipeline is proposed for the supply and discharge of water for Exploratory Works which will pump water between Talbingo Reservoir and the exploratory tunnel portal, portal construction pad and accommodation camp.
	A package water treatment plant is proposed at the accommodation camp to provide potable water to the accommodation camp and portal construction pad facilities and will be treated to a standard that complies with the Australian Drinking Water Guidelines. The accommodation camp water supply will be pumped via the water pipeline from Talbingo Reservoir at Middle Bay.
	A package waste water (sewage) treatment plant (STP) is proposed at the accommodation camp for Exploratory Works waste water. The STP will produce effluent quality comparable to standard for inland treatment facilities in the region (eg Cabramurra). Following treatment waste water will be discharged to Talbingo reservoir via the water services pipeline connecting the accommodation camp to Talbingo Reservoir.
	Waste water from the exploratory tunnel and concrete batching plant will be either re-used on site or sent to the waste water treatment plant for treatment prior to discharge.

2.9 Construction and schedule

2.9.1 Geotechnical investigation

To assist the design development for the portal construction pad, accommodation camp, Middle Bay Road, Spillway Road, and Lobs Hole Ravine Road, further survey of ground conditions is required. A program of geotechnical investigations including geophysical survey, construction of test pits, and borehole drilling within the disturbance footprint, will be undertaken as part of construction activities. Excavation of test pits in areas where information on relatively shallow subsurface profiles is required, or where bulk sampling is required for laboratory testing. Borehole drilling is required to facilitate the detailed design of cuttings, bridge foundations, retaining wall foundations, and drainage structures.

2.9.2 Construction activities

A disturbance footprint has been identified for Exploratory Works. The extent of the disturbance footprint is shown on Figure 2.1 and shows the area required for construction, including the buildings and structures, portal construction pad, road widening and bridges, laydown areas, and rock emplacement areas. Typical construction activities that will occur within the footprint are summarised in Table 2.4.

Table 2.4 Construction activities

Activity	Typical method
Geophysical and geotechnical investigation	Geophysical surveys will generally involve: • laying a geophone cable at the required location and establishing seismic holes; • blasting of explosives within seismic holes; and • in-reservoir geophysics surveys will use an air gun as the seismic source. Geotechnical surveys will generally involve: • establishing a drill pad including clearing and setup of environmental controls where required; • drilling a borehole to required depth using a tracked or truck mounted drill rig; and • installing piezometers where required for future monitoring program. Geophysical and geotechnical investigation within Talbingo Reservoir will be carried out using barges and subject to environmental controls.
Site establishment for portal construction pad, accommodation camp, rock placement areas and laydown areas	Site establishment will generally involve: • identifying and flagging areas that are to be avoided during the Exploratory Works period; • clearing of vegetation within the disturbance footprint, typically using chainsaws, bulldozers and excavators; • civil earthworks to create a stable and level area suitable for establishment. This will involve a cut and fill approach where required to minimise the requirement for imported material; • installing site drainage, soil erosion and other permanent environmental controls where required; • surface finishing, compacting only existing material where possible, or importing additional material. Where suitable, this material will be sourced locally (eg from upgrade works to Lobs Hole Ravine Road); and • set up and commissioning of supporting infrastructure, including survey marks.
Road works	Upgrades of existing tracks (no widening) will generally involve: • identifying and flagging areas that are to be avoided during the Exploratory Works period; and • removing high points, infilling scours, levelling of rutting, and compacting surfaces. Extension or widening of existing tracks will generally involve: • identifying and flagging areas that are to be avoided during the Exploratory Works period; • installing site drainage, soil erosion and other permanent environmental controls where required; • clearing and earthworks within the disturbance footprint; and • placing road pavement material on the roadway.
Bridge works	Establishment of permanent bridges will generally involve: • installing erosion and sedimentation controls around watercourses and installing scour protection as required; • establishing temporary diversions within the watercourse where required, including work to maintain fish passage; • establishing temporary bridges to facilitate permanent bridge construction; • constructing permanent bridges including piling, establishment of abutments and piers; and • removal and rehabilitation of temporary bridges and diversions.
Barge access works	Establishment of barge access infrastructure will generally involve: • installing sediment controls; • excavating and dredging of barge ramp area and navigation channel; • installing precast concrete planks and bollards; and • set up and commissioning of supporting infrastructure.

Table 2.4 Construction activities

Activity	Typical method
Exploratory tunnel construction	The drill and blast excavation process will be repeated cyclically throughout the tunnelling works, involving: • marking up and drilling blast holes in a predetermined pattern in the working face of the tunnel; • loading the blast holes with explosives, attaching detonators and connecting the holes into a blast sequence, and detonating the blast; • ventilating the tunnel to remove blast fumes and dust; • removing blasted rock; • scaling and wash down of the tunnel roof and walls to remove loosened pieces of rock; • geological mapping of the exposed rock faces and classification of the conditions to determine suitable ground support systems for installation; • installing ground support; and • advancing construction ventilation ducting and other utilities including power, water, compressed air and communications.

2.9.3 Ancillary construction areas

Ancillary facilities and laydown areas have been identified within the conceptual layout for the portal construction pad and accommodation camp. A number of other indicative construction and laydown areas have also been identified to support Exploratory Works. A summary of these sites are:

- Upper Lobs Hole Ravine Road laydown area;
- rock emplacement area laydown, storage and ancillary uses;
- barge access infrastructure laydown areas at Talbingo and Middle Bay; and
- other minor laydown areas as needed during site establishment of watercourse crossings.

All laydown areas are within the disturbance footprint identified for Exploratory Works.

In addition, an area near Camp Bridge has been identified to be used for a plant nursery and organic stockpile area.

2.9.4 Construction workforce requirements

i Staffing levels

It is currently expected that workforce for Exploratory Works will be approximately 200 people in total at peak construction. Workers are anticipated to work a 'swing' shift, for example two weeks on and one week off. These workers will be accommodated within the accommodation camp at Lobs Hole when rostered on.

The majority of the workforce will work on a fly-in fly-out and drive-in drive-out basis. It is expected that the majority of workers will fly in and out of either Cooma Airport or Canberra Airport and then travel to site via bus.

During construction of the accommodation camp, workers will be accommodated at Cabramurra. Some workers may also be accommodated at Snowy Hydro existing accommodation units at Talbingo during construction of the Talbingo barge ramp. No accommodation will be required outside of Cabramurra, the construction accommodation camp or Talbingo for the Exploratory Works workforce.

ii Hours of operation

It is expected that construction of the exploratory tunnel and haulage of rock material between the tunnel and excavated rock stockpile locations at Lobs Hole will be 24 hours a day, seven days a week for the duration of the tunnel drilling and blasting operation. Other construction activities, including the establishment works, road and infrastructure works, will normally work a 12 hour day, seven days a week.

The transport of materials along the haul route from Snowy Mountains Highway, Link Road and Upper Lobs Hole Ravine Road will only occur during day time hours (except during emergency), to avoid impacts to threatened species (Smoky Mouse). Transport by barge will be 24 hours a day, seven days a week.

2.9.5 Timing and staging

Exploratory Works are expected to take about 34 months, with the exploratory tunnel expected to be completed by late 2021.

It is expected that the construction works will be completed largely in parallel. However, road and access works are expected to be completed within the first six months from commencement. The proposed staging of construction activities are highlighted in Table 2.5.

Table 2.5 Indicative staging of construction

Construction works	2019	2020	2021
Access roads			
Portal construction pad			
Accommodation camp			
Services infrastructure			
Barge access infrastructure			
Tunnelling			
Excavated rock management			

2.10 Site rehabilitation

All Exploratory Works align with components of the main works for Snowy 2.0. However, should Snowy 2.0 not be approved or not progress, the project area will need to be rehabilitated, and project elements decommissioned in consultation with NPWS. Anticipated rehabilitation activities are summarised in Table 2.6.

Table 2.6 Planned Exploratory Works rehabilitation activities

Exploratory Works element	Indicative rehabilitation activities
Exploratory tunnel	Tunnel to remain open, and allowed to flood in lower portion provided groundwater impacts are negated.
Exploratory tunnel portal area	Permanent portal facade to be constructed, portal to be sealed from entry.
Portal construction pad and associated infrastructure	To be demobilised and all infrastructure removed. Site to be revegetated and returned to “original state”.
Excavated rock emplacement areas	Emplaced excavated rock in the western emplacement area to be removed offsite and area to be revegetated and returned to “original state”. The eastern emplacement area could remain in-situ and the landform rehabilitated as agreed with NPWS.
Accommodation camp	To be demobilised and all infrastructure removed. Site to be revegetated and returned to “original state”.
Road access works	No remediation required as works are to be designed to be permanent.
Barge access infrastructure	No remediation works required as wharf and loading ramps are designed as permanent. Wharf can be removed if desired.
Services and infrastructure	To be demobilised and all infrastructure removed. Site to be revegetated and returned to “original state”.

2.11 Decommissioning

Should Snowy 2.0 not proceed following the commencement or completion of Exploratory Works, elements constructed are able to be decommissioned and areas rehabilitated. Given works are within KNP, Snow Hydro will liaise closely with NPWS to determine the extent of decommissioning and types of rehabilitation to be undertaken. This approach will be taken to ensure that decommissioning allows for integration with future planned recreational use of these areas and to maintain the values of KNP.

3 Bush fire risk factors

Fire suppression operations can be made more challenging as a result of adverse bio-physical risk factors, such as weather conditions, terrain and aspect, vegetation characteristics, limited access and existing potential ignition sources. The addition of activities associated with the construction of the Exploratory Works adds additional risks.

3.1 Regional fire weather

An analysis of the fire weather experienced in the project area and the surrounding region provides insight into bush fire behaviour potential. Fire Danger Index (FDI) is based upon the LGA and Fire Weather District, as determined by the NSW RFS, where the development is to be located. As the Exploratory Works occur in the Snowy Valleys LGA, a FDI of 80 (Southern Slopes Fire Weather Districts) has been used to inform bush fire behaviour on the project area (NSW RFS 2017a). The Exploratory Works are located within the Riverina Highlands Bush Fire Management Committee (BFMC) area and are adjacent to the Snowy Monaro BFMC area. They ascribe the following regional weather characteristics:

- Snowy Monaro BFMC:
  - the typical/average climate is cool-temperate;
  - winters are long and cold, with temperatures regularly falling below freezing and periodic snowfalls occurring through the region;
  - the bush fire season generally runs from October to March; and
  - in some years, good summer rains, drier than normal autumn conditions, severe winter frosts and gale force winds result in created an increased fire danger throughout the winter months (Snowy Monaro BFMC 2009).
- Riverina Highlands BFMC:
  - the typical/average climate is cool-temperate;
  - rainfall occurs predominantly in winter and the bush fire season runs from November to March;
  - prevailing weather conditions associated with the bush fire season are generally north-westerly winds accompanied by high daytime temperatures and low relative humidity; and
  - frequent dry lightning storms occur during the bush fire season (Riverina Highlands BFMC 2009).

Throughout the year, the predominant winds across the KNP are from the north-west to the south-west, but local variations are experienced as a result of the rugged topography. Valleys may funnel winds and passing fronts can cause dramatic wind shifts. The north-westerly winds tend to be warmer and drier than the south-westerlies (NPWS 2008).

The *Kosciuszko National Park Fire Management Strategy 2008-2013* (NPWS 2008) provides insight into the general weather patterns that occur throughout the year within the KNP, in relation to fire risk (Table 3.1).

Table 3.1 Typical pattern of the yearly fire season in Kosciuszko National Park

Period	Unplanned fire risk	General conditions
September – December	Moderate	Week long high pressure synoptic patterns can bring cool dry and gusty northerly to westerly airstreams which are commonly followed by cooler south to south-westerly winds in mid to late spring and occasionally in December.
		Extreme fire danger days occur when strong to gusty hot north-westerly winds precede cold fronts, after prolonged spells of dry weather in November and December.
		Multiple ignitions can occur in remote areas of the KNP with the passage of dry lightning storms during later spring and throughout the summer.
		Fires can occur in frost cured vegetation at higher elevations.
January – April	High	The summer period has warm to hot conditions at lower elevations and cooler conditions at higher elevations.
		Warm periods can be interspersed with south-easterly or easterly airstreams that bring drizzle or rain from the coast to the east side of the KNP.
		Thunderstorms are frequent sometimes producing localised heavy rainfall and lightning strikes.
		Severe fires are likely to occur when January and February rains are below average and dry thunderstorms occur.
		Extreme fire danger days occur in December – February.
May – June	Low	Moist mild weather occurs during this part of the year.
		Severe fires are unlikely.
July - August	Low	A winter pattern of cool dry westerly airstreams dominate with occasional cold southerly fronts bringing snow about the ranges.
		Weekly passage of cold fronts produces rain and snow above 1200 m.
		Frosts are common.
		Severe fires are unlikely.

Source: 1. NPWS 2008

3.2 Regional fire history

Fire history records for the KNP date back to 1956. By 2008 NPWS had compiled records of 556 unplanned fires, an average of about 11 fires per year, and 195 planned fires within the KNP. Responsibility for fire management within the KNP was assumed by NPWS in 1986. Between 1986 and 2008, 113 prescribed burns were completed in the KNP covering a total area of 58,339 ha. This is an average of approximately five burns per year. Overall between 1957 and 2008, 11 per cent (%) of KNP had not burnt, 51% had burnt once and 30% had burnt twice. Over the same period more than 98% of the park had average inter-fire intervals of more than 17 years and only 0.17% or 1140 ha had burnt, on average, at inter-fire intervals of less than 10 years.

The project area was previously affected by bush fire during the 2002 to 2003 fire season. This was the most significant fire event experienced within the KNP since records have been kept and the most spatially extensive fire recorded since 1939 (NPWS 2008). This single fire season had significant, although generally short term, impacts on a wide range of natural and cultural heritage values within the KNP (NPWS 2008).

3.3 Ignition sources

3.3.1 Existing ignition sources

The main sources of ignition of unplanned fires in both the Lake Snowy Monaro BFMC area and the Riverina Highlands BFMC area are reported to be:

- lightning strikes during late spring and early summer;
- accidental ignition from the arcing of high voltage power lines and vegetation management within the summer months;
- escapes from legal and illegal burning off, mainly in rural areas;
- escapes from campfires from recreation users of the area; and
- arson, mainly in the Summer months on high fire days.

The *KNP Fire Management Strategy 2008-2013* (NPWS 2008) provides insight into the proportion of ignition types recorded in the KNP for the period from 1957 to 2007. The main cause of ignitions within the KNP is lighting (37%). However, of the recorded lighting ignitions, 86 (35% of all lighting ignitions) were recorded during the 2002 to 2003 fire season. NPWS (2008) reports arson (including suspected arson) as accounting for the second highest known cause of ignition (18%), followed by camp/cooking (9%), miscellaneous (including power line, smoking and motor vehicles) (5%), burning off (2%) and unknown (29%). The high proportion of unknown causes reflects the rugged topography and isolated nature of the KNP making it difficult to access and ascertain specific causes. It is likely that a high proportion of the unknown causes in more remote areas are from lightning strikes (NPWS 2008).

3.3.2 Project related ignition sources

The main potential sources of ignition of unplanned fires from the Exploratory Works are likely to be:

- diesel generators;
- fuel farm and bowsers (near the portal entrance and at the construction compound at Lobs Hole);
- the magazine (explosives) storage;
- the transport and use of explosives (for the extraction of rock from the exploratory tunnel and perhaps for the removal of hard rock associated with construction activities and road building);
- LPG gas tanks at the accommodation camp kitchen;
- vehicles driving over long grass;
- vehicle accidents;
- sparks generated from hot works from construction site compounds at Lobs Hole and the Exploratory tunnel and from plant and equipment used in construction activities at Lobs Hole and the exploratory tunnel and locations of construction activity, more generally; and
- human error (e.g. non-compliance of hot works procedures).

3.4 Vegetation

The vegetation of the KNP is characterised by three broad fuel types:

- forests and woodlands;
- heathlands; and
- grasslands and shrublands at higher elevations.

The project area is characterised by the forest fuel type, which contains four main categories of fuels. These are the relatively compact surface layer of fine fuels and decaying leaf litter, the elevated and relatively well aerated near surface and shrub layers, the canopy and bark (NPWS 2008).

Dr David Keith compiled broad scale native vegetation classifications and maps between 2001 and 2004 for NSW (the Keith formations) (Keith 2004). PBP uses the Keith formations to classify bush fire hazard vegetation (the PBP classifications). Vegetation mapping of the project area has been undertaken by EMM Consulting Pty Ltd (2018) as part of the Biodiversity Assessment for the EIS. EMM (2018b) has mapped the vegetation according to plant community types (PCTs). Identification of PCTs was confirmed with reference to the community profile descriptions (and diagnostic species tests) held within the NSW Vegetation Information System (VIS): Classification Version 2.1.

The following describes the vegetation within and surrounding the locations of the proposed accommodation camp and portal construction pad, where buildings and other infrastructure will be situated for the Exploratory Works.

3.4.1 Accommodation camp

Vegetation mapped by EMM (2018) within the footprint of the accommodation camp and for a 140 m buffer from all boundaries is shown in Table 3.2 and Figure 3.1. As shown, all vegetation types align with the dry sclerophyll forest vegetation formation, as classified by Keith (2004). Therefore the predominant vegetation classification, as per PBP, is forest.

Table 3.2 Vegetation within a 140 m buffer of the accommodation camp

Plant Community Type (PCT)[1]	Vegetation formation (Keith 2004)	PBP classification
PCT 296 – Brittle Gum - peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Dry Sclerophyll Forests (Shrubby sub-formation)	Forest
PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Forest
PCT 729 – Broad- leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner	Dry Sclerophyll Forests (Shrubby sub-formation)	Forest
PCT 999 - Norton's Box – Broadleaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrubby sub-formation)	Forest

Source: 1.EMM (2018b)

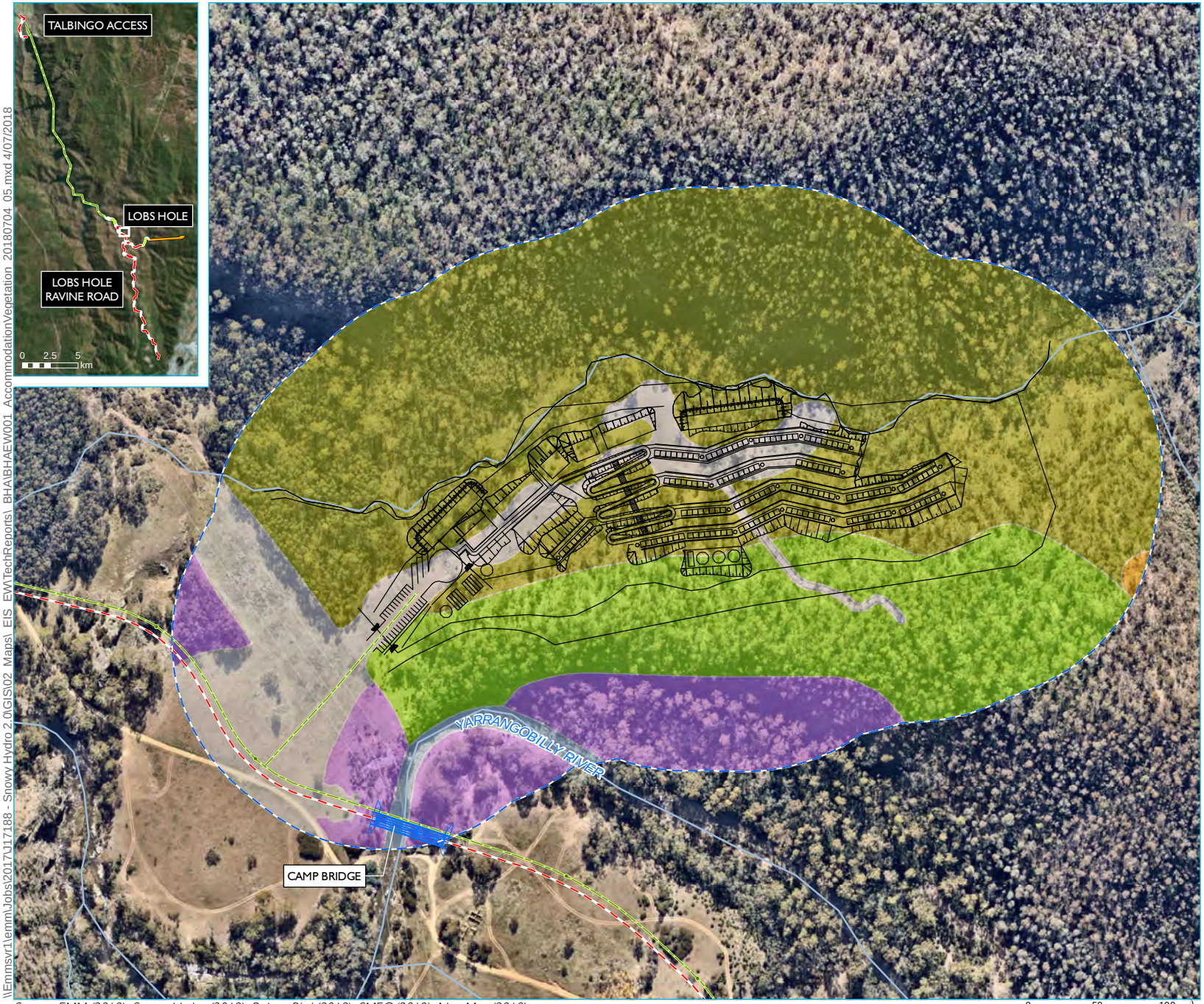
3.4.2 Portal construction pad

Vegetation mapped by EMM (2018b) within the footprint of the portal construction pad envelope and for a 140 m buffer from all boundaries is shown in Table 3.3 and Figure 3.2. As shown, all vegetation types align with the dry sclerophyll forest vegetation formation, as classified by Keith (2004). Therefore the predominant vegetation classification, as per PBP, is forest.

Table 3.3 Vegetation within a 140 m buffer of the portal construction pad

Plant Community Type (PCT)[1]	Vegetation formation (Keith 2004)	PBP classification
PCT 296 – Brittle Gum - peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Dry Sclerophyll Forests (Shrubby sub-formation)	Forest
PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Forest

Source: 1.EMM (2018)



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KEY

- Exploratory tunnel
- Access road upgrade
- Access road extension
- Permanent bridge
- Accommodation camp conceptual layout
- Communications cable
- Watercourse / drainage line
- 140 m buffer
- Cleared
- Water

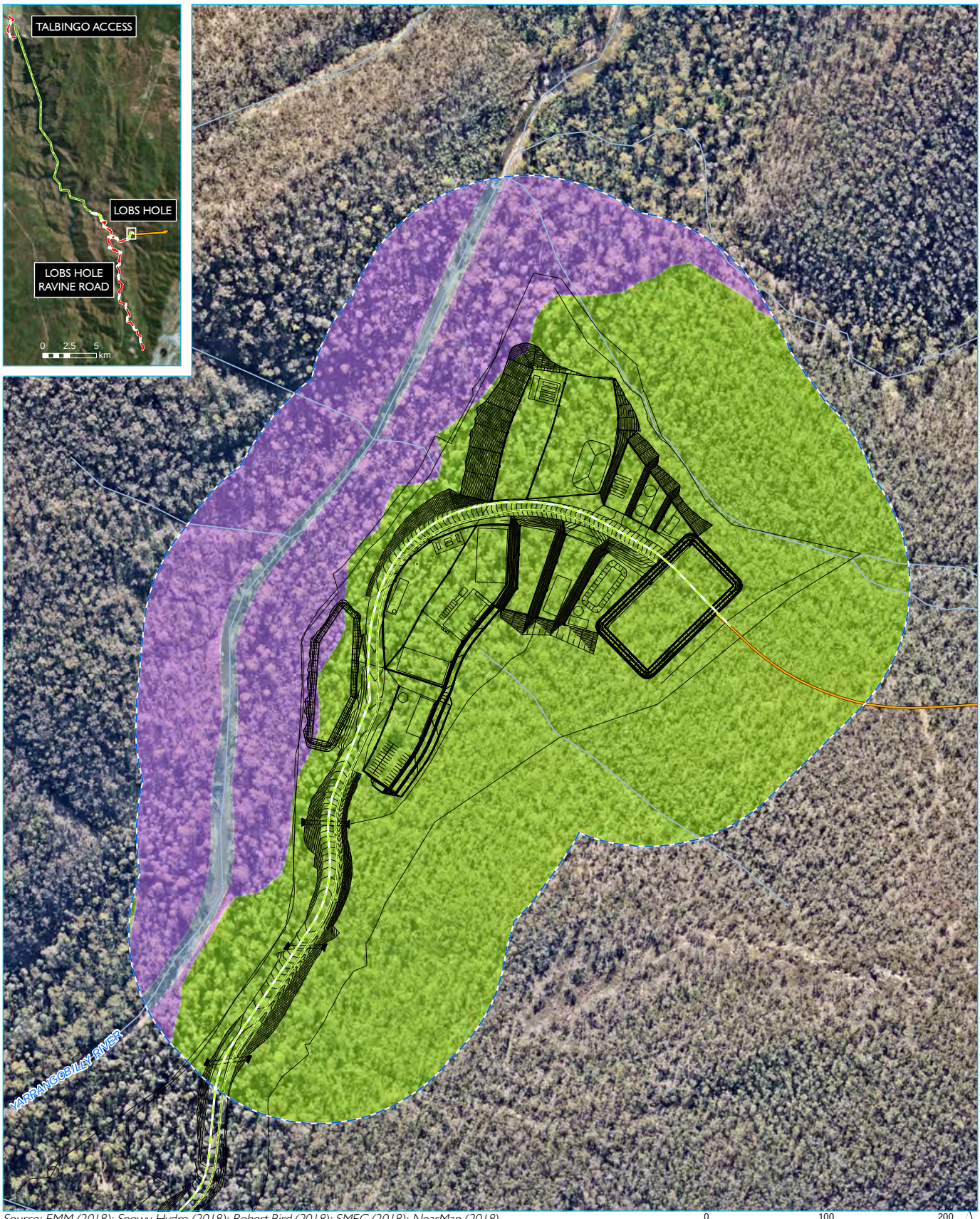
Plant community type

- Forest - PCT 296 - Brittle Gum - peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion
- Forest - PCT 302 - Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion
- Forest - PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion
- Forest - PCT 999 - Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion

Source: EMM (2018); Snowy Hydro (2018); Robert Bird (2018); SMEC (2018); NearMap (2018)

Vegetation mapping – accommodation camp

Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 3.1



Source: EMM (2018); Snowy Hydro (2018); Robert Bird (2018); SMEC (2018); NearMap (2018)

0 100 200 m

GDA 1994 MGA Zone 55

N

KEY

- Exploratory tunnel
- Access road upgrade
- Access road extension
- Portal construction pad conceptual layout
- Communications cable
- Watercourse
- 140 m buffer
- Cleared
- Water

Plant community type

- Forest - PCT 296 - Brittle Gum - peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion
- Forest - PCT 302 - Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion

Vegetation mapping – portal construction pad

Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 3.2

snowy 2.0 EMM

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3.5 Slope

Slope is an important contributor to a bush fire's rate of spread. A bush fire will spread more quickly up a steep slope in comparison with a gradual slope or over flat land. Slopes have been classified in accordance with the provisions of the PBP and are combined with vegetation classes in an area to determine APZs for the development type. The slope over a distance of 100 m from the edges of the accommodation camp and the portal construction pad envelope boundaries (where the forest hazard will remain, after earthworks) was determined using a digital elevation model with a 2 m cell size. The slopes were classified according to PBP:

- all flat and upslope vegetation (considered 0°);
- >0 to 5 degrees (°) downslope vegetation;
- >5 to 10° downslope vegetation;
- >10 to 15° downslope vegetation; and
- >15 to 18° downslope vegetation.

In identifying the effective slope, it may be found that there are a variety of slopes covering different distances within the vegetation. The effective slope is considered to be the slope that supports vegetation which will most significantly influence the bush fire behaviour for each aspect. In proximity to the Exploratory Works, slopes vary in gradient from 0° (upslope/flat) to over 18° downslope.

The following describes the slopes surrounding the location of the proposed accommodation camp and portal construction pad, where buildings and other infrastructure will be situated for the Exploratory Works, and where forest vegetation (the hazard) has been mapped (Section 3.4).

3.5.1 Accommodation camp

Lobs Hole is located in a long narrow valley flat with steeply sloping valley walls away from the valley flats. As the accommodation camp is within Lobs Hole, the topography generally slopes upwards from the camp. Therefore, the slopes surrounding the accommodation camp in Lobs Hole, under which the hazard (forest vegetation) occurs are mainly upslope, that is, vegetation occurs upslope of the accommodation camp. This means the effective slope, as per the PBP, is 0° (upslope/flat).

However, when analysing the slopes within 100 m of the accommodation camp, there are localised depressions and steeper slopes. For example, the Yarrangobilly River, south-west of the accommodation camp, has a very steep downslope (>18°). This slope then reaches a ridgeline and changes direction to be upslope of the camp. In areas north of the accommodation camp, there are downslopes of between >0 to 10°, of which most will be cleared for the future APZ (see Section 4.1). Beyond this there are downslopes between >0 to 5° for short distances (approximately 20 m) before there is very steep upslope vegetation (considered 0°) for over 100 m.

Slopes surrounding the location of the accommodation camp and for a 100 m buffer around the camp are shown in Figure 3.3. Taking into consideration the vegetation which will be cleared as the future APZ, the slopes have been grouped into the slope classifications, as shown in Table 3.4.

Table 3.4 Effective slope under the hazard within a 100 m buffer of the accommodation camp

Direction	Effective Slope under vegetation (forest) hazard
North	>18° downslope vegetation on the 3rd order watercourse for approximately 5 m; and Flat and upslope vegetation (considered 0°) for approximately 95 m and beyond slope analysis.
North-east	>18° downslope vegetation on the 3rd order watercourse for approximately 5 m; and Flat and upslope vegetation (considered 0°) for approximately 95 m and beyond slope analysis.
East	>0 to 5° downslope vegetation (west to east slope); and >5-10° downslope on the cross slope (south to north).
South-east	Flat and upslope vegetation (considered 0°) for approximately 100 m.
South	Flat and upslope vegetation (considered 0°) for approximately 60 m; then >18° downslope vegetation (Yarrangobilly River) for 40 m.
South-west	A combination of: Flat and upslope vegetation (considered 0°); Between >0 to18° downslope vegetation; >18° downslope vegetation (Yarrangobilly River); and Previously cleared land where no hazard occurs.
West	>0 to 5° downslope vegetation; and Previously cleared land.
North-west	>0 to 10° downslope vegetation for approximately 20 m; and Flat and upslope vegetation (considered 0°) for approximately 75 m and beyond slope analysis.

3.5.2 Portal construction pad

The portal construction pad is to be located adjacent to the Yarrangobilly River and on the low north-western slopes of a mountain. The topography at the portal construction pad generally slopes upwards from west to east. Therefore, the slope to the west of the portal construction pad, under which the hazard (forest vegetation) occurs is downslope, that is, vegetation occurs downslope of the construction pad. Conversely, to the east of the portal construction pad, the hazard (forest vegetation) is upslope of the construction pad, meaning the effective slope is 0° (upslope/flat).

Slopes surrounding the location of the proposed portal construction pad and for a 100 m buffer from all boundaries are shown in Figure 2.4. The slopes have been grouped into the slope classifications, as shown in Table 3.5.

Table 3.5 Effective slope under the hazard within a 100 m buffer of the portal construction pad

Direction	Effective Slope under vegetation (forest) hazard
North	>5 to 10° downslope vegetation for 100 m.
North-east	An average of between 10 to 15° downslope vegetation for 100 m (cross slope) with steeper slopes of >18°downslope vegetation and >18°upslope vegetation (considered 0°) within the water courses.
East	Flat and upslope vegetation (considered 0°) for 100 m and beyond slope analysis.
Watercourse gully in the east	10 to >18°downslope vegetation.
South-east	Flat and upslope vegetation (considered 0°) for 100 m and beyond slope analysis.
South	>0 to 15° downslope vegetation for 100 m.

Table 3.5 Effective slope under the hazard within a 100 m buffer of the portal construction pad

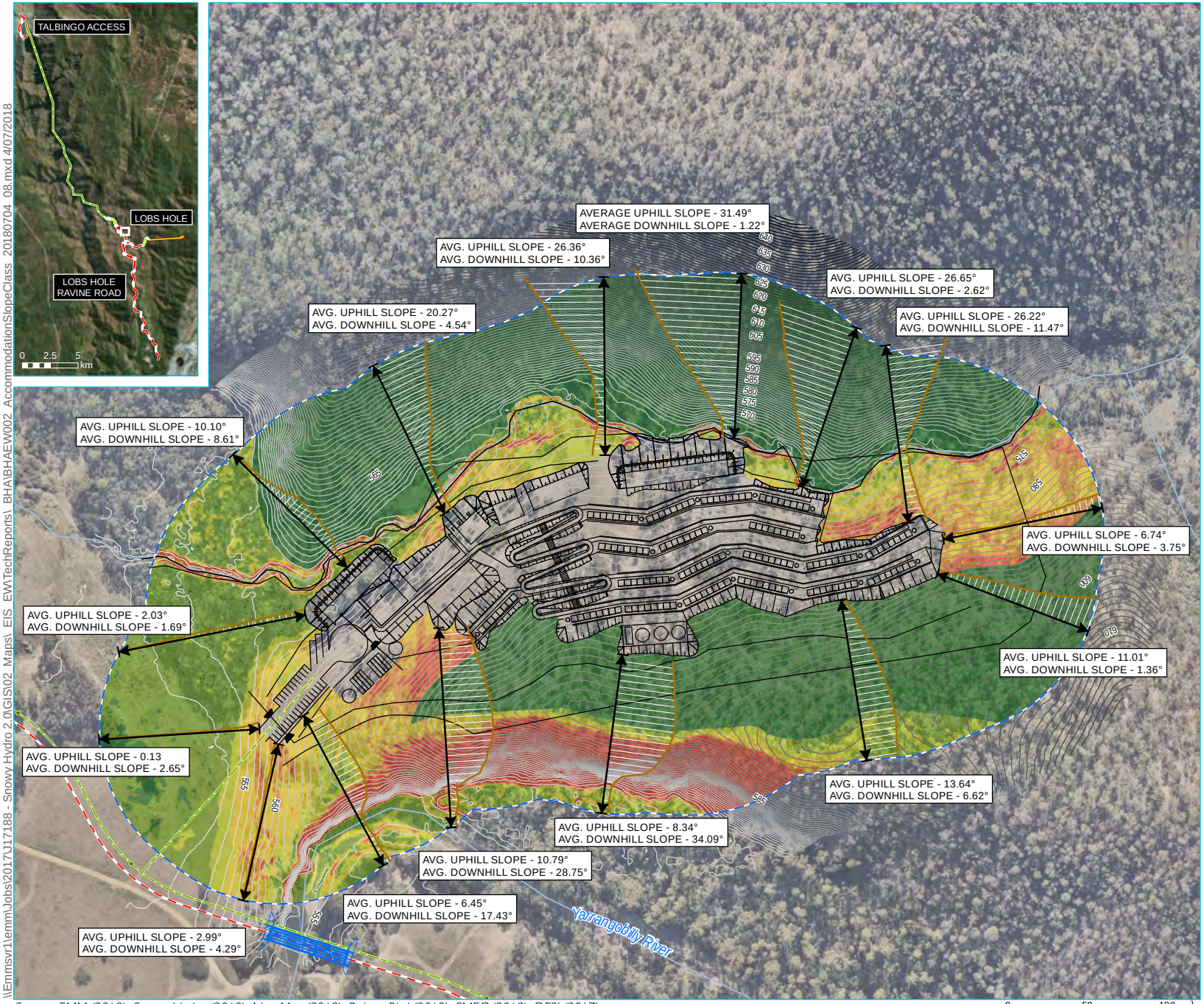
Direction	Effective Slope under vegetation (forest) hazard
South-west	>5 to 10° downslope vegetation for 100 m.
West	>5 to 10° downslope vegetation for 100 m.
North-west	>5 to 10° downslope vegetation for approximately 80 m; and Flat and upslope vegetation (considered 0°) for approximately 20 m and beyond slope analysis.
North-northwest	>5 to 10° downslope vegetation for 100 m.

3.6 Limited access

Isolated development, particularly in rugged, heavily timbered country, poses significant challenges from a bush fire risk perspective (NSW RFS 2017b). The KNP FMS (NPWS 2008) notes that within the KNP, single access 'in-holdings' or other facilities, as relevant to the Exploratory Works, pose a bush fire risk as the opportunity of escape is limited such as by a single access, and could be cut off by an approaching fire front. The KNP FMS (NPWS 2008) places importance on maintaining a strategic road access, water point and helipad network, to attempt to overcome the access constraints posed by the rugged topography of the KNP.

3.7 Inadequate construction standards

Poorly designed structures in bush fire prone areas, including within the project area, will increase a buildings susceptibility to bush fire risk. Although industrial infrastructure such as that proposed for the Exploratory Works is generally resilient, components of the construction could be damaged during a bush fire event through exposure to direct flame, radiant heat, smoke or ember. Consequently the overall structure or function of a building could be compromised. Conversely, improvements to the design and construction of buildings enhance their survivability from bush fires.



KEY

- Exploratory tunnel
- Access road upgrade
- Access road extension
- Permanent bridge
- Accommodation camp conceptual layout
- Communications cable
- Watercourse
- Contour (551 m - 648 m, 1 m interval)
- Slope profile
- 100 m buffer

Slope classes

- Flat or all upslope vegetation (considered 0°)
- >0 - 5° downslope vegetation
- >5 - 10° downslope vegetation
- >10 - 15° downslope vegetation
- >15 - 18° downslope vegetation
- >18° downslope vegetation

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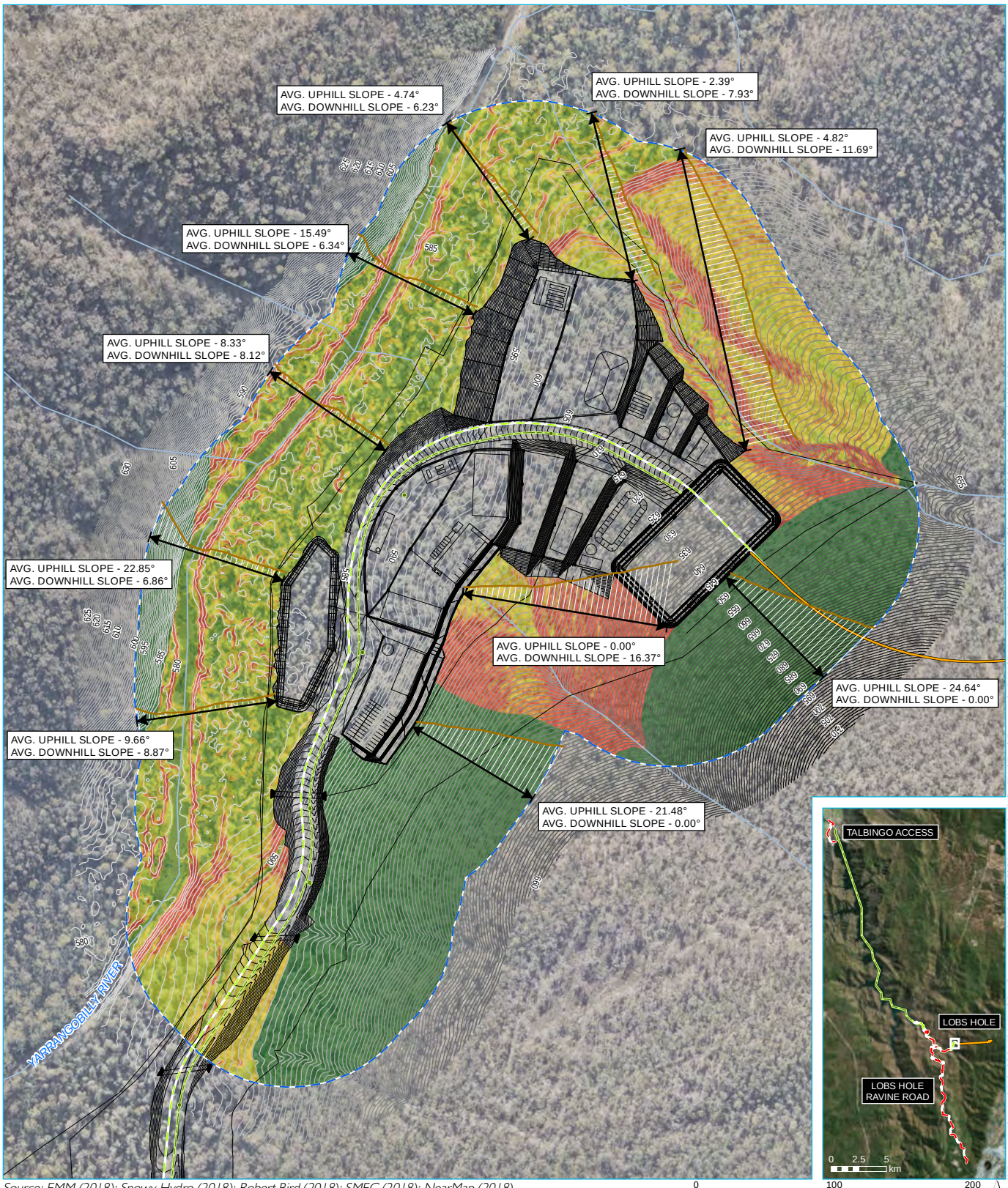
Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); Robert Bird (2018); SMEC (2018); DFSI (2017)

Slope – accommodation camp

Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 3.3



Source: EMM (2018); Snowy Hydro (2018); Robert Bird (2018); SMEC (2018); NearMap (2018)

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KEY

- Exploratory tunnel
- Access road upgrade
- Access road extension
- Portal construction pad conceptual layout
- Communications cable
- Watercourse
- Contour (577 m - 712 m, 1 m interval)
- Slope profile
- 100 m buffer

Slope classes

- Flat or all upslope vegetation (considered 0°)
- >0 - 5° downslope vegetation
- >5 - 10° downslope vegetation
- >10 - 15° downslope vegetation
- >15 - 18° downslope vegetation
- >18° downslope vegetation

Slope – portal construction pad

Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 3.4

4 Bush fire prevention and protection overview

The key principles for bush fire prevention and protection for the proposed Exploratory Works are:

- the provision of clear separation between buildings and bush fire hazards in the form of fuel-reduced Asset Protection Zones (APZs);
- appropriate access standards for staff, contractors, visitors and emergency services;
- adequate water supply and pressure;
- suitable location of services and other infrastructure that pose potential ignition risk; and
- suitable construction standards and design of buildings.

The key principles are discussed in relation to the Exploratory Works.

4.1 Asset protection zones

The intent of an APZ is to provide sufficient space and maintain reduced fuel loads, so as to ensure that radiant heat levels at building are below critical limits and to prevent direct flame contact with a building. An APZ is the distance that buildings are set back from vegetation that represents a bush fire hazard. APZs are provided for the following reasons:

- to provide sufficient separation from buildings for safe fire fighting;
- to reduce radiant heat at buildings;
- to reduce the influence of convection driven winds;
- to reduce the threat of ember attack on buildings; and
- to allow for dispersal of smoke.

APZs are divided into an 'inner protection area' (IPA) and, where there is adjacent forest vegetation, an 'outer protection area' (OPA). The IPA provides a defendable space and reduces heat intensities near buildings. The OPA helps reduce the length of flames (by the retention of some trees), the speed of fire advance and the likelihood of fire spread by 'crowning'.

The KNP FMS (NPWS 2008) requires environmental impact assessments for proposed fire management works programs, including the need to impose APZs as required. The impacts of the clearing of vegetation for the APZs outlined within this BFRHA have been considered within the Exploratory Works EIS (EMM 2018a), particularly in regards to biodiversity, heritage, surface water and visual impacts.

4.1.1 Accommodation camp

The accommodation camp for the Exploratory Works is considered long-term accommodation (exceeding 6 weeks in duration) and to satisfy the objectives of PBP, an acceptable solution would be to provide an APZ as for residential and rural residential subdivision, to prevent flame contact and ignition of external building materials. As such, the accommodation camp has been designed to comply with the specific requirements for APZs and related construction standards set out in PBP and AS 3959 – 2009, for residential and rural residential subdivisions, where applicable to the Exploratory Works.

APZs are determined with reference to Table 2.4.3 (for forest vegetation) in the bushfire construction standards (AS 3959 – 2009), which compares predominant fire hazard vegetation formations (refer section 3.4), effective slopes near subject buildings (refer section 3.5) and fire weather at a site (FDI) (refer section 3.1). OPAs and subsequent IPAs are determined with reference to Table A2.7 of the PBP, for the appropriate effective slope in forest vegetation and FDI 80.

4.1.2 Portal construction pad and barge access infrastructure

The bush fire construction standards and associated APZs are not considered as a set of 'deemed to satisfy' provisions for commercial and industrial facilities. However, in many instances, these types of developments will require on-site parking and loading areas. In these cases, it is prudent to place these facilities in the most appropriate location in order to establish defendable space for fire fighting purposes, as well as to mitigate the potential for ignition of surrounding bush land from Exploratory Works sources.

The portal construction pad consists of a series of structures (administration building, consumables storage, workshop and communications hut) and other Exploratory Works elements (batch plant, explosive magazine storage, water treatment plant, fuel storage, stockpile, generator sets, and water tanks) surrounded by hardstand areas, car parks, retaining walls/batter and a haul road that all provide setback of the structures and other Exploratory Works elements from the bush fire hazard.

Chapter 8 of the draft *Planning for Bush fire Protection* 2017 (NSW RFS 2017c, currently on exhibition), provides further advice on APZs for 'other development', including wind farm and mining (underground and open cut) and petroleum production; as a minimum, a 10 m APZ from the structures/associated buildings/infrastructure, is recommended to be maintained to the standard of an IPA for the life of the development.

The infrastructure to be located at the barge access locations (north and south) is likely to consist of a site office or similar facilities with car park and hardstand areas, including an area to park watercraft associated with emergency egress via the barge access route. The hardstand and car park will be designed to provide a set-back for these facilitates from any vegetation hazard. Appropriate APZs will be determined upon detailed design of the access points, noting that the southern Talbingo access point is heavily vegetated.

4.2 Access

4.2.1 Accommodation camp

i Project access

The intent of the PBP measures outlined for property access for residential and rural residential subdivision is to provide safe access to and from the public road system for fire fighters providing property protection during a bush fire and for occupants faced with evacuation.

Property access, within PBP, is defined as access from the public road system onto private land and access to the habitable building by fire fighters. For the Exploratory Works, project access is a relevant term, and is defined as the access from the Link Road (public road) onto Lobs Hole Ravine Road (the main private project access route) and to the accommodation camp.

Access to the accommodation camp is along Snowy Mountains Highway and the Link Road (both two-way public roads). Lobs Hole Ravine Road provides the single point of access from the Link Road, to Lobs Hole including the accommodation camp. Egress is via the same roads, in reverse order.

Lobs Hole Ravine Road will provide the only road access for the movement of construction personnel, light equipment and for emergency services for the Exploratory Works. This access however, may be restrictive for very heavy equipment and access could be compromised in winter, in the case of an accident or if the road is blocked. As there is a very low likelihood of bush fire to occur within the winter months, the Lobs Hole Ravine Road access road is unlikely to be blocked due to snow or ice during a bush fire emergency. The Lobs Hole Ravine Road access could be blocked in the instance that two large vehicles were trying to travel in opposite directions.

To provide an alternative to road access, a barge option is proposed, not only for bulky and heavy equipments but also in the case of emergency. The barge access route will provide a secondary egress option for staff, via dedicated watercraft to be kept at the barge access infrastructure locations, in the event of bush fire emergency. This secondary access route, with appropriate procedures for evacuation, will be written into emergency response and evacuation procedures for the Exploratory Works (see section 7.1).

An existing helipad occurs within the vicinity of the Exploratory Works project area providing another alternative access/egress point in the event of an emergency.

The location and topography of the Exploratory Works means that not all property access solutions for residential and rural residential subdivision (accommodation camp) will be met. Therefore, a range of solutions are required to meet the objectives of PBP for access, noting that the majority of the Exploratory Works is considered ‘other development’ in PBP. The addition of the barge access route and the helipad provides alternative options for emergency situations and addresses the KNP FMS (NPWS 2008), which places importance on maintaining a strategic road access, water point and helipad network, to attempt to overcome the access constraints posed by the rugged topography of the KNP.

ii Fire trails

The intent of the PBP measures outlined for fire trails for residential and rural residential subdivision is to provide suitable access for fire management purposes and maintenance of APZs.

There are existing NPWS fire trails within the vicinity of the project area that will provide access for NPWS for back burning and to create containment lines for fires in the vicinity of the Exploratory Works.

4.2.2 Portal construction pad

Whilst bush fire is not captured in the BCA for Class 5-8 buildings, the following objectives are required to be applied in relation to access at the portal construction pad:

- to provide safe access to and from the public road system for fire fighters providing property protection during a bush fire and for occupant egress with evacuation.

Project access to the portal construction pad is along the same route as for the accommodation camp; along Snowy Mountains Highway and the Link Road (both two-way public roads) and then along Lobs Hole Ravine Road, the single access point to the project area in Lobs Hole. Access from Lobs Hole Ravine Road, in Lobs Hole, to the portal construction pad is via Mine Trail Road. Egress is via the same roads, in reverse order.

As per the accommodation camp, the Lobs Hole Ravine Road access will be important for the movement of construction personnel, light equipment and for emergency services for the Exploratory Works. This access however, may be restrictive for very heavy equipment and access could be compromised in the instance that two large vehicles were trying to travel in opposite directions.

4.2.3 Barge access infrastructure

As per the portal construction pad, bush fire is not captured in the BCA for Class 5-8 buildings however the following objective will be applied in relation to access at the barge access (north and south) infrastructure:

- to provide safe access to and from the public road system for fire fighters providing property protection during a bush fire and for occupant egress with evacuation.

To provide a project access alternative to the Lobs Hole Ravine Road access, a barge option is required for the transport of bulky and heavy equipment for the Exploratory Works. The barge access will be from Talbingo Reservoir via a wharf near the Talbingo dam to Lobs Hole via a ramp and wharf on the lower reaches of Yarrangobilly River (designated as 'Middle Bay'). This access may also serve as an alternative egress route in the event of bush fire emergency (see section 4.2.1).

4.3 Location and adequacy of services

Adequate supply of water is essential for fire fighting purposes. In addition, gas and electricity should be located so as to not contribute to the risk of fire or impede the fire fighting effort.

4.3.1 Accommodation camp

The measures outlined for the location and adequacy of services, for residential and rural residential subdivision, within PBP are designed to ensure adequate services of water for the protection of buildings during and after the passage of a bush fire, and to locate gas and electricity so as not to contribute to the risk of fire to a building.

For rural-residential and rural developments (or settlements) in bush fire prone areas, a water supply reserve dedicated to fire fighting purposes should be installed and maintained. According to PBP, the supply of water can be an amalgam of minimum quantities for each lot in the subdivision (community titled subdivisions), or held individually on each lot. For the Exploratory Works accommodation camp, a dedicated static water supply will be provided for fire fighting purposes. PBP also outlines required minimum quantity, construction standard (including flow, connections and fittings) for static water supply.

Chapter 4, Section 4.1.1 (c) of PBP notes that subdivision for the creation of isolated rural developments, particularly in rugged, heavily timbered country, poses additional problems in the provision of adequate levels of protection from bush fires. Where developments are in these areas, occupants and fire fighters may have to travel long distances through bush fire prone vegetation. In addition, the isolation means that, if a fire impacts on the development, occupants may be a long way from fire fighting assistance. As a result, greater emphasis should be placed upon water supplies and fire protection systems such as spray systems. In such cases, dedicated water supplies may exceed the standard requirements.

4.3.2 Portal construction pad and barge access infrastructure

Whilst bush fire is not captured in the BCA for Class 5-8 buildings, the following objectives will be applied to the portal construction pad and barge access (north and south) infrastructure in relation to water and services:

- to provide adequate services of water for the protection of buildings during and after the passage of bush fire, and to locate gas and electricity so as not to contribute to the risk of fire to a building.

4.4 Location of hazardous materials and ignition sources

There will be hazardous materials and potential ignition sources associated with the Exploratory Works that will have the potential to be a source of ignition for unplanned fires.

PBP notes that some developments are considered by their very nature to be hazardous, as much for their ability to start bush fires as their susceptibility to bush fire impacts but does not provide any measures for the suitable storage of hazardous materials.

4.4.1 Accommodation camp

The main potential sources of ignition of unplanned fires from the Exploratory Works, at the accommodation camp, are likely to be:

- diesel generators; and
- LPG gas tanks at the accommodation camp kitchen.

Whilst the LPG gas tank storage at the accommodation camp will be captured within the measures and acceptable solutions of PBP, the storage and use of diesel generators is not. Therefore, the following objective will be applied in relation to the storage of the diesel generators at the accommodation camp:

- consideration of storage of hazardous materials away from the hazard wherever possible.

4.4.2 Portal construction pad, construction compound at Lobs Hole and barge access infrastructure

The main potential sources of ignition of unplanned fires from the Exploratory Works, at the portal construction pad, construction compound at Lobs Hole and barge access infrastructure, are likely to be:

- diesel generators;
- fuel farm and bowsers (near the portal entrance and at the construction compound at Lobs Hole);
- the magazine (explosives) storage;
- the transport and use of explosives (for the extraction of rock from the exploratory tunnel and perhaps for the removal of hard rock associated with construction activities and road building); and
- sparks generated from hot works from construction site compounds at Lobs Hole and the Exploratory tunnel and from plant and equipment used in construction activities at Lobs Hole and the exploratory tunnel; and locations of construction activity, more generally).

Whilst bush fire is not captured in the BCA for Class 5-8 buildings, the following objectives will be applied in relation to the storage of hazardous materials at the portal construction pad, construction compound at Lobs Hole and barge access (north and south) infrastructure:

- consideration of storage of hazardous materials away from the hazard wherever possible.

A suitable storage facility will be designed at the detailed design stage for storage of the ammunition for blasting activities and fuel storage, to prevent ignition of surrounding vegetation and to reduce the storage area susceptibility to bush fire impacts.

4.5 Construction standards and design

4.5.1 Accommodation camp

The accommodation camp for the Exploratory Works is considered long-term accommodation (exceeding 6 weeks) and to satisfy the objectives of PBP, an acceptable solution would be to design the accommodation camp to comply with the specific requirements for construction standards and related APZs set out in PBP and the bush fire construction standards (AS 3959 – 2009), for residential and rural residential subdivisions, where applicable to the Exploratory Works.

The KNP FMS (NPWS 2008) confirms that for new developments, PBP and appropriate building standards as specified in the bushfire construction standard (AS 3959 – 2009) and the BCA, NPWS will apply the same standards to any new developments in the KNP.

4.5.2 Portal construction pad and barge access infrastructure

It is considered that the structures within the exploratory tunnel portal area and Talbingo access are classified as Class 5 to 8 buildings (which include offices, shops, factories, warehouses, public car parks and other commercial and industrial facilities) under the BCA. The BCA does not provide for any bush fire specific performance requirements for these particular classes of building. As such the bush fire construction standard is not considered as a set of 'deemed to satisfy' provisions; however, compliance with the standards, including ember protection, should be considered when meeting the aims and objectives of PBP. This is particularly relevant to the administration building, which will accommodate higher numbers of staff, contractors and visitors. Commercial buildings must also have fully compliant fire safety systems in accordance with AS and BCA requirements.

4.6 Community bush fire refuge

In the emergency situation that offsite evacuation cannot occur, there will be a higher reliance on the procedure for onsite refuge at the Exploratory Works. PBP does not specifically address community bush fire refuges and as such, the assessment of such development requires consultation with the Commissioner of the NSW RFS. A community bush fire refuge is a designated building open to the public that can provide short-term shelter from the immediate life-threatening effects of a bush fire event.

It is emphasized that a community bush fire refuge should only be considered as one of a suite of measures to protect staff, contractors and visitors from the dangers of bush fires at the Exploratory Works. The other measures include suitable APZs, access and egress, location and design of services, construction standard, and emergency and awareness planning, as specified within this document. A refuge is not a guarantee for occupant safety and therefore there will be further emphasis on emergency response and evacuation for the Exploratory Works (section 7.1 and 7.2).

5 Application of bush fire prevention and protection

The key principles for bush fire prevention and protection, as discussed within Section 4 are applied as bush fire protection and prevention measures, in relation to the Exploratory Works.

5.1 Asset protection zones

5.1.1 Accommodation camp

APZs, including IPAs and OPAs, for the accommodation camp are shown in Table 5.1 and Figure 5.1.

Table 5.1 APZs for the accommodation camp

Direction from buildings	Total APZ	Inner protection area (IPA)	Outer protection area (OPA)[1]
North	33 m	18 m	15 m
North-east	21 m	11 m	10 m
East	33 m	18 m	15 m
South-east	21 m	11 m	10 m
South	21 m	11 m	10 m
South-west	52 m	32 m	20 m
West	27 m	22 m	5 m
North-west	27 m	22 m	5 m

Notes: 1. Allowable OPA as specified in Table A2.7 of PBP.

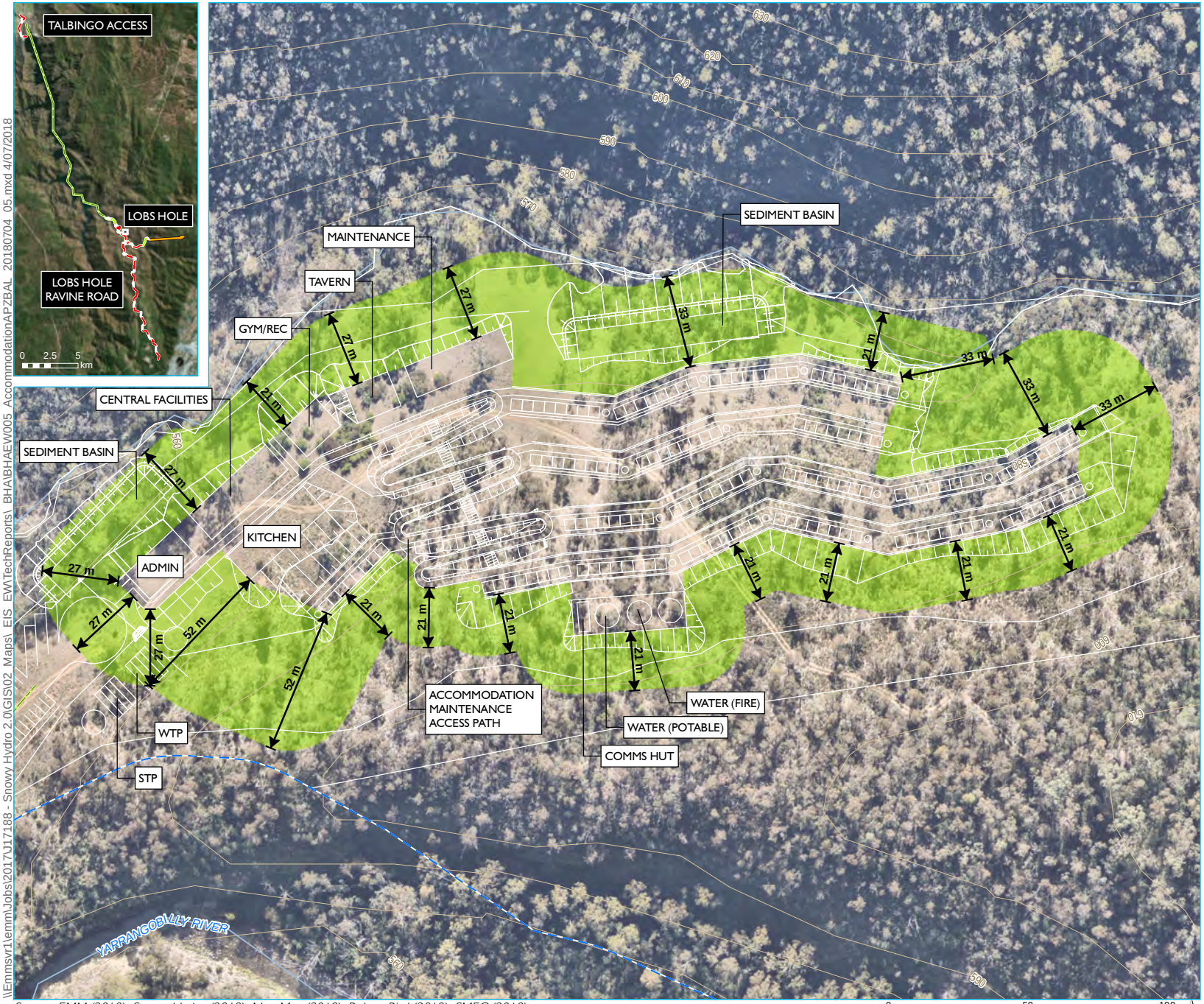
Table 5.2 outlines the performance criteria and acceptable solutions for APZs, as per PBP for residential and rural residential subdivisions, and states how the accommodation camp complies.

Table 5.2 Standards for APZs – residential and rural residential subdivisions

Performance criteria	Acceptable solutions	Compliance of accommodation camp
Radiant heat levels at any point on a proposed building will not exceed 29 kW/m^2	An APZ is provided in accordance with the relevant tables/ figures in Appendix 2 of PBP	Complies. APZs between 21 m and 52 m are provided, in accordance with Appendix 2 of PBP and Table 2.4.3 of AS 3959 - 2009. APZs were determined by undertaking a vegetation and slope analysis, as detailed in Section 2. The APZs will have the IPA and OPA widths as specified within Table 4.1.
	The APZ is wholly within the boundaries of the development site. Exceptional circumstances may apply (see section 3.3 of PBP)	Complies. The APZ is entirely within land which will be leased by Snowy Hydro who will have access to the APZ at all times for maintenance.

Table 5.2 Standards for APZs – residential and rural residential subdivisions

Performance criteria	Acceptable solutions	Compliance of accommodation camp
APZs are managed and maintained to prevent the spread of a fire towards buildings	In accordance with the requirements of *Standards for Asset Protection Zones* (NSW RFS 2005)	Complies. The APZ will be managed in accordance with Snowy Hydro Emergency Management Standard – *Asset Protection Plan for Snowy Hydro Assets in Kosciuszko National Park* (2010) and *Standards for Asset Protection Zones* (NSW RFS 2005).
APZ maintenance is practical, soil stability is not compromised and the potential for crown fires is negated	The APZ is located on lands with a slope less than 18°	Complies. The APZ on the eastern aspect of the accommodation camp is on an upslope of greater than 18°. As the APZ and hazard is upslope of the camp, this equates to an effective slope of 0° and will not make the canopy fuels on the slope more available to a fire nor reduce the advantage of the APZ. The slope however may present difficulties for APZ maintenance and soil stability. The APZ will comprise a combination of terraced landscaping, retaining walls and sloping land. The terraced landscaping and retaining walls will help stabilise the land and ease access and maintenance issues. The use of personnel with hand-held equipment to maintain the vegetation on the sloped areas that are not terraced will provide suitable outcomes to maintain the APZ.



KEY

- Exploratory tunnel
- Access road upgrade
- Access road extension
- Communications cable
- Watercourse
- Contour (10m)
- Yarrangobilly buffer (50 m from top of bank)
- Asset protection zone (APZ)

APZs – accommodation camp

Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); Robert Bird (2018); SMEC (2018)

0 50 100 m

GDA 1994 MGA Zone 55

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Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 5.1

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5.1.2 Portal construction pad

The portal construction pad consists of hardstand areas, car parks, retaining walls/batter and a haul road that all provide setback of the structures and other Exploratory Works elements from bush fire. The setbacks achieved for the exploratory tunnel conduction pad elements are shown in Table 5.3 and Figure 5.2.

Table 5.3 APZs for the portal construction pad elements

Structure/component	Direction from building/ component	Total setback provided	Setback components
Administration	North	159.07 m	Retaining wall, consumables storage, hardstand, haul road.
	East	14.23 m	Benched retaining wall.
	South	28.01 m	Hardstand, car park and retaining wall.
	West	85.65 m	Hardstand, retaining wall, haul road and sediment basin.
Consumables storage	North	105.05 m	Hardstand, haul road and retaining wall.
	East	10.16 m	Benched retaining wall.
	South	37.69 m	Retaining wall and hardstand.
	West	74.27 m	Hardstand, retaining wall, haul road and sediment basin.
Batch plant	North	134.20 m	Hardstand, workshop, haul road and retaining wall.
	East	197.17 m	Benched retaining wall.
	South	18.33 m	Hardstand, consumables storage and retaining wall.
	West	99.99 m	Hardstand, haul road and retaining wall.
Workshop	North	101.02 m	Haul road, hard stand, fuel storage and retaining wall.
	East	166.44 m	Retaining wall and hardstand.
	South	31.59 m	Hardstand and batch plant.
	West	88.13 m	Hardstand, haul road and retaining wall.
Explosive magazine and bunding	North	175.46 m	Hardstand, haul road and retaining wall.
	East	141.68 m	Hardstand, retaining wall and water treatment plant.
	South	18.11 m	Hardstand and retaining wall.
	West	151.08 m	Hardstand and retaining wall
Water treatment plant	North	204.76 m	Hardstand, tunnelling affected water and haul road.
	East	101.81 m	Hardstand and portal entrance.
	South	18.56 m	Hardstand and retaining wall.
	West	203.86 m	Hardstand, retaining wall and explosive magazine and associated bunding.
Fuel storage	North	24.86 m	Hardstand and retaining wall.
	East	48.39 m	Hardstand and retaining wall.
	South	193.68 m	Hardstand and haul road.
	West	33.94 m	Hardstand and retaining wall.
Stockpile	North	53.01 m	Hardstand and retaining wall.
	East	38.82 m	Hardstand, retaining wall and generator sets.
	South	135.01 m	Hardstand and haul road.
	West	91.43 m	Hardstand and retaining wall.

Table 5.3 APZs for the portal construction pad elements

Structure/component	Direction from building/ component	Total setback provided	Setback components
Generator sets	North	76.58 m	Hardstand and retaining wall.
	East	35.94 m	Hardstand, retaining wall and fire water tanks.
	South	133.48 m	Hardstand and haul road.
	West	141.73 m	Hardstand, retaining wall and stockpile.
Fire water tanks	North	33.27 m	Hardstand and retaining wall.
	East	19.42 m	Hardstand, retaining wall and communications hut.
	South	133.67 m	Hardstand and haul road.
	West	183.84 m	Hardstand, retaining wall and generator sets.
Communications hut	North	29.80 m	Hardstand and retaining wall.
	East	19.31 m	Hardstand and portal entrance.
	South	105.44 m	Hardstand and haul road.
	West	221.80 m	Hardstand, retaining wall and fire water tanks.

As shown in Table 5.3, in all cases, a 10 m set back from the hazard is achieved. Further consideration will be given to the administration building, at the detailed design stage, for the allowance of an APZ, to ensure there is defendable space for the building that allows access for fire-fighters as well as reducing the radiant heat levels that may be experienced at this structure.

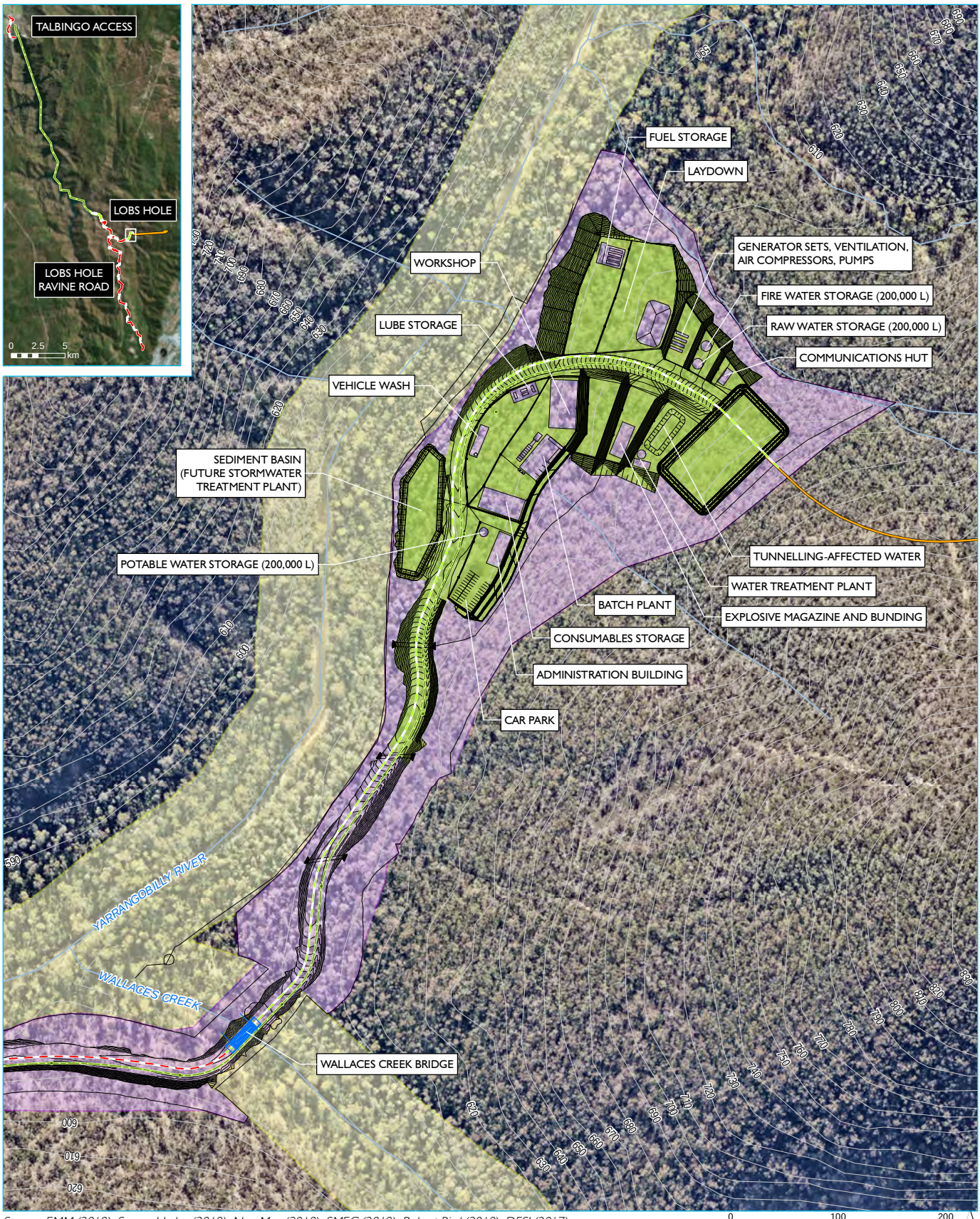
The detailed design stage should also consider the accessibility of fire trucks within the defendable space of the portal construction pad structures, as well as the accessibility to the fire water tanks.

5.1.3 Barge access infrastructure

Although the design of barge access infrastructure (north and south) is yet to be finalised, the structures will be in proximity to lay down areas, and potentially car and watercraft spaces. At the detailed design stage, it is prudent to place the structures in the most appropriate location, in relation to the lay down and car park, in order to establish defendable space for fire fighting purposes, as well as to mitigate the potential for ignition of surrounding bush land from Exploratory Works sources.

Further consideration will be given to the structures at the barge access (north and south), at the detailed design stage, for the allowance of appropriate APZs (considering distance to and the slope under the hazard), to ensure there is defendable space for the building that allows access for fire-fighters as well as reducing the radiant heat levels that may be experienced at the structures.

The detailed design stage should also consider the accessibility of fire trucks within the defendable space of the barge access structures.



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Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); Robert Bird (2018); DFSI (2017)

KEY

- Exploratory tunnel
- Access road upgrade
- Access road extension
- Permanent bridge
- Portal construction pad conceptual layout
- Communications cable
- Watercourse
- Contour (10m)
- Asset protection zone (APZ)
- Disturbance footprint
- Avoidance footprint

APZs – portal construction pad

Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 5.2

5.2 Access

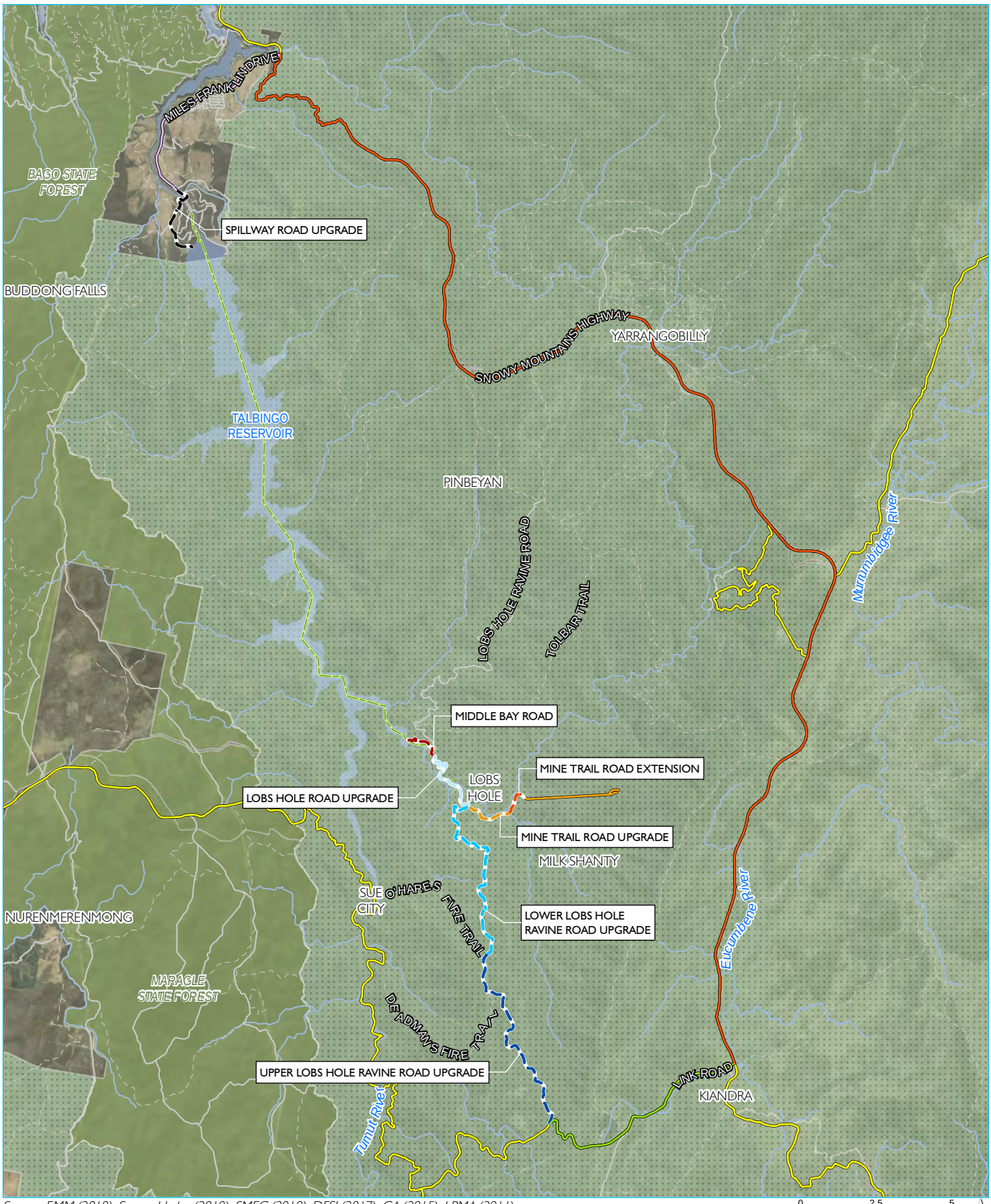
5.2.1 Accommodation camp

iii Project access

The proposed Lobs Hole Ravine Road access road upgrades and construction, for access to and from the accommodation camp for the Exploratory Works, have been designed based on access for a truck and dog trailer and will comprise:

- Upper Lobs Hole Ravine Road upgrade (7.5 km) (Figure 5.3):
  - gravel pavement to 4 m lane width; and
  - gravel pavement capable of carrying more than 28 tonne (t).
- Lower Lobs Hole Ravine Road upgrade (6 km) (Figure 5.3):
  - gravel pavement to a 4 m lane width; and
  - gravel pavement capable of carrying more than 28 t.
- Lobs Hole Ravine Road at construction compound upgrade (7.3 km) (Figure 5.3):
  - two-way traffic suitable for large plant and equipment;
  - gravel pavement road incorporating culvert and drainage and retaining walls, capable of carrying more than 28 t;
  - the gravel pavement road traverses a floodplain within Lobs Hole, with inundation typically occurring once every 2 to 5 years. The road will include drainage infrastructure that will enable unrestricted access during and shortly following periods of a localised flood event. The road does not traverse a wetland or any other land potentially subject to periodic inundation; and
  - a bridge over the Yarrangobilly River (Camp Bridge) consisting of steel girders with composite deck and capable of carrying more than 28 t.

Table 5.4 outlines the performance criteria and acceptable solutions for property access, as per PBP, for residential and rural residential subdivision, and states how the accommodation camp complies.



Source: EMM (2018); Snowy Hydro (2018); SMEC (2018); DFSI (2017); GA (2015); LPMA (2011)

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KEY

- Exploratory tunnel
- Communications cable
- Main road
- Local road
- Vehicular track
- Perennial watercourse
- Scheme storage
- Kosciuszko National Park
- State forest

Existing access roads (no proposed works)

- Miles Franklin Drive
- Snowy Mountains Highway
- Link Road

Proposed access road upgrades

- Spillway road upgrade
- Lobs Hole Road upgrade
- Lower Lobs Hole Ravine Road upgrade
- Upper Lobs Hole Ravine Road upgrade
- Mine Trail Road upgrade

Proposed new access road

- Middle Bay Road
- Mine Trail Road extension

Access

Snowy 2.0
Bush Fire Risk and Hazard Assessment
Exploratory Works
Figure 5.3

Table 5.4 Standards for property access – residential and rural residential subdivisions

Performance criteria	Acceptable solutions	Compliance of accommodation camp
Access to properties is provided in recognition of the risk to fire fighters and/ or evacuating occupants.	At least one alternative property access road is provided for individual dwellings (or groups of dwellings) that are located more than 200 m from a public through road.	Will not comply. The single road access and egress route for the accommodation camp is via Lobs Hole Ravine Road. The barge access route provides a secondary egress option in the event of an emergency. This secondary access route will be via dedicated watercraft to be kept at the barge access infrastructure locations with appropriate procedures for evacuation written into the emergency response and evacuation procedures for the Exploratory Works. An existing helipad occurs within the vicinity of the Exploratory Works project area providing another alternative access/egress point in the event of an emergency.
The capacity of road surfaces and bridges is sufficient to carry fully loaded fire fighting vehicles.	Bridges clearly indicate load rating and pavements and bridges are capable of carrying a load of 28 t.	Will comply. The road and bridge upgrades will have the capacity to carry a load of 28 t. Bridges will clearly indicate load rating.
All weather access is provided.	Roads do not traverse a wetland or other land potentially subject to periodic inundation (other than a flood or storm surge).	Will comply. Stream flows of the Yarrangobilly River are predominately confined to the river's channel. However, after significant rainfall, inundation of floodplain areas will occur for a short period of time while the river is in flood. Inundation of the floodplain areas will typically occur once every 2 to 5 years. Further, many of the minor waterways within the ravine area are ephemeral. There are no wetlands within the ravine area that are periodically inundated. The access roads within the floodplain or that cross ephemeral waterways will include drainage infrastructure that will enable unrestricted access during and shortly following periods of wet weather.
Road widths and design enable safe access for vehicles.	A minimum carriageway width of 4 m for rural-residential areas, rural landholdings or urban areas with a distance of greater than 70 m from the nearest hydrant point to the most external part of a proposed building (or footprint).	Will comply. Upper and Lower Lobes Hole Ravine roads will be upgraded to 4 m width. The remaining sections will allow two-way traffic for heavy vehicles.

Table 5.4 Standards for property access – residential and rural residential subdivisions

Performance criteria	Acceptable solutions	Compliance of accommodation camp
	In forest, woodland and heath situations, rural property access roads have passing bays every 200 m that are 20 m long by 2 m wide, making a minimum trafficable width of 6 m at the passing bay. Alternatively, for fire trail standards (Page 25 of PBP), the trail has the capacity for passing by: - reversing bays using the access to properties to reverse fire tankers, which are 6 m wide and 8 m deep to any gates, with an inner minimum turning radius of 6 m and an outer minimum radius of 12 m; and/or - a passing bay every 200 m, 20 m long by 3 m wide, making a minimum trafficable width of 7 m at the passing bay.	Will not comply. Upper and Lower Lobs Hole Ravine road will be constrained in terms of width (4 m) and will not include passing bays every 200 m. There are existing wider sections of the road, as well as a lay down area at approximately 6.5 km. Two existing fire trail exits occur at approximately 5.5 km and 7 km. These could be used for reversing of fire trucks. Lobs Hole Ravine Road will allow two-way passing at the construction compound (for 7.3 km) as well as at the intersections of and along Middle Bay Wharf access road (950 m) and Spillway Road upgrade (3 km). Consideration should be given to the implementation of passing bays or reversing bays (as per fire trail standards) at regular intervals during the upgrade of Upper and Lower Lobs Hole Ravine Road. This will improve the access and egress constraints along this section of road.
	A minimum vertical clearance of 4 m to any overhanging obstructions, including tree branches.	Will comply.
	Internal roads for rural properties provide a loop road around any dwelling or incorporate a turning circle with a minimum 12 m outer radius.	Will not comply. Consideration at the detailed design stage should be given to a fire trail that surrounds the entire accommodation camp and as part of the APZ, to allow for property protection.
	Curves have a minimum inner radius of 6 m and are minimal in number to allow for rapid access and egress.	Will comply. There are no curves with a 6 m inner radius or below.
	The minimum distance between inner and outer curves is 6 m.	Will comply. All curves are above a distance of 6 m between inner and outer curves.
	The crossfall is not more than 10°.	Will comply.
	Maximum grades for sealed roads do not exceed 15° and not more than 10° for unsealed roads.	Will not comply. Lobs Hole Ravine Road, an unsealed road, has sections with steep gradients (more than 10°).
	Access to a development comprising more than three dwellings have formalised access by dedication of a road and not by right of way.	Will comply.

iv Fire trails

There are existing NPWS fire trails within the vicinity of the Exploratory Works. Lobs Hole Ravine Road (beyond the project area) and Tolbar Trail (Figure 5.3) are dedicated NPWS fire trails that travel from Lobs Hole and then north of the Exploratory Works. These trails can provide access for NPWS for back burning and to create containment lines for fires in vicinity of the Exploratory Works and are maintained by NPWS as per the specifications set out in the KNP FMS (NPWS 2008). Two more NPWS fire trails occur off Lobs Hole Ravine Road; O'Hares Fire Trail is located approximately halfway along Lobs Hole Ravine Road and travels west to the Talbingo Reservoir, and Deadmans Fire Trail also off Lobs Hole Ravine Road travels to the west to the power line corridor and then further to a dead end. These two fire trails, due to their termination at a dead end, are unlikely to be as useful for NPWS during fire fighting operations. The fire trails in the vicinity of the Exploratory Works are shown in Figure 5.3.

At the detailed design stage, consideration should be given to a fire trail, around the perimeter of the accommodation camp and within the APZ of the camp. This will provide access for fire fighting vehicles performing property protection, in the event of a bush fire in proximity to the camp. This fire trail could also form part of the IPA around the accommodation camp. If incorporated into the design of the accommodation camp, the fire trail would need to comply with the applicable standards set out in PBP for fire trails, as well as those set out in the KNP FMS (NPWS 2008).

5.2.2 Portal construction pad

The proposed Mine Trail Road upgrade and extension, for access to and from Lobs Hole to the portal construction pad for the Exploratory Works, has been designed to provide access for a truck and dog trailer and will comprise:

- Mine Trail Road upgrade (2.2 km) (Figure 5.3):
  - two-way traffic suitable for large plant and equipment;
  - gravel pavement road incorporating several culverts, drainage channels and outlet protection works, capable of carrying more than 28 t;
  - a bridge over Wallaces Creek consisting of steel girders with composite deck and capable of carrying more than 28 t;
  - a minimum vertical clearance of 4 m to any overhead obstructions including branches;
  - a minimum distance between inner and outer curves of 6 m;
  - a crossfall not more than 10°; and
  - does not traverse a wetland or other land potentially subject to inundation.
- Mine Trail Road extension (1 km) (Figure 5.3):
  - two-way traffic suitable for large plant and equipment;
  - gravel pavement road incorporating several culverts, drainage channels and outlet protection works, capable of carrying more than 28 t;
  - a minimum vertical clearance of 4 m to any overhead obstructions including branches;

- a minimum distance between inner and outer curves of 6 m;
- a crossfall not more than 10°; and
- does not traverse a wetland or other land potentially subject to inundation.

5.2.3 Barge access infrastructure

The alternative barge access route upgrades and construction, for alternative access to and from the accommodation camp for the Exploratory Works, have been designed based on access for a truck and dog trailer and will comprise:

- Middle Bay Wharf access road (950 m) (Figure 5.3):
  - two-way traffic suitable for large plant and equipment;
  - gravel pavement road incorporating several culverts, drainage channels and outlet protection works, capable of carrying more than 28 t;
  - a minimum vertical clearance of 4 m to any overhead obstructions including branches;
  - a minimum distance between inner and outer curves of 6 m;
  - a crossfall not more than 10°; and
  - does not traverse a wetland or other land potentially subject to inundation.
- Spillway Road upgrade (3 km) (Figure 5.3):
  - two-way traffic suitable for large plant and equipment;
  - gravel pavement road incorporating several culverts, drainage channels and outlet protection works, capable of carrying more than 28 t;
  - bridges capable of carrying more than 28 t;
  - a minimum distance between inner and outer curves of 6 m;
  - a crossfall not more than 10°; and
  - does not traverse a wetland or other land potentially subject to inundation.

The location and topography of the Exploratory Works means that not all access solutions for residential and rural residential subdivision (accommodation camp) will be met. Therefore, a range of solutions will be implemented to meet the objectives of PBP for access, noting that the majority of the Exploratory Works is considered ‘other development’ in PBP.

5.3 Location and adequacy of services

5.3.1 Accommodation camp

A static water supply with a capacity of 200,000 litres for fire fighting purposes has been incorporated into the accommodation camp design. These tanks will be topped up at the beginning of the fire season and repeatedly throughout the season as required (section 6.1). The water supply will comply with the provisions as set out in PBP and in regards to the KNP FMS (NPWS 2008). If spray systems are to be incorporated into the design of the buildings, dedicated fire water supplies will need to be increased to accommodate the systems.

Power supply to provide electricity to the accommodation camp structures will be provided by 45 kilovolt-ampere (kva) 3 phase, 56 amp per phase diesel generators and a temporary high voltage/low voltage reticulation network.

Bottled LPG gas supplies, for cooking and heating, may be located on the outside of the kitchen and possibly other structures at the accommodation camp. The gas bottles will be located and have suitable fittings so as to not lead to the ignition of surrounding bushland or the fabric of buildings.

Table 5.5 outlines the performance criteria and acceptable solutions for services, as per PBP residential and rural residential subdivision, and states how the accommodation camp complies, or provides the specifications for those elements to be incorporated at the detailed design stage.

Table 5.5 Standards for services – residential and rural residential subdivisions

Performance criteria	Acceptable solutions	Compliance of accommodation camp
Non-reticulated water supply		
For rural-residential and rural developments (or settlements) in bush fire prone areas, a water supply reserve dedicated to fire fighting purposes is installed and maintained. The supply of water can be an amalgam of minimum quantities for each lot in the subdivision (community titled subdivisions), or held individually on each lot.	The minimum dedicated water supply required for fire fighting purposes for each occupied building excluding drenching systems, is provided in accordance with Table 4.2 of PBP.	Will comply. Fire water supply storage will be based on 15l/s for 2hrs, as a minimum. This has been used as a standard for Queensland Regional Utilities. Dedicated water supply tanks, with a total capacity of 200,000 litres will be at the accommodation camp (Figure 5.1). This exceeds 15l/s for 2 hrs. The unique set up of the accommodation camp (up to 150 individual rooms) makes comparison with Table 4.2 of PBP difficult. If fire spray systems are incorporated into the accommodation camp at detailed design stage, dedicated fire water supplies will be increased to accommodate the systems.
	A suitable connection for fire fighting purposes is made available and within the IPA and away from the structure. A 65 mm Storz outlet with a ball valve is fitted to the outlet.	Will comply. To be incorporated at the detailed design stage of the buildings.
	Ball valves and pipes are adequate for water flow and are metal rather than plastic.	Will comply. To be incorporated at the detailed design stage of the buildings.

Table 5.5 Standards for services – residential and rural residential subdivisions

Performance criteria	Acceptable solutions	Compliance of accommodation camp
	Underground tanks have an access hole of 200 mm to allow tankers to refill direct from the tank. Underground tanks are clearly marked. A hardened ground surface for truck access is supplied within 4 m of the access hole.	n/a Tanks will be above ground.
	Above ground tanks are manufactured of concrete or metal and raised tanks have their stands protected. Plastic tanks are not used. Tanks on the hazard side of a building are provided with adequate shielding for the protection of fire fighters. Above ground tanks are manufactured of concrete or metal and raised tanks have their stands constructed from non-combustible material or have their stands protected. Plastic tanks are not used. Tanks on the hazard side of a building are provided with adequate shielding for the protection of fire fighters from radiant heat.	Will comply. To be incorporated at the detailed design stage of the buildings.
	All above ground water pipes external to the building are metal including and up to any taps.	Will comply. To be incorporated at the detailed design stage of the buildings.
	Where pumps are provided, they are shielded against bush fire attack and are minimum 5hp or 3kW petrol or diesel-powered pumps. Any hose and reel for fire fighting connected to the pump shall be 19 mm (internal diameter).	Will comply. To be incorporated at the detailed design stage of the buildings.
	Fire hose reels are constructed in accordance with the standard *AS/NZS 1221:1997 Fire hose reels*, and are installed in accordance with *AS 2441:2005 Installation of fire hose reels*	Will comply. To be incorporated at the detailed design stage of the buildings.
Electricity services		
Location of electricity services limits the possibility of ignition of surrounding bushland or the fabric of buildings. Regular inspection of lines is undertaken to ensure they are not fouled by branches.	Where practicable, electrical transmission lines are underground.	n/a There will be no electrical transmission lines for the Exploratory works.
	Where overhead electrical transmission lines are proposed: • lines are installed with short pole spacing (30 m), unless crossing gullies, gorges or riparian areas; and • no part of a tree is closer to a power line than the distance set out in accordance with the specifications in *ISSC3 Guideline for Managing Vegetation Near Power Lines.*	n/a There will be no overhead electrical transmission lines for the Exploratory works.

Table 5.6 Standards for services – residential and rural residential subdivisions

Performance criteria	Acceptable solutions	Compliance of accommodation camp
Gas services		
Location of gas services will not lead to ignition of surrounding bushland or the fabric of buildings.	Reticulated or bottled gas is installed and maintained in accordance with AS 1596 and the requirements of relevant authorities.	Will comply. To be incorporated at the detailed design stage of the buildings.
	Metal piping is to be used.	Will comply. To be incorporated at the detailed design stage of the buildings.
	All fixed gas cylinders are kept clear of all flammable materials to a distance of 10 m and shielded on the hazard side of the installation.	Will comply. To be incorporated at the detailed design stage of the buildings.
	If gas cylinders need to be kept close to the building, the release valves are directed away from the building and at least 2 m away from any combustible material, so that they do not act as a catalyst to combustion.	Will comply. To be incorporated at the detailed design stage of the buildings.
	Connections to and from gas cylinders are metal.	Will comply. To be incorporated at the detailed design stage of the buildings.
	Polymer sheathed flexible gas supply lines to gas meters adjacent to buildings are not used.	Will comply. To be incorporated at the detailed design stage of the buildings.

5.3.2 Portal construction pad and barge access infrastructure

Another static water supply with a capacity of 200,000 litres for fire fighting purposes has been incorporated into the portal construction pad design. These tanks will be topped up at the beginning of the fire season and repeatedly throughout the season as required (section 6.1). The water supply will comply with the provisions as set out in PBP and in regards to the KNP FMS (NPWS 2008). If spray systems are to be incorporated into the design of the buildings at the portal construction pad, dedicated fire water supplies will need to be increased to accommodate the systems.

Consideration should be given to a static water supply that complies with the provisions as set out in PBP and in regards to the KNP FMS (NPWS 2008) at the barge access infrastructure (north and south), at the detailed design stage.

5.4 Location of hazardous materials and ignition sources

5.4.1 Accommodation camp

Diesel generators and associated fuel storage tanks at the accommodation camp will need to be designed, housed and maintained so as not serve as a risk to surrounding bushland. Diesel generators and associated fuel storage tanks should be located away from the hazard, wherever possible.

5.4.2 Portal construction pad, construction compound at Lobs Hole and barge access infrastructure

Like the accommodation camp, diesel generators and associated fuel storage tanks at the portal construction pad, construction compound at Lobs Hole and the barge access (north and south) infrastructure will need to be designed, housed and maintained so that they will not serve as a risk to surrounding bushland and will be located away from the hazard, wherever possible.

Suitable storage facilities will be designed at the detailed design stage for storage of the ammunition for blasting activities and fuel storage, to prevent ignition of surrounding vegetation and to reduce the storage area susceptibility to bush fire impacts.

A Bush Fire Management Plan for the Exploratory Works will detail measures and procedures to prevent fires igniting during the works (see section 6.2).

5.5 Construction standards and design

5.5.1 Accommodation camp

The accommodation camp will comply with the construction requirements of PBP and the bushfire construction standards (AS 3959 – 2009) for residential development. This includes:

- the general bush fire construction requirements in Section 3 of AS 3959 – 2009;
- the construction requirements for Bush Fire Attack Level 29 (BAL-29) in Section 7 of AS 3959 – 2009; and
- the additional construction requirements outlined in Appendix 3 Addendum of PBP, in relation to ember protection, as related to BAL 29 (sarking).

5.5.2 Portal construction pad and barge access infrastructure

The Exploratory Works buildings at the portal construction pad and the barge access (north and south) are industrial and commercial and, therefore, do not have bush fire construction levels specified in the bushfire construction standards (AS 3959 – 2009). Notwithstanding, PBP requires that such buildings comply with the general bush fire construction requirements in section 3 of AS 3959 – 2009.

Further, to prevent embers, buildings that enclose combustible infrastructure will include ember protection similar to AS 3959 - 2009 BAL 12.5 standards (including the additional construction requirements outlined in Appendix 3 Addendum of PBP, in relation to ember protection). This generally requires no gaps greater than 3 mm and sealing or screening areas with gaps exceeding this.

Commercial buildings will also have fully compliant fire safety systems in accordance with AS and BCA requirements. Systems must be regularly serviced and audited in accordance with AS 1851 – 2012 *Routine service of fire protection systems and equipment*, and AS 2293 set (and amendments) – 2005 *Emergency escape lighting and exit signs.*

The commercial buildings for the Exploratory Works will be constructed to comply with these requirements.

Further consideration will be given to the administration building at the portal construction pad, at the detailed design stage, to consider the construction of this structure at a higher standard (BAL 29 or higher), in relation to its distance from the hazard and in consideration of the number of staff it will hold during the operation of the Exploratory Works.

5.6 Community bush fire refuge

A community bush fire refuge will be required at Lobs Hole providing a refuge for anyone caught out by fire preventing an escape by way of the single entry and exit road. This will include those staying at the accommodation camp. Decisions as to the location and design of the refuge will need to be made at the detailed design stage. The refuge will be located and designed with regards to:

- the requirements for all developments on bush fire prone land in NSW;
- the specifications and requirements of PBP (for Special Fire Protection Purposes) and the *Guidelines for the identification and inspection of Neighbourhood Safer Places in NSW* (NSW RFS 2017b) including:
    - ensuring the building is situated to prevent direct flame contact, material ignition and radiant heat levels of 10kW/m^2;
    - ensuring the APZ situated between the building and the hazard is maintained in accordance with the NSW RFS document *Standards for Asset Protection Zones*;
    - ensuring the building can withstand bush fire attack in the form of wind, smoke, embers, radiant heat and flame contact, with a minimum construction standard of BAL 12.5 under the bushfire construction standards (AS 3959-2009);
    - the building will be provided with a certificate issued by a person who is recognised by the NSW RFS as a qualified consultant in bush fire risk assessment, which states that the development conforms to the relevant specifications and requirements; or
    - if the development does not conform to the relevant specifications and requirements, consult with the Commissioner of the NSW RFS on the measures to take with respect to the development to protect against the dangers of bush fire.

The community bush fire refuge will be designed and constructed in regards to the above, as well as in consideration of the Australian Building Codes Board (ABCD) *Design and Construction of Community Bushfire Refuges Handbook.* This non-mandatory document provides guidance on the design and construction of a community bush fire refuge, describing the level of performance to be achieved, enabling the design of a refuge to be developed from first principles, in order to maximise its potential to meet community needs on a specific site.

A refuge designed in accordance with the *Design and Construction of Community Bushfire Refuges Handbook* is not a guarantee for occupant safety; therefore there will be further emphasis on emergency response and evacuation for the Exploratory Works (section 7.1 and 7.2).

The 1488 Bistro and Canteen (Cabramurra Bistro), located in Cabramurra, is identified as a Neighbourhood Safer Place (Building) in the Snowy Mountains LGA. Miles Franklin Park, located at Talbingo, is identified as a Neighbourhood Safer Place (Open Space) in the Snowy Mountains LGA. The Cabramurra Bistro and Miles Franklin Park are the closest Neighbourhood Safer Place options (for Lobs Hole Ravine Road project access and the barge access, respectively) for refuge if evacuation occurs from the Exploratory Works. These Neighbourhood Safer Place locations are considered in emergency evacuation from the Exploratory Works (see section 7.1).

6 Bush fire preparedness and procedures

Specific management actions are proposed to ensure suitable bush fire preparedness is undertaken as part of the Exploratory Works and ahead of the bush fire season, as well as specific procedures to limit the risk of ignition of surrounding bush land resulting from the Exploratory Works.

The KNP FMS (NPWS 2008) provides provisions for fire protection strategies to be prepared by leaseholders for all lease areas. The following maintenance requirements and procedures are consistent with the relevant strategies within the KNP FMS.

6.1 Maintenance

Maintenance is critical in the prevention of property losses during and following a bush fire. Table 6.1 outlines the measures that should be implemented as part of a Bush fire Management Plan (BFMP) for the Exploratory Works, should it be approved, and in advance of and throughout the bush fire season (typically running from October to March).

Table 6.1 Building and property maintenance measures

Feature	Responsibility	Maintenance strategy and frequency/timing
Access	Snowy Hydro	All access roads and tracks identified within this document must be inspected annually and management actions undertaken if roads and tracks are considered unsuitable for emergency vehicle passage (inspect for erosion, fallen timber, locked gates, and dead end tracks).
		Ensure gates are wide enough and in good condition for entry and exit of fire fighting vehicles (in advance of bush fire season).
		Ensure that there are no overhanging branches or objects that would prevent access (minimum 4 m vertical clearance) (in advance of and throughout bush fire season).
		Ensure all pumps and water sources are working, clearly marked and easy to find (in advance of and throughout bush fire season).
		Ensure all fittings are compatible with NPWS fire trucks (in advance of bush fire season).
		Ensure all security clearances, communication and access arrangements have been updated and confirmed with NPWS in readiness for upcoming season (in advance of bush fire season).
		Ensure perimeter roads and defendable space is free of obstacles to provide access for NPWS fire fighting appliances and personnel (in advance of and throughout bush fire season).
		Ensure the existing helipad is maintained to allow for the safe arrival, departure and surface movement of helicopters.
		Ensure the watercraft to be kept at the barge access points for emergency egress is in good working order (in advance of and daily during the bush fire season). The major causes of breakdown in open waters are engine failure, fuel shortage or contamination, mechanical failure and battery failure.
Building maintenance	Snowy Hydro	Ensure hoses and hose reels are not perished and fittings are tight and in good order (in advance of and throughout bush fire season).
		Ensure removal of material such as litter from roofs and gutters (in advance of and throughout bush fire season).
		Store flammable liquids away from buildings or in approved storage compounds (in advance of and throughout bush fire season).

Table 6.1 Building and property maintenance measures

Feature	Responsibility	Maintenance strategy and frequency/timing
		Ensure combustible materials are located well away from the buildings (in advance of and throughout bush fire season).
		Ensure rooflines have no broken or dislodged roofing material and there are no gaps in the roof or eaves (in advance of and throughout the bush fire season).
		Ensure screens on windows and doors are in good condition without breaks, tears or holes that allow penetration of airborne embers into the building in the event windows are open (in advance of and throughout the bush fire season).
		Ensure that where fitted drenching or spray systems are regularly tested before the commencement of the bush fire season.
		Ensure doors are fitted with draught seals and well maintained before the commencement of the bush fire season.
		Systems must be regularly serviced and audited in accordance with AS 1851 – 2012 *Routine Service of Fire Protection Systems and Equipment*, and AS 2293 Set – 2005 *Emergency Escape Lighting and Exit Signs.*
		Maintenance of active fire safety systems associated with the community bush fire refuge, such as mechanical ventilation systems, hose reels or external facade spray systems would be expected to require significant ongoing maintenance in order to ensure that they perform effectively in the event of an emergency.
APZs and landscaping	Snowy Hydro	Inspect and maintain the APZ, in accordance with Snowy Hydro Emergency Management Standard – *Asset Protection Plan for Snowy Hydro Assets in Kosciuszko National Park* (2010) and *Standards for Asset Protection Zones* (NSW RFS 2005) prior to the onset of and throughout the bush fire season each year. Including:
		Keep grass cut to less than 10 cm by twice-yearly slashing to maintain grass at 50 mm to 100 mm nom. height and additional slashing throughout the bush fire season to manage fuel loads.
		Avoid the use of organic mulch in bush fire prone areas with non-flammable material used as an alternative ground cover, e.g. Scoria, pebbles, and recycled crushed bricks.
		Remove dry grass, leaves, twigs and loose bark.
		Keep areas under fences, fence posts and gates and trees raked and cleared of fuel.
		Trees and other vegetation in the vicinity of power lines are managed in accordance with the Electricity supplier specifications.
Water supply	Snowy Hydro	Top up of static water supply at beginning and throughout bush fire season.

6.2 Procedures

The BFMP should also include appropriate work procedures, so as to limit the potential of ignition of surrounding bushland, and will include:

- specific storage and maintenance procedures for potential ignition sources (fuel farm, magazine storage, diesel generators);
- a hot works procedure;
- hot work activities will be required to attain internal work permits;
- no hot works on total fire bans, Park fire bans, and/or conditions associated with severe fire weather to minimise the chance of fires being started;

- fire fighting equipment will be kept on active sites at all times. Equipment should include (but not be limited to) a 4WD Striker with slip on water unit equipped with diesel pump, hoses, extinguishers, knap sacks and hand tools as well as the availability of a 10,000 litre water tanker (eg NPWS tanker);

- notification of the local NPWS for any works that have the potential to ignite surrounding vegetation, proposed to be carried out during the bush fire season to ensure weather conditions are appropriate;

- immediate notification to the local NPWS of the location and nature of any accidental ignition of surrounding vegetation, that was either able to be successfully extinguished using the fire fighting equipment or that otherwise has spread into surrounding vegetation; and

- assist NPWS in the investigation of the cause of any unplanned fires in proximity to the Exploratory Works, should they occur.

6.3 Monitoring and review

The BFMP should be reviewed after incidents of bush fire as well as annually at the end of each bush fire season (April through May). The BFMP should be amended after the review process, if required, to increase the effectiveness of the BFMP. This process will allow any scheduled tasks not undertaken when originally planned to be incorporated into subsequent management activities. A monitoring and review process should include, as a minimum:

- monitor against the aims and objectives of the BFMP;

- update the BFMP based on current best practice guidelines;

- assess the risk, obligations and management measures against any new legislative changes;

- ensure the reporting of any fires including ignition source, location, size and assets impacts, response and suppression activities and if NPWS or other emergency services attended, is captured; and

- review and update of management actions should be undertaken annually at the end of each bush fire season (April through May).

7 Bush fire emergency management

The Exploratory Works has the potential to expose staff to bush fire in an isolated area, with limited access provisions that could potentially hinder safe evacuation. In the event that vegetation is ignited from a project-related source, the Exploratory Works has the potential to impact upon neighbouring communities. Bush fire emergency management procedures are proposed that include bush fire response and evacuation, bush fire awareness, a community bush fire refuge place in the case that offsite evacuation cannot occur and monitoring and review procedures.

7.1 Emergency response and evacuation

In the case of a bush fire emergency, the optimal mitigation response to protect human life is evacuation. The location and topography of the project area means that not all access solutions, under PBP, will be met (section 4.2). Therefore, there will be a higher reliance on the procedures for emergency response and offsite evacuation. Further, if Exploratory Works activities ignite surrounding vegetation it has the potential to impact upon neighbouring communities and therefore response planning should include those areas outside of the project boundary.

A Bush Fire Emergency Response and Evacuation Plan will be required for the Exploratory Works and should incorporate all relevant safety procedures and normative management recommendations detailed in the relevant Acts, Regulations and Australian Standards.

The Bush Fire Emergency Response and Evacuation Plan will, as a minimum:

- include the requirements for pre-bush fire season and continual bush fire awareness (see section 7.2);
- include the requirements for immediate notification to the local NPWS of accidental ignition of surrounding vegetation (see section 6.2);
- include mechanisms for notification of neighbouring communities (Yarrangobilly Caves village and the village of Talbingo) of accidental ignition of surrounding vegetation leading to bush fire that may impact upon them. This will allow the neighbouring communities to appropriately implement their own emergency response and evacuation plans, noting that on days of catastrophic fire weather, the NSW RFS recommends leaving early as the only safe option;
- identify the circumstances under which different evacuation types are to be implemented, in response to a bush fire emergency;
- include a mechanism for the early relocation of staff, noting that on days of catastrophic fire weather, the NSW RFS recommends leaving early as the only safe option;
- contain detailed plans of all Emergency Assembly Areas including “onsite” and “offsite” arrangements;
- include requirements for appropriate onsite refuge area signage and communications;
- contain details of site layout that show all relevant information;
- include transportation arrangements (eg number of vehicles/watercraft required), designated assembly points and time required to have transportation available,

- identify the specific structure and role of emergency control for the site (eg fire wardens); staff will require training consistent with their responsibilities within the emergency control organisational structure with the equipment provided;

- include the requirements for training in preparation for response to an emergency, including trial emergency evacuations via Lobs Hole Ravine Road and via the barge access route (see section 7.2);

- include the requirements for clarifying a safe egress route (via Lobs Hole Ravine Road or the barge access route) and an understanding of the extent/spread of local fires before allowing the evacuating persons to leave the site;

- include the requirements for egress and communication in the scenario that persons are leaving the Exploratory Works as emergency services are attending the Exploratory Works (noting that sections of Upper and Lower Lobs Hole Ravine Road are single lane only); and

- include mechanisms for communication with NPWS and neighbouring communities (Yarrangobilly Caves village and the village of Talbingo) on suitable egress routes and an understanding of the impacts that the egress of high numbers of project staff may have on the neighbouring communities ability to safely egress along the Snowy Mountains Highway.

Although the Exploratory Works is not classified as Special Fire Protection Purpose (SFPP) under PBP, the project will accommodate large numbers of persons, some of whom may have little or no previous experience with bush fire. In addition, there may be communication barriers and logistical problems with high numbers of people. Hence, it is critical that Snowy Hydro applies suitable measures to prepare staff for any potential bush fire event. Where applicable, the plan should be developed to be consistent with the requirements and approach of:

- *A Guide to Developing a Bush Fire Emergency Management and Evacuation Plan* (NSW RFS 2014);

- Australian Standard 3745-2010 *Planning for emergencies in facilities* (Standards Australia 2010); and

- the relevant provisions of the *KNP Fire Management Strategy* (NPWS 2008).

Copies of the Bush Fire Emergency Response and Evacuation Plan for the Exploratory Works should be provided to the NPWS and the NSW RFS for its information prior to commencement of the project.

7.2 Bush fire awareness

Bush fire awareness planning is based on predicted potential bush fire behaviour for combinations of fuel types and fire danger levels. Table 7.1 outlines the minimum recommended mechanisms to develop bush fire awareness of the Exploratory Works, to be included as part of the Bush Fire Emergency Response and Evacuation Plan for the Exploratory Works.

Table 7.1 Bush fire awareness measures

Feature	Responsibility	Awareness strategy and frequency/timing
Induction process	Snowy Hydro	Provide bush fire awareness training to all new staff members and contractors, prior to and during the bush fire season.
Staff briefings and pre-season drills	Snowy Hydro	Provide details of requirements for staff briefings and pre-season fire drills in the Bush Fire Emergency Response and Evacuation Plan and procedures. Briefings and fire drills to be coordinated by Snowy Hydro (or delegate), prior to the bush fire season.
Formal meetings	Snowy Hydro	Formal meetings to be conducted prior to the bush fire season (as part of bush fire awareness), when higher fire weather is forecast or there are fire events in the surrounding area.
		Potential participants to include staff, contractors, neighbouring community representatives and external fire authorities and land managers (eg NPWS and NSW RFS).
Monitor fire weather	Snowy Hydro	Communicate fire weather warnings, severe weather warnings and total fire bans daily during the bush fire danger season to all staff, contractors and visitors at the Exploratory Works. Information can be found on Fire information page (Fire danger ratings and total fire bans) of the NSW RFS website, and the Local Alerts page on the NPWS KNP website.
		The recognition of Very High or greater Fire Danger Days triggering a requirement to view the Fire information page (Fires Near, Major fire updates) on the NSW RFS website, and the Local Alerts page on the NPWS KNP website.
		Staff, contractors and visitors to be aware of and to respond accordingly to the three levels of alert under the national bush fire warning system (Advice, Watch and Alert, Emergency Warning).
Standard procedures	Snowy Hydro	Review and distribute the Bush fire Management Plan and procedures, and Bush Fire Emergency Response and Evacuation Plan for the Exploratory Works.

7.3 Community bush fire refuge

A procedure for onsite refuge is required for the emergency situation where offsite evacuation cannot occur. The Bush Fire Emergency Response and Evacuation Plan should identify the circumstances under which onsite refuge should occur, noting that refuges should only be considered as a last resort, when it is no longer possible to evacuate to an area which is not at risk of bush fire. To this end, a community bush fire refuge is required. At this stage, details of the bush fire refuge have still to be finalised. Requirements for the bush fire refuge can be contained within the Bush Fire Emergency Response and Evacuation Plan which will:

- identify the circumstances under which different evacuation types are to be implemented, in response to a bush fire emergency. It is noted that on days of catastrophic fire weather, the NSW RFS recommends leaving early as the only safe option;
- include the requirements for periodic trial emergency refuge in order to:
  - become familiar with any pre-occupation activities required to be undertaken; and
  - ensure that the refuge is capable of performing its intended function.

Emergency refuge training should be in the context that an occupants ability to act and make optimal choices during a bush fire event will be influenced by their mental preparation, the availability of information for decision making, their perception of a real threat and their considered response (ABCD 2014).

7.4 Monitoring and review

The Bush Fire Emergency Response and Evacuation Plan should be reviewed after incidents of bush fire as well as annually at the end of each bush fire season (April through May). The Bush Fire Emergency Response and Evacuation Plan should be amended after the review process, if required, to increase the effectiveness of the plan. A monitoring and review process should include, as a minimum:

- monitoring against the aims and objectives of the Bush Fire Emergency Response and Evacuation Plan;
- updating the Bush Fire Emergency Response and Evacuation Plan based on current best practice guidelines;
- assessing the risk, obligations and management measures against any new legislative changes; and
- reviewing and updating emergency procedures annually at the end of each bush fire season (April through May).

8 Summary of mitigation measures

Table 8.1 provides a summary of the bush fire prevention and protection strategies (mitigation measures) that have been included in the design process or that are recommended at the detailed design stage or as management measures to minimise the impacts of bush fire on the Exploratory Works, as detailed in Sections 5, 6 and 7.

After the fire prevention and protection strategies have been incorporated into the design and implementation of appropriate APZs, the suitable construction of buildings, suitable access provisions and suitable services (provision and location of water and strategic location of potential ignition sources), two management plans are to be implemented to maintain the proposed mitigation measures as well as to manage the residual bush fire risk for the Exploratory Works. These are:

- *Snowy 2.0 Exploratory Works Bush fire Management Plan* (BFMP); and
- *Snowy 2.0 Exploratory Works Bush Fire Emergency Response and Evacuation Plan.*

Table 8.1 Summary of management measures and commitments

Mitigation component	Management measure/commitment/recommendation	Relevant standard/guideline/procedure/plan
The provision of APZs.	• APZs (including IPAs and OPAs) to be designed implemented and maintained as prescribed in Section 5.1. • At the detailed design stage, consideration will be given to the administration building, for the allowance of an APZ, to ensure there is defendable space for the building that allows access for fire-fighters as well as reducing the radiant heat levels that may be experienced at this structure. • At the detailed design stage, consideration will be given to the accessibility of fire trucks within the defendable space of the portal construction pad structures, as well as the accessibility to the fire water tanks at this location.	• *Planning for bush fire protection 2006* (NSW RFS). • Australian Standard 3959 -2009 *Construction of Buildings in Bushfire-prone Areas* (AS 3959 - 2009). • Snowy Hydro Emergency Management Standard – *Asset Protection Plan for Snowy Hydro Assets in Kosciuszko National Park* (2010). • *Standards for Asset Protection Zones* (NSW RFS 2005). • Snowy 2.0 Exploratory Works Bush Fire Management Plan (BFMP).
Access.	• Appropriate access standards for staff, fire fighters, emergency service workers and those involved in evacuation as discussed in Section 5.2. • Consideration should be given to the implementation of passing bays or reversing bays (as per PBP fire trail standards) at regular intervals in the upgrade of Upper and Lower Lobs Hole Ravine Road. This will improve the access and egress constraints along this section of road. • At the detailed design stage, consideration should be given to a fire trail, around the perimeter of the accommodation camp and within the APZ of the camp. This will provide for access for fire fighting vehicles performing property protection, in the event of a bush fire in proximity to the camp. This fire trail could also form part of the IPA around the accommodation camp.	• *Planning for bush fire protection 2006* (NSW RFS).
Water supply.	• Adequate water supply and pressure to be designed implemented and maintained as prescribed in Sections 5.3 and 6.2. • If spray systems are to be incorporated into the design of the buildings, dedicated fire water supplies will need to be increased to accommodate the systems.	• *Planning for bush fire protection 2006* (NSW RFS). • Australian Standard 1221 - 1997 *Fire hose reels (AS/NZS 1221 - 1997).* • Australian Standard 2441 - 2005 *Installation of fire hose reels* (AS 2441:2005). • Snowy 2.0 Exploratory Works Bush Fire Management Plan (BFMP).

Table 8.1 Summary of management measures and commitments

Mitigation component	Management measure/commitment/recommendation	Relevant standard/guideline/procedure/plan
Services (gas and electricity).	• Location and maintenance of services so as not to contribute to the risk of bush fire or impede the fire fighting effort as discussed in Sections 5.3 and 6.2.	• *Planning for bush fire protection 2006 (NSW RFS).* • Australian Standard 1596 - 2014 *The storage and handling of LP gas* (AS 1596 – 2014). • ***Snowy 2.0 Exploratory Works Bush fire Management Plan* (BFMP).**
The storage of hazardous materials and ignition sources.	• Diesel generators and associated fuel storage at the portal construction pad, construction compound at Lobs Hole and the barge access (north and south) infrastructure will need to be designed, housed and maintained so that they will not serve as a risk to surrounding bushland and will be located away from the hazard, wherever possible. • A suitable storage facility will be designed for storage of the ammunition for blasting activities and fuel storage, to prevent ignition of surrounding vegetation and to reduce the storage area susceptibility to bush fire impacts. • A *Bush Fire Management Plan* for the Exploratory Works will detail measures and procedures to prevent fires igniting during the works (see section 6.2).	• ***Snowy 2.0 Exploratory Works Bush fire Management Plan* (BFMP).**
Construction standards and design.	• Buildings to be constructed in accordance with relevant NCC, BCA and Australian Standards as prescribed in Section 5.5.	• *Planning for bush fire protection* 2006 (NSW RFS), including Appendix 3 Addendum. • Australian Standard 3959 -2009 *Construction of Buildings in Bushfire-prone Areas* (AS 3959 - 2009). • Australian Standard 1851 – 2012 *Routine service of fire protection systems and equipment* (AS 1851-2012). • Australian Standard 2293 set (and amendments) – 2005 *Emergency escape lighting and exit signs* (AS 2293-2005).

Table 8.1 Summary of management measures and commitments

Mitigation component	Management measure/commitment/recommendation	Relevant standard/guideline/procedure/plan
Community bush fire refuge.	• A community bush fire refuge will be required at Lobs Hole providing a refuge for anyone caught out by fire preventing an escape by way of the single entry and exit road. This will include those staying at the accommodation camp. Decisions as to the location and design of the refuge will need to be made at the detailed design stage and to be in regards to Section 5.6.	• *Planning for bush fire protection 2006 (NSW RFS) (SFPP),* including Appendix 3 Addendum. • *Guidelines for the identification and inspection of Neighbourhood Safer Places in NSW* (NSW RFS 2017b). • *Standards for Asset Protection Zones* (NSW RFS 2005). • Australian Standard 3959 -2009 *Construction of Buildings in Bushfire-prone Areas* (AS 3959 - 2009). • the building will be provided with a certificate issued by a person who is recognised by the NSW RFS as a qualified consultant in bush fire risk assessment, which states that the development conforms to the relevant specifications and requirements, or • If the development does not conform to the relevant specifications and requirements, consult with the Commissioner of the NSW RFS on the measures to take with respect to the development to protect against the dangers of bush fire. • Australian Building Codes Board (ABCD) *Design and Construction of Community Bushfire Refuges Handbook* (ABCD 2014)
Bush fire preparedness and procedures.	• Specific management actions are proposed to ensure suitable bush fire preparedness is undertaken as part of the Exploratory Works and ahead of the bush fire season, as well as specific procedures to limit the risk of ignition of surrounding bush land resulting from the Exploratory Works (Section 6.1). • Appropriate work procedures, so as to limit the potential of ignition of surrounding bushland are to include those measures in Section 6.2. • A *Bush Fire Management Plan* for the Exploratory Works will detail the maintenance measures and procedures during the works (Section 6).	• ***Snowy 2.0 Exploratory Works Bush fire Management Plan* (BFMP).**

Table 8.1 Summary of management measures and commitments

Mitigation component	Management measure/commitment/recommendation	Relevant standard/guideline/procedure/plan
Bush fire emergency management.	• Bush fire emergency management procedures are proposed that include bush fire response and evacuation, bush fire awareness, a community bush fire refuge place in the case that offsite evacuation cannot occur and monitoring and review procedures (Section 7). • A *Bush Fire Emergency Response and Evacuation Plan* for the Exploratory Works will detail these procedures (Section 7).	• *A Guide to Developing a Bush Fire Emergency Management and Evacuation Plan* (NSW RFS 2014). • Australian Standard 3745-2010 *planning for emergencies in facilities* (Standards Australia 2010). • The relevant provisions of the *Kosciuszko National Park Fire Management Strategy 2008-2013* (NPWS 2008). • ***Snowy 2.0 Exploratory Works Bush Fire Emergency Response and Evacuation Plan.***

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