



A P P E N D I X

F

BIODIVERSITY DEVELOPMENT ASSESSMENT





Biodiversity development assessment report

Exploratory Works for Snowy 2.0

Prepared for Snowy Hydro Limited
July 2017





Servicing projects throughout Australia and internationally

SYDNEY

Ground floor, Suite 01, 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500
F 02 9493 9599

NEWCASTLE

Level 1, Suite 6, 146 Hunter Street
Newcastle NSW 2300
T 02 4907 4800
F 02 4907 4899

BRISBANE

Level 10, 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3839 1800
F 07 3839 1866

ADELAIDE

Level 1, 70 Pirie Street
Adelaide SA 5000
T 08 8232 2253

Biodiversity development assessment report

Exploratory Works for Snowy 2.0

Prepared for Snowy Hydro Limited | 13 July 2018

Suite 6, Level 1, 146 Hunter Street
Newcastle NSW 2300

T +61 (0)2 4907 4800

F +61 (0)2 4926 1312

E info@emmconsulting.com.au

www.emmconsulting.com.au

Biodiversity development assessment report

Final

Report Biodiversity Development Assessment Report | Prepared for Snowy Hydro Limited | 13 July 2018

Prepared by **Nathan Garvey**

Approved by **Brett McLennan**

Position Associate Ecologist

Position Director

Signature



Signature



Date 13 July 2018

Date 13 July 2018

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

© Reproduction of this report for educational or other non-commercial purposes is authorised without prior written permission from EMM provided the source is fully acknowledged. Reproduction of this report for resale or other commercial purposes is prohibited without EMM's prior written permission.

Document Control

Version	Date	Prepared by	Reviewed by
1	13 July 2018	Nathan Garvey	Rob Morris Brett McLennan Duncan Peake



T +61 (0)2 4907 4800 | F +61 (0)2 4926 1312

Suite 6, | Level 1, | 146 Hunter Street | Newcastle | New South Wales | 2300 | Australia

www.emmconsulting.com.au

Executive Summary

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). The purpose of the 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 m below ground level.

The Exploratory Works comprise:

- establishment of an exploratory tunnel to the site of the underground power station for Snowy 2.0;
- establishment of a portal construction pad;
- excavated rock management, including subaqueous rock placement;
- establishment of an accommodation camp;
- road establishment 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; and
- establishment of services infrastructure such as diesel-generated power and communication.

This report documents the terrestrial biodiversity assessment methods and results, the initiatives built into the Exploratory Works project design to avoid and minimise biodiversity impacts, and the additional mitigation and management measures proposed, including offset requirements, to address any residual impacts not able to be avoided.

The Exploratory Works is located predominantly within the South Eastern Highlands Interim Biogeographic Regionalisation of Australia (IBRA) region and Bondo IBRA subregion, and with the Kosciuszko National Park (KNP). The Exploratory Works project area intersects two major creeks; Wallaces Creek and the Yarrangobilly River, along with a number of minor watercourses. Native vegetation is largely intact, with 90% native vegetation cover within a 1,500 m buffer of the survey area, providing a high degree of connectivity to large and contiguous patches of vegetation.

Significant field surveys have been undertaken across the Exploratory Works surveys area, including initial field assessments, detailed vegetation mapping, vegetation integrity assessments and comprehensive targeted flora and fauna surveys which have exceeded NSW and Commonwealth survey guidelines.

Native vegetation within the Exploratory Works area reflects past land use. Lobs Hole has a long history of occupation, first used in the early 1800s for the movement of stock and recently used for copper mining to 1917. Contemporarily, Lobs Hole is used for recreation, including camping. These activities and past land uses have resulted in significant amounts of clearing and disturbance of vegetation in the area. Native vegetation and fauna habitats have been modified by past disturbances associated with land clearing, livestock grazing and weed invasion. Native vegetation has re-established itself throughout Lobs Hole; however, Blackberry, a weed of national significance, has established itself to the point of infestation within the area, particularly in gullies and along the Yarrangobilly River. Land at Talbingo also shows significant levels of disturbance due to the construction of Tumut 3 power station as a part of the original Snowy Scheme. The upper sections of Lobs Hole Ravine Road remain relatively intact, with higher quality vegetation present. Vegetation mapping identified nine PCTs within the Exploratory Works project area. These nine PCTs have been stratified into 28 vegetation zones on the basis of broad condition state. Seventeen vegetation zones show significant levels of disturbance, while a further four show some degree of impact. Seven vegetation zones are considered representative of relatively intact vegetation of high quality. Vegetation integrity scores reflect this condition, with scores varying between 4.2 and 71.3.

Threatened species surveys did not identify any threatened flora species within or adjacent to the Exploratory Works survey area. Ten threatened fauna species have been recorded within or adjacent to the Exploratory Works survey area; five ecosystem credit species and five species credit species. A significant result was the identification of a population of the critically endangered Smoky Mouse along a ridge associated with the upper sections of Lobs Hole Ravine Road. This species is known from a limited number of extant sites in NSW. Other species identified include the Gang-gang Cockatoo and Masked Owl, with breeding habitat for these two species identified along the upper sections of Lobs Hole Ravine Road and in the riparian zone of the Yarrangobilly River. The Eastern Pygmy-possum was recorded at numerous locations within the Exploratory Works survey area, from the upper reaches of Lobs Hole Ravine to Lobs Hole. A healthy population of the Booroolong Frog was recorded along the entire length of the Yarrangobilly River within and adjacent to the Early Works project area; this population is likely to extend upstream to at least Blue Creek Firetrail.

A key focus of project design has been to avoid and minimise impacts to biodiversity values identified during the field surveys, in recognition of the location of the Exploratory Works in the KNP. This has included an iterative process to the design, including the following steps:

- identification of biodiversity values through comprehensive, rigorous and thorough biodiversity surveys;
- communication of identified values to the project team, including Snowy Hydro and the design team;
- consultation between the design team and project ecologists on various elements to consider both direct and indirect impacts and work through an iterative design process, with multiple iterations of design elements to achieve best practice outcomes;
- consultation with key government stakeholders, including the NSW Office of Environment and Heritage (OEH), NSW National Parks and Wildlife Service (NPWS) and Commonwealth Department of the Environment and Energy (DoEE), including species experts and accountable officers, to seek input and discuss measures proposed to avoid, minimise and mitigate impacts;
- feedback of consultation into the design process; and
- finalisation of measures to avoid, minimise and mitigate impacts.

This has resulted in significant design revisions to avoid impacts, including restriction of works along the upper sections of Lobs Hole Ravine Road to the existing road surface to avoid impacts to Smoky Mouse habitat, and limitation of works within a 50 m buffer around the Yarrangobilly River to avoid and minimise impacts to the Booroolong Frog. In addition, works have been sited, wherever possible, in disturbed parts of the project area to minimise impacts to biodiversity. Significant controls have been put in place to avoid, minimise and mitigate indirect impacts, including restriction of traffic movements along Lobs Hole Ravine Road to avoid impacts to Smoky Mouse, and implementation of site preparation works, significant sediment control, rehabilitation and water quality monitoring.

Residual impacts following implementation of all controls include:

- clearing of 95.2 ha of native vegetation; and
- impacts to 70.64 ha of threatened species habitat for five species credit species.

A total of 1,865 ecosystem credits and 2,060 species credits are required to offset these impacts.

In summary, a significant effort has been undertaken to understand the biodiversity values within the Exploratory Works survey area, and design the project to avoid and minimise impacts to identified values. The Exploratory Works have been sited, where possible, within disturbed areas as a priority. Where this could not be achieved impacts have been minimised and mitigated through implementation of appropriate controls. Residual impacts will be offset in accordance with the objective and principles outlined in the biodiversity offset framework, and before impacts occur.

Table of contents

Executive Summary	ES.1
PART A	Stage 1: Biodiversity Assessment
Chapter 1	Introduction
1.1	The project
1.2	Purpose of this report
1.3	Location of Exploratory Works
1.4	Project area, survey area, disturbance and avoidance footprint definitions
1.5	Proponent
1.6	Assessment guidelines and requirements
1.7	Information sources
1.7.1	Other relevant reports
1.7.2	Publications and databases
1.7.3	Spatial data
1.8	Legislative requirements
Chapter 2	Project description
2.1	Overview
2.2	Exploratory tunnel
2.3	Portal construction pad
2.4	Excavated rock management
2.4.1	On land placement
2.4.2	Subaqueous placement
2.5	Accommodation camp
2.6	Road and access provisions
2.6.1	Access road works
2.6.2	Watercourse crossings
2.7	Barge access infrastructure
2.8	Services and infrastructure
2.9	Construction and schedule
2.9.1	Geotechnical investigation
2.9.2	Construction activities
2.9.3	Ancillary construction areas
2.9.4	Construction workforce requirements
2.9.5	Timing and staging
2.10	Site rehabilitation
2.11	Decommissioning
2.12	Key aspects relevant to biodiversity

Table of contents *(Cont'd)*

Chapter 3	Legislative context	33
3.1	Commonwealth	33
3.1.1	Environment Protection and Biodiversity Conservation Act 1999	33
3.2	State	33
3.2.1	Environmental Planning and Assessment Act 1979	33
3.2.2	Biodiversity Conservation Act 2016	34
3.2.3	Fisheries Management Act 1994	35
3.2.4	Biosecurity Act 2015	35
3.2.5	National Parks and Wildlife Act 1979	36
Chapter 4	Landscape features	37
4.1	Project area, survey area, disturbance and avoidance footprint definitions	37
4.2	Landscape features	37
4.2.1	Bioregions and landscapes	37
4.2.2	Watercourses and wetlands	38
4.2.3	Connectivity	38
4.2.4	Areas of geological significance and soil hazard features	39
4.2.5	Areas of outstanding biodiversity value	40
4.3	Assessment of site context	40
Chapter 5	Native vegetation	47
5.1	Background review	47
5.2	Methods	48
5.2.1	Detailed vegetation mapping and habitat assessment	48
5.2.2	Vegetation integrity assessment	49
5.3	Results	50
5.3.1	Vegetation description	50
5.3.2	Plant community types	51
5.3.3	Vegetation zones	64
5.3.4	Assessment of patch size	88
5.3.5	Vegetation integrity score	88
5.4	Groundwater dependent ecosystems	90
5.4.1	Identification of potential GDEs	91
5.4.2	Assessment of potential groundwater impacts	95
5.4.3	Final risk assessment for identified GDEs	96
Chapter 6	Threatened species	97
6.1	Fauna habitat assessment	97
6.2	Ecosystem credit species assessment	98

Table of contents *(Cont'd)*

6.3	Species credit species assessment	100
6.3.1	Habitat constraints assessment (Step 2)	100
6.3.2	Identifying candidate species credit species for further assessment (Step 3)	102
6.3.3	Targeted survey methods	109
6.3.4	Targeted survey results	129
6.3.5	Species credit species	144
<hr/>		
PART B	Stage 2: Impact Assessment	
<hr/>		
Chapter 7	Impact assessment (biodiversity values)	151
7.1	Potential direct, indirect and prescribed impacts	151
7.2	Measures to avoid, minimise and mitigate impacts	154
7.2.1	Access roads – Link Road to Lobs Hole	154
7.2.2	Access roads – barge access to Lobs Hole and the exploratory tunnel	156
7.2.3	Exploratory tunnel, tunnel portal and construction pad	159
7.2.4	Accommodation camp	161
7.2.5	Excavated rock management	163
7.2.6	Barge access and subaqueous rock placement	168
7.2.7	Site preparation works – all project elements	168
7.2.8	Monitoring and adaptive management	170
7.3	Impact summary	174
7.3.1	Summary of measures to avoid, minimise and mitigate impacts	174
7.3.2	Serious and irreversible impacts (SAII)	181
7.3.3	Impacts requiring offsets	181
7.3.4	Impacts not requiring offsets	188
7.4	Biodiversity offset framework	190
<hr/>		
Chapter 8	Conclusion	199
<hr/>		
References		203
<hr/>		

Appendices

A	Vegetation integrity assessment - datasheets
B	Vegetation integrity assessment - plot data
C	Fauna survey effort summary
D	Targeted survey weather conditions
E	Water Quality Results
F	Credit Report

Tables

1.1	Biodiversity related elements of the SEARS and how they have been addressed	4
1.2	OEH requirements and how they have been addressed	5
2.1	Access road works summary	22
2.2	Watercourse crossing summary	22
2.3	Summary of services and infrastructure	27
2.4	Construction activities	28
2.5	Planned Exploratory Works rehabilitation activities	31
5.1	Definitions used in delineation of vegetation zones	49
5.2	Plant community types mapped within the Exploratory Works disturbance footprint	52
5.3	Vegetation zones mapped within the Exploratory Works disturbance footprint	64
5.4	PCT 285 Broad-leaved Sally grass – sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion description	66
5.5	PCT 296 - Brittle Gum – peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	69
5.6	PCT 300 –Ribbon Gum – Narrow-leaved (Robertsons) Peppermint montane fern – grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and Kosciuszko escarpment	72
5.7	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	74
5.8	PCT 311 –Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	77
5.9	PCT 643 –Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion	79
5.10	PCT 729 – Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	81
5.11	PCT 999 – Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	84
5.12	PCT 1196 – Snow Gum – Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	86
5.13	Vegetation zones mapped within the Exploratory Works project area	88
5.14	Terrestrial GDE assessment	93
5.15	Modelled baseflow to Yarrangobilly River	95
6.1	Assessment of ecosystem credit species within the Exploratory Works disturbance footprint	99
6.2	Assessment of habitat constraint features within the Exploratory Works survey area	101
6.3	Species credit species and status and habitat suitability assessment	103
6.4	Stratification units and survey area – diurnal birds	119
6.5	Methods and survey effort – diurnal birds	120

Tables

6.6	Stratification units and survey area – nocturnal birds	121
6.7	Methods and survey effort – nocturnal birds	121
6.8	Stratification units and survey area – small terrestrial mammals	122
6.9	Methods and survey effort- small terrestrial mammals	123
6.10	Stratification units and survey area – large terrestrial mammals	123
6.11	Methods and survey effort – large terrestrial mammals	124
6.12	Stratification units and survey area – arboreal mammals	125
6.13	Methods and survey effort – arboreal mammals	125
6.14	Stream lengths – amphibians	127
6.15	Methods and survey effort- amphibian	127
6.16	Species credit species, habitat suitability and targeted survey results	145
7.1	Indicative surface water monitoring framework	166
7.2	Summary of impacts, and measures to avoid, minimise and mitigate these impacts	175
7.3	Summary of ecosystem credits required for all vegetation zones for the Exploratory Works	183
7.4	Summary of threatened species credit required for the Exploratory Works	186
7.5	Summary of impacts not requiring offsets – native vegetation	189
8.1	Mitigation measures - Biodiversity	200
B.1	Vegetation integrity plot data	B.1
C.1	Fauna survey effort summary	C.1
D.1	Targeted survey weather conditions	D.1
D.1	Water quality results summary: Yarrangobilly River (base flow conditions)	E.1

Figures

1.1	Regional location of Snowy 2.0 and Exploratory Works	6
1.2	Exploratory Works project area	7
2.1	Exploratory Works elements	12
2.2	Exploratory tunnel location	14
2.3	Exploratory tunnel indicative cross section	15
2.4	Conceptual layout – portal construction pad	16
2.5	Conceptual layout – excavated material emplacement areas	18
2.6	Subaqueous excavated rock placement	20
2.7	Conceptual layout – accommodation camp	21
2.8	Access road upgrades and establishment	23
2.9	Excavated material haul route	24
2.10	Barge access locations	26
2.11	Indicative timing of Exploratory Works elements	30

Figures

4.1	Location map, Exploratory Works	44
4.2	Site map, Exploratory Works	45
5.1	Plant Community Type and vegetation zone mapping within the Exploratory Works project area, including plots locations	53
6.1	Flora survey locations	110
6.2	Fauna survey locations	128
6.3	Threatened species overview	139
6.4	Diurnal bird survey results	140
6.5	Nocturnal bird survey results	141
6.6	Small terrestrial mammal survey results	142
6.7	Amphibian survey results	143
7.1	Indicative water monitoring locations	173
7.2	Serious and irreversible impacts, impacts requiring offsets, impacts not requiring offsets and areas not requiring assessment	191

Photographs

4.1	Boulder streams along Lobs Hole Ravine Road	39
4.2	In situ calcareous fossils of the Lick Hole Formation	40
5.1	The Lobbs Hole Copper Mine in ~1901, showing disturbance to native vegetation (photo taken by Ernest Clayton Andrews, source: Geological Survey of NSW)	51
5.2	Broad-leaved Sally grass – sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion – Plot 1012	68
5.3	Brittle Gum – peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion – Plot 76	71
5.4	Ribbon Gum – Narrow-leaved (Robertsons) Peppermint montane fern – grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and Kosciuszko escarpment – Plot 156	73
5.5	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 – Plot 97	76
5.6	Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion – Plot 154	78
5.7	Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion – Plot 173	80
5.8	Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion – Plot 1002	83
5.9	Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion – Plot 136	85

Photographs

5.10	Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion – Plot 1038	87
6.1	Gang-gang Cockatoos	131
6.2	Masked Owl	132
6.3	Eastern Pygmy-possum (image courtesy of Lachlan Hall)	134
6.4	Smoky Mouse	136
6.5	Booroolong Frog	138

PART A

Stage 1: Biodiversity Assessment

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.

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.

1.2 Purpose of this report

This Biodiversity Development Assessment Report (BDAR) supports the EIS for the Exploratory Works. It documents the terrestrial biodiversity assessment methods and results, the initiatives built into the project design to avoid and minimise associated impacts, to terrestrial biodiversity, and the mitigation, and management measures, including offset requirements, proposed to address any unavoidable residual impacts.

The specific objectives of this assessment are to:

- describe the existing biodiversity values and existing environment;
- identify and assess potential the for presence of biodiversity values including threatened species and communities under relevant legislation including the NSW *Biodiversity Conservation Act 2017* (BC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- identify ecological constraints within and impacts arising from the Exploratory Works;
- provide mitigation measures to reduce the impacts from the proposal on biodiversity wherever possible; and
- where impacts are unavoidable, consider compensatory measures that are appropriate for the Exploratory Works.

This BDAR has been prepared in accordance with the Biodiversity Assessment Method (BAM, OEH 2017).

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 Project area, survey area, disturbance and avoidance footprint definitions

The Exploratory Works would be undertaken within the project area shown in Figure 1.1. Within the project area are the disturbance and avoidance footprints.

The disturbance footprint shows all areas where land could be directly disturbed by Exploratory Works, and includes all areas subject to clearing and ground disturbance. The avoidance footprint shows areas where disturbance to land has been avoided. The development of the disturbance and avoidance footprints was the result of an iterative design process where the biodiversity values within the proposed action area were taken into consideration. This approach allowed for the identification of constraints early in the process, providing flexibility during the design phase of the project to avoid and minimise impact to identified constraints.

Both desktop assessments and field surveys have been undertaken to assess the biodiversity values at a State and Commonwealth level that occur across the survey area. The survey area includes the disturbance and avoidance footprints as well as some additional land not utilised, and is shown in Figure 1.2.

1.5 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.

1.6 Assessment guidelines and requirements

This terrestrial biodiversity assessment has been prepared in accordance with the Secretary’s Environmental Assessment Requirements (SEARs) for Exploratory Works, issued first on 17 May 2018 and revised on 20 June 2018, as well as relevant governmental assessment requirements, guidelines and policies, and in consultation with the relevant government agencies.

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

Table 1.1 Biodiversity related elements of the SEARS and how they have been addressed

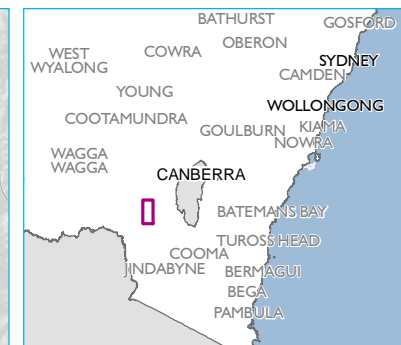
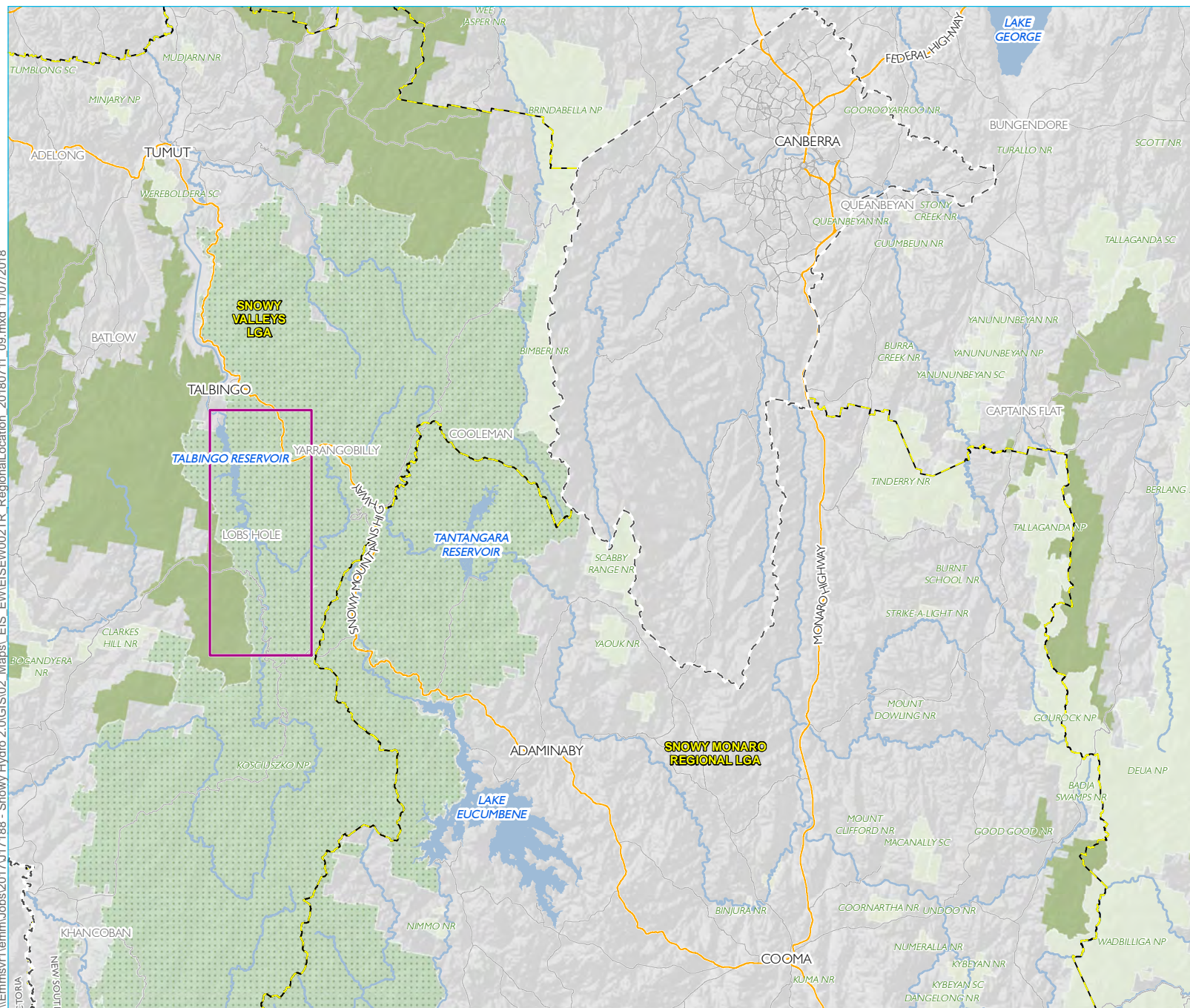
Requirement	Section addressed
In particular, the EIS must address the following matters:	
Biodiversity – including:	
An assessment of the biodiversity values and the likely biodiversity impacts of the project in accordance with the <i>NSW Biodiversity Conservation Act 2016</i> , the Biodiversity Assessment Method (BAM) and documented in a Biodiversity Development Assessment Report (BDAR)	This report.
A strategy to offset any residual impacts of the project focusing on improving the biodiversity and conservation values of the Kosciuszko National Park in the medium to long term.	Section 7.4
An assessment of the impacts of the project on aquatic ecology, including impacts on key fish habitat and threatened species of fish.	See Exploratory Works EIS Aquatic Ecology report (Cardno 2018).

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. A copy of the NSW Office of Environment and Heritage (OEH) advice to DPE was attached to the SEARs and matters relevant to the BDAR are listed in Table 1.2.

Table 1.2 **OEH requirements and how they have been addressed**

Requirement	Section addressed
A strategy for the design, management and rehabilitation of rock stockpile sites, including the use or disposal of rock materials in the short, medium and long term.	Section 2.4, Section 7.2.5 and Section 5.4 and Appendix Q of the EIS.
A strategy to offset any residual impacts of the project focusing on improving the biodiversity and conservation values of the Kosciuszko National Park in the medium to long term by exploring opportunities for funding biodiversity conservation actions allowable through satisfaction of the Biodiversity Conservation Act 2016 ancillary rules.	Section 7.4
Offsets must be additional to any riparian remediation required for construction activities in the Lobs Hole (Ravine) development footprint.	Noted.
Identification of direct and Indirect Impacts associated with the project, Including any exacerbation of threats to park values from feral predators, weeds/pests and pathogenic diseases, noise, light and road kill of native fauna.	Section 7.

\\Emmsvr1\emm\Jobs\2017\17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS_EWEISEW002TR_RegionalLocation_20180711_09.mxd 11/07/2018

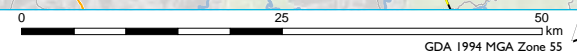


- KEY**
- Exploratory Works project area
 - Main road
 - Local road
 - Watercourse
 - Waterbodies
 - Kosciuszko National Park
 - NPWS reserve
 - State forest
 - Local government area boundary
 - State boundary

Regional location of Snowy 2.0 and Exploratory Works

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 1.1

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





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

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

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 1.2



T:\Jobs\2017\17188 - Snowy Hydro 2.0\GIS\02_Maps\LEIS_EWIEISEW033_ExploratoryWorksProjectArea_20180703_05.mxd 11/07/2018

1.7 Information sources

1.7.1 Other relevant reports

This terrestrial biodiversity assessment has been prepared with reference to other technical reports that were prepared as part of the Exploratory Works EIS. The other relevant reports referenced in this terrestrial biodiversity assessment are listed below.

- Aquatic ecology assessment (Cardno 2018) – Appendix G of the EIS
- Bushfire risk and hazard assessment (EMM 2018e) – Appendix V of the EIS
- Excavated rock emplacement areas assessment (SGME 2018) – Appendix K of the EIS
- Geodiversity review (EMM 2018a) – Appendix I of the EIS
- Groundwater assessment (EMM 2018b) – Appendix N of the EIS
- Noise and vibration impact assessment (EMM 2018c) – Appendix T of the EIS
- Rehabilitation strategy (SMEC 2018) – Appendix E of the EIS
- Surface water assessment (EMM 2018d) – Appendix M of the EIS
- Traffic and Transport Assessment Report (SCT 2018) – Appendix Q of the EIS

1.7.2 Publications and databases

In order to provide context for the Exploratory Works, information about flora and fauna species, populations, communities and habitats from the locality (generally within 10 km) was obtained from the following databases:

- OEH (2018a) *BioNet Atlas of NSW Wildlife* (Bionet) for previous threatened species records;
- Commonwealth Department of Environment and Energy (DoEE) *Protected Matters Search Tool* (PMST) for MNES (DoEE 2018), including threatened species likely to occur within the Exploratory Works areas; and
- the *NSW Plant Community Types* (PCTs), as held within the Vegetation Information System (VIS) Classification 2.1 database (OEH 2018b).

1.7.3 Spatial data

Spatial data encompassing the Exploratory Works project area, including the disturbance and avoidance footprints, was obtained from SMEC and Snowy Hydro. Base map data was obtained from Department of Finance, Services and Innovation (DFSI) NSW databases, with cadastral data obtained from DFSI digital cadastral database. Mapping for stream orders was obtained from DPI (2013).

The following spatial datasets were utilised during the development of this report:

- *State Vegetation Type Map: Riverina Region Version v1.2 - VIS_ID 4469* (OEH 2016a);
- *Mitchell Landscapes Version V3.1* (OEH 2016b);
- *Interim Biogeographic Regionalisation of Australia (IBRA) Version 7* (DoEE 2017);
- Directory of important wetlands (DoEE 2018); and
- NSW Wetlands (OEH 2010).

Mapping undertaken during the site assessment was conducted using a hand-held GPS unit, mobile tablet computer and aerial photo interpretation. Accuracy is subject to accuracy of GPS devices, generally ± 5 m. Mapping has been produced using a Geographic Information System (GIS; ArcGIS 10.5).

1.8 Legislative requirements

The project has been assessed against the key biodiversity legislation and government policy, including:

- EPBC Act;
- BC Act;
- *NSW Fisheries Management Act 1994* (FM Act);
- *NSW Environmental Planning and Assessment Act 1979* (EP&A Act);
- *NSW Biosecurity Act 2015*; and
- *NSW National Parks and Wildlife Act 1974* (NPW Act).

These are discussed further in Section 3.

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:

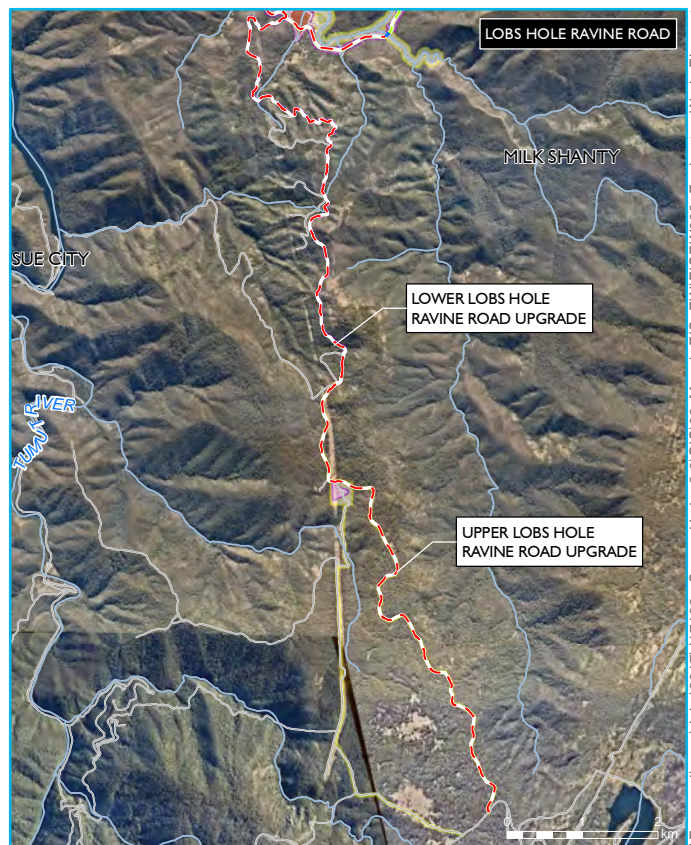
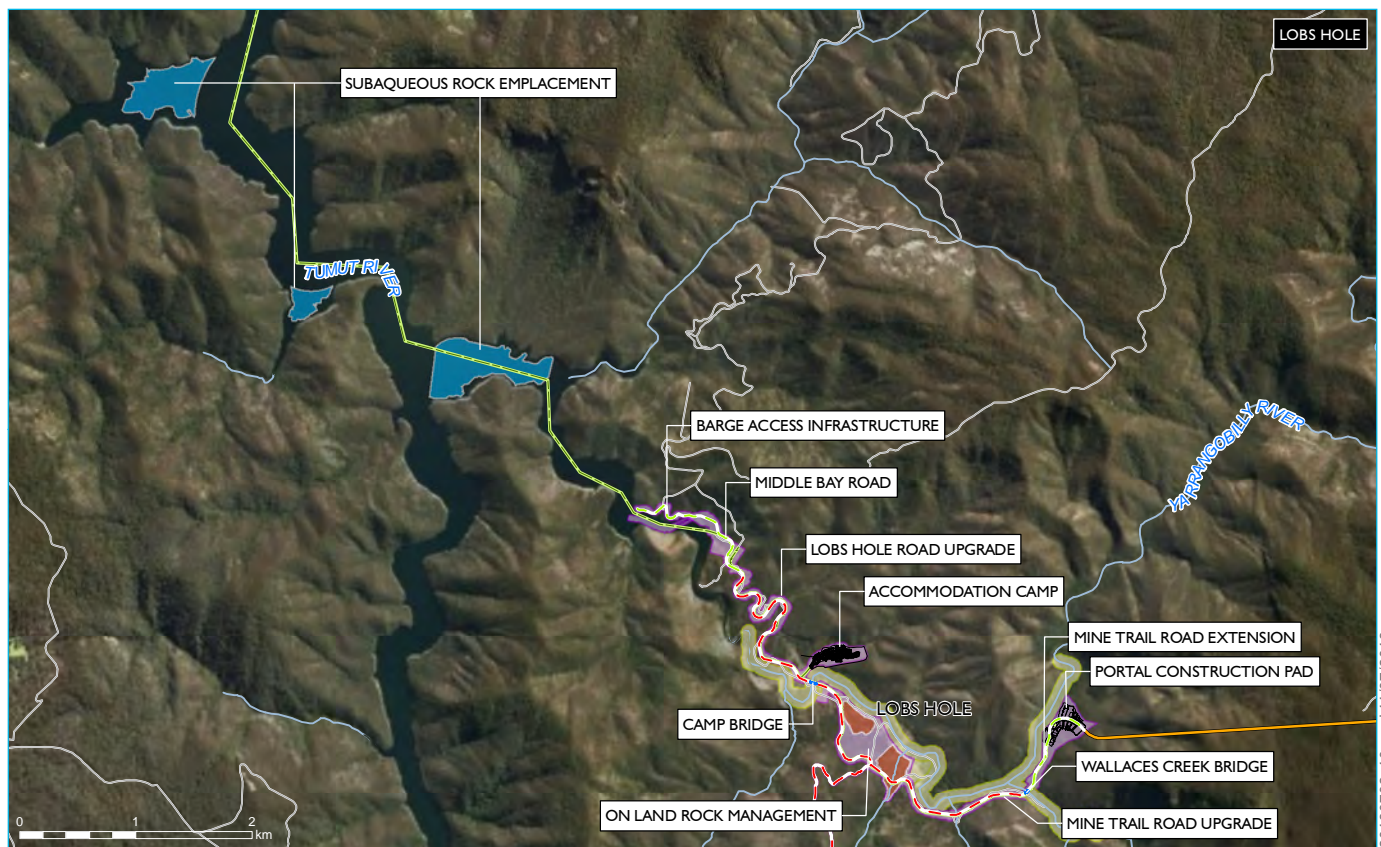
- establishment of an exploratory tunnel to the site of the underground power station for Snowy 2.0;
- horizontal and other test drilling, investigations and analysis in situ at the proposed cavern location and associated areas, and around the portal construction pad, access roads and excavated rock 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.



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

GDA 1994 MGA Zone 55



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
Biodiversity Development Assessment Report
Exploratory Works
Figure 2.1



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.

\\Emmsvr1\emm\Jobs\2017\17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS EWTechReports\ WIA\WIAEW003 TunnelPadPortal_20180702_08.mxd 11/07/2018



- 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

Exploratory tunnel location

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 2.2

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



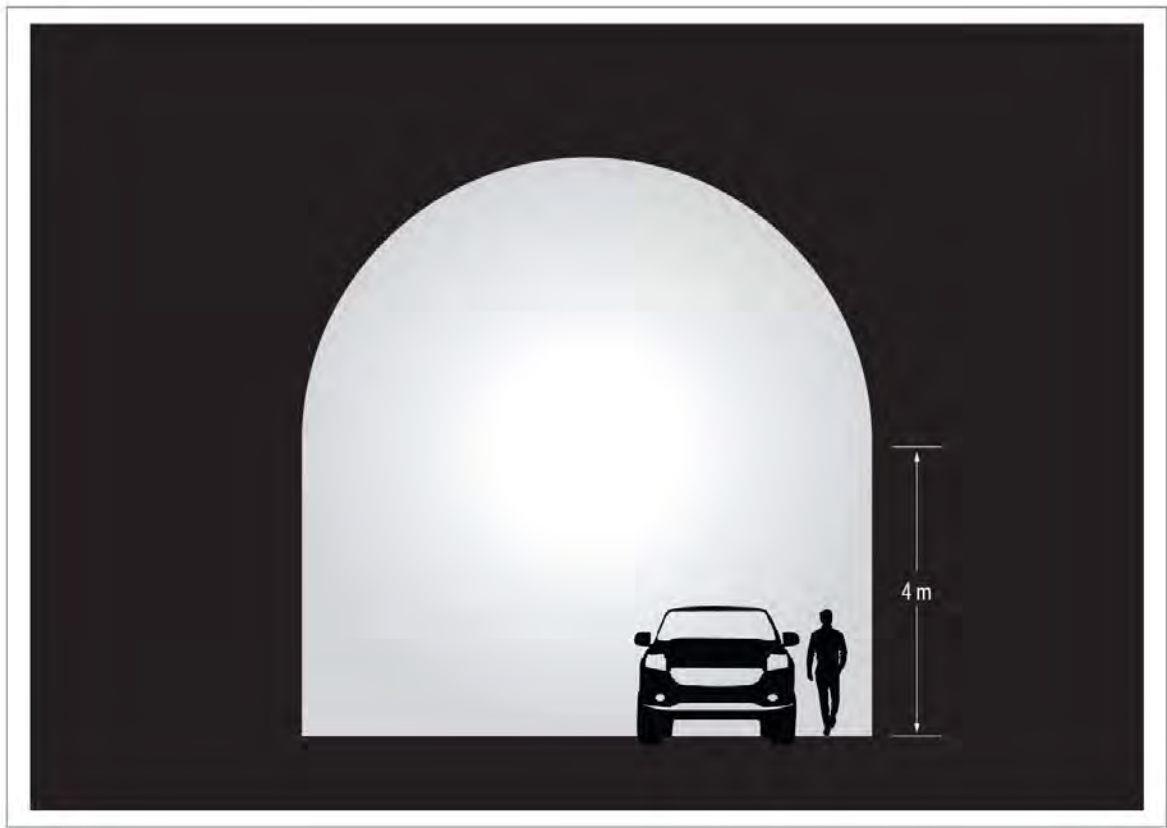
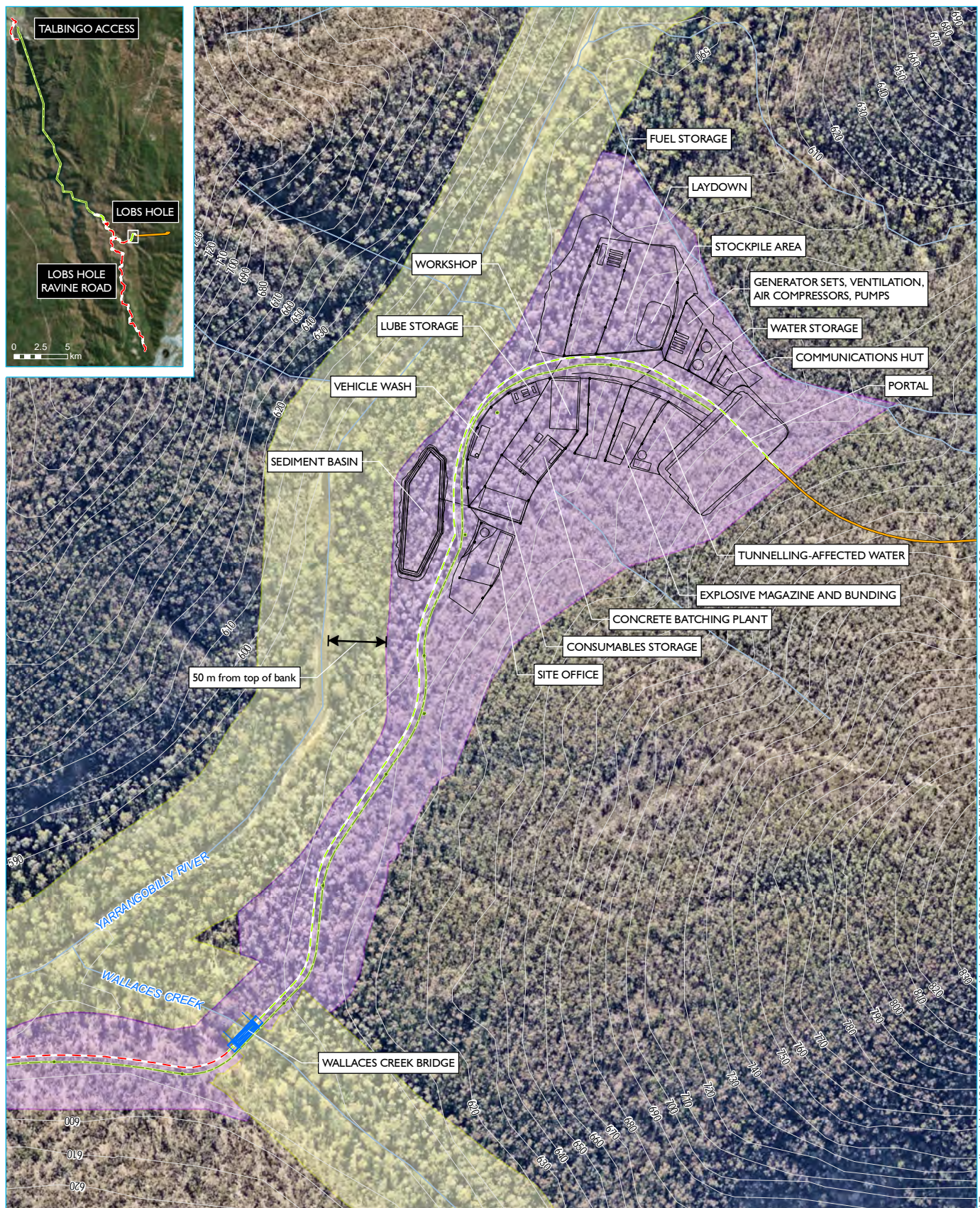


Figure 2.3 Exploratory tunnel indicative cross section

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 m².



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

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
Biodiversity Development Assessment Report
Exploratory Works
Figure 2.4



2.4 Excavated rock management

It is estimated that approximately 750,000 m³ 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.

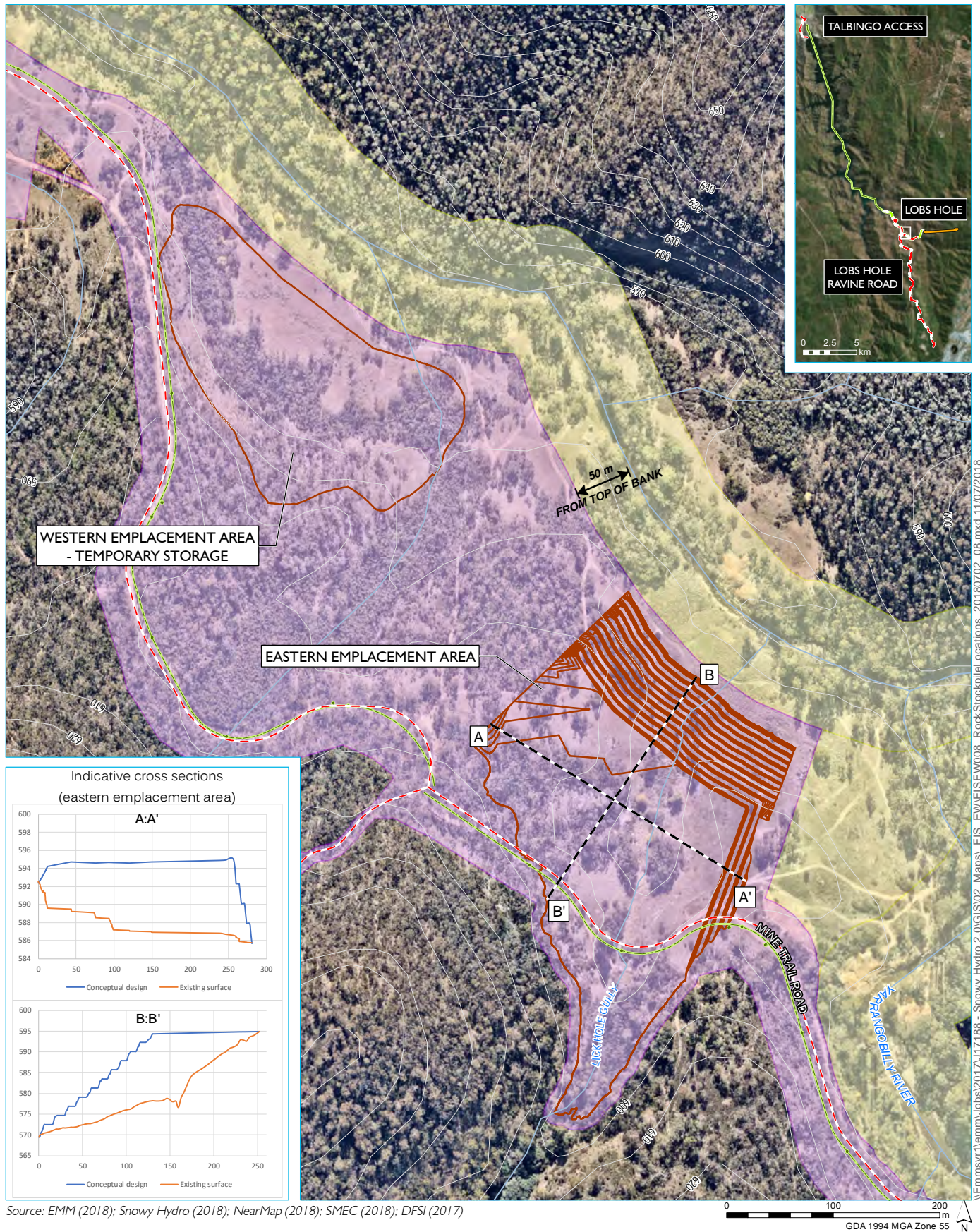
The eastern emplacement area has a capacity of up to 600,000 m³ of material. It will be approximately 25 m maximum depth and will be benched down to the northern edge of the emplacement which is setback 50 m from the Yarrangobilly River.

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.



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
Biodiversity Development Assessment Report
Exploratory Works
Figure 2.5



2.4.2 Subaqueous placement

An initial 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

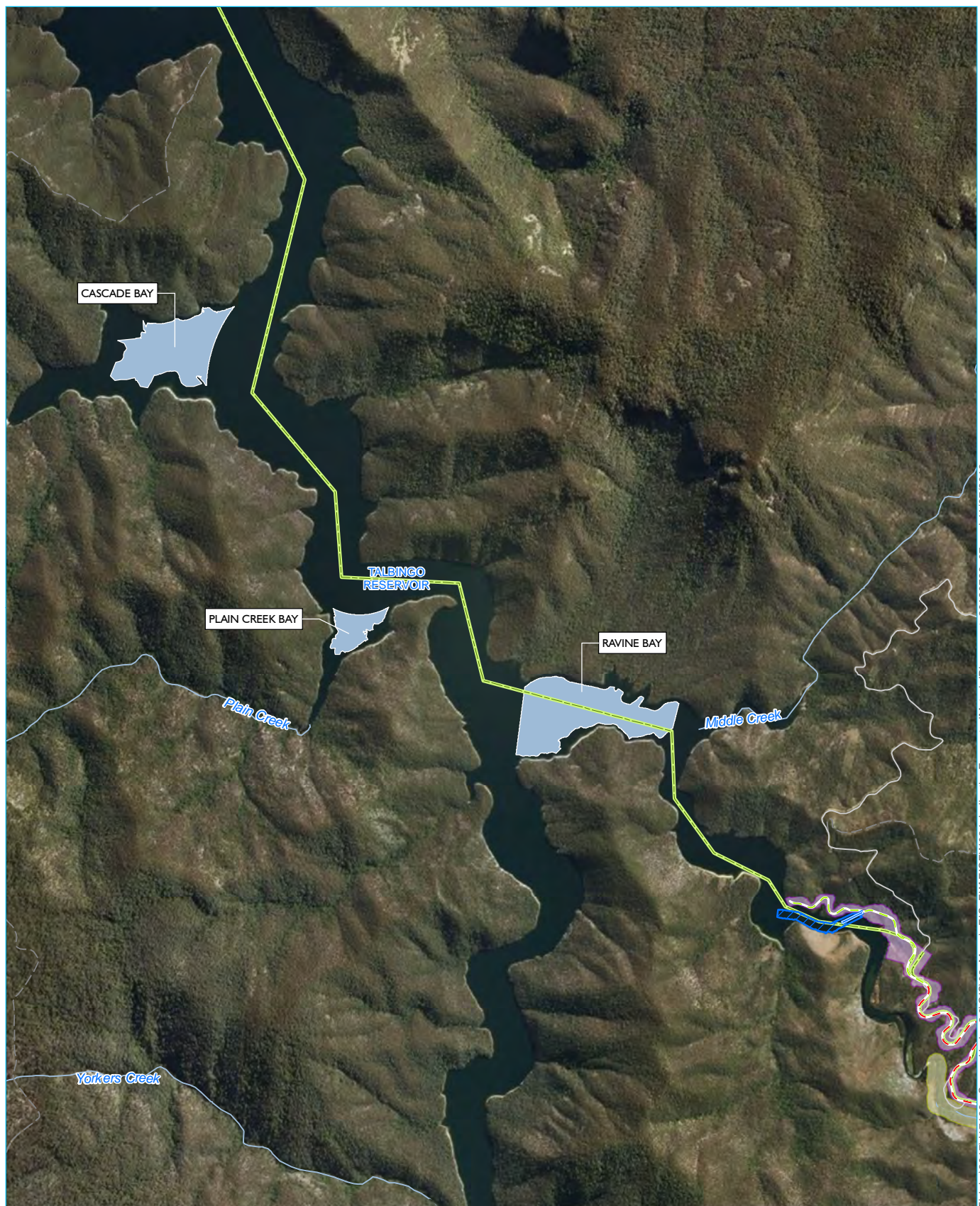
An accommodation camp is proposed to provide accommodation and supporting services for workers in close proximity to the exploratory tunnel. The accommodation camp layout is shown on Figure 2.7 and includes ensuite rooms surrounding central facilities including a kitchen, tavern, gym, admin office, laundry, 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)

KEY

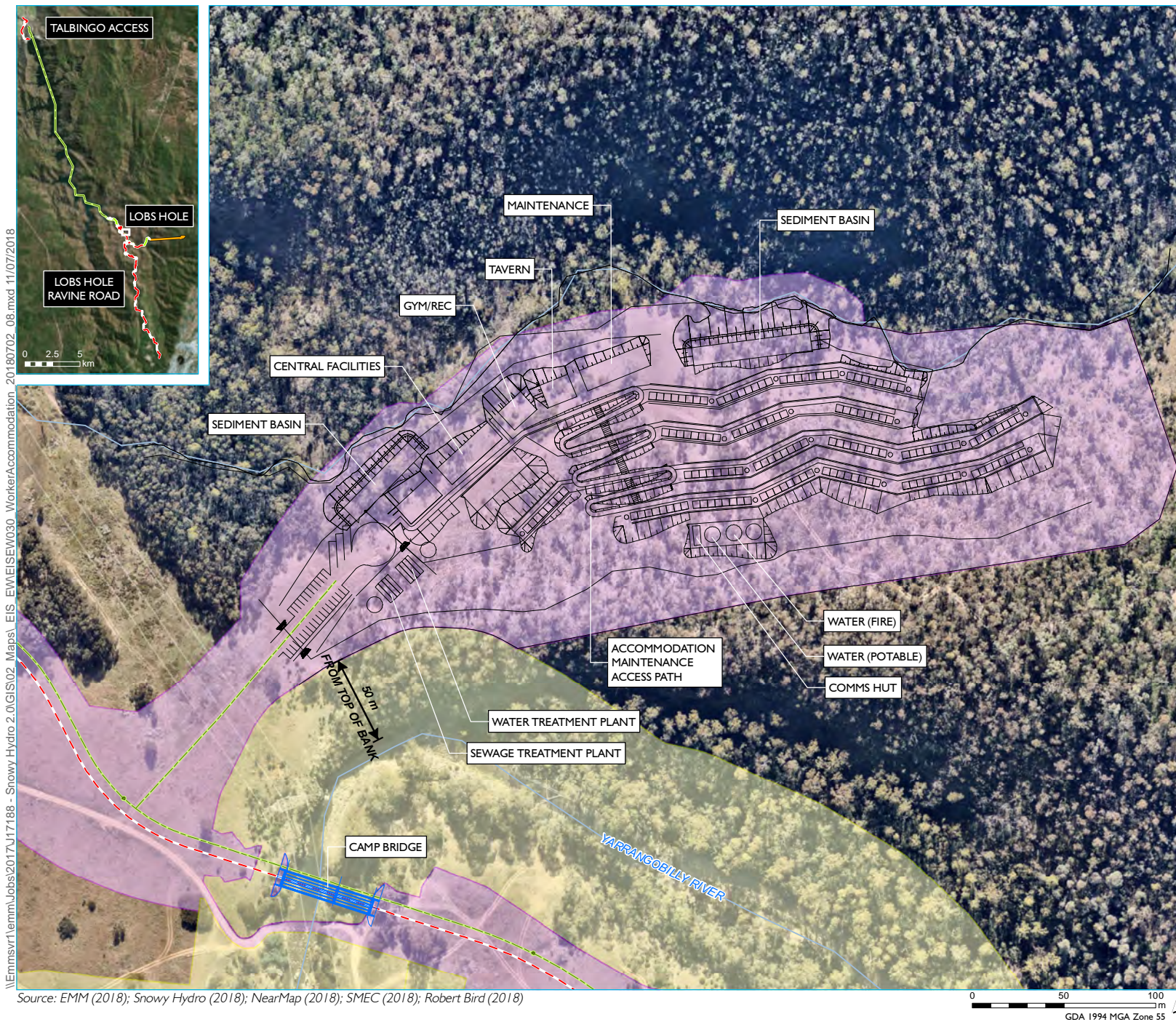
- - Access road upgrade
- - Access road extension
- - Communications cable
- - Subaqueous rock emplacement
- - Major watercourse
- - Local road
- - Track
- Middle Bay barge access
- ▨ Disturbance area - barge infrastructure
- Disturbance footprint
- Avoidance footprint

Subaqueous excavated rock placement

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 2.6



T:\Jobs\2017\17188 - Snowy Hydro 2.0\GIS\02_Maps\EIS_EW\EISEW034_IndicativeExcavatedMaterialPlacement_20180702_07.mxd 11/07/2018



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

Conceptual layout –
accommodation camp

Snowy 2.0
Biodiversity Development Assessment Report
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.

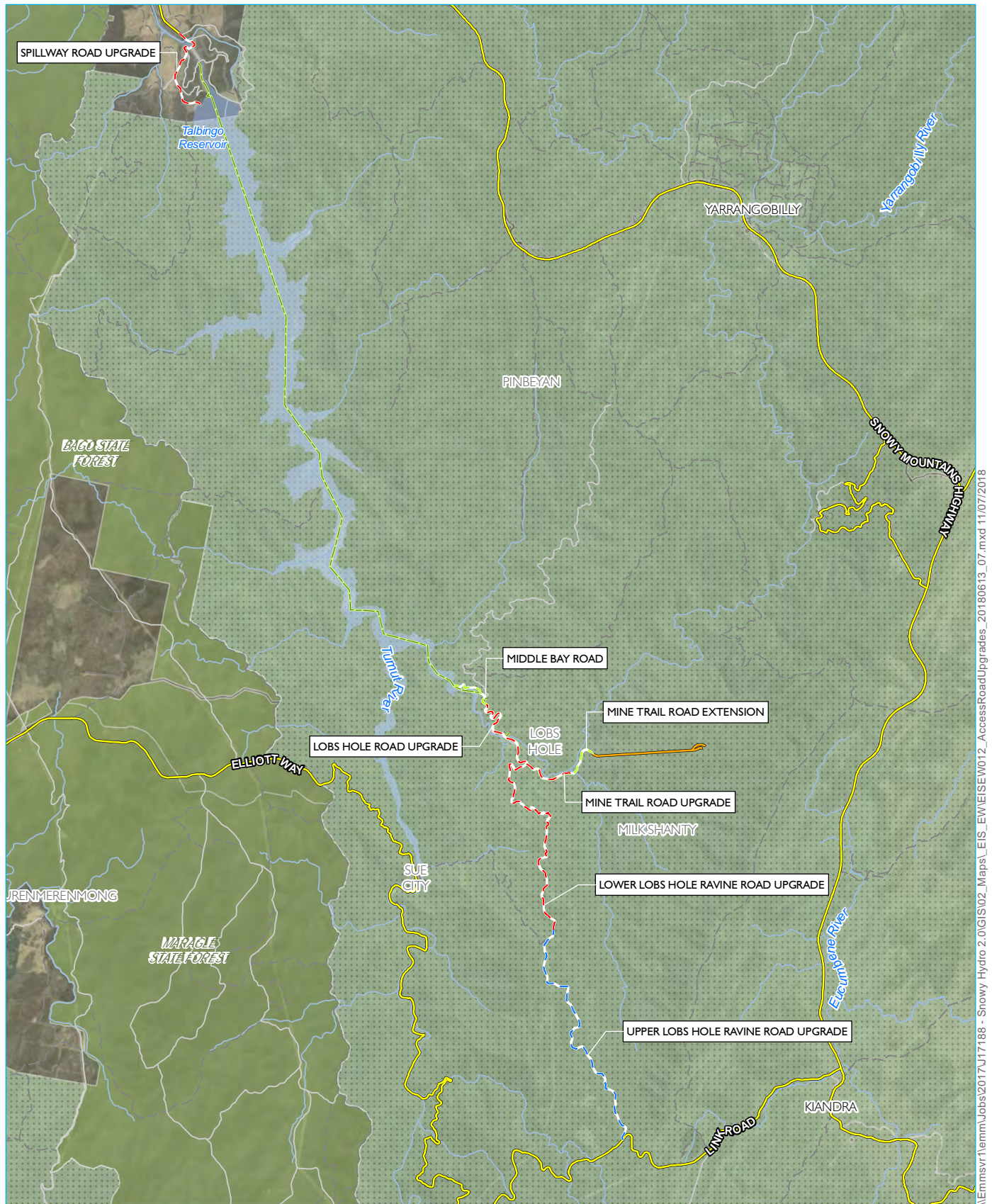
While no cut and fill earthworks or vegetation clearing is proposed along Upper Lobs Hole Ravine Road, a laydown area is proposed within and adjacent to the existing transmission line easement. This area will be used to store materials required for the road works to the lower section of Lobs Hole Ravine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

2.6.2 Watercourse crossings

Bridge construction will be required at two locations as described in Table 2.2. The locations of these 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.



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

KEY

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

Access road upgrades and establishment

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 2.8



\\Emmsvr1\emm\Jobs\2017\17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS_EWEISEW005_ExcavatedRockHaulRoute_20180702_10.mxd 11/07/2018



- 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
 - Blue Middle Bay barge access
 - Disturbance footprint
 - Avoidance footprint

Excavated material haul route

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 2.9

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

0 250 500
m
GDA 1994 MGA Zone 55



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:

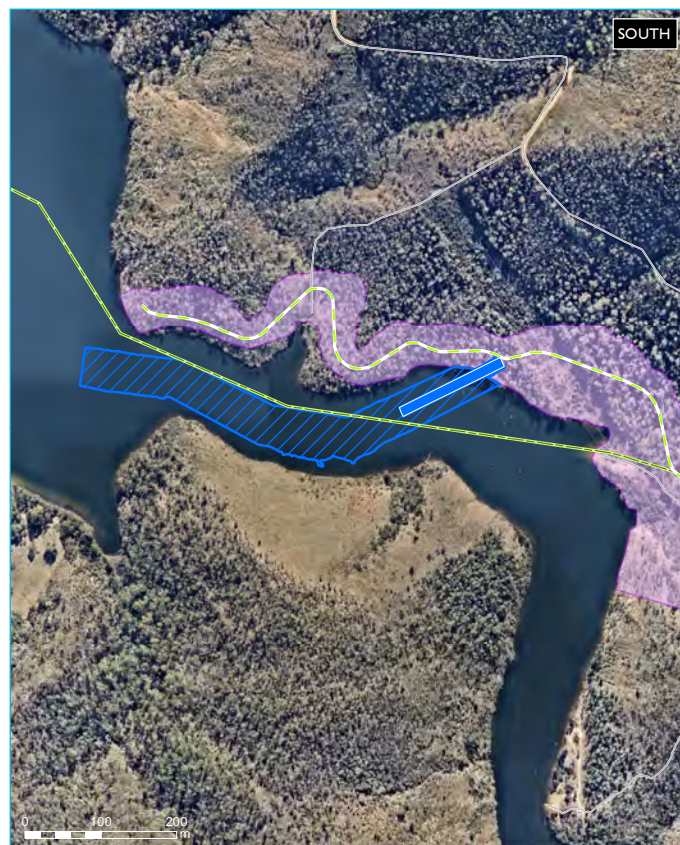
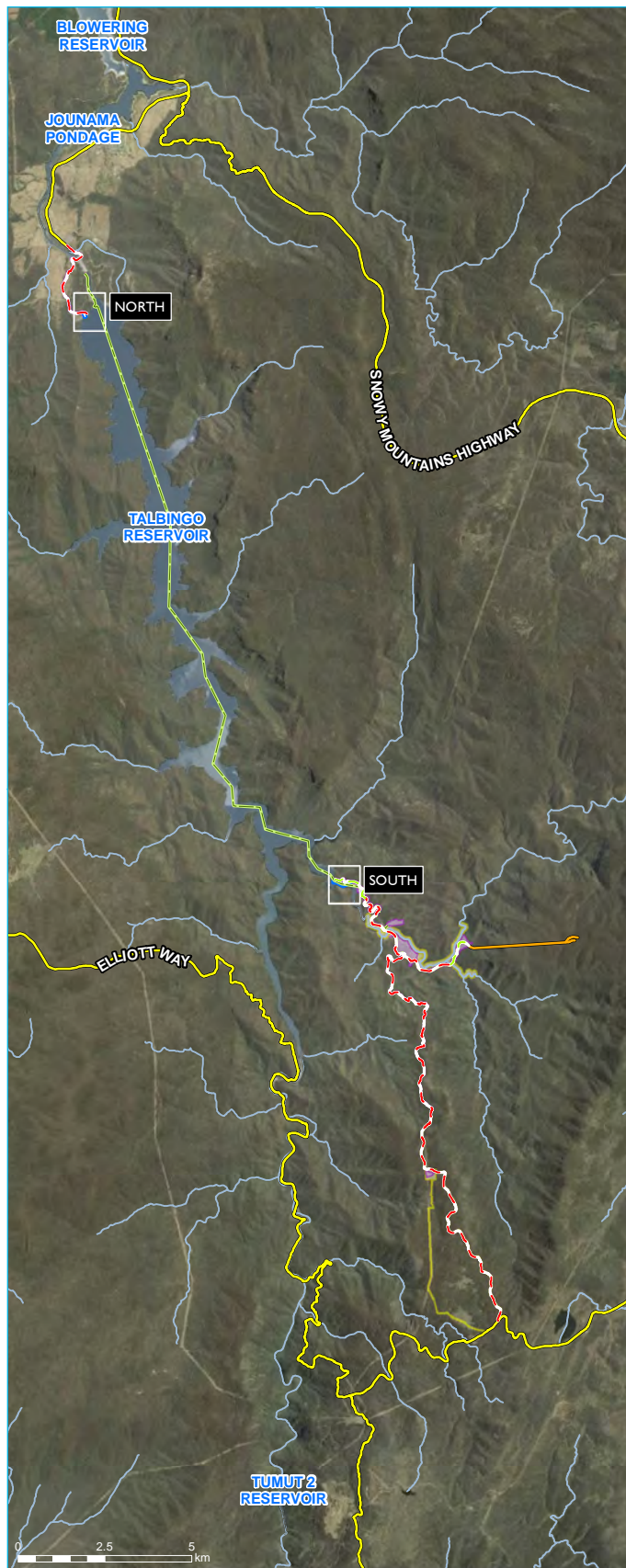
- geophysical and geotechnical investigation of the barge access area to inform detailed design;
- site establishment and excavation of barge access area;
- installation of precast concrete panels at the ramp location;
- installation of bollards for mooring lines;
- removal of trees and debris to establish 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 treatment facilities. A summary of services required is provided at Table 2.3.



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

GDA 1994 MGA Zone 55

KEY

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

Barge access locations

Snowy 2.0
Biodiversity Development Assessment Report
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)	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>

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 proposed. 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 for Exploratory Works. Excavation of test pits is proposed 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 widenings 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	<p>Geophysical surveys will generally involve:</p> <ul style="list-style-type: none"> • 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. <p>Geotechnical surveys will generally involve:</p> <ul style="list-style-type: none"> • 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. <p>Geophysical and geotechnical investigation within Talbingo Reservoir will be carried out using barges and subject to environmental controls.</p>
Site establishment for portal construction pad, accommodation camp, rock placement areas and laydown areas	<p>Site establishment will generally involve:</p> <ul style="list-style-type: none"> • 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	<p>Upgrades of existing tracks (no widening) will generally involve:</p> <ul style="list-style-type: none"> • 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. <p>Extension or widening of existing tracks will generally involve:</p> <ul style="list-style-type: none"> • 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	<p>Establishment of permanent bridges will generally involve:</p> <ul style="list-style-type: none"> • 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.

Table 2.4 **Construction activities**

Activity	Typical method
Barge access works	Establishment of barge access infrastructure will generally involve: <ul style="list-style-type: none">• 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.
Exploratory tunnel construction	The drill and blast excavation process will be repeated cyclically throughout the tunnelling works, involving: <ul style="list-style-type: none">• 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 Figure 2.11.



Figure 2.11 Indicative timing of Exploratory Works elements

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 2.5.

Table 2.5 **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.

2.12 Key aspects relevant to biodiversity

Impacts to biodiversity are likely to arise in two ways; via direct impacts from clearing of native vegetation, which is also habitat for fauna, during construction activities, and via indirect impacts to adjacent (retained) areas during both construction and operational activities. Potential direct impacts include:

- clearing of habitat for threatened species from all project elements; and
- disturbance of river/creek beds and banks during bridge construction.

The Exploratory Works also have potential to result in indirect impacts. These include:

- increased noise, vibration and dust levels from activities in Lobs Hole, particularly activities associated with the portal, excavated rock management and accommodation camp;
- lighting for night works around the barge access, portal, excavated rock management and accommodation camp;
- fauna vehicle strike along access roads;
- sediment runoff and/or contaminant runoff into adjacent watercourses from activities associated with the portal construction pad, excavated rock, accommodation camp and access roads;
- increase in weeds and feral animals across the project area; and
- fragmentation of habitats.

3 Legislative context

This chapter provides a brief outline of the key biodiversity legislation and government policy considered in this assessment.

3.1 Commonwealth

3.1.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities, heritage places and water resources which are defined as MNES (Matters of National Environmental Significance) under the EPBC Act. These are:

- world heritage properties;
- places listed on the National Heritage Register;
- Ramsar wetlands of international significance;
- threatened flora and fauna species and ecological communities;
- migratory species;
- Commonwealth marine areas;
- the Great Barrier Reef Marine Park;
- nuclear actions (including uranium mining); and
- water resources, in relation to coal seam gas or large coal mining development.

Under the EPBC Act, an action that may have a significant impact on a MNES is deemed to be a 'controlled action' and can only proceed with the approval of the Commonwealth Minister for the Environment. An action that may potentially have a significant impact on a MNES is to be referred to DoEE for determination as to whether or not it is a controlled action. If deemed a controlled action the project is assessed under the EPBC Act for approval.

The Exploratory Works project has been referred to the Commonwealth Minister for the Environment (EPBC 2018/8217). Impacts to MNES, including threatened species and communities listed under the EPBC Act, have been assessed separately (EMM 2018e).

3.2 State

3.2.1 Environmental Planning and Assessment Act 1979

The EP&A Act was enacted to encourage the consideration and management of impacts of proposed development or land-use changes on the environment and the community. The EP&A Act is administered by the NSW Department of Planning and Environment (DPE).

The EP&A Act provides the overarching structure for planning in NSW; however, is supported by other statutory environmental planning instruments (EPIs) including State environmental planning policies (SEPPs). EPIs relevant to the natural environment are outlined further below.

i [State Environmental Planning Policy \(State and Regional Development\) 2011](#)

Snowy 2.0 has been declared to be Critical State Significant Infrastructure (CSSI) by the NSW Minister for Planning under the provisions of the EP&A Act and is defined in clause 9 of Schedule 5 of the SRD SEPP.

ii [State Environmental Planning Policy No 44 – Koala Habitat Protection](#)

State Environmental Planning Policy No 44 – Koala Habitat Protection (SEPP 44) aims to encourage the conservation and management of natural vegetation areas that provide habitat for koalas to ensure permanent free-living populations will be maintained over their present range and to reverse the current trend of koala-population decline. It applies to areas of native vegetation greater than 1 ha and in councils listed in Schedule 1 of SEPP 44. The Exploratory Works is located in the Snowy Valleys Council LGA, which is listed in Schedule 1, therefore Koala habitat has been considered within this assessment.

No Koalas or scats were found in the Exploratory Works survey area during targeted surveys (see Section 6.3.4). The site is therefore not considered core Koala habitat under the SEPP 44.

3.2.2 [Biodiversity Conservation Act 2016](#)

The BC Act commenced operation on 25 August 2017. It repeals and replaces the NSW *Threatened Species and Conservation Act 1995* as the legislation responsible for the conservation of biodiversity in NSW through the protection of threatened flora and fauna species, populations and ecological communities. The BC Act, together with the NSW *Biodiversity Conservation Regulation 2017* (BC Regulation), established the Biodiversity Offsets Scheme (BOS).

The BOS includes establishment of the biodiversity assessment method (the BAM, OEH 2017) for use by accredited persons in biodiversity assessment under the scheme. The purpose of the BAM is to assess the impact of actions on threatened species and threatened ecological communities, and their habitats and determine offset requirements. For CSSI, use of the BAM is mandatory.

The BAM sets out the requirements for a repeatable and transparent assessment of terrestrial biodiversity values on land in order to:

- identify the biodiversity values on land subject to proposed development area;
- determine the impacts of a proposed development; and
- quantify and describe the biodiversity credits required to offset the residual impacts of proposed development on biodiversity values.

The biodiversity assessment for the Exploratory Works has been undertaken in accordance with the requirements of the BAM, as set out in this BDAR.

3.2.3 Fisheries Management Act 1994

The FM Act contains provisions for the conservation of fish stocks, key fish habitat, biodiversity, threatened species, populations and ecological communities. It regulates the conservation of fish, vegetation and some aquatic macroinvertebrates and the development and sharing of the fishery resources of NSW for present and future generations. The FM Act lists threatened species, populations and ecological communities, key threatening processes (KTPs) and declared critical habitat. Assessment guidelines to determine whether a significant impact is expected are detailed in section 220ZZ and 220ZZA of the FM Act.

Another objective of the FM Act is to conserve key fish habitats (KFH). These are defined as aquatic habitats that are important to the sustainability of recreational and commercial fishing industries, the maintenance of fish populations generally and the survival and recovery of threatened aquatic species. KFH is defined in sections 3.2.1 and 3.2.2 of the *Policy and Guidelines for Fish Conservation and Management* (DPI 2013) (Section 2.3.1).

The impact of Exploratory Works on threatened aquatic species, populations, communities, habitats and KFH have been assessed separately and are presented in the aquatic ecology assessment (Cardno 2018).

3.2.4 Biosecurity Act 2015

The NSW Biosecurity Act 2015 has superseded the *Noxious Weeds Act 1993*, which has now been repealed.

The primary objective of the Biosecurity Act is to provide a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter, dealing with biosecurity matter, carriers and potential carriers, and other activities that involve biosecurity matter, carriers or potential carriers.

The Biosecurity Act stipulates management arrangements for weed biosecurity risks in NSW, with the aim to prevent, eliminate and minimise risks. Management arrangements include:

- any land managers and users of land have a responsibility for managing weed biosecurity risks that they know about or could reasonably be expected to know about;
- applies to all land within NSW and all waters within the limits of the State; and
- local strategic weed management plans will provide guidance on the outcomes expected to discharge duty for the weeds in that plan.

The *Riverina Regional Strategic Weed Management Plan 2017 - 2022* (RLLS 2017) outlines how government, industry, and the community will share responsibility and work together to identify, minimise, respond to and manage weeds within the Riverina Region, which includes the Exploratory Works project area. The plan also supports regional implementation of the Biosecurity Act.

Blackberry (*Rubus fruticosus* species aggregate), a weed of national significance and State Priority was identified within the Exploratory Works survey area. The Biosecurity Act requires mandatory measures are implemented as per Part 2, Division 8, clause 33 of the *NSW Biosecurity Regulation 2018*; a person must not import into the State or sell.

Sweet Briar (*Rosa rubiginosa*), identified within the Exploratory Works survey area, is identified in Appendix 2 of RLLS (2017) as another weed of concern to the Riverina Region. Weeds identified in Appendix 2 may be subject to the General Biosecurity Duty, as outlined in the Biosecurity Act, and may be a focus for local management plans and coordinated campaigns by the community and other stakeholders in the region.

3.2.5 National Parks and Wildlife Act 1979

Under the NPW Act, the Director General of NPWS is responsible for the care, control and management of all national parks and various other categories of protected area. The primary responsibilities of NPWS under this legislation are the protection and maintenance of natural and cultural values, and the fostering of public appreciation, understanding and enjoyment of those values.

The KNP *Plan of Management* (PoM, DEC 2006a) details management objectives for such features within the park such as native plants and animals, soils, karst, rivers, lakes etc. Management objectivities follow those specified within the NPW Act. Relevant management objectives include:

- native plant species and communities are maintained and/or rehabilitated and include a representative range of successional stages and age classes;
- viable populations of all native animal species that currently occur in the park are maintained or restored;
- the diversity of native species found in the park is maximised at a regional scale; and
- research informs the management of the native animals of the park.

The requirements of the NPW Act and KNP PoM have been considered in this report.

4 Landscape features

The identification of landscape features in the Exploratory Works project area was determined using Section 4 of the BAM (OEH 2017), as summarised within this chapter.

4.1 Project area, survey area, disturbance and avoidance footprint definitions

The Exploratory Works would be undertaken within the project area shown in Figure 1.1. Within the project area are the disturbance and avoidance footprints.

The disturbance footprint shows all areas where land could be directly disturbed by Exploratory Works, and includes all areas subject to clearing and ground disturbance. The avoidance footprint shows areas where disturbance to land has been avoided. The development of the disturbance and avoidance footprints was the result of an iterative design process where the biodiversity values within the proposed action area were taken into consideration. This approach allowed for the identification of constraints early in the process, providing flexibility during the design phase of the project to avoid and minimise impact to identified constraints.

Both desktop assessments and field surveys have been undertaken to assess the biodiversity values at a State and Commonwealth level that occur across the survey area. The survey area includes the disturbance and avoidance footprints as well as some additional land not utilised, and is shown in Figure 1.2.

4.2 Landscape features

4.2.1 Bioregions and landscapes

The Exploratory Works project area occurs across three IBRA regions and subregions (Figure 4.1):

- the barge access infrastructure located at Talbingo, at the northern end of Talbingo Reservoir, is located within the NSW South Western Slopes IBRA region and Inland Slopes IBRA subregion;
- the southern end of Lobs Hole Ravine Road is located in the Australian Alps IBRA region and Snowy Mountains IBRA subregion; and
- the majority of works, including access roads and activities in Lobs Hole, are located within the South Eastern Highlands IBRA region and Bondo IBRA subregion.

As the majority of the Exploratory Works project area is located in the South Eastern Highlands IBRA region and Bondo IBRA subregion these were the region and subregion used in this assessment.

The Exploratory Works project area occurs across four BioNet NSW Landscapes (formerly Mitchell Landscapes, Figure 4.1):

- Cabramurra - Kiandra Basalt Caps and Sands;
- Kings Cross Montane;
- Pinbeyan - Ravine Ranges; and
- Tooma Granite Ranges.

As the majority of the Exploratory Works project area is located in the Pinbeyan - Ravine Ranges BioNet NSW Landscape this was the landscape used in this assessment.

4.2.2 Watercourses and wetlands

The Exploratory Works project area is located within the Murrumbidgee catchment in the Australian Alps, south-eastern NSW. The Murrumbidgee catchment covers 84,000 square kilometres of southern NSW. It is bordered by the Great Dividing Range to the east, the Lachlan Catchment to the north and the Murray Catchment to the south (NOW 2011).

The Exploratory Works project area intersects two major watercourses; Wallaces Creek and the Yarrangobilly River. Within the project area, Wallaces Creek forms a sixth order stream while the Yarrangobilly River forms a seventh order stream. Yarrangobilly River and Wallaces Creek are perennial streams. Stream substratum consists of unconsolidated boulder, cobble, pebble and gravel substratum with little evidence of siltation. The riparian zone of both watercourses are reasonably well vegetated, except for the lower section of the Yarrangobilly River which has been subject to clearing in Lobs Hole. In this area some banks are unvegetated. Both watercourses are subject to significant weed infestation, in particular with Blackberry (*Rubus* spp.).

The Exploratory Works project area also intersects two additional named watercourses; Lick Hole Gully and Cave Gully. Both watercourses are third order streams, and have intermittent flows. Substrate consists of gravels and bedrock, with reasonably well vegetated riparian zones in upper reaches but largely cleared in the lower reaches in Lobs Hole. The Exploratory Works project area also intersects a number of unnamed first, second and third order streams. The larger watercourses generally have intermittent flow regimes while the smaller watercourses are generally ephemeral, flowing for short periods after rain. They provide very little permanent aquatic habitat.

The Exploratory Works project area spans Talbingo Reservoir. The reservoir was constructed between 1968 and 1971 as a part of the Snowy Scheme. It has a surface area of 1,940 ha and has a capacity of 921,000 ML when full. The reservoir supplies water to the Tumut 3 power station.

The edges of the reservoir are located largely within the KNP, except for the northern section adjacent to the dam wall. The edges are largely vegetated, including intact native vegetation. Numerous stags are located within the reservoir, resulting from the inundation of forests when the dam was completed. Talbingo Reservoir is mapped in the NSW Wetlands spatial dataset (OEH 2010).

No Directory of Important Wetlands in Australia (DIWA) wetlands or Ramsar wetlands are located within or immediately adjacent to the Exploratory Works project area.

Wetlands, watercourses and associated buffers are shown in Figure 4.2.

4.2.3 Connectivity

The Exploratory Works are predominantly located within KNP which is largely vegetated across its 673,543 ha extent, with intact remnant vegetation extending into a further 1.6 M ha across the Australian Alps. The extent of vegetation across the KNP provides a high degree of connectivity.

The various watercourses provide suitable connectivity for aquatic and semi-aquatic species (such as fish and amphibians) and species which use linear features (such as birds and bats) to navigate. The wooded area supports connective feature for terrestrials and arboreal mammals, birds, reptiles etc. The areas within Lobs Hole containing open grassland, paddock trees are considered less suitable for the movement of mammals that require vegetation cover to avoid predation.

4.2.4 Areas of geological significance and soil hazard features

Several areas of geological significance are located within the Exploratory Work project area. A summary is provided below, with further details in EMM (2018a)

i Periglacial landforms

The Pleistocene glacial landforms in KNP are the only examples of this landform on the mainland of Australia and are of national and international significance (OEH, 2011). Periglacial features of the park include terracing, solifluction lobes, sliding and shattered boulders and block streams (also known as scree slopes or boulder streams). The periglacial evidence can be found in most areas above 1,000 m and possibly as far down as 600 m.

Block streams (or scree slopes) are listed under 'Rocks and Landforms' in Schedule 1 (Significant Natural and Cultural Features) of the KNP PoM (DEC 2006a). They are defined as 'river' or field of rocks that have moved downhill on mass and which were held together by ice. They occur in various areas of KNP, including the Exploratory Works project area, where they occur along a section of Lobs Hole Ravine Road (Figure 4.1). The block stream at this location is dated to about 20,000 years ago. Rapid condition assessments are assigned to the Ravine block stream every three years, in accordance with the *KNP Geodiversity Action Plan* (OEH 2011).



Photograph 4.1 Boulder streams along Lobs Hole Ravine Road

ii Ravine karst areas

Outcropping strata of the Devonian age Lick Hole Formation (Geoscience Australia 2017) is located along the lower section of Lobs Hole Ravine Road, approximately 12 km from the intersection with Link Road. The geological formation was formerly known as the Lick Hole Limestone (Geological Survey of New South Wales 1966). It is exposed in a hill slope road cutting which ranges up to about 2 m in height.

The strata consists of grey friable shale with a high density of calcareous, rounded nodules. The nodules are light brown in colour, hard and brittle, and slightly elongated with dimensions typically of about 2 to 3 cm in diameter and 4 to 10 cm in length. Some appear to display the remains of branching structure, and are assumed to be corals. Less abundant shell fish fossils were also observed.

The Australian Stratigraphic Units Database (Geoscience Australia, 2017) describes the Lick Hole Formation as a “fossiliferous well-bedded marine limestone with a pronounced rubbly appearance to spheroidal concretions to 10 cm, and calcareous shale; fossils include corals, trilobites, brachiopods and molluscs”.



Photograph 4.2 **In situ calcareous fossils of the Lick Hole Formation**

4.2.5 Areas of outstanding biodiversity value

There are no areas of outstanding biodiversity value within a 1,500 m buffer of the Exploratory Works project area.

4.3 Assessment of site context

The site context has been assessed in accordance with Section 4.3 of BAM (OEH 2017) for site-based developments.

Mapping of vegetation within a 1,500 m buffer of the Exploratory Works project area was undertaken using aerial mapping interpretation and spatial data from the State Vegetation Type Map: Riverina Region Version v1.2 - VIS_ID 4469 (OEH 2016a). This mapping was modified using the vegetation extent as mapped by EMM (see Section 5). Thirty-seven PCTs were mapped within the 1500 m buffer, including:

- PCT - 266 White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion;

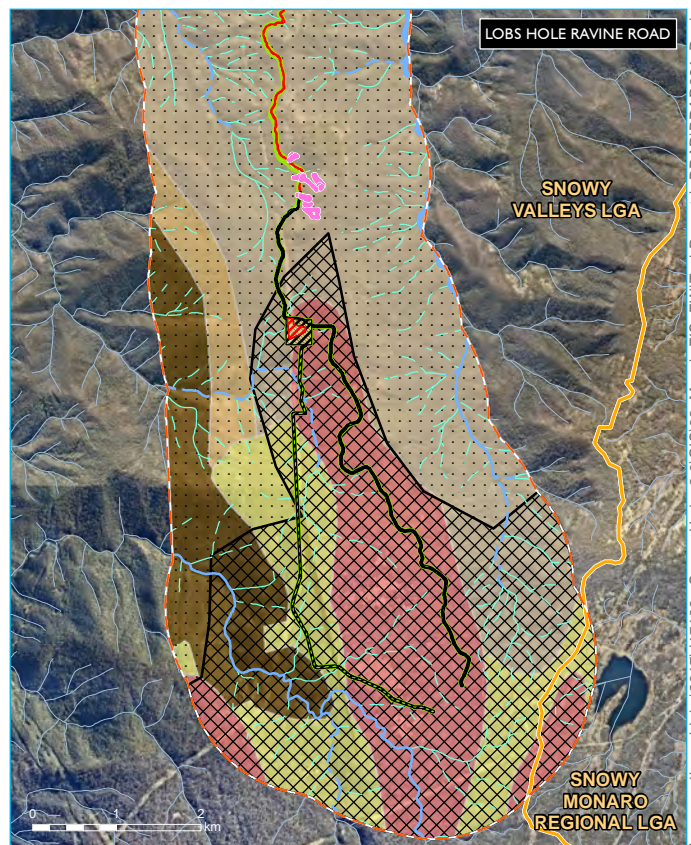
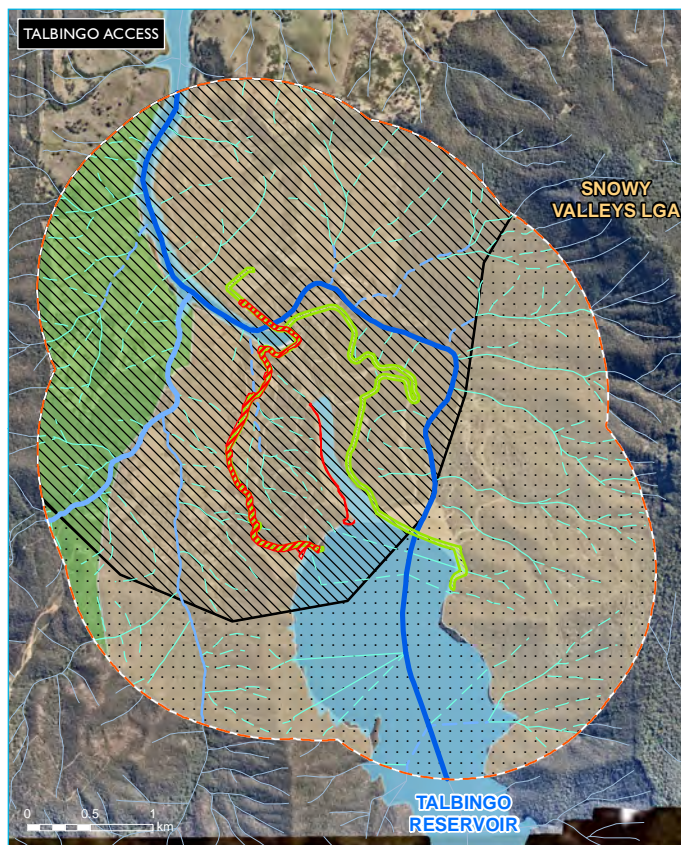
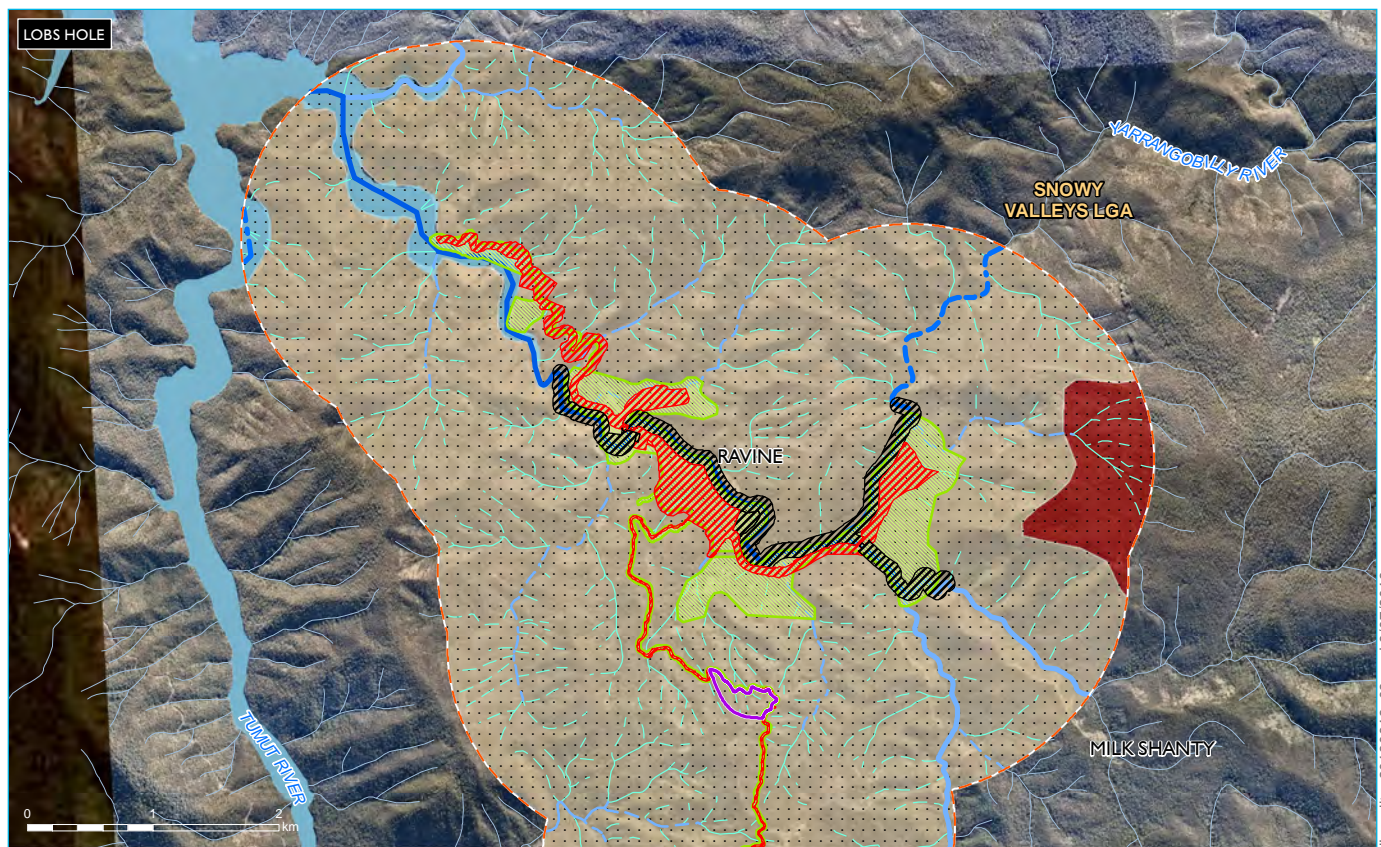
- PCT - 277 Blakelys Red Gum - Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion;
- PCT - 280 Red Stringybark - Blakelys Red Gum +/- Long-leaved Box shrub/grass hill woodland of the NSW South Western Slopes Bioregion;
- PCT - 283 Apple Box - Blakelys Red Gum moist valley and footslopes grass-forb open forest of the NSW South Western Slopes Bioregion;
- PCT - 285 Broad-leaved Sally grass - sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion;
- PCT - 287 Long-leaved Box - Red Box - Red Stringybark mixed open forest on hills and hillslopes in the NSW South Western Slopes Bioregion;
- PCT - 290 Red Stringybark - Red Box - Long-leaved Box - Inland Scribbly Gum tussock grass - shrub low open forest on hills in the southern part of the NSW South Western Slopes Bioregion;
- PCT - 295 Robertsons Peppermint - Broad-leaved Peppermint - Nortons Box - stringybark shrub-fern open forest of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion;
- PCT - 296 Brittle Gum - peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion;
- PCT - 297 Broad-leaved Peppermint - Nortons Box - Red Stringybark tall open forest on red clay on hills in the southern part of the NSW South Western Slopes Bioregion;
- PCT - 298 Apple Box - Nortons Box - Blakelys Red Gum valley flat moist grassy tall open forest in the southern NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion;
- PCT - 299 Riparian Ribbon Gum - Robertsons Peppermint - Apple Box riverine very tall open forest of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion;
- PCT - 300 Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment;
- PCT - 301 Drooping Sheoke - *Ricinocarpus bowmannii* - grasstree tall open shrubland of the Coolac - Tumut Serpentine Belt;
- PCT - 304 Candlebark - Apple Box - Narrow-leaved Peppermint tall open forest on granite in the Tumbarumba region of the South Eastern Highlands Bioregion and upper NSW South Western Slopes Bioregion;
- PCT - 305 Apple Box - Broad-leaved Peppermint - Red Stringybark shrubby hill open forest in the upper NSW South Western Slopes Bioregion and adjacent South Eastern Highlands Bioregion;
- PCT - 306 Red Box - Red Stringybark - Nortons Box hill heath shrub - tussock grass open forest of the Tumut region;

- PCT - 310 Nortons Box - Red Stringybark grassy tall open forest on sheltered slopes in the Tumbarumba - Murray River region of the NSW South Western Slopes Bioregion;
- PCT - 313 Brittle Gum - Broad-leaved Peppermint open forest with tall dense shrub understorey on riparian coarse grained granitic soils in the NSW South Western Slopes Bioregion;
- PCT - 314 Apple Box - Red Stringybark basalt scree open forest in the upper Murray River region;
- PCT - 316 Nortons Box - Red Box - Red Stringybark +/- Nodding Flax Lily forb-grass open forest mainly on the Tumut region;
- PCT - 319 Tumbledown Red Gum - White Cypress Pine hill woodland in the southern part of the NSW South Western Slopes Bioregion;
- PCT - 637 Alpine and sub-alpine peatlands, damp herbfields and fens, South Eastern Highlands Bioregion and Australian Alps Bioregion;
- PCT - 638 Alpine Ash - Mountain Gum moist shrubby tall open forest of montane areas, southern South Eastern Highlands Bioregion and Australian Alps Bioregion;
- PCT - 639 Alpine Ash - Snow Gum shrubby tall open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion;
- PCT - 641 Alpine grassland/herbfield and open heathlands in Kosciuszko National Park, Australian Alps Bioregion;
- PCT - 643 Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion;
- PCT - 644 Alpine Snow Gum - Snow Gum shrubby woodland at intermediate altitudes in northern Kosciuszko NP, South Eastern Highlands Bioregion and Australian Alps Bioregion;
- PCT - 893 Kangaroo Grass - *Poa fawcettiae* open grassland on limestone in northern Kosciuszko NP, Australian Alps Bioregion;
- PCT - 939 Montane wet heath and bog of the eastern tablelands, South Eastern Highlands Bioregion;
- PCT - 953 Mountain Gum - Snow Gum - Broad-leaved Peppermint shrubby open forest of montane ranges, South Eastern Highlands Bioregion and Australian Alps Bioregion;
- PCT - 1100 Ribbon Gum - Snow Gum grassy forest on damp flats, eastern South Eastern Highlands Bioregion;
- PCT - 1190 Snow Gum - Candle Bark shrubby open forest in valleys of the southern ACT ranges, South Eastern Highlands Bioregion;
- PCT - 1191 Snow Gum - Candle Bark woodland on broad valley flats of the tablelands and slopes, South Eastern Highlands Bioregion;
- PCT - 1196 Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion;

- PCT - 1224 Sub-alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion; and
- PCT - 1271 Tea-tree tall riparian shrubland, South Eastern Highlands Bioregion, South East Corner Bioregion and Australian Alps Bioregion.

A conservative approach was undertaken to include all areas of native vegetation, including the mapped candidate native grassland (as verified) that are likely to be derived from the mapped woodland communities. This approach allowed a greater list of threatened species to be filtered in for later assessment of habitat suitability for the Exploratory Works.

Native vegetation cover within the buffer area (including the survey area) was determined as the sum of the areas of native vegetation map units listed above, divided by the entire buffer area. Approximately 8,104 ha of native vegetation was mapped within the 8,986 ha buffer area. Native vegetation cover within the buffer area is approximately 90%.



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

GDA 1994 MGA Zone 55

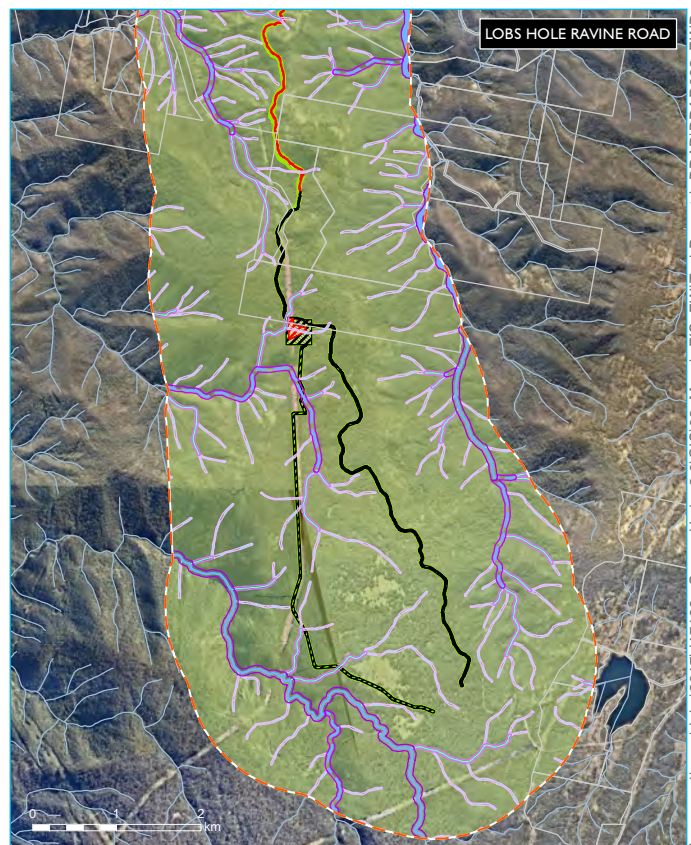
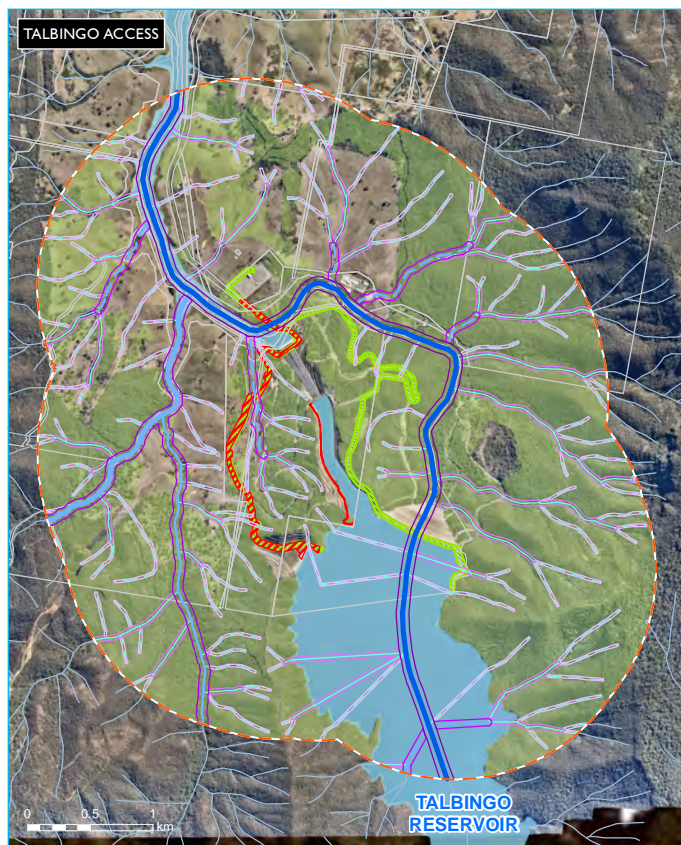
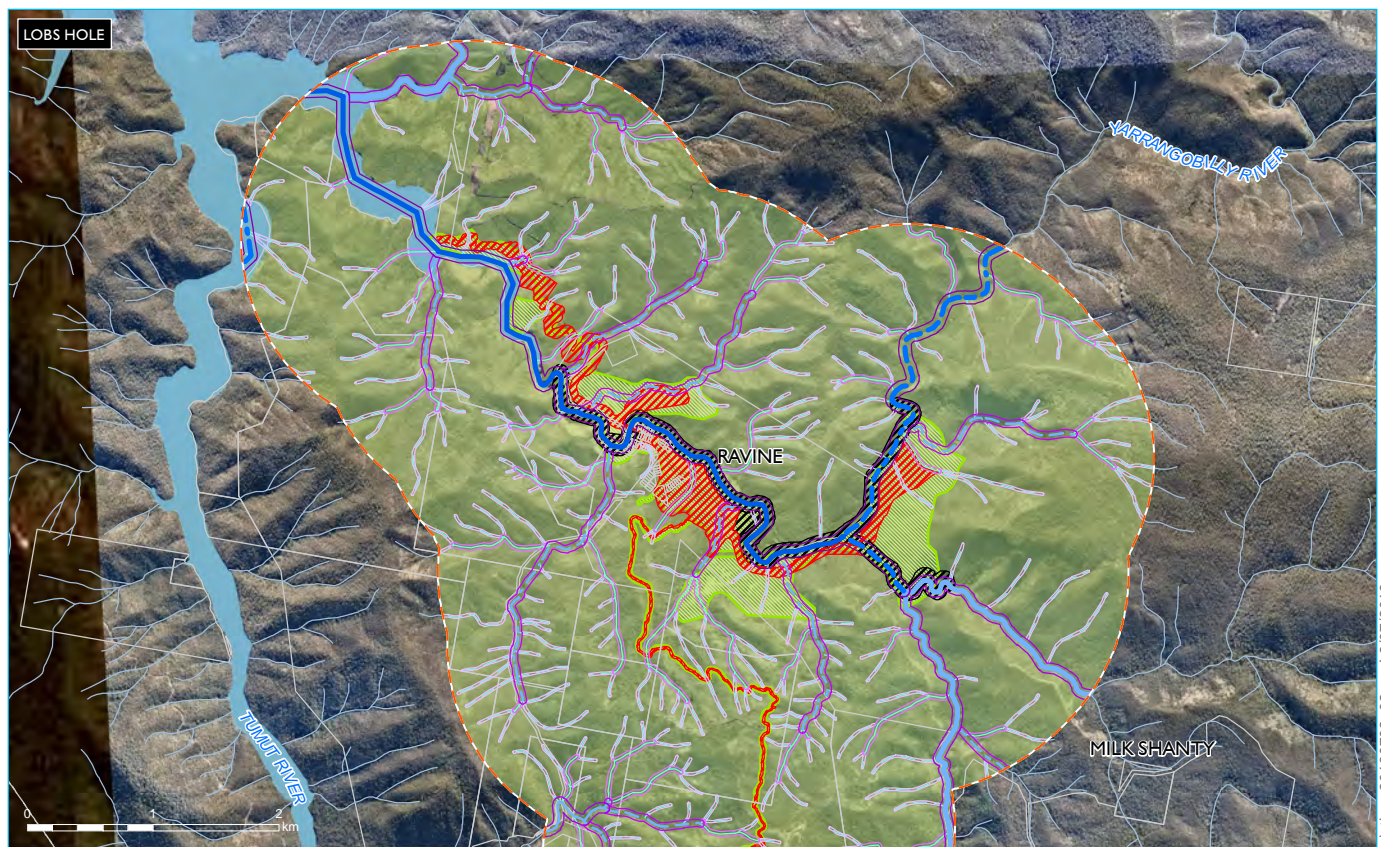
KEY

- | | | |
|--|------------------------------|--|
| 1,500m buffer | NSW Wetlands (OEI, 2009) | Lick Hole Formation outcrop |
| Local government area | Watercourse | Periglacial block stream |
| Survey area | Strahler stream order | Mitchell landscape |
| Project area | 1st order | Cabramurra - Kiandra Basalt Caps and Sands |
| Disturbance footprint | 2nd order | Cootamundra - Tumut Serpentine and Ultramafics |
| Avoidance footprint | 3rd order | Kings Cross Montane |
| IBRA 7 (Region - Sub region) | 4th order | Minjary Hills and Ranges |
| Australian Alps - Snowy Mountains | 5th order | Pinbeyan - Ravine Ranges |
| NSW South Western Slopes - Inland Slopes | 6th order | Tantangara High Plains and Peaks |
| South Eastern Highlands - Bongo | 7th order | Tooma Granite Ranges |

Regional locality

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 4.1





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

GDA 1994 MGA Zone 55

KEY

Cadastral	Strahler stream order	NSW Wetlands (OEI, 2009)
1,500 m buffer	1st order	Watercourse
Native vegetation extent	2nd order	Riparian buffer
Survey area	3rd order	10 m
Project area	4th order	20 m
Disturbance footprint	5th order	30 m
Avoidance footprint	6th order	40 m
	7th order	50 m

Description of Exploratory Works

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 4.2

5 Native vegetation

The extent of native vegetation within the Exploratory Works was determined using Section 5 of the BAM (OEH 2017), as summarised within this chapter.

5.1 Background review

A review of regional vegetation mapping (OEH 2016a) was undertaken to inform the site survey. OEH (2016a) identifies twenty-four PCTs within the Exploratory Works survey area:

- PCT - 277 Blakelys Red Gum - Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion;
- PCT - 280 Red Stringybark - Blakelys Red Gum +/- Long-leaved Box shrub/grass hill woodland of the NSW South Western Slopes Bioregion;
- PCT - 285 Broad-leaved Sally grass - sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion;
- PCT - 290 Red Stringybark - Red Box - Long-leaved Box - Inland Scribbly Gum tussock grass - shrub low open forest on hills in the southern part of the NSW South Western Slopes Bioregion;
- PCT - 295 Robertsons Peppermint - Broad-leaved Peppermint - Nortons Box - stringybark shrub-fern open forest of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion;
- PCT - 296 Brittle Gum - peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion;
- PCT - 298 Apple Box - Nortons Box - Blakelys Red Gum valley flat moist grassy tall open forest in the southern NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion;
- PCT - 299 Riparian Ribbon Gum - Robertsons Peppermint - Apple Box riverine very tall open forest of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion;
- PCT - 300 Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment;
- PCT - 301 Drooping Sheoke - *Ricinocarpus bowmannii* - grasstree tall open shrubland of the Coolac - Tumut Serpentine Belt;
- PCT - 304 Candlebark - Apple Box - Narrow-leaved Peppermint tall open forest on granite in the Tumbarumba region of the South Eastern Highlands Bioregion and upper NSW South Western Slopes Bioregion;
- PCT - 305 Apple Box - Broad-leaved Peppermint - Red Stringybark shrubby hill open forest in the upper NSW South Western Slopes Bioregion and adjacent South Eastern Highlands Bioregion;

- PCT - 306 Red Box - Red Stringybark - Nortons Box hill heath shrub - tussock grass open forest of the Tumut region;
- PCT - 638 Alpine Ash - Mountain Gum moist shrubby tall open forest of montane areas, southern South Eastern Highlands Bioregion and Australian Alps Bioregion;
- PCT - 639 Alpine Ash - Snow Gum shrubby tall open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion;
- PCT - 641 Alpine grassland/herbfield and open heathlands in Kosciuszko National Park, Australian Alps Bioregion;
- PCT - 643 Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion;
- PCT - 644 Alpine Snow Gum - Snow Gum shrubby woodland at intermediate altitudes in northern Kosciuszko NP, South Eastern Highlands Bioregion and Australian Alps Bioregion;
- PCT - 953 Mountain Gum - Snow Gum - Broad-leaved Peppermint shrubby open forest of montane ranges, South Eastern Highlands Bioregion and Australian Alps Bioregion;
- PCT - 1100 Ribbon Gum - Snow Gum grassy forest on damp flats, eastern South Eastern Highlands Bioregion;
- PCT - 1190 Snow Gum - Candle Bark shrubby open forest in valleys of the southern ACT ranges, South Eastern Highlands Bioregion;
- PCT - 1191 Snow Gum - Candle Bark woodland on broad valley flats of the tablelands and slopes, South Eastern Highlands Bioregion;
- PCT - 1196 Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion; and
- PCT - 1224 Sub-alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion.

The presence of these PCTs was assessed and confirmed in line with the methods outlined below.

5.2 Methods

The following sections outline the methods employed to map vegetation, and to assess the vegetation integrity of native vegetation within the within the survey area.

5.2.1 Detailed vegetation mapping and habitat assessment

A preliminary assessment of the survey area was undertaken between August 2017 and October 2017. Additional mapping was undertaken in February and March 2018 due to the inclusion of additional survey areas. This preliminary assessment included detailed vegetation mapping and habitat assessments.

The survey area was traversed on foot and by vehicle, with vegetation mapped and aligned with NSW PCTs. PCTs were stratified into vegetation zones based on broad condition state using the definitions in Table 5.1.

Table 5.1 Definitions used in delineation of vegetation zones

Condition class	Description
Moderate/good - High	Largely intact with all stratum present and minimal disturbance
Moderate/good - Medium	Some elements or stratum missing or immature, but minimal disturbance
Moderate/good - Other	Regeneration is occurring due to previous human impacts, such as clearing or fire, but minimal to moderate disturbance to other stratum
Moderate/good - Poor	Tree stratum present, but understorey vegetation degraded due to weeds or other major disturbance.
Low	Tree stratum and shrub stratum missing. Native vegetation restricted to groundcover

Where there was some uncertainty about correct PCT alignment, or to justify PCT alignment, a series of rapid vegetation assessments (RVAs) were undertaken, with the three dominant species in the overstorey, midstorey and groundcover recorded.

Vegetation was mapped in the field using GPS-enabled tablet computers using Collector for ArcGIS™. Field data was then aligned with a canopy height model (CHM) developed using Light Detection and Ranging (LiDAR) data in a GIS.

5.2.2 Vegetation integrity assessment

Following the stratification of vegetation zones within the survey area, native vegetation integrity was assessed using data obtained via a series of plots, as per the methodology outlined in Section 5 of the BAM (OEH 2017). Plot data was collected from the survey area between November 2017 and April 2018. At each plot location the following was undertaken:

- one 20 x 20 m plot, for assessment of composition and structure; and
- one 20 x 50 m plots for assessment of function, including a series of five 1 x 1 m plots to assess average leaf litter cover.

The assessment of composition and structure, based on a 20 x 20 m plot, recorded species name, stratum, growth form, cover and abundance rating for each species present within the plot. Cover (foliage cover) was estimated for all species rooted in or overhanging the plot, and recorded using decimals (if less than 1%, rounded to whole number (1-5%) or estimated to the nearest 5% (5- 100%). Abundance was counted (up to 20) and estimated above 20, and recorded using the following intervals: 1, 2, 3, 4, 5, 10, 20, 50, 100, 500, 1,000, 1,500, 2,000 etc.

The assessment of function recorded the number of large trees, the presence of tree stem size class, tree regeneration, number of trees with hollows and length of fallen logs, as well as leaf litter cover within the 20 x 50 m plot and five 1 x 1 m subplots. The minimum number of plots and transects per vegetation zone was determined using Table 4 of the BAM (OEH 2017). A total of 102 plots were undertaken within or in close proximity (250 m) to the survey area, with 48 plots used in determining vegetation integrity scores. Datasheets are provided in Appendix A while compiled plot data is provided in Appendix B.

5.3 Results

5.3.1 Vegetation description

The Exploratory Works survey area is located across three key areas:

- Lobs Hole Ravine Road;
- Lobs Hole; and
- Northern end of Talbingo Reservoir.

Vegetation along the upper (southern) extent of Lobs Hole Ravine Road is largely intact, with minimal disturbance evident. Vegetation comprises tall montane forests with large trees and a shrubby understorey. Weed invasion is minimal, limited to road edges. The lower section of Lobs Hole Ravine Road, generally below 1,200 m, consists of dry sclerophyll forests with a shrubby to grassy understorey. In some areas disturbance due to past land use is evident and significant, while in other areas there is minimal disturbance. Weediness varies, depending on past land use, and is heavy in some areas.

Lobs Hole has a long history of occupation, first used in the early 1800s for the movement of stock. Since this time Lobs Hole has been the site of prospecting, grazing, settlement, refuge from the winters of Kiandra, gardening and agriculture. From the 1860s to approximately 1917, Lobs Hole was the site of copper mining (Photograph 5.1). During the construction of the Snowy Scheme, Lobs Hole was well used during surveying work. A major surveying camp was set up by Major Clews at Lobs Hole (believed to be at the junction of the Yarrangobilly and Tumut rivers and now under water, but this is not confirmed) and the Wallaces Creek camp was apparently located near to the junction of Wallaces Creek and Yarrangobilly River (exact location unknown). Lobs Hole is now a public camping area (Ravine Campground) with a boat ramp which is used to access the southern reaches of Talbingo Reservoir.

These activities and past land uses have resulted in significant amounts of clearing and disturbance of vegetation in the area. Native vegetation, which includes fauna habitats have been modified by past disturbances associated with land clearing, livestock grazing and weed invasion. Native vegetation has re-established itself throughout Lobs Hole; however, Blackberry, a weed of national significance, has established itself to the point of infestation within the area, particularly in gullies and along the Yarrangobilly River.



Photograph 5.1 **The Lobbs Hole Copper Mine in ~1901, showing disturbance to native vegetation (photo taken by Ernest Clayton Andrews, source: Geological Survey of NSW)**

The area around the proposed barge access infrastructure at the northern end of Talbingo Reservoir has been subject to clearing and disturbance associated with the construction of the dam wall and Tumut 3 power station. Large areas have been cleared and are largely devoid of native vegetation. However, some areas of moderate quality vegetation occur within the survey area.

5.3.2 Plant community types

Site investigations, including determination of vegetation communities using the methods described in Section 5.2.1, identified the presence of nine PCTs within the Exploratory Works disturbance footprint (Figure 5.1). The PCT, vegetation formation and vegetation class (Keith 2004) are described within Table 5.2.

Table 5.2 Plant community types mapped within the Exploratory Works disturbance footprint

Plant community type	Vegetation formation	Vegetation class	Area (ha)
PCT 285 – Broad-leaved Sally grass – sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Upper Riverina Dry Sclerophyll Forests	5.41
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Dry Sclerophyll Forest (Shrubby sub-formation)	Southern Tableland Dry Sclerophyll Forests	47.40
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Wet Sclerophyll Forests (Grassy sub-formation)	Southern Tableland Wet Sclerophyll Forests	8.13
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)	Upper Riverina Dry Sclerophyll Forests	10.39
PCT 311 - Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Upper Riverina Dry Sclerophyll Forests	2.78
PCT 643 - Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion	Alpine Complex	Alpine Heaths	0.12
PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Dry Sclerophyll Forests (Shrubby sub-formation)	Southern Tableland Dry Sclerophyll Forests	17.34
PCT 999 - Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrubby sub-formation)	Southern Tableland Dry Sclerophyll Forests	0.64
PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	Grassy Woodlands	Subalpine Woodlands	2.98
TOTAL			95.20

Each of the nine PCTs is described in further detail within the following section.

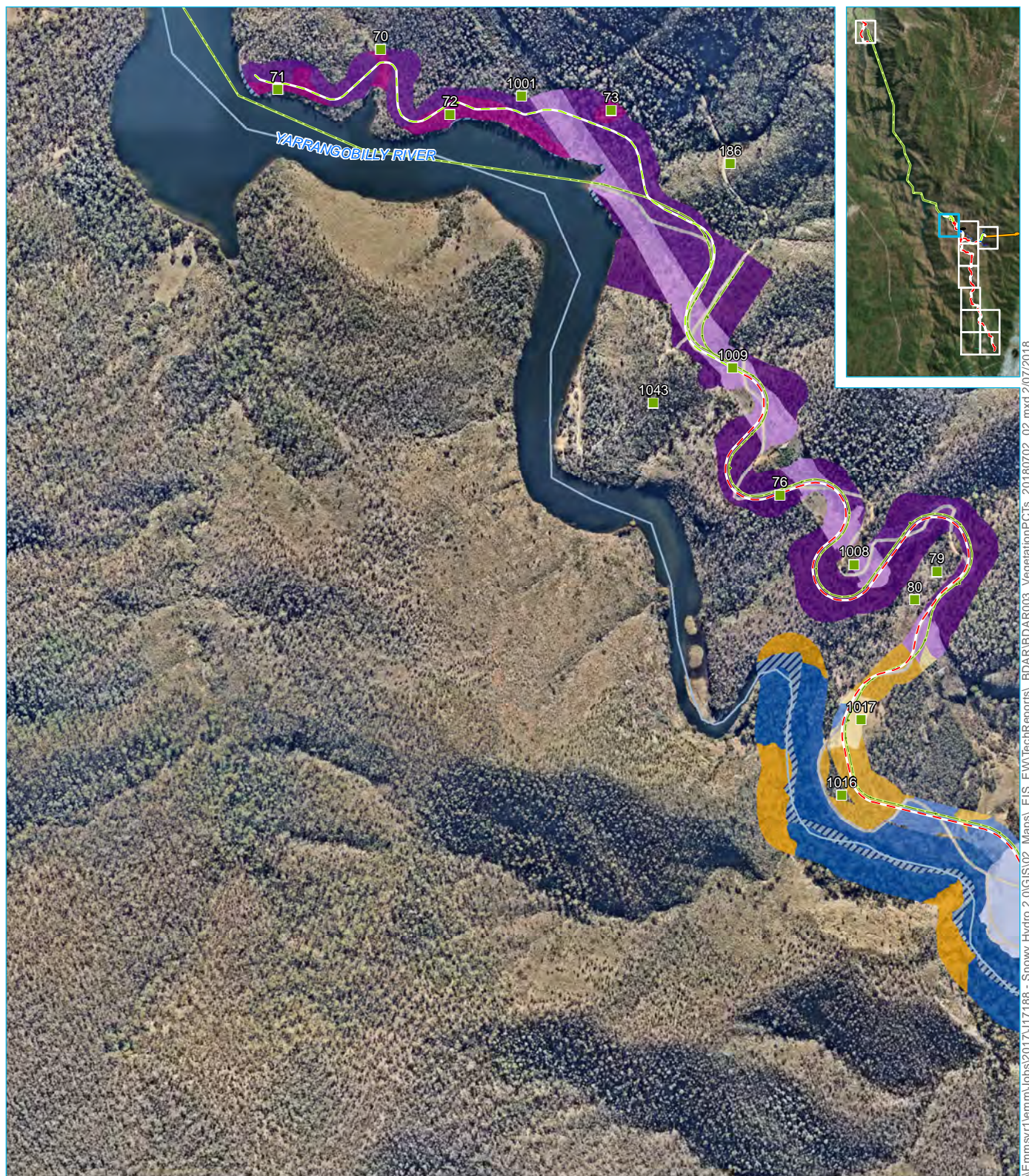


KEY

- Plot location
- Exploratory tunnel
- - Access road upgrade
- - Access road extension
- - Communications cable
- Watercourse
- Cleared land
- Heavily disturbed land
- Water
- PCT 311
- Moderate/good - High
- Moderate/good - Medium
- Moderate/good - Other

Plant Community Type and
vegetation zone mapping within the
Exploratory Works project area,
including plot locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 5.1a



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

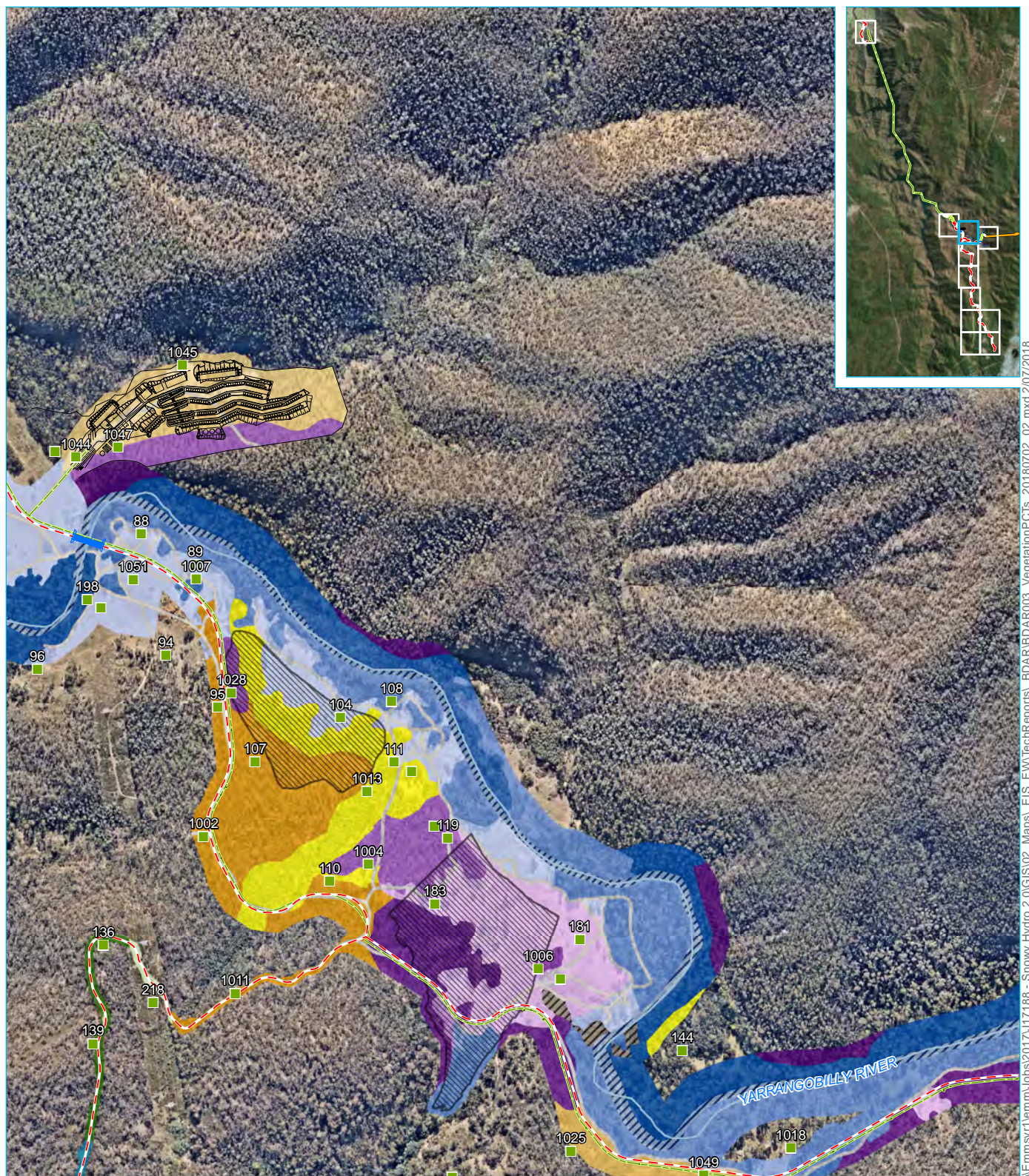
KEY

■ Plot location	PCT 302
— Exploratory tunnel	■ Moderate/good - High
- - Access road upgrade	■ Moderate/good - Medium
- - Access road extension	■ Moderate/good - Other
- - Communications cable	■ Low
— Watercourse	PCT 729
■ Cleared land	■ Moderate/good - High
■ Water	■ Moderate/good - Medium
PCT 296	■ Moderate/good - Poor
■ Moderate/good - High	■ Moderate/good - Other
■ Moderate/good - Medium	■ Moderate/good - Derived grassland
■ Moderate/good - Derived grassland	
PCT 300	
■ Moderate/good - High	

Plant Community Type and
vegetation zone mapping within the
Exploratory Works project area,
including plot locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 5.1b





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

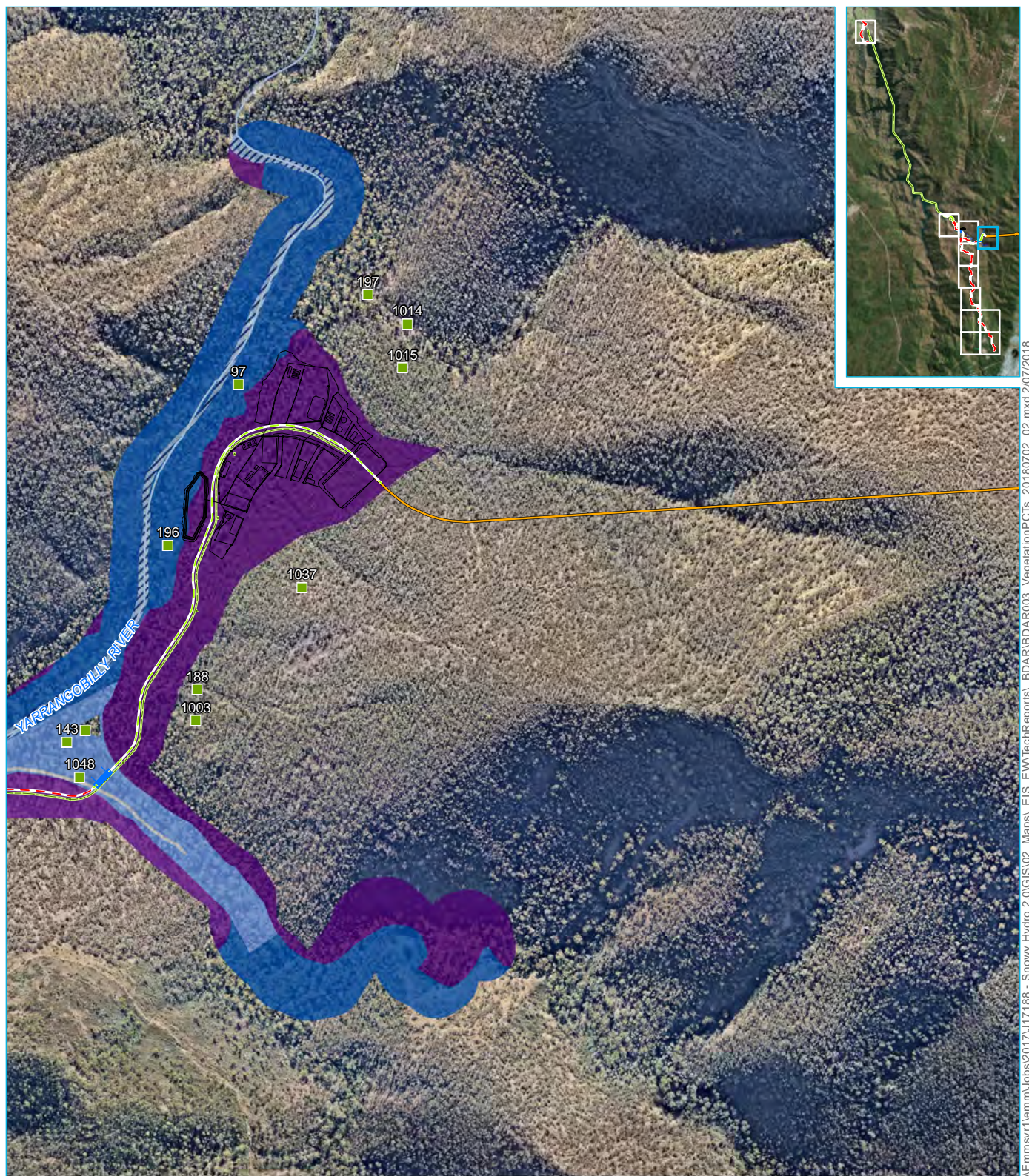
KEY

■ Plot location	PCT 296	■ Low
— Exploratory tunnel	■ Moderate/good - High	PCT 311
- - - Access road upgrade	■ Moderate/good - Medium	■ Moderate/good - High
- - - Access road extension	■ Moderate/good - Poor	PCT 729
— Permanent bridge	■ Moderate/good - Other	■ Moderate/good - High
— Accommodation camp conceptual layout	■ Moderate/good - Derived grassland	■ Moderate/good - Poor
— Communications cable	■ Low	■ Moderate/good - Other
▨ On land rock management	PCT 302	■ Moderate/good - Derived grassland
— Watercourse	■ Moderate/good - High	PCT 999
— Cleared land	■ Moderate/good - Medium	■ Moderate/good - High
▨ Heavily disturbed land	■ Moderate/good - Poor	■ Moderate/good - Derived grassland
▨ Water	■ Moderate/good - Other	
PCT 285	■ Moderate/good - Derived grassland	
■ Moderate/good - Poor		

Plant Community Type and
vegetation zone mapping within the
Exploratory Works project area,
including plot locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 5.1c





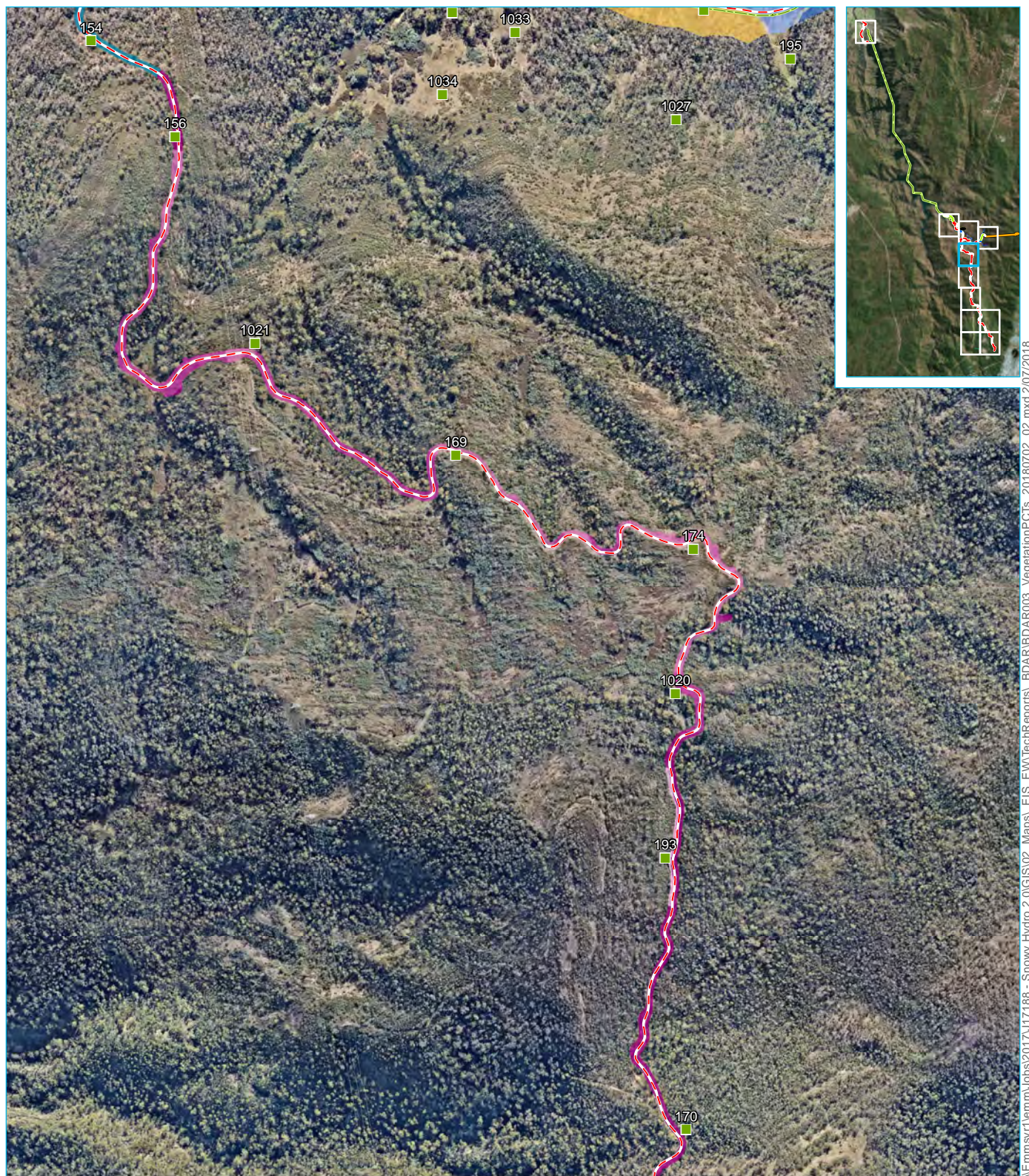
Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); Robert Bird (2018); DFSI (2017)

KEY

- Plot location
- Exploratory tunnel
- - - Access road upgrade
- - - Access road extension
- Permanent bridge
- Portal construction pad conceptual layout
- Communications cable
- Watercourse
- Cleared land
- Water
- PCT 296
 - Moderate/good - High
 - Moderate/good - Medium
- PCT 302
 - Moderate/good - High
 - Moderate/good - Other

Plant Community Type and
vegetation zone mapping within the
Exploratory Works project area,
including plot locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 5.1d



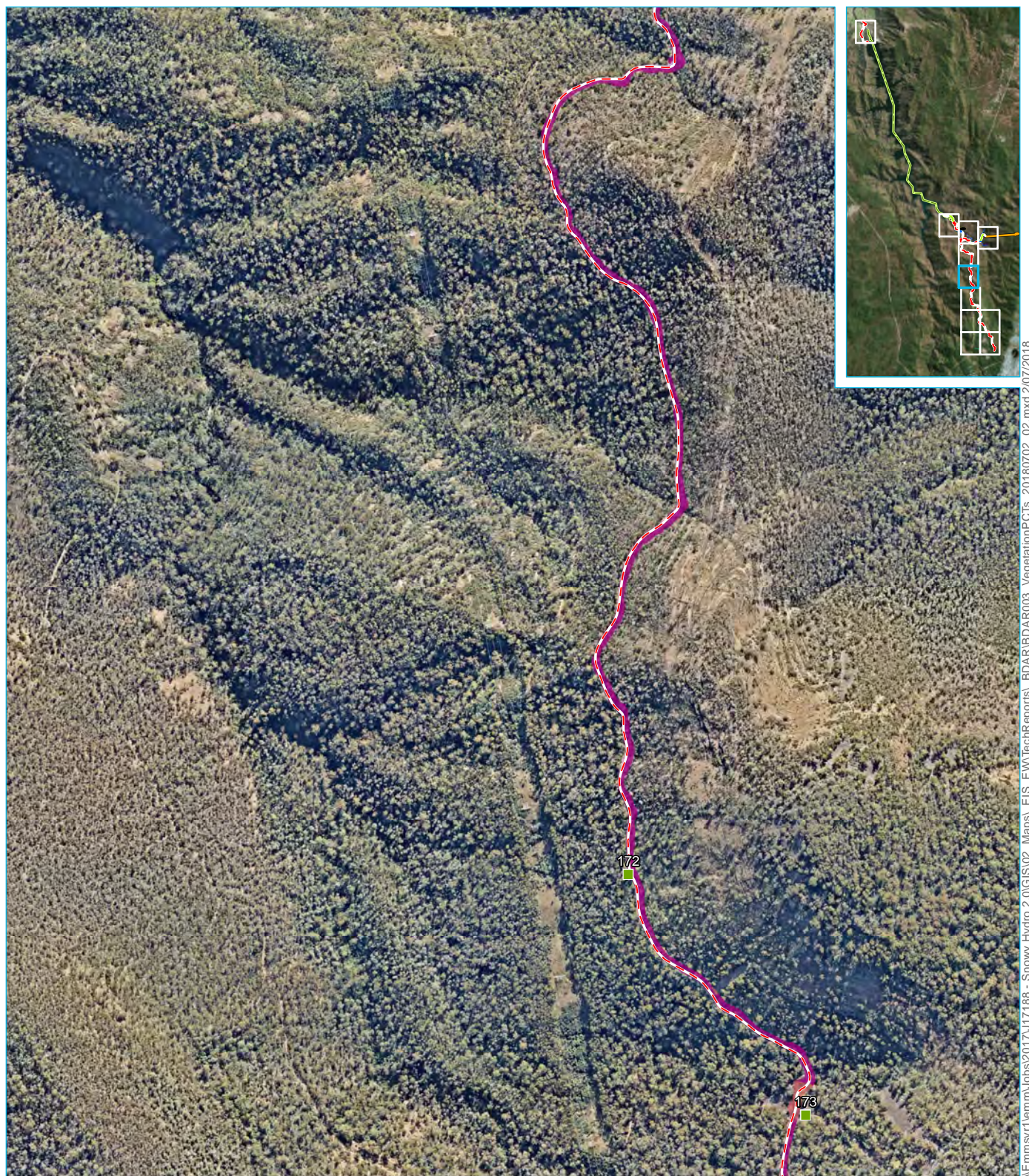
Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); Robert Bird (2018); DFSI (2017)

KEY

■ Plot location	PCT 302
— Exploratory tunnel	Moderate/good - Poor
- - Access road upgrade	Moderate/good - Other
- - Access road extension	Moderate/good - Derived grassland
- - Communications cable	PCT 311
■ Cleared land	Moderate/good - High
PCT 296	PCT 729
Moderate/good - Medium	Moderate/good - Poor
PCT 300	
Moderate/good - High	
Moderate/good - Medium	
Moderate/good - Other	
Moderate/good - Derived grassland	

Plant Community Type and
vegetation zone mapping within the
Exploratory Works project area,
including plot locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 5.1e



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

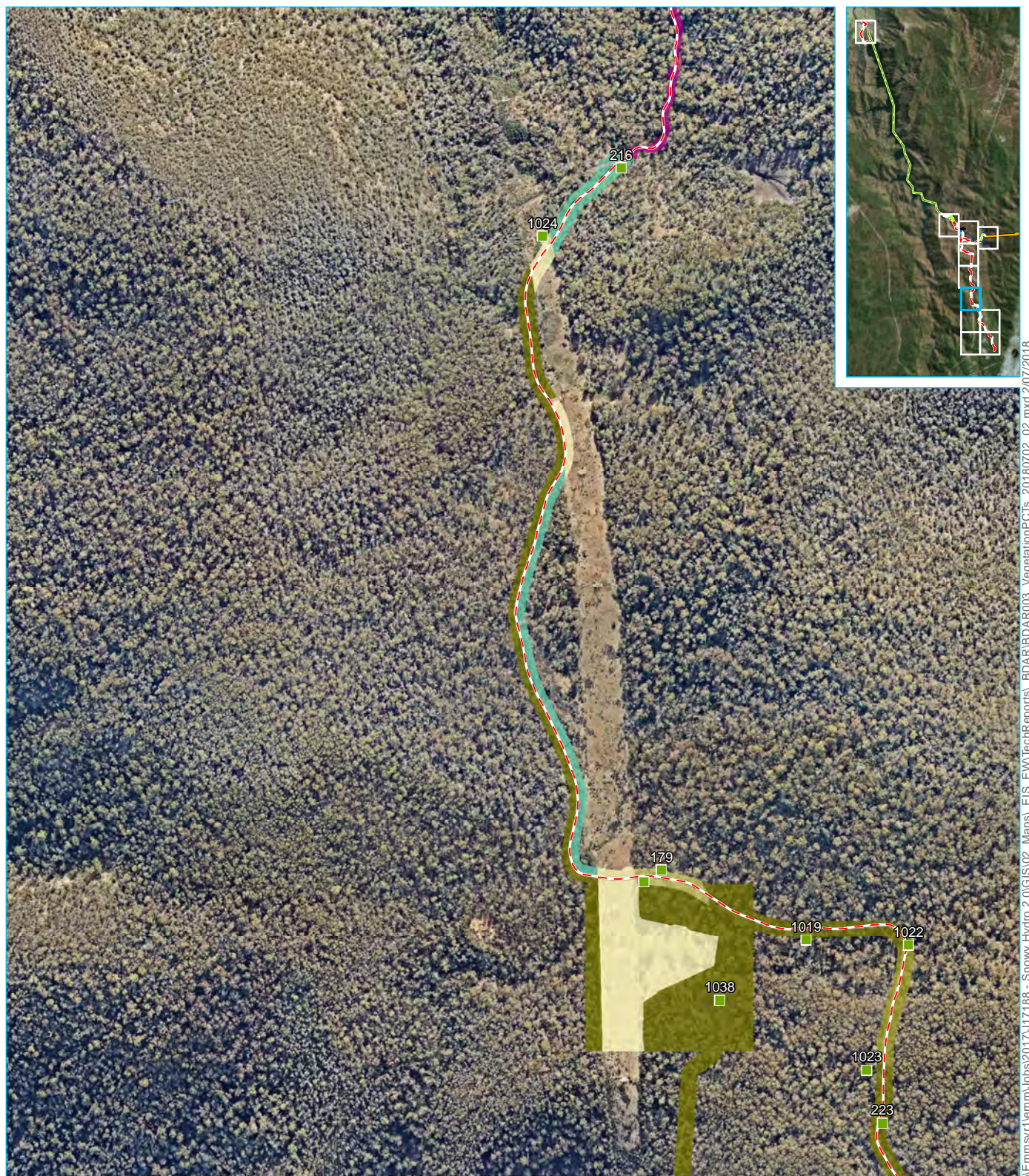
KEY

- Plot location
- Exploratory tunnel
- - Access road upgrade
- - Access road extension
- - Communications cable
- Cleared land
- PCT 300
- Moderate/good - High
- PCT 643
- Low

Plant Community Type and
vegetation zone mapping within the
Exploratory Works project area,
including plot locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 5.1f





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

KEY

- Plot location
- Exploratory tunnel
- - - Access road upgrade
- - - Access road extension
- - - Communications cable
- Cleared land
- PCT 300
- Moderate/good - High
- PCT 643
- Low
- PCT 953
- Moderate/good - High
- PCT 1196
- Moderate/good - High
- Moderate/good - Medium
- Moderate/good - Poor
- Moderate/good - Derived grassland

Plant Community Type and
vegetation zone mapping within the
Exploratory Works project area,
including plot locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 5.1g





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

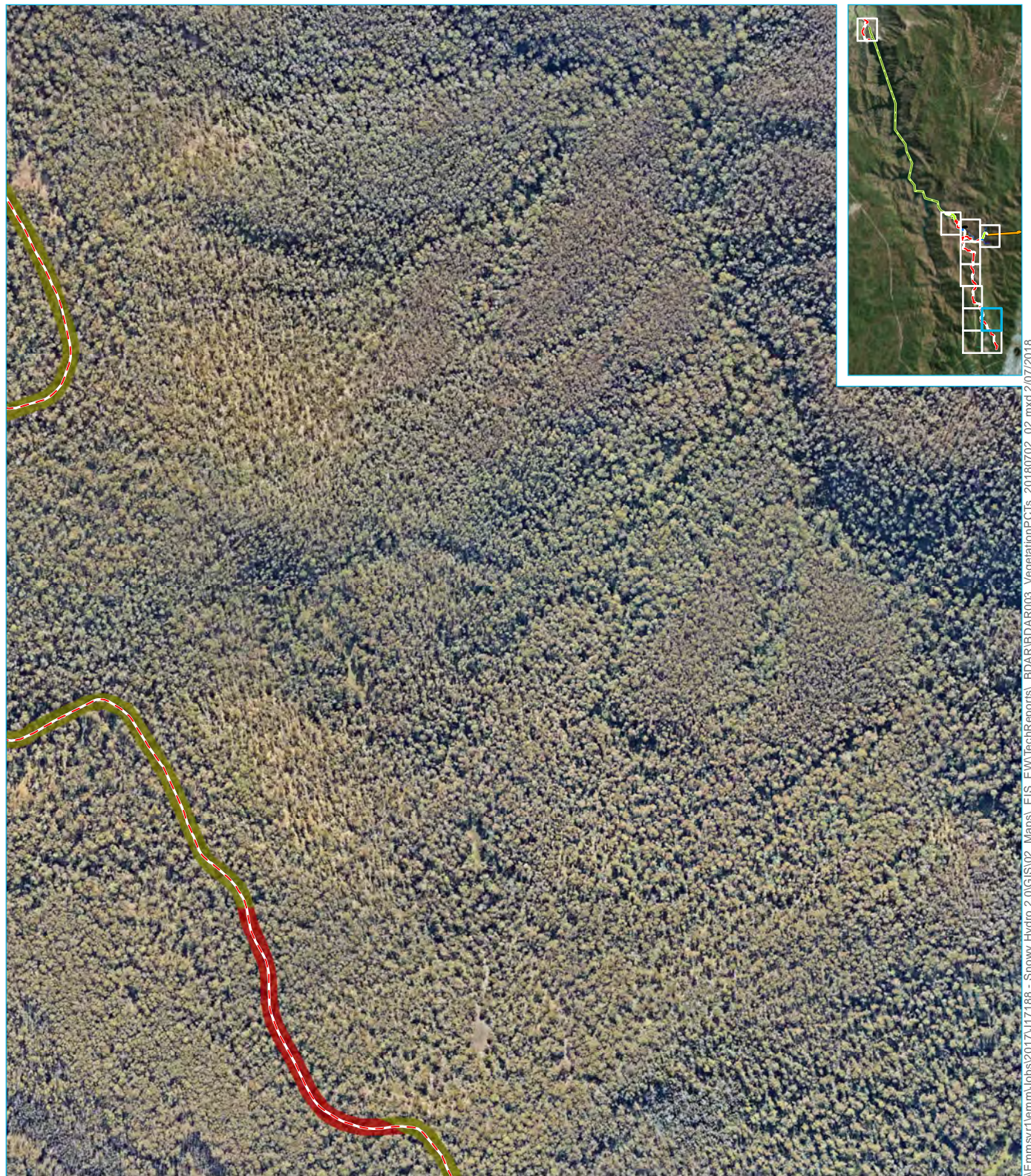
KEY

- Plot location
- Exploratory tunnel
- - - Access road upgrade
- - - Access road extension
- - - Communications cable
- PCT 296
- Moderate/good - High
- PCT 1196
- Moderate/good - High
- Moderate/good - Derived grassland

Plant Community Type and
vegetation zone mapping within the
Exploratory Works project area,
including plot locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 5.1h





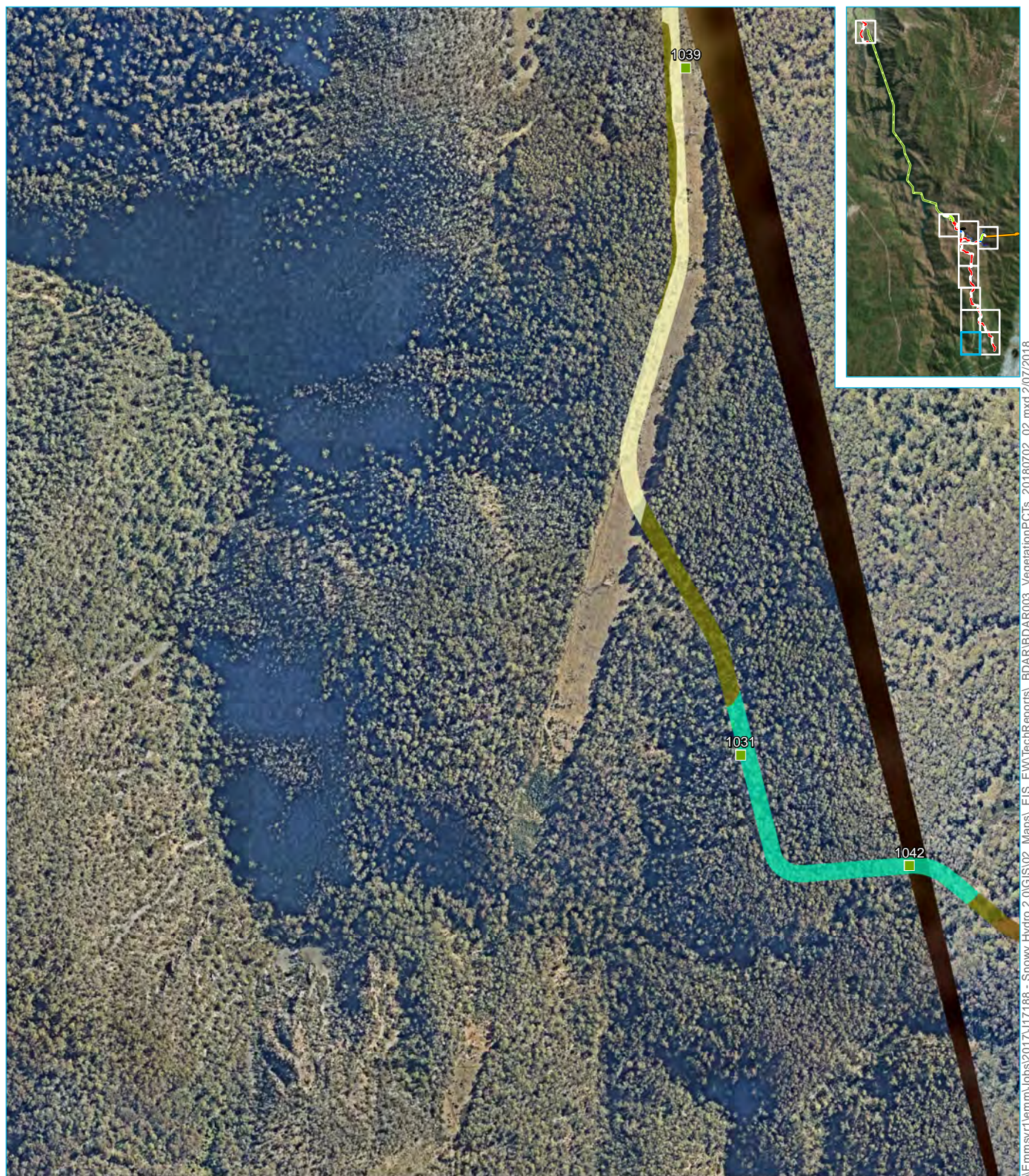
Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); Robert Bird (2018); DFSI (2017)

KEY

- Exploratory tunnel
- - Access road upgrade
- - Access road extension
- - Communications cable
- PCT 639
- Moderate/good - High
- PCT 1196
- Moderate/good - High

Plant Community Type and
vegetation zone mapping within the
Exploratory Works project area,
including plot locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 5.1i



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

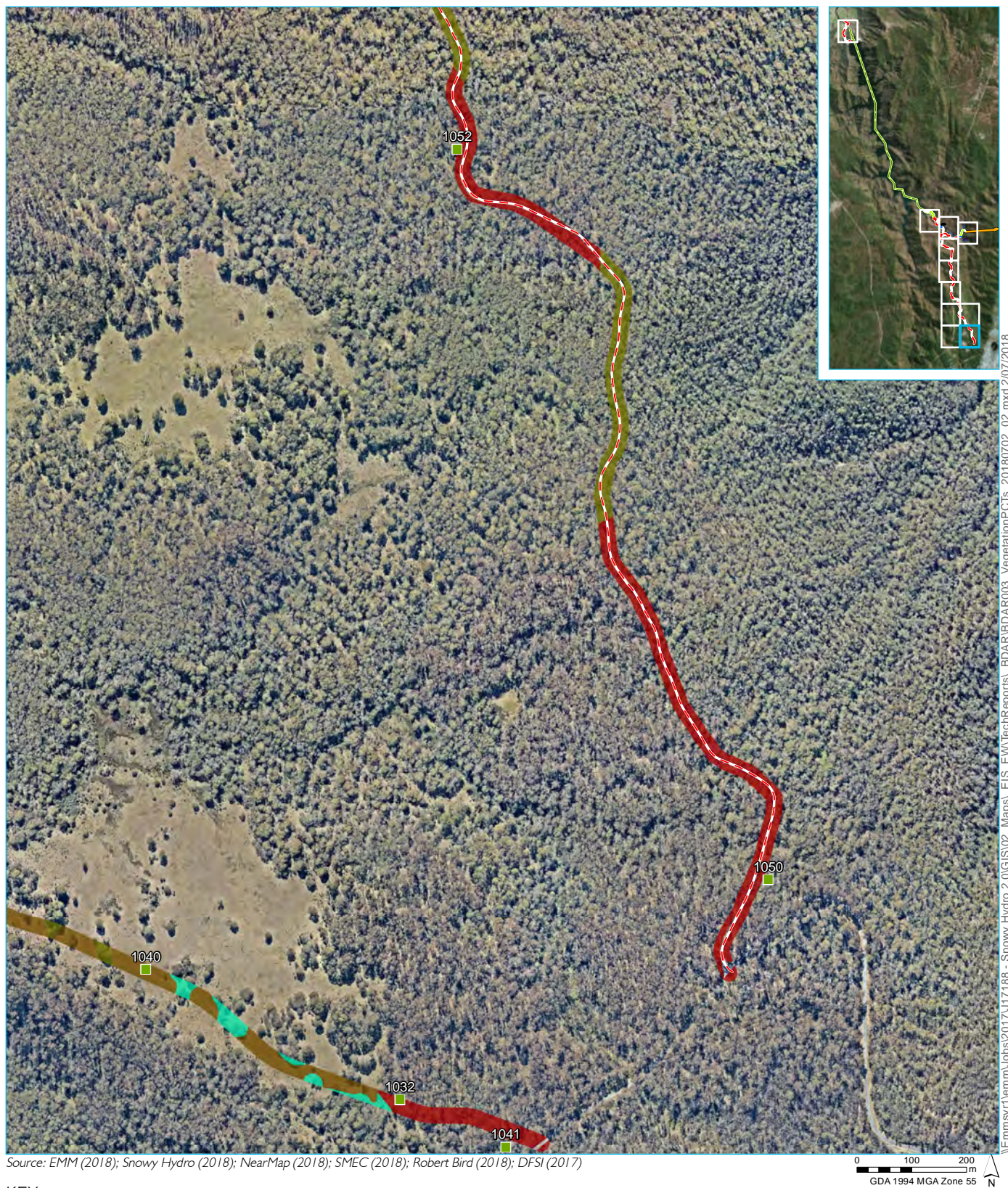
KEY

- Plot location
- Exploratory tunnel
- - Access road upgrade
- - Access road extension
- - Communications cable
- PCT 644
- Moderate/good - High
- PCT 1196
- Moderate/good - High
- Moderate/good - Derived grassland
- PCT 1224
- Moderate/good - Poor

Plant Community Type and
vegetation zone mapping within the
Exploratory Works project area,
including plot locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 5.1j





KEY

- Plot location
- Exploratory tunnel
- - - Access road upgrade
- - - Access road extension
- Communications cable
- Cleared land
- PCT 639
- Moderate/good - High
- PCT 644
- Moderate/good - High
- PCT 1196
- Moderate/good - High
- PCT 1224
- Moderate/good - Poor

Plant Community Type and
vegetation zone mapping within the
Exploratory Works project area,
including plot locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 5.1k



5.3.3 Vegetation zones

Each of the nine PCTs identified within the Exploratory Works disturbance footprint was stratified into vegetation zones based on broad condition state, as per the method outlined in Section 5.2.1, and allocated a condition class as per the descriptions in Table 5.1. This process identified 28 vegetation zones within the Exploratory Works project area, as outlined in Table 5.3.

Table 5.3 Vegetation zones mapped within the Exploratory Works disturbance footprint

Plant community type	Condition	Ancillary Code	Area (ha)
PCT 285 – Broad-leaved Sally grass – sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	Moderate/good	Poor	5.41
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Low	-	4.89
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Moderate/good	High	20.47
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Moderate/good	Medium	12.34
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Moderate/good	Poor	0.56
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Moderate/good	Derived grassland	5.14
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Moderate/good	Other	4.00
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Moderate/good	High	5.41
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Moderate/good	Medium	1.61
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Moderate/good	Derived grassland	0.12
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Moderate/good	Other	0.98
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	Low	-	5.33

Table 5.3 **Vegetation zones mapped within the Exploratory Works disturbance footprint**

Plant community type	Condition	Ancillary Code	Area (ha)
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	Moderate/good	High	0.46
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	Moderate/good	Poor	0.32
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	Moderate/good	Derived Grassland	0.50
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	Moderate/good	Other	3.77
PCT 311 - Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	Moderate/good	High	1.58
PCT 311 - Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	Moderate/good	Medium	1.12
PCT 643 - Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion	Low	-	0.12
PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Moderate/good	High	8.00
PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Moderate/good	Medium	1.49
PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Moderate/good	Poor	2.18
PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Moderate/good	Derived grassland	1.39
PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Moderate/good	Other	4.28
PCT 999 - Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	Moderate/good	High	0.51
PCT 999 - Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	Moderate/good	Derived grassland	0.13

Table 5.3 Vegetation zones mapped within the Exploratory Works disturbance footprint

Plant community type	Condition	Ancillary Code	Area (ha)
PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	Moderate/good	High	0.07
PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	Moderate/good	Derived grassland	2.91
TOTAL			95.09

Descriptions of each PCT are provided in the following tables. PCTs and vegetation zones are mapped in Figure 5.1.

Table 5.4 PCT 285 Broad-leaved Sally grass – sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion description

PCT 285 – Broad-leaved Sally grass – sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion

PCT ID	285
Common name	Broad-leaved Sally grass – sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion
Condition classes	A single vegetation class was mapped in the Exploratory Works disturbance footprint: <ul style="list-style-type: none"> Moderate/good – Poor
Extent within Exploratory Works	Moderate/good – Poor: 5.4 ha
Description	<p>Broad-leaved Sally (<i>Eucalyptus camphora</i>) is the dominant canopy species with few Candlebark (<i>Eucalyptus rubida</i>) scattered throughout. Midstorey consists of Wedge-leaved Wattle (<i>Acacia pravissima</i>), Dwarf Cherry (<i>Exocarpus strictus</i>), Sifton Bush (<i>Cassinia arcuata</i>), Blackwood (<i>Acacia melanoxylon</i>) and Small-leaved Silver Wattle (<i>Acacia dealbata</i> subsp. <i>alpina</i>). The ground cover includes a mix of native grasses, sedges, rushes and both native and exotic forbs. Grass species include Kangaroo Grass (<i>Themeda triandra</i>), <i>Poa seiberiana</i>, Tussock (<i>Poa labillardierei</i>), Weeping Grass (<i>Microleana stipoides</i>), Wiry Panic (<i>Entolasia stricta</i>). Sedges and Rush species include <i>Carex gaudichaudiana</i>, <i>Carex inversa</i> and Wattle Mat-rush (<i>Lomandra filliformis</i>). Native forbs include Hoary Guinea Flower (<i>Hibbertia obtusifolia</i>), Raspwort (<i>Gonocarpus teucroides</i>), Bidgee-widgee (<i>Acaena novae-zelandiae</i>), Daphne Heath (<i>Brachyloma daphnoides</i>), Native Raspberry (<i>Rubus parvifolius</i>) and <i>Oxalis perennans</i>. Blackberry (<i>Rubus fruticosus</i> sp. <i>agg</i>) is the dominating exotic species and was observed to be outcompeting many native forbs and grasses. Other exotic species include Sweet Briar (<i>Rosa rubiginosa</i>), St Johns Wort (<i>Hypericum perforatum</i>), Yorkshire Fog (<i>Holcus lanatus</i>) and Common Centaury (<i>Centaureum erythraea</i>).</p> <p>This PCT is located on alluvial or colluvial organic grey to brown clay loam soils associated with valleys floors or adjacent drainage lines in Lobs Hole, adjacent to the Yarrangobilly River. This area has experienced significant disturbance due to historical land clearing and pastoral usage. The area is now a public camping ground and subject to ongoing disturbance. As a result of past and current land use much of this PCT is in poor condition, with significant weed infestations, particularly of Blackberry.</p>
Survey effort	Moderate/good – Poor: 3 plots (111, 1012, 1013).

Table 5.4 PCT 285 Broad-leaved Sally grass – sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion description

PCT 285 – Broad-leaved Sally grass – sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion

Condition description	The community is in poor condition with the exotics Blackberry and St John's Wort outcompeting native species in the groundcover forming dense thickets. Vegetation was assessed as being in poor condition.
Characteristic species used for identification of PCT	According to the NSW VIS Classification Version 2.1, the canopy layer species recorded within this community align with the dominant species listed as characteristic for this PCT. These include Broad-leaved Sally. Aligning midstorey and ground cover species include Blackwood, Small-leaved Silver Wattle, Hoary Guinea Flower, Native Raspberry, Bidgee-widgee, and Weeping Grass.
Justification of evidence used to identify the PCT	Apart from species composition, the stated distribution is southern section of the NSW South Western Slopes and adjoining South Eastern Highlands Bioregions. The occurrence of the community on alluvial or colluvial organic grey to brown podzolic clay loam soils, on poorly drained valley flats or lining creeks in hill or mountain landscapes is consistent with this PCT. The characteristic species, as listed above, are consistent with the PCT, with Broad-leaved Sally being the characteristic overstorey species. The mid-storey is dominated by Blackwood and Small-leaved Silver Wattle while the ground layer is dominated by Tussock and Weeping Grass which are all characteristic of the PCT.
Status	Commonwealth EPBC Act: not listed NSW BC Act: not listed Justification: The VIS states the PCT likely relates to the Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and South Western Slopes Bioregions (BC Act) endangered ecological community (EEC). Using the key in EPA (2016) plot 111 is keyed out as being the EEC with a likelihood of 12-16%, while plots 1012 and 1013 are considered not characteristic of the EEC with the likelihood of an incorrect diagnosis of 0-2%. Given the dominant species in the overstorey of the PCT, Broad-leaved Sally, is not one of the characteristic species used to define the community (NSWSC 2011) the PCT is considered unlikely to align with the EEC.
Estimate of percent cleared value of PCT	75%



Photograph 5.2 **Broad-leaved Sally grass – sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion – Plot 1012**

Table 5.5 PCT 296 - Brittle Gum – peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion

PCT 296 - Brittle Gum – peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion

PCT ID	296
Common name	Brittle Gum – peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion
Condition class	<p>PCT 296 is in various conditions throughout the Exploratory Works disturbance footprint. As a result, six vegetation zones have been mapped:</p> <ul style="list-style-type: none"> • Low • Moderate/good – High • Moderate/good – Medium • Moderate/good – Poor • Moderate/good – Derived Grassland • Moderate /good – Other
Extent within Exploratory Works	<p>Low: 4.9 ha</p> <p>Moderate/good – High: 20.5 ha</p> <p>Moderate/good – Medium: 12.3 ha</p> <p>Moderate/good – Poor: 0.6 ha</p> <p>Moderate/good – Derived Grassland: 5.1 ha</p> <p>Moderate /good – Other: 4.0 ha</p>
Description	<p>Brittle gum (<i>Eucalyptus mannifera</i> subsp. <i>mannifera</i>), Broad-leaved Peppermint (<i>Eucalyptus dives</i>) and Red Stringybark (<i>Eucalyptus macrohyncha</i>) are the dominant canopy trees within this vegetation community. Robertson's Peppermint (<i>Eucalyptus robertsonii</i> subsp. <i>robertsonii</i>) was recorded scattered throughout. The shrub layer varies between a fairly sparse to dense cover comprising of Silver wattle (<i>Acacia dealbata</i>), Native Blackthorn (<i>Bursaria spinosa</i>), Common Fringe-myrtle (<i>Calytrix tetragona</i>), Hoary guinea flower (<i>Hibbertia obtusifolia</i>), Mountain Banksia (<i>Banksia caneii</i>) and <i>Cassinia longifolia</i>. The groundcover consists of a variety of native grasses, forbs, rushes and sedges. Grasses including Tussock (<i>Poa labillardierei</i>), Snowgrass (<i>Poa sieberiana</i> var. <i>sieberiana</i>), Silvertop Wallaby Grass (<i>Rytidosperma pallidum</i>) and <i>Poa sieberiana</i> var. <i>cyanophylla</i> while native forbs comprise of Raspwort (<i>Gonocarpus teucroides</i>), Grass Trigger plant (<i>Stylidium graminifolium</i>), Small St John's Wort (<i>Hypericum gramineum</i>) and Hairy Apple Berry (<i>Billardiera scandens</i>). Rushes and sedges include Wattle Mat-rush (<i>Lomandra filiformis</i> subsp. <i>filiformis</i>) and Fluke Bogrush (<i>Schoenus apogon</i>). Exotic species recorded within this vegetation type include St John's Wort (<i>Hypericum perforatum</i>), Blackberry (<i>Rubus fruticosus</i> sp. agg), Sweet Briar (<i>Rosa rubiginosa</i>) and Common Centaury (<i>Centaureum erythraea</i>).</p> <p>This PCT is mapped on steep to moderate slopes, on a variety of light grey to brown clay loam, rocky loam and sandy clay loam soils within the Exploratory Works. Often found located adjacent and upslope from PCT 285 and PCT 302.</p>
Survey effort	<p>Low: two plots (181, 183)</p> <p>Moderate/good – High: three plots (76, 188, 1003)</p> <p>Moderate/good – Medium: three plots (79, 186, 1001)</p> <p>Moderate/good – Poor: one plot (1006)</p> <p>Moderate/good – Derived Grassland: three plots (57, 1008, 1009)</p> <p>Moderate /good – Other: two plots (1004, 1005)</p>

Table 5.5 PCT 296 - Brittle Gum – peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion

PCT 296 - Brittle Gum – peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion

Condition description	<p>The community covers a large portion of the study area and the condition varied between both moderate/good to low.</p> <p>Some areas in Lobs Hole have been cleared, and are mapped in Low condition. Adjacent areas, where clearing has occurred but regeneration is present, were mapped in as being in the Other condition class. Cleared areas with a higher native component were mapped as Derived Grasslands; this included underneath powerlines and small areas in Lobs Hole. Some areas in Lobs Hole where there is significant weed invasion were mapped as being in Poor condition. Areas outside of Lobs Hole were generally mapped in Medium or High condition depending on stratum present.</p>
Characteristic species used for identification of PCT	<p>According to the NSW VIS Classification Version 2.1, the canopy layer species recorded within this community align with the dominant species listed as characteristic for this PCT. These include Brittle Gum and Broad-leaved Peppermint. Aligning shrub layer species include Silver wattle, Native Blackthorn and (<i>Cassinia longifolia</i>). Ground layer species include Snowgrass, Silvertop Wallaby Grass and Wattle Mat-rush.</p>
Justification of evidence used to identify the PCT	<p>Apart from species composition, the stated distribution is within the IBRA Bioregions of NSW South Western Slopes, South Eastern Highland and Australian Alps is consistent with the identification of the PCT. The occurrence of the community on sandy loamy clay soils as well as the landscape position on steep hillslopes within a mountainous and/or hilly landform is consistent for this PCT. The characteristic species, as listed above, are consistent with the PCT with the main diagnostic feature being a canopy dominated by Brittle Gum and Broad-leaved Peppermint. The mid-storey contains a number of characteristic species as does the ground layer.</p>
Status	<p>Commonwealth EPBC Act: not listed</p> <p>NSW BC Act: not listed</p>
Estimate of percent cleared value of PCT	40%



Photograph 5.3

Brittle Gum – peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion – Plot 76

Table 5.6 PCT 300 –Ribbon Gum – Narrow-leaved (Robertsons) Peppermint montane fern – grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and Kosciuszko escarpment

PCT 300 –Ribbon Gum – Narrow-leaved (Robertsons) Peppermint montane fern – grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and Kosciuszko escarpment	
PCT ID	300
Common name	Ribbon Gum – Narrow-leaved (Robertsons) Peppermint montane fern – grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and Kosciuszko escarpment
Condition class	<p>PCT 300 is in various conditions throughout the Exploratory Works disturbance footprint. As a result, four vegetation zones have been mapped:</p> <ul style="list-style-type: none"> • Moderate/good – High • Moderate/good – Medium • Moderate/good – Derived Grassland • Moderate /good – Other
Extent within Exploratory Works	<p>Moderate/good – High: 5.4 ha</p> <p>Moderate/good – Medium: 1.6 ha</p> <p>Moderate/good – Derived Grassland: 0.1 ha</p> <p>Moderate /good – Other: 1.0 ha</p>
Description	<p>Ribbon Gum (<i>Eucalyptus viminalis</i>) and Narrow-leaved Peppermint (<i>Eucalyptus robertsonii</i> subsp. <i>robertsonii</i>) dominate this community. The shrub layer comprises of, Silver wattle (<i>Acacia dealbata</i>), Handsome Flat Pea (<i>Platylobium formosum</i>), Wedge-leaved Wattle (<i>Acacia pravissima</i>), Narrow Leaf Hop Bush (<i>Dodonaea viscosa</i> subsp. <i>angustissima</i>), Bulbine Lily (<i>Bulbine bulbosa</i>), <i>Cassinia longifolia</i> and River Lomatia (<i>Lomatia myricoides</i>). Ground cover includes a number of native grasses, rushes and forbs. Grasses recorded include Slender Wallaby Grass (<i>Rytidosperma penicillatum</i>), <i>Dichelachne rara</i>, Longhair Plume Grass (<i>Dichelachne crinita</i>), Tussock (<i>Poa labillardierei</i>), and Speargrass (<i>Austrostipa scabra</i>). Native forbs include Bidgee-widgee (<i>Acaena novae-zelandiae</i>), Tall Bluebell (<i>Wahlenbergia stricta</i> subsp. <i>stricta</i>), Small St John's Wort (<i>Hypericum gramineum</i>), <i>Glycine tabacina</i>, Prickly Woodruff (<i>Asperula scoparia</i>) and Native violet (<i>Viola betonicifolia</i>). The exotic species Delicate Hairgrass (<i>Aira elegantissima</i>), Common Centaury (<i>Centaureum erythraea</i>), St John's Wort (<i>Hypericum perforatum</i>) and Blackberry (<i>Rubus fruticosus</i> sp. agg) were recorded within the community.</p> <p>This community was mapped on sheltered hill slopes at slightly higher elevations and adjacent to PCT 296. Located on a variety of red/brown loam to clay loam soils within the Exploratory Works project area.</p>
Survey effort	<p>Moderate/good – High: three plots (72, 156, 172)</p> <p>Moderate/good – Medium: one plot (1020)</p> <p>Moderate/good – Derived Grassland: one plot (193)</p> <p>Moderate /good – Other: one plot (169)</p>
Condition description	<p>This communities condition was recorded as moderate/good throughout the study area however is does vary between High and other ancillary codes. Patches assigned to the condition class Other are located in areas previously cleared on the slopes above Lobs Hole Ravine (see Photograph 5.1) adjacent to Lobs Hole Ravine Road. In these areas, some regeneration is present. An adjacent area is lacking in regeneration and was assigned to Derived Grassland condition class. Areas adjacent to the two areas described previously, where some level of disturbance is still evident but a mature overstorey is present, were assigned to the Medium condition class. Areas with largely intact strata were assigned to the High condition class.</p>

Table 5.6 **PCT 300 –Ribbon Gum – Narrow-leaved (Robertsons) Peppermint montane fern – grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and Kosciuszko escarpment**

Characteristic species used for identification of PCT	According to the NSW VIS Classification Version 2.1, the canopy layer species recorded within this community align with the dominant species listed as characteristic for this PCT. These include Ribbon Gum and Robertson's Peppermint. Aligning shrub layer species include Silver Wattle, Handsome Flat Pea, Wedge-leaved Wattle and River Lomatia. Understorey species that were used as an identifying species include Bidgee-widgee, Small St John's Wort, <i>Glycine tabacina</i> , Prickly Woodruff and Native Violet.
Justification of evidence used to identify the PCT	Apart from species composition, the stated distribution within the South Eastern Highland and Australian Alps IBRA Bioregions is consistent. Occurs on deep red/brown loam soils derived from granite and sedimentary substrates on sheltered hill slopes in a mountain landform pattern at elevations between 700 m and 1,150 m on the south-western edge of the south Eastern Highlands Bioregion including in Kosciuszko National Park.
Status	Commonwealth EPBC Act: not listed NSW BC Act: not listed
Estimate of percent cleared value of PCT	20%



Photograph 5.4 **Ribbon Gum – Narrow-leaved (Robertsons) Peppermint montane fern – grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and Kosciuszko escarpment – Plot 156**

Table 5.7 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

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

PCT ID	302
Common name	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
Condition class	<p>PCT 302 is in various conditions throughout the Exploratory Works disturbance footprint. As a result, five vegetation zones have been mapped:</p> <ul style="list-style-type: none"> • Low • Moderate/good – High • Moderate/good – Poor • Moderate/good – Derived Grassland • Moderate /good – Other
Extent within Exploratory Works	<p>Low: 5.3 ha</p> <p>Moderate/good – High: 0.5 ha</p> <p>Moderate/good – Poor: 0.3 ha</p> <p>Moderate/good – Derived Grassland: 0.5 ha</p> <p>Moderate /good – Other: 3.8 ha</p>
Description	<p>Ribbon Gum (<i>Eucalyptus viminalis</i>), Black Sally (<i>Eucalyptus stellulata</i>) and <i>Eucalyptus camphora</i> subsp. <i>humeana</i> are the dominant overstorey species in this PCT. The shrub layer comprises of Wedge-leaved Wattle (<i>Acacia pravissima</i>), Native Blackthorn (<i>Bursaria spinosa</i>), Dolly Bush (<i>Cassinia aculeata</i>), Hazel Pomaderris (<i>Pomaderris aspera</i>), <i>Pomaderris angustifolia</i>, Hoary Guinea Flower (<i>Hibbertia obtusifolia</i>), Matted Parrot-pea (<i>Dillwynia sericea</i>), Blackwood (<i>Acacia melanoxylon</i>), Dwarf Cherry (<i>Exocarpus stricta</i>), <i>Cassinia longifolia</i> Rosemary Grevillea (<i>Grevillea rosmarinifolia</i>) and River Lomatia (<i>Lomatia myricoides</i>). Ground cover includes a number of native grasses, rushes and forbs. Grasses recorded include Kangaroo Grass (<i>Themeda triandra</i>), Common Couch (<i>Cynodon dactylon</i>), Tussock (<i>Poa labillardierei</i>) and <i>Poa sieberiana</i>, Bulbine Lily (<i>Bulbine bulbosa</i>), Variable Glycine (<i>Glycine tabacina</i>), Common Woodruff (<i>Asperula conferta</i>), Bracken Fern (<i>Pteridium esculentum</i>), Tall Sedge (<i>Carex appressa</i>) and Stinking Pennywort (<i>Hydrocotyle laxiflora</i>). A high number of exotic species were recorded in some vegetation zones, including Square Tail Fescue (<i>Vulpia bromoides</i>), Delicate Hairgrass (<i>Aira elegantissima</i>), Common Centaury (<i>Centaurium erythraea</i>), St John's Wort (<i>Hypericum perforatum</i>), Catsear (<i>Hypercharis redicata</i>), Common Sowthistle (<i>Sonchus oleraceus</i>), Sheep Sorrel (<i>Acetosella vulgaris</i>) and Blackberry (<i>Rubus fruticosus</i> sp. agg).</p> <p>This community is found on a variety of brown loam to clay loam soils within the Exploratory Works disturbance footprint, adjacent to creek and watercourses. This is the predominant riparian community along the Yarrangobilly River.</p>
Survey effort	<p>Low: three plots (88, 96, 1051)</p> <p>Moderate/good – High: one plot (97)</p> <p>Moderate/good – Poor: one plot (1007)</p> <p>Moderate/good – Derived Grassland: one plot (1018)</p> <p>Moderate /good – Other: two plots (1048, 108)</p>

Table 5.7 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

Condition description	This community's condition was recorded as both moderate/good and Low. The areas where a Low condition class was recorded are in areas subject to historical clearing, and subject to ongoing disturbance from recreational use. These areas have high exotic weed cover. Some adjacent areas show regeneration of canopy species, and were assigned to the Other condition class. Several patches on midslopes, where clearing has occurred but a largely native groundcover is maintained, were assigned to the Derived Grassland condition class. Areas assigned to a Medium condition class show a more native groundcover, were lacking either the midstorey or had a disturbed overstore. The patches assigned to a High condition class are generally located away from human influence, and thus have a more intact strata.
Characteristic species used for identification of PCT	According to the NSW VIS Classification Version 2.1, the canopy layer species recorded within this community align with the dominant species listed as characteristic for this PCT. These include Ribbon Gum and <i>Eucalyptus camphora</i> subsp. <i>humeana</i> . Aligning shrub layer species include Blackwood, Hazel Pomaderris, <i>Pomaderris angustifolia</i> and River Lomatia. Understorey species that were used as a identifying species include Kangaroo Grass, Tall Sedge and Common Couch.
Justification of evidence used to identify the PCT	Apart from species composition, the stated distribution is within the South Eastern Highland IBRA Bioregions and on clays or humic gleys over gravel along creeks is consistent with the PCT; this community was recorded running adjacent to and on the flats around the Yarrangobilly River. Overall, PCT 302 was considered best fit, but does not provide an ideal fit for this PCT.
Status	<p>Commonwealth EPBC Act: not listed</p> <p>NSW BC Act: not listed</p> <p>Justification: The VIS states the PCT likely relates to two threatened communities. It is considered a partial subset of White Box Yellow Box Blakely's Red Gum Woodland EEC/CEEC and likely related to Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and South Western Slopes Bioregions EEC. The PCT is not considered part of the White Box Yellow Box Blakely's Red Gum Woodland EEC/CEEC as the characteristic tree species are not present.</p> <p>Using the key in EPA (2016) plot 108 is keyed out as being the EEC with a likelihood of 12-16%, while all other plots are considered not characteristic of the EEC with the likelihood of an incorrect diagnosis of 0-2%. Although Ribbon Gum, a characteristic overstorey species is present, the EEC occurs above 600 m elevation (NSWSC 2011) PCT 302 within the Exploratory Works project area is below 600 m. These factors combined indicate that the PCT is unlikely to be representative of the EEC.</p>
Estimate of percent cleared value of PCT	50%



Photograph 5.5 **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 – Plot 97**

Table 5.8 PCT 311 –Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion

PCT 311 – Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion

PCT ID	311
Common name	Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion
Condition class	<p>PCT generally in good condition within the Exploratory Works disturbance footprint, but with some disturbance evident in areas. Two vegetation zones were mapped:</p> <ul style="list-style-type: none"> • Moderate/good – High • Moderate/good – Medium
Extent within Exploratory Works	<p>Moderate/good – High: 1.6 ha</p> <p>Moderate/good – Medium: 1.1 ha</p>
Description	<p>Nortons Box (<i>Eucalyptus nortonii</i>), Red Stringybark (<i>Eucalyptus macrorhyncha</i>) and Broad-leaved Peppermint (<i>Eucalyptus dives</i>) dominate this community. The shrub layer comprises of Common Fringe-myrtle (<i>Calytrix tetragona</i>), Narrow-leaved Hopbush (<i>Dodonaea viscosa</i> subsp. <i>angustissima</i>), Hoary guinea flower (<i>Hibbertia obtusifolia</i>), Native Blackthorn (<i>Busaria spinosa</i>), <i>Cassinia longifolia</i>, Dwarf Cherry (<i>Exocarpus strictus</i>), Silver wattle (<i>Acacia dealbata</i>), Daphne Heath (<i>Brachyloma daphnoides</i>), <i>Dillwynia sieberi</i> and Creamy Stackhousia (<i>Stackhousia monogyna</i>). This community has a diverse ground cover comprising of native forbs, sedges, rushes and grasses. Native grasses include Speargrass (<i>Austrostipa scabra</i>), Ringed Wallaby Grass (<i>Rytidosperma caespitosum</i>) and Plumegrass (<i>Dichelachne hirtella</i>). Native forbs, rushes and sedges recorded include Purple Coral Pea (<i>Hardenbergia violacea</i>), <i>Senecio bathurstianus</i>, Native Geranium (<i>Geranium solanderi</i> var. <i>solanderi</i>), Poisen Rock Fern (<i>Cheilanthes sieberi</i>), (<i>Gonocarpus tetragynus</i>), Stinking Pennywort (<i>Hydrocotyle laxiflora</i>), Twining glycine (<i>Glycine clandestine</i>), <i>Lomandra filiformis</i> subsp. <i>coriacea</i>, and <i>Carex breviculmis</i>. A number of exotic species were recorded including Delicate Hairgrass (<i>Aira elegantissima</i>), Common Centaury (<i>Centaureum erythraea</i>), St Johns Wort (<i>Hypericum perforatum</i>), Scarlet pimpernel (<i>Lysimachia arvensis</i>), Sweet Briar (<i>Rosa rubiginosa</i>) and Silver Grass (<i>Vulpia bromoides</i>).</p> <p>This community is found on a red/brown soil with a clay loam texture, along the lower sections of Lobs Hole Ravine Road and at the northern end of Talbingo Reservoir, within the Exploratory Works disturbance footprint.</p>
Survey effort	<p>Moderate/good – High: one plot (154)</p> <p>Moderate/good – Medium: one plot (1029)</p>
Condition description	Patches of this community along Lobs Hole Ravine Road were assigned to a High condition class, with most strata present and little evidence of disturbance. Patches at Talbingo were assigned to Medium condition class due to disturbance along road edges, but transitioned into High condition class away from the road edge. All areas had little evidence of weed invasion, although impacts from past clearing were evident.
Characteristic species used for identification of PCT	According to the NSW VIS Classification Version 2.1, the canopy layer species recorded within this community align with the dominant species listed as characteristic for this PCT. These include Nortons Box, Red Stringybark and Broad-leaved Peppermint. Aligning shrub layer species include Daphne Heath, <i>Cassinia longifolia</i> , Native Blackthorn and Hoary Guinea Flower. Understorey species that were used as identifying species include <i>Lomandra filiformis</i> subsp. <i>coriacea</i> , Purple Coral Pea, Twining Glycine, and Stinking Pennywort.

Table 5.8 **PCT 311 –Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion**

PCT 311 – Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	
Justification of evidence used to identify the PCT	Apart from species composition, the stated distribution is within the South Eastern Highland and Australian Alps IBRA Bioregions aligns. This community was recorded on the mid slopes leading into Lobs Hole on red/brown soils which is consistent with NSW VIS Classification Version 2.1.
Status	Commonwealth EPBC Act: not listed NSW BC Act: not listed
Estimate of percent cleared value of PCT	40%



Photograph 5.6 **Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion – Plot 154**

Table 5.9 PCT 643 –Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion

PCT 643 –Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion

PCT ID	643
Common name	Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion
Condition class	A single vegetation zone was mapped within the Exploratory Works disturbance footprint: <ul style="list-style-type: none"> • Low
Extent within Exploratory Works	Low: 0.1 ha
Description	This PCT was used to map granite blockstreams on Lobs Hole Ravine Road (see Section 4.2.4). While no canopy species are listed to be present in this PCT by the NSW VIS Classification Version 2, Ribbon Gum (<i>Eucalyptus viminalis</i>) and White Sally (<i>Eucalyptus pauciflora</i>) were recorded due to the configuration of the 20m x 20m assessment plot, with these species overhanging the plot. The shrub layer is largely absent, with a low cover of <i>Casinia longifolia</i> , Small-fruited Hakea (<i>Hakea macrocarpa</i>), Blackwood (<i>Acacia melanoxylon</i>), Silver Wattle (<i>Acacia dealbata</i>) and Matted Parrot Pea (<i>Dillwynia prostrata</i>) at the edges of the plot. Ground cover is sparse, but present in the accumulated debris and soils in the blockstream. Ground cover species include a number of native grasses, rushes and forbs. Grasses recorded include Kangaroo Grass (<i>Themeda triandra</i>), Rock Tussock-grass (<i>Poa petrophila</i>), Tussock (<i>Poa labillardierei</i>), and <i>Poa sieberiana</i> var. <i>cyanophylla</i> . Native forbs Bracken Fern (<i>Pteridium esculentum</i>), Australian Indigo (<i>Indigofera australis</i>), Blanket Leaf (<i>Bedfordia arborescens</i>), Native Geranium (<i>Geranium solanderi</i> var. <i>solanderi</i>), <i>Polyscias sambucifolia</i> subsp., <i>Crypandra amara</i> var. <i>amara</i> , Grass Trigger plant (<i>Stylidium graminifolium</i>) and Bidgee Widgee (<i>Acaena novae-zelandiae</i>). Blackberry (<i>Rubus fruticosus</i> sp. agg) was the only exotic species recorded within the community.
Survey effort	Low: one plot (173)
Condition description	The PCT consists largely of granite boulders. Little vegetation is present in the blockstream, and thus it was assigned to the Low condition class. However, this lack of cover is natural. Minor occurrences of Blackberry were evident.
Characteristic species used for identification of PCT	Species were not used to identify the PCT.
Justification of evidence used to identify the PCT	The presence of blockstreams was used to justify the presence of the PCT; however, the PCT is located below the 1,300 m elevation limit outlined in VIS. Considered best fit.
Status	Commonwealth EPBC Act: not listed NSW BC Act: not listed
Estimate of percent cleared value of PCT	0%



Photograph 5.7 Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion – Plot 173

Table 5.10 PCT 729 – Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion

PCT 729 – Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion

PCT ID	729
Common name	Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion
Condition class	<p>PCT 729 occurs in various conditions throughout the Exploratory Works disturbance footprint. As a result, five vegetation zones have been mapped:</p> <ul style="list-style-type: none"> • Moderate/good – High • Moderate/good – Medium • Moderate/good – Poor • Moderate/good – derived grassland • Moderate/good – other
Extent within Exploratory Works	<p>Moderate/good – High: 8.0 ha</p> <p>Moderate/good – Medium: 1.5 ha</p> <p>Moderate/good – Poor: 2.2 ha</p> <p>Moderate/good – Derived grassland: 1.4 ha</p> <p>Moderate/good – other: 4.3 ha</p>
Description	<p>Candlebark (<i>Eucalyptus rubida</i>), Broad-leaved Peppermint (<i>Eucalyptus dives</i>) and Robertsons Peppermint (<i>Eucalyptus robertsonii</i> subsp. <i>robertsonii</i>) dominate this community. The shrub layer comprises of Common Fringe-myrtle (<i>Calytrix tetragona</i>), Hoary guinea flower (<i>Hibbertia obtusifolia</i>), Mountain Banksia (<i>Banksia canei</i>), Native Blackthorn (<i>Busaria spinosa</i>), <i>Cassinia longifolia</i>, Dwarf Cherry (<i>Exocarpus strictus</i>), Wedge-leaved Wattle (<i>Acacia pravissima</i>), Silver wattle (<i>Acacia dealbata</i>), Daphne Heath (<i>Brachyloma daphnoides</i>), Pink Beard Heath (<i>Leucopogon ericoides</i>) and Showy Parrot Pea (<i>Dillwynia sericea</i>). Ground cover comprising of native forbs, sedges, rushes and grasses. Native grasses include Kangaroo Grass (<i>Themeda triandra</i>), Snowgrass (<i>Poa sieberiana</i> var. <i>sieberiana</i>), and <i>Dichelachne rara</i>. Native forbs, rushes and sedges recorded include Scaly Buttons (<i>Leptorhynchus squamatus</i>), Raspwort (<i>Gonocarpus teucrioides</i>), Poverty Raspwort (<i>Gonocarpus tetragynus</i>), Stinking Pennywort (<i>Hydrocotyle laxiflora</i>), Bears-ear (<i>Cymbonotus lawsonianus</i>), <i>Oxalis perennans</i>, Rough Bedstraw (<i>Galium gaudichaudii</i>), Tall Bluebell (<i>Wahlenbergia stricta</i>), Creeping Cudweed (<i>Euchiton japonicas</i>), Honeypots (<i>Acrotriche serrulata</i>), Small St Johns Wort (<i>Hypericum gramineum</i>), Wattle Mat-rush (<i>Lomandra filiformis</i> subsp. <i>coriacea</i>), Mat-rush (<i>Lomandra confertifolia</i>) and <i>Juncus usitatus</i>. A number of exotic species were recorded including Delicate Hairgrass (<i>Aira elegantissima</i>), Common Centaury (<i>Centaureum erythraea</i>), St John's Wort (<i>Hypericum perforatum</i>), Catsear (<i>Hypochaeris radicata</i>), Sweet Briar (<i>Rosa rubiginosa</i>) and Haresfoot Clover (<i>Trifolium arvense</i>).</p> <p>This community is mapped on lower slopes, adjacent to and in Lobs Hole. Occurs on fairly open sites on loam/clay soils.</p>
Survey effort	<p>Moderate/good – High: three plots (107, 1002, 1011)</p> <p>Moderate/good – Medium: one plot (1016)</p> <p>Moderate/good – Poor: two plots (1025, 1049)</p> <p>Moderate/good – Derived grassland: one plot (1045)</p> <p>Moderate/good – Other: two plots (1046, 1047)</p>

Table 5.10 **PCT 729 – Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion**

PCT 729 – Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion

Condition description	Areas assigned to the High condition class occur on the southern side of Lobs Hole, in areas where clearing has likely been less extensive and regeneration is more advanced, and thus most strata are present and disturbance is less evident. Areas assigned to the Medium, Poor, Other and Derived Grassland condition classes are located on the northern side the Yarrangobilly River and have been subject to varying levels of disturbance. Areas assigned to Derived Grassland and Other condition classes have been subject to clearing, with varying levels of regeneration (limited to nil respectively). These areas show a largely native shrub layer and groundcover. A small area in Poor condition has significant weed invasion. Areas in Medium condition have a mature overstorey, but shows moderate levels of disturbance, with some strata limited.
Characteristic species used for identification of PCT	According to the NSW VIS Classification Version 2.1, the canopy layer species recorded within this community align with the dominant species listed as characteristic for this PCT. These include Candlebark, Robertson's Peppermint and Broad-leaved Peppermint. Aligning shrub layer species include Daphne Heath, <i>Cassinia longifolia</i> and Silver Wattle. Understorey species that were used as an identifying species include Snowgrass and <i>Dichelachne rara</i> .
Justification of evidence used to identify the PCT	Apart from species composition, the stated distribution within the South Eastern Highland and Australian Alps IBRA Bioregions, and the location on fairly open sites on loam/clay soils, positioned on exposed, lower slopes is consistent with NSW VIS Classification Version 2.1.
Status	Commonwealth EPBC Act: not listed NSW BC Act: not listed
Estimate of percent cleared value of PCT	35%



Photograph 5.8

Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion – Plot 1002

Table 5.11 PCT 999 – Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion

PCT 999 – Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	
PCT ID	999
Common name	Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion
Condition class	Two condition classes have been mapped within the Exploratory Works disturbance footprint: <ul style="list-style-type: none"> • Moderate/good – High • Moderate/good – Derived grassland
Extent within Exploratory Works	Moderate/good – High: 0.5 ha Moderate/good – Derived grassland: 0.1 ha
Description	<p>Nortons Box (<i>Eucalyptus nortonii</i>), and Broad-leaved Peppermint (<i>Eucalyptus dives</i>) and dominate canopy within this community. The shrub layer comprises of Common Fringe-myrtle (<i>Calytrix tetragona</i>), Hoary guinea flower (<i>Hibbertia obtusifolia</i>), Native Blackthorn (<i>Busaria spinosa</i>), <i>Cassinia longifolia</i>, <i>Cassinia aculeate</i> subsp. <i>aculeate</i>, <i>Cassytha pubescens</i>, <i>Pimelea curviflora</i> var. <i>sericea</i>, Dwarf Cherry (<i>Exocarpus strictus</i>), Silver Wattle (<i>Acacia dealbata</i>), Daphne Heath (<i>Brachyloma daphnoides</i>), <i>Leucopogon virgatus</i> and Showy Parrot Pea (<i>Dillwynia sericea</i>). Ground cover comprising of native forbs, sedges, rushes and grasses. Native grasses include Kangaroo Grass (<i>Themeda triandra</i>), Snowgrass (<i>Poa sieberiana</i> var. <i>sieberiana</i>), Plumegrass (<i>Dichelachne hirtella</i>) Smooth-flower Wallaby Grass (<i>Rytidosperma pilosum</i>) and <i>Austrostipa scabra</i> subsp. <i>falcate</i>. Native forbs, rushes and sedges recorded include Poverty Raspwort (<i>Gonocarpus tetragynus</i>), Australian indigo (<i>Indigofera australis</i>), <i>Dianella longifolia</i> var. <i>longifolia</i>, <i>Cheilanthes sieberi</i>, Native Carrot (<i>Daucus glochidiatus</i>), Tufted Bluebell (<i>Wahlenbergia communis</i>), Tall Bluebell (<i>Wahlenbergia stricta</i>), Wattle Mat-rush (<i>Lomandra filiformis</i> subsp. <i>coriacea</i>), <i>Lepidosperma laterale</i>, Blue Flax Lily (<i>Dianella revolute</i> var. <i>revolute</i>) and Native Geranium (<i>Geranium solanderi</i> var. <i>solanderi</i>). A number of exotic species were recorded including Delicate Hairgrass (<i>Aira elegantissima</i>), Common Centaury (<i>Centaureum erythraea</i>), and St Johns Wort (<i>Hypericum perforatum</i>).</p> <p>This community is mapped on the lower reaches of Lobs Hole Ravine Road, on fairly shallow red brown soils with a loamy clay to silt clay texture.</p>
Survey effort	Moderate/good – High: one plot (136) Moderate/good – Derived grassland: One plot (218)
Condition description	This community was assigned to two condition class. Areas mapped as High have a largely intact strata, while areas of Derived Grassland have had the overstorey cleared due to an electricity easement. This has resulted in differences in cover of various species.
Characteristic species used for identification of PCT	According to the NSW VIS Classification Version 2.1, the canopy layer species recorded within this community align with the dominant species listed as characteristic for this PCT. These include Nortons Box and Broad-leaved Peppermint; the lack of Red Stringybark was used to differentiate this from PCT 311. Aligning shrub layer species include Common Fringe-myrtle and <i>Cassinia longifolia</i> while understorey species that were used as an identifying species include Snowgrass, <i>Austrostipa scabra</i> subsp. <i>falcate</i> , <i>Dianella longifolia</i> var. <i>longifolia</i> , Native Geranium and Kangaroo Grass.
Justification of evidence used to identify the PCT	Apart from species composition, the stated distribution is within the South Eastern Highland IBRA Bioregion and with a landscape position on lower slopes and valleys.
Status	Commonwealth EPBC Act: not listed NSW BC Act: not listed
Estimate of percent cleared value of PCT	15%



Photograph 5.9 **Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion – Plot 136**

Table 5.12 PCT 1196 – Snow Gum – Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion

PCT 1196 – Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	
PCT ID	1196
Common name	Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion
Condition class	Two condition classes have been mapped within the Exploratory Works disturbance footprint: <ul style="list-style-type: none"> • Moderate/good – High • Moderate/good – Derived grassland
Extent within Exploratory Works	Moderate/good – High: 0.1 ha Moderate/good – Derived grassland: 2.9 ha
Description	<p>Mountain Gum (<i>Eucalyptus dalrympleana</i>) and Snow Gum (<i>Eucalyptus pauciflora</i>), dominate the canopy within this community. There is a diverse shrub layer comprising of, <i>Daviesia ulicifolia</i>, <i>Daviesia mimosoides</i> subsp. <i>mimosoides</i>, <i>Platylobium formosum</i> subsp. <i>formosum</i>, Dolly Bush (<i>Cassinia aculeata</i>), Mountain Hickory (<i>Acacia obliquinerva</i>), Slender Rice-flower (<i>Pimelea linifolia</i> var. <i>linifolia</i>), Creamy Candles (<i>Stackhousia monogyna</i>), River Lomatia (<i>Lomatia myricoides</i>), Coffee Berry (<i>Coprosma hirtella</i>), Dwarf Cherry (<i>Exocarpus stricta</i>), Leaf Bossiaea (<i>Bossiaea foliosa</i>) an Blackwood (<i>Acacia melanoxylon</i>). Ground cover comprising of native forbs, sedges, rushes and grasses. Native grasses include Snowgrass (<i>Poa sieberiana</i> var. <i>sieberiana</i>), <i>Poa induta</i> and Tussock (<i>Poa labillardierei</i>). Native forbs, rushes and sedges recorded include Native Violet (<i>Viola betonicifolia</i>), Prickly Starwort (<i>Stellaria pungens</i>), Variable Glycine (<i>Glycine tabacina</i>), Native Geranium (<i>Geranium solanderi</i>), Small Poranthera (<i>Poranthere microphylla</i>), Trailing Speedwell (<i>Veronica plebeia</i>), Spiny-headed Mat-rush (<i>Lomandra longifolia</i>), Common Woodruff (<i>Asperula conferta</i>), Native Violet (<i>Viola betonicifolia</i>), Grass Trigger plant (<i>Stylidium graminifolium</i>), <i>Acaena agnipila</i>, Bulbine Lily (<i>Bulbine bulbosa</i>), Swamp Dock (<i>Rumex brownii</i>), <i>Senecio gunnii</i>, Alpine Shaggy Pea (<i>Podolobium alpestre</i>), Mountain Caladenia (<i>Caladenia alpine</i>), Common Buttercup (<i>Ranunculus lappaceus</i>), Slender Woodruch (<i>Luzula atrata</i>), Old Man's Beard (<i>Clematis aristata</i>), <i>Lomandra filiformis</i> subsp. <i>coriacea</i>, <i>Brachyscome spathulata</i> and Bidgee Widgee (<i>Acaena novae-zelandiae</i>). Exotic species such as Catsear (<i>Hyperchaeris radicata</i>), White Clover (<i>Trifolium repens</i>) and Blackberry (<i>Rubus fruticosus</i> sp. agg) were recorded within the community.</p> <p>This community occurs as a tall shrubby forest, and is found on the upper slopes and ridges along Lobs Hole Ravine Road to around 1,200 m. Found on brown to dark brown soils with a loamy clay texture. Depth of the soils varies between medium to deep.</p>
Survey effort	<p>Moderate/good – High: one plot (1038)</p> <p>Moderate/good – Derived grassland: one plot (1024 – this was entered twice into the calculator due to a lack of plots for this derived community).</p>
Condition description	This PCT is generally in High condition within the Exploratory Works project area, with large old trees present and minimal disturbance evident. An areas previously cleared beneath the powerline, to be used as a laydown area, is mapped in Derived grassland condition.
Characteristic species used for identification of PCT	According to the NSW VIS Classification Version 2.1, the canopy layer species recorded within this community align with the dominant species listed as characteristic for this PCT. These include Mountain Gum and Snow Gum. Aligning shrub layer species include <i>Daviesia ulicifolia</i> , <i>Daviesia mimosoides</i> subsp. <i>mimosoides</i> , <i>Platylobium formosum</i> subsp. <i>formosum</i> and Coffee Berry. while understorey species that were used as an identifying species include Snowgrass, Prickly Starwort, Bidgee Widgee, <i>Senecio gunnii</i> , Small Poranthera, Spiny-headed Mat-rush, Native Violet and <i>Brachyscome spathulata</i> .

Table 5.12 **PCT 1196 – Snow Gum – Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion**

PCT 1196 – Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	
Justification of evidence used to identify the PCT	Apart from species composition, the stated distribution is within the South Eastern Highland and Australian Alps IBRA Bioregions and landscape position along the upper slopes and ridges of Lobs Hole Ravine Road is consistent with NSW VIS Classification Version 2.1.
Status	Commonwealth EPBC Act: not listed NSW BC Act: not listed Justification: This VIS states that this PCT forms part of the Tablelands Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregions EEC. Due to the lack of grassy understory throughout these woodland it is not considered to align with the threatened ecological communities above.
Estimate of percent cleared value of PCT	5%



Photograph 5.10 **Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion – Plot 1038**

5.3.4 Assessment of patch size

For each vegetation zone within the Exploratory Works disturbance footprint, patch size was assessed using a select process in ArcGIS, using existing vegetation mapping (OEH 2016a) and aerial imagery. All intact native vegetation separated by a distance of less than 100 m (woody vegetation ecosystems) or 30 m (non-woody vegetation ecosystems) was mapped sequentially.

This process showed that vegetation within the Exploratory Works project area forms part of large patches of connecting vegetation throughout KNP, with patch sizes of greater than 100 ha. This patch size was used in the calculator.

5.3.5 Vegetation integrity score

The vegetation integrity score for each vegetation zone is presented in Table 5.13.

Table 5.13 Vegetation zones mapped within the Exploratory Works project area

Plant community type	Condition	Ancillary Code	Vegetation integrity score
PCT 285 – Broad-leaved Sally grass – sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	Moderate/good	Poor	67.5
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Low	-	8.5
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Moderate/good	High	63.9
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Moderate/good	Medium	54.5
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Moderate/good	Poor	4.2
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Moderate/good	Derived grassland	41.5
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Moderate/good	Other	68.4
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Moderate/good	High	57.6
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Moderate/good	Medium	56.2
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Moderate/good	Derived grassland	42.1

Table 5.13 **Vegetation zones mapped within the Exploratory Works project area**

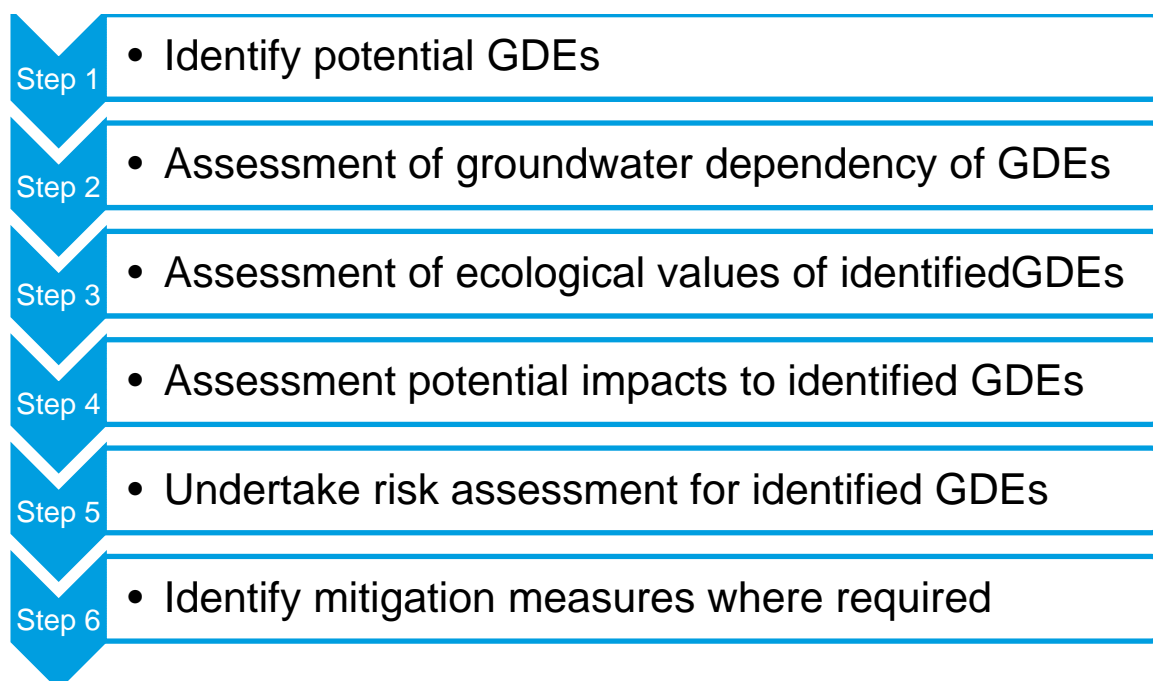
Plant community type	Condition	Ancillary Code	Vegetation integrity score
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Moderate/good	Other	29
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	Low	-	15
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	Moderate/good	High	62.2
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	Moderate/good	Poor	26.6
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	Moderate/good	Derived Grassland	55.2
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	Moderate/good	Other	49.7
PCT 311 - Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	Moderate/good	High	51.8
PCT 311 - Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	Moderate/good	Medium	70.8
PCT 643 - Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion	Low	-	9.2
PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Moderate/good	High	63.5
PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Moderate/good	Medium	63.6
PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Moderate/good	Poor	66.2
PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Moderate/good	Derived grassland	11.1

Table 5.13 **Vegetation zones mapped within the Exploratory Works project area**

Plant community type	Condition	Ancillary Code	Vegetation integrity score
PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Moderate/good	Other	50.8
PCT 999 - Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	Moderate/good	High	64
PCT 999 - Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	Moderate/good	Derived grassland	38.3
PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	Moderate/good	High	71.3
PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	Moderate/good	Derived grassland	39.7

5.4 Groundwater dependent ecosystems

A groundwater dependent ecosystem (GDE) risk assessment has been completed in accordance with the NSW Government *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (Serov et al. 2012). This assessment follows the process detailed below:



5.4.1 Identification of potential GDEs

Ecosystems that could rely on either the surface or subsurface expression of groundwater within or surrounding the Exploratory Works project area are those associated with:

- creeks where deep groundwater is discharging and provides baseflow. This includes the Yarrangobilly River and some drainage lines in the northern and western areas of the project area;
- shallow (perched) groundwater systems;
- springs associated with the steep escarpment across the eastern extent of the Exploratory Works project area; and
- terrestrial vegetation overlying shallow groundwater (within the vegetation's root zone).

These ecosystems have been classified into three categories according to their dependence on groundwater:

- non-dependent;
- facultative;
- entirely dependent/obligate:
 - opportunistic;
 - proportional; and
 - highly dependent.

Considerations in evaluating PCTs and their potential dependency on groundwater included:

- the physiology of plant species that occur in that community and their likely dependence on water availability;
- the PCTs location in the landscape; and
- if the rooting depth of vegetation would be able to take up groundwater based on likely depth of the aquifer and soil characteristics.

Access to the groundwater is dependent on a number of factors with the core factor being the depth to the watertable. As terrestrial vegetation communities are composed of a range of vegetation types with a range of rooting depths and strategies there is a relationship between groundwater depth and the types and composition of the vegetation that is able to access it (Serov P 2013).

i Potential GDEs

There are no listed high priority terrestrial or aquatic GDEs within the *Water Sharing Plan for the Murrumbidgee Unregulated and Alluvial Water Sources 2012*. Yarrangobilly Caves is a High Priority GDE listed within the *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011*; Yarrangobilly Caves is located within the groundwater model domain for the whole project, approximately 8 km north of the current Project area. The Yarrangobilly Caves is considered an obligate-highly dependent GDE; their formation over time and current structure is maintained by groundwater levels, flow and quality. Yarrangobilly Caves has been studied, and monitored, as part of the groundwater assessment, and there are no impacts predicted to occur at Yarrangobilly Caves as a result of the Exploratory Works (EMM 2018a). They are not considered further in this assessment.

Terrestrial vegetation overlies shallow groundwater (0-5 mbgl) across most of the Exploratory Works project area, with higher vegetation density occupying riparian corridors adjacent the Yarrangobilly River and adjoining tributaries, such as Stable Creek and Wallaces Creek. Mapping of groundwater depths across the project area was undertaken as a part of the groundwater assessment (EMM 2018b). This information was used to undertake an assessment of potential terrestrial GDEs was undertaken against all PCTs recorded within the survey area, and is provided in Table 5.14.

Table 5.14 Terrestrial GDE assessment

Plant community type	Area (ha)	Assigned category of groundwater dependency	Justification
PCT 285 – Broad-leaved Sally grass – sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	5.41	Facultative	This community occurs on alluvial or colluvial soils, and is found lining creeks adjacent to the Yarrangobilly River and on hill slopes in the locality. This PCT occurs in areas where groundwater is less than 5 m deep and, therefore, has potential to access groundwater sporadically at these locations. The PCT is likely to be maintained by surface water inflows from creeks and watercourses, with some minor dependence on groundwater during periods of drought or low flow.
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	42.51	Facultative	This PCT occurs broadly across the survey area, on mid to lower slopes, including in some areas where groundwater is less than 5 m deep. This community does not occur in areas where groundwater flows are likely to be concentrated, such as riparian areas or gullies. A conservative assessment has been undertaken and it is assumed that this PCT has a facultative reliance on groundwater, with some dependence on groundwater inflows to maintain structure and function.
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	8.12	Non-dependent	This community does not occur in areas of shallow groundwater.
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	10.38	Entirely/obligate - proportional	This community is located in alluvial and colluvial soils along the Yarrangobilly River. The watercourses in the project area are generally gaining streams, where the base of a stream is lower in elevation than the surrounding water table, and the stream can gain water from groundwater inflow (ie baseflow). Based on this, the vegetation along this zone is likely to be entirely/obligate groundwater dependent, with an opportunistic dependency where the PCT gets some of its water requirements via groundwater, but can exist without the input of groundwater, as long as there is no prolonged drought.
PCT 311 - Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	7.17	Non-dependent	This community does not occur in areas of shallow groundwater.

Table 5.14 **Terrestrial GDE assessment**

Plant community type	Area (ha)	Assigned category of groundwater dependency	Justification
PCT 643 - Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion	0.12	Non-dependent	This community does not occur in areas of shallow groundwater.
PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	17.34	Non-dependent	This community does not occur in areas of shallow groundwater.
PCT 999 - Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	0.64	Non-dependent	This community does not occur in areas of shallow groundwater.
PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	2.73	Non-dependent	This community does not occur in areas of shallow groundwater.

Three of the native vegetation types in the Exploratory Works survey area are considered GDEs:

- PCT 285 – Broad-leaved Sally grass – sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion;
- PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion; and
- 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.

GDEs within the survey area are deemed to have high ecological value, based on their occurrence with KNP, good water quality and quantity parameters and aquifer structure given limited disturbance, patch size criteria given high levels of connectivity, and delivery of ecosystem services.

All other PCTs are considered non-dependent.

5.4.2 Assessment of potential groundwater impacts

A detailed assessment of potential groundwater impacts is provided in EMM (2018b).

The surface water feature closest to the proposed exploratory tunnel, and therefore most likely to experience impacts from its construction, is the Yarrangobilly River. Modelled baseflow to the Yarrangobilly River, along with its tributaries Wallaces Creek, Stable Creek, Milk Shanty Creek and Mill Creek, is presented in Table 5.15. Impacts have been presented for the base case and maximum plausible impact scenario as both absolute modelled values and percentage change.

In both cases the maximum reduction in baseflow does not occur during construction, but develops once the system has reached a new equilibrium. The base case and maximum plausible impact scenarios predict baseflow reduction of 0.67% (19 ML/yr) and 2.29% (178 ML/yr) respectively. The corresponding predicted steady state tunnel inflows are 104 ML/yr and 214 ML/yr, with the remaining difference attributed to a localised reduction in evapotranspiration primarily around the portal and first few hundred metres of tunnel.

Table 5.15 Modelled baseflow to Yarrangobilly River

Time	Base case		Maximum plausible impact	
	Baseflow (ML/yr)	Change	Baseflow (ML/yr)	Change (%)
Present day steady state	2,799	n/a	7,774	n/a
1 year into construction	2,798	-0.05%	7,765	-0.11%
End of construction	2,795	-0.14%	7,760	-0.18%
Post construction steady state	2,781	-0.67%	7,596	-2.29%

The lowest monthly stream flow 390 ML/month (4,680 ML/yr), with a modelled 60% contributed by baseflow. The model predicts a reduction baseflow of between 19 and 178 ML/yr, representing 0.4% to 3.8% of lowest monthly stream flow. This level is considered negligible and highly unlikely to impact on GDEs.

5.4.3 Final risk assessment for identified GDEs

Based on the ecological values of the GDEs present in the project area and the impacts arising from the project, the overall risk assessment, prepared in accordance with Serov et al. (2012), GDEs are considered as having high ecological value/low risk of impact (category A).

The mitigation measures required by Serov et al. (2012) for this risk level include:

- protection measures for aquifer and GDEs;
- continue protection measures for aquifers and GDEs;
- undertake baseline risk monitoring;
- undertake periodic monitoring and assessment; and
- continue monitoring as a part of adaptive management.

Management and monitoring of groundwater is outlined in EMM (2018b).

6 Threatened species

6.1 Fauna habitat assessment

Concurrent with the vegetation mapping a habitat assessment was undertaken seeking to identify the following fauna habitat features within the Exploratory Works survey area:

- habitat trees including large hollow-bearing trees;
- availability of flowering shrubs and feed tree species;
- waterway condition;
- quantity of ground litter and logs; and
- searches for indirect evidence.

This habitat assessment identified that in sections of the Exploratory Works survey area where disturbance has been limited, fauna habitat features are abundant. In areas subject to disturbance such as clearing, fauna habitat features are limited.

The upper section of Lobs Hole Ravine Road consist of tall wet sclerophyll forests to 40 m, dominated by Mountain Gum, Snow Gum and Alpine Ash (*Eucalyptus delagatensis*), with a shrubby to grassy understorey. Habitat complexity at ground level is high. In this area, hollows are abundant with good numbers of large, old trees. Large logs, coarse woody debris and leaf litter are abundant on ground, providing shelter for a high number of fauna species. Watercourses are limited, and where they occur, are ephemeral and only found to flow for brief periods after heavy rains.

Below approximately 1,200 m, vegetation transitions to drier sclerophyll forests with a shrubby understorey. Broad-leaved Peppermint, Robertson's Peppermint and Brittle Gum dominate the overstorey, with a sparse to moderately dense shrubby midstorey and sparse grassy groundcover. In these areas, hollows are limited to old, mature trees which tend to be rare. Large logs, coarse woody debris and leaf litter are also less common, provided more limited habitat for fauna species. Watercourses are more abundant on steep slopes, but are even more highly ephemeral and only found to flow for brief periods after heavy rains. This vegetation extends down into Lobs Hole and includes areas outside the riparian zone and includes the northern end of Talbingo Reservoir.

Along intermittent and permanent watercourses in Lobs Hole a number of riparian communities occur. Where these communities are intact, large trees are moderately common and support large hollows. In many sections of the Exploratory Works survey area, the midstorey and understorey are heavily disturbed, with significant weed invasion particularly thickets of Blackberry. Where weeds are not present, a dense shrubby midstorey is present over a sparse groundcover. Coarse woody debris, logs and leaf litter varies from absent to moderately sparse, depending on past disturbance. There are limited areas considered to be of good quality for fauna species.

In Lobs Hole and at Talbingo Reservoir there are large sections of the Exploratory Works project area which have been cleared and lack many structural elements. These areas provide minimal habitat for fauna species.

6.2 Ecosystem credit species assessment

A list of ecosystem credit species predicted to occur within the Exploratory Works survey area, based on the PCTs present and generated by the calculator associated within the BAM (OEH 2017) is provided in Table 6.1. The potential for these species to occur within the Exploratory Works disturbance footprint was assessed in accordance with Section 6.2 of the BAM (OEH 2017).

Table 6.1 **Assessment of ecosystem credit species within the Exploratory Works disturbance footprint**

Scientific name	Common name	Justification for exclusion
<i>Artamus cyanopterus cyanopterus</i>	Dusky Woodswallow	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo (Foraging)	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
<i>Chthonicola sagittata</i>	Speckled Warbler	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
<i>Daphoenositta chrysoptera</i>	Varied Sittella	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	Not excluded.
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle (Foraging)	The White-bellied Sea-eagle feeds on fish and freshwater turtles, but also waterbirds, reptiles, mammals and carrion, using a perch near water. Species excluded from all PCTs not associated with the Yarrangobilly River or Talbingo Reservoir (all PCTs except PCTs 296, 300 and 302) and from cleared vegetation zones (condition class Low or Derived grassland).
<i>Hieraaetus morphnoides</i>	Little Eagle (Foraging)	Not excluded.
<i>Lophoictinia isura</i>	Square-tailed Kite	Not excluded.
<i>Melanodryas cucullata cucullata</i>	Hooded Robin	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat (Foraging)	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
<i>Neophema pulchella</i>	Turquoise Parrot	Not excluded.
<i>Ninox connivens</i>	Barking Owl (Foraging)	Not excluded.
<i>Ninox strenua</i>	Powerful Owl (Foraging)	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
<i>Pachycephala olivacea</i>	Olive Whistler	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
<i>Petaurus australis</i>	Yellow-bellied Glider	Excluded from cleared vegetation zones (condition class Low or Derived grassland) due to lack of hollow bearing trees.
<i>Petroica boodang</i>	Scarlet Robin	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
<i>Petroica phoenicea</i>	Flame Robin	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
<i>Phascolarctos cinereus</i>	Koala (Foraging)	Excluded from all PCTs as the species is rare in KNP and no evidence was observed during targeted surveys.
<i>Pseudomys fumeus</i>	Smokey Mouse	Excluded from Derived grassland vegetation zone of PCT 1196.
<i>Stagonopleura guttata</i>	Diamond Firetail	Not excluded.
<i>Tyto novaehollandiae</i>	Masked Owl	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
<i>Varanus rosenbergi</i>	Rosenberg's Goanna	Not excluded.

6.3 Species credit species assessment

6.3.1 Habitat constraints assessment (Step 2)

An assessment of habitat constraints for threatened species was undertaken in accordance with Step 2 of Section 6.4 of the BAM (OEH 2017). For those threatened species predicted to occur, for which habitat constraints are listed, an assessment was undertaken of the presence of the habitat features within the Exploratory Works survey area.

The species generated by the calculator with habitat constraints, as well as the results of the habitat constraints assessment, are shown in Table 6.2.

Table 6.2 **Assessment of habitat constraint features within the Exploratory Works survey area**

Scientific name	Common name	Feature	Sensitivity to gain class	Habitat constraint present in development site	Justification
<i>Grevillea iaspicula</i>	Wee Jasper Grevillea	Confined to an area between 0 and 10 km west of the Goodradigbee River and extending 5 km to the south and 15 km to the north of Wee Jasper	High	No	The Exploratory Works survey area is not located in any of the areas identified in the calculator.
<i>Litoria spenceri</i>	Spotted Tree Frog	Waterbodies River environments with rocky habitat or with 500 m of rocky river	Very high	Yes	The survey area contains waterbodies and river environments with rocky habitat.
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	Hollow bearing trees	High	Yes	The survey area contains hollow bearing trees.
<i>Pomaderris cotoneaster</i>	Cotoneaster Pomaderris	South of northern KNP boundary	High	Yes	The survey area is located to the south of the northern boundary of KNP.
<i>Pseudophryne pengilleyi</i>	Northern Corroboree Frog	Above 700 m above sea level (ASL)	Very high	Yes	The majority of Lobs Hole Ravine Road is located above 700 m ASL. Lobs Hole, where the majority of works will be sited, is located below this elevation.
<i>Thesium australe</i>	Austral Toadflax	Kosciuszko National Park	Moderate	Yes	The project area is located within KNP.

Using the process outlined in Step 2 of Section 6.4 of the BAM (OEH 2017) only one species, Wee Jasper Grevillea, was excluded from requiring further consideration. No further assessment is required as per section 6.4.1.13 of the BAM (OEH 2017).

The Spotted Tree Frog, Brush-tailed Phascogale, Cotoneaster Pomaderris, Northern Corroboree Frog and Austral Toadflax have not been excluded on the basis of the identified habitat constraints. Further consideration is given to these species in Section 6.3.2.

6.3.2 Identifying candidate species credit species for further assessment (Step 3)

To develop a list of species credit species for further assessment, an assessment was undertaken in accordance with Step 3 of Section 6.4 of the BAM (OEH 2017), as shown in Table 6.3.

Table 6.3 Species credit species and status and habitat suitability assessment

Scientific name	Common name	Candidate species	Justification
Flora			
<i>Pomaderris cotoneaster</i>	Cotoneaster Pomaderris	Yes	<p>Cotoneaster Pomaderris has a very disjunct distribution, being known from the Nungatta area, northern KNP (near Tumut). Cotoneaster Pomaderris has been recorded in a range of habitats in predominantly forested country. The habitats include forest with deep, friable soil, amongst rock beside a creek, on rocky forested slopes and in steep gullies between sandstone cliffs.</p> <p>Although unlikely to occur, based on the species geographic distribution, the survey area contains forest and rocky forested slopes that are considered suitable habitat to support this species based on the limited understanding of the species ecology.</p>
<i>Thesium australe</i>	Austral Toadflax	Yes	<p>Austral Toadflax occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast, often in association with Kangaroo Grass (<i>Themeda australis</i>) and often in wet areas. This species is a root parasite that takes water and some nutrients from other plants, especially Kangaroo Grass. This species is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands region.</p> <p>Most PCTs within the Exploratory Works survey area are unlikely to support this species, as they are shrubby and lack moist areas. Suitable damp, grassy woodland habitat likely to be restricted to PCT 285 and damp areas of PCT 1196 within the project area.</p>
Fauna			
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo (Breeding)	Yes	<p>In spring and summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. Nests are located in hollows that are 10 cm in diameter or larger and at least 9 m above the ground in eucalypts. The Exploratory Works survey area contains suitable breeding habitat to support this species.</p>
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	Yes	<p>The Eastern Pygmy-possum is found in a broad range of habitats from rainforest through sclerophyll forest and woodland to heath, but in most areas woodlands and heath appear to be preferred. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes. Also feeds on insects throughout the year. This feed source may be more important in habitats where flowers are less abundant such as wet forests. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (<i>Pseudocheirus peregrinus</i>) dreys or thickets of vegetation (eg grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks.</p> <p>The Exploratory Works survey area supports suitable habitat for this species.</p>

Table 6.3 **Species credit species and status and habitat suitability assessment**

Scientific name	Common name	Candidate species	Justification
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle (Breeding)	No	<p>Habitats are characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea. Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. Nest trees are typically large emergent eucalypts and often have emergent dead branches or large dead trees nearby which are used as 'guard roosts'. Nests are large structures built from sticks and lined with leaves or grass.</p> <p>No nests suitable for the species were observed during the habitat assessment. Breeding habitat unlikely to occur within the Exploratory Works survey area.</p>
<i>Hieraetus morphnoides</i>	Little Eagle	No	<p>The Little Eagle occupies open eucalypt forest, woodland or open woodland. Sheoak or <i>Acacia</i> woodlands and riparian woodlands of interior NSW are also used. The species nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter.</p> <p>No nests suitable for the species were observed during the habitat assessment. Breeding habitat unlikely to occur within the Exploratory Works survey area.</p>
<i>Litoria booroolongensis</i>	Booroolong Frog	Yes	<p>The Booroolong Frog is associated with permanent streams in a variety of vegetation types. Primary habitat requirements are extensive rock bank structures along permanent rivers with the key feature of these rock structures being rock crevices in relatively shallow, slow to medium-flowing sections of stream.</p> <p>Suitable habitat for this species was identified along the Yarrangobilly River and Wallaces Creek within the Exploratory Works survey area during the habitat assessment.</p>
<i>Litoria spenceri</i>	Spotted Tree Frog	No	<p>The Spotted Tree Frog is extremely rare and occurs in scattered, geographically isolated populations. Historically it was known from two streams in southern NSW on the north-west side of the Great Dividing Range; however both populations appeared to have become locally extinct. One population has been re-established via a reintroduction program. Occur among boulders or debris along naturally vegetated, rocky fast flowing upland streams and rivers.</p> <p>Due to the extremely limited population distribution in NSW this species is considered unlikely to occur within the Exploratory Works survey area (D. Hunter pers. comm.).</p>
<i>Litoria verreauxii alpina</i>	Alpine Tree Frog	No	<p>The Alpine Tree Frog occurs in the south-eastern NSW and Victorian high country (alpine and sub-alpine zones) generally above 1,100 m ASL. Most locations are within the KNP and some are close to alpine resorts. Found in a wide variety of habitats including woodland, heath, grassland and herb fields. Breed in natural and artificial wetlands including ponds, bogs, fens, streamside pools, stock dams and drainage channels that are still or slow flowing.</p> <p>The majority of the works are located below 1,100 m ASL, and therefore outside of this species habitat distribution. Areas within the Exploratory Works survey area above 1,100 m ASL do not support suitable sub-alpine stream habitat with streamside pools, or other still waterbodies suitable for the species. This species is unlikely to occur within the Exploratory Works survey area.</p>

Table 6.3 **Species credit species and status and habitat suitability assessment**

Scientific name	Common name	Candidate species	Justification
<i>Lophoictinia isura</i>	Square-tailed Kite (Breeding)	No	<p>The Square-tailed Kite is found in a variety of timbered habitats including dry woodlands and open forests. The species shows a particular preference for timbered watercourses, where nests are constructed in a fork or on large, horizontal limbs.</p> <p>No nests suitable for the species were observed during the habitat assessment. Breeding habitat unlikely to occur within the Exploratory Works survey area.</p>
<i>Mastacomys fuscus</i>	Broad-toothed Rat	Yes	<p>The Broad-toothed Rat occurs in two widely separated areas: the wet alpine and subalpine heaths and woodlands in KNP. The Broad-toothed Rat lives in a complex of runways through the dense vegetation of its wet grass, sedge or heath environment, and under the snow in winter. Food is mostly, gathered at night, in summer and autumn and during the afternoon and early evening in winter. The diet consists almost solely of greenery - grass and sedge stems, supplemented by seeds and moss spore cases.</p> <p>Open grassy woodlands within the Exploratory Works survey area, in sub-alpine areas in the upper reaches of Lobs Hole Ravine, and a small area of dense <i>Poa</i> spp. dominated grassland adjacent to the Mines Trail in Lobs Hole Ravine was considered marginal habitat for this species.</p>
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat (Breeding)	No	<p>Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Maternity caves have very specific temperature and humidity regimes, and are known from a limited number of sites across the species range.</p> <p>The Exploratory Works survey area contains no suitable roosting structures for this species. This species is unlikely to roost within the project area.</p>
<i>Ninox connivens</i>	Barking Owl (Breeding)	Yes	<p>Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Roost in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as Acacia and Casuarina species. It typically breeds in hollows of large eucalypts or paperbarks, usually near watercourses or wetlands. Nest-hollow entrances are 2-35 m above the ground with a diameter of 20-46 cm and depth of 20-300 cm. During nesting season, the male perches in a nearby tree overlooking the hollow entrance.</p> <p>The Exploratory Works survey area contains suitable habitat. Suitable nesting habitat is limited to areas of mature trees that are mainly located along the Yarrangobilly River.</p>
<i>Ninox strenua</i>	Powerful Owl (Breeding)	Yes	<p>The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest, requiring large tracts of forest or woodland habitat. The species nests in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. Nest in unburnt gullies and lower slopes within 100 m of streams.</p> <p>The Exploratory Works survey area contains suitable habitat. Suitable nesting habitat is limited to areas of mature trees along the Yarrangobilly River.</p>

Table 6.3 Species credit species and status and habitat suitability assessment

Scientific name	Common name	Candidate species	Justification
<i>Petaurus norfolcensis</i>	Squirrel Glider	Yes	<p>The Squirrel Glider inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. The species prefers mixed species stands with a shrub or Acacia mid-storey. The species relies on large old trees with hollows for breeding and nesting; however, trees need to be less than 50 m apart.</p> <p>Suitable feed and nesting trees are limited to the habitat along the Yarrangobilly River and the upper sections of Lobs Hole Ravine Road within the Exploratory Works survey area.</p>
<i>Petroica rodinogaster</i>	Pink Robin	Yes	<p>Inhabits rainforest and tall, open eucalypt forest, particularly in densely vegetated gullies. Like most Robins, requires perching habitat from which it can predate insects and spiders, but does spend significant time on the ground.</p> <p>Potential for the species to occur within the Exploratory Works survey area.</p>
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	Yes	<p>The Brush-tailed Phascogale prefers dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. The species also inhabits heath, swamps, rainforest and wet sclerophyll forest. Nests and shelters in tree hollows with entrances 2.5 - 4 cm wide. Known to use many different hollows over a short time span.</p> <p>Although the species is scarce in the KNP, with a single record, the species is retained as a candidate species.</p>
<i>Phascolarctos cinereus</i>	Koala	Yes	<p>Koalas live in eucalypt woodlands and forests. Home range size varies according to quality of habitat, ranging from less than two to several hundred hectares. The trees within the Exploratory Works project area provide foraging or sheltering resources for Koala. Ribbon Gum, identified as a Koala feed tree, is present within the Exploratory Works project area.</p> <p>Recent Koala records are scarce in the KNP; however, as suitable habitat exists, the species is retained as a candidate species.</p>
<i>Pseudomys fumeus</i>	Smoky Mouse (Breeding)	Yes	<p>The precise habitat requirements of the Smoky Mouse are not clear. A wide range of vegetation communities are occupied, from damp coastal heath in East Gippsland, to sub-alpine heath. A characteristic of Smoky Mouse localities, except those in wet gullies, is a floristically diverse shrub layer with members of the plant families Epacridaceae, Fabaceae and Mimosaceae well represented. Ground cover is also likely to be critical and can be in the form of dense low vegetation, such as occurs in heaths, or grass tussocks, rocks and logs in more open habitats. Soil conditions also need to be conducive to burrowing and growth of hypogeal fungi, a major component of the diet (Menkhorst and Broome 2008a, 2008b).</p> <p>Suitable habitat for this species is located in the higher regions of the Exploratory Works survey area above 1,100 m along Lobs Hole Ravine Road.</p>

Table 6.3 **Species credit species and status and habitat suitability assessment**

Scientific name	Common name	Candidate species	Justification
<i>Pseudophryne pengilleyi</i>	Northern Corroboree Frog	No	<p>The Northern Corroboree Frog occurs in forests, sub-alpine woodlands and tall heath in the Fiery Range from the Snowy Mountains Highway to Wee Jasper. Populations also occur in the pine plantations near Tumut. Summer breeding habitat includes pools and seepages in sphagnum bogs, wet heath, wet tussock grasslands and herbfields in low-lying depressions. Outside the breeding season adults move away from the bogs into the surrounding heath, woodland and forest to overwinter under litter, logs and dense groundcover.</p> <p>The area of the Exploratory Works survey area above 700 m ASL does not provide suitable habitat for this species, either within or in proximity to survey area.</p>
<i>Tyto novaehollandiae</i>	Masked Owl (Breeding)	Yes	<p>The Masked Owl lives in dry eucalypt forests and woodlands from sea level to 1,100 m. The species requires old hollow-bearing eucalypts greater than 90 cm diameter at breast height, with hollows greater than 40 cm wide, greater than 100 cm deep and at least 3 m above the ground, for breeding. Will breed in a variety of topographic positions.</p> <p>The Exploratory Works survey area contains suitable nesting habitat along the upper reaches of Lobs Hole Ravine Road and along the Yarrangobilly River, where suitable sized hollows are present.</p>

This assessment identified the following species as candidate species requiring further assessment:

- Cotoneaster Pomaderris;
- Austral Toadflax;
- Gang-gang Cockatoo (breeding habitat only);
- Eastern Pygmy-possum;
- Booroolong Frog;
- Broad-toothed Rat;
- Barking Owl (breeding habitat only);
- Powerful Owl (breeding habitat only);
- Squirrel Glider;
- Pink Robin;
- Brush-tailed Phascogale;
- Koala;
- Smoky Mouse (breeding habitat only); and
- Masked Owl (breeding habitat only).

The following additional species were included as candidate species for the purposes of the EPBC Act assessment process (EMM 2018e):

- Three threatened flora species:
 - Curtis' Colobanth (*Colobanthus curtisiae*);
 - Blue-tongued Greenhood (*Pterostylis oreophila*);
- Three migratory bird species:
 - Rainbow Bee-eater;
 - Satin Flycatcher;
 - Rufous Fantail; and
- The Greater Glider (*Petauroides volans*).

Targeted surveys were undertaken, and the presence or absence of these species in the Exploratory Works survey area determined, in accordance with Section 6.4 of the BAM (OEH 2017). Survey methods and outcomes are discussed further below.

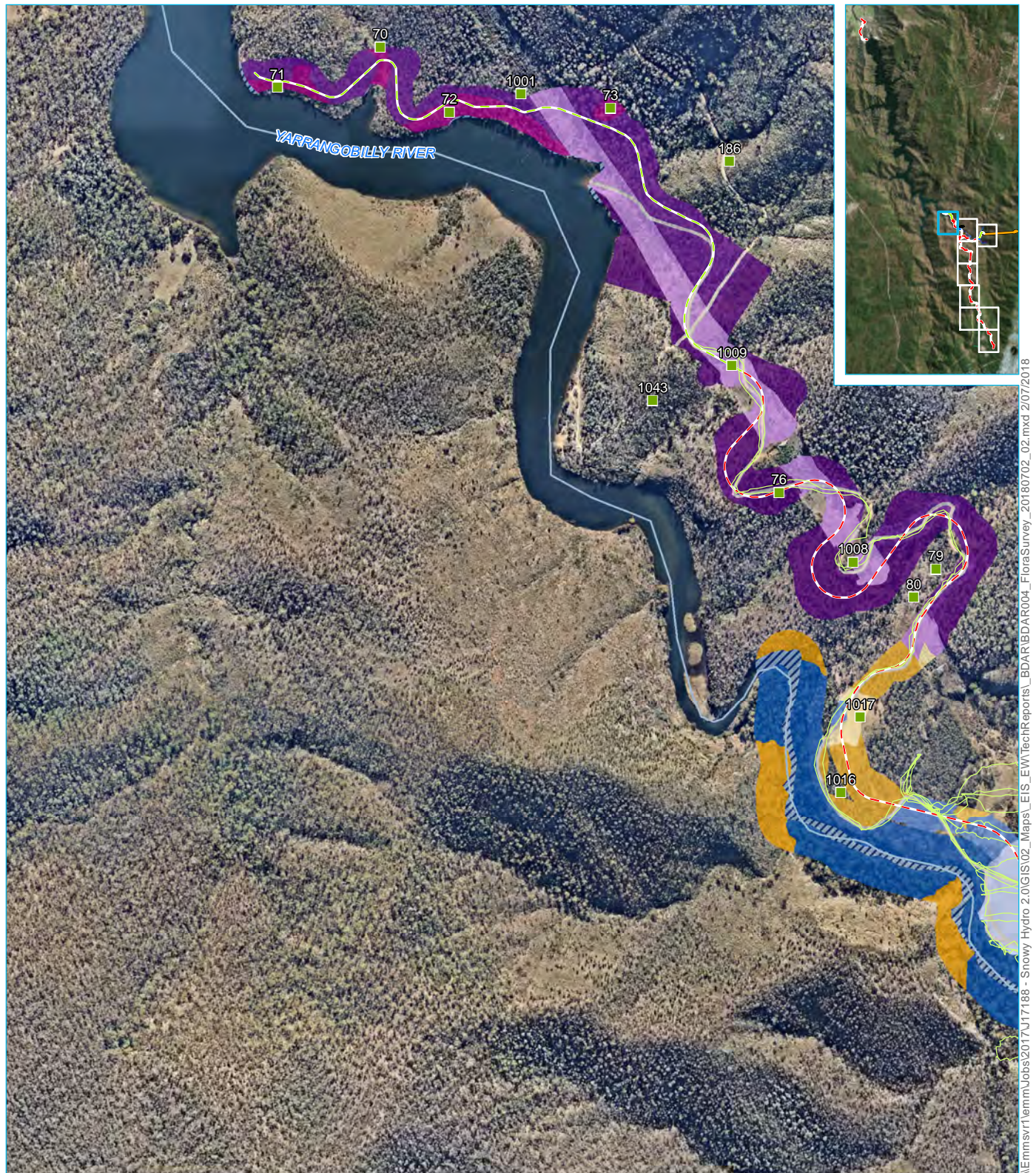
6.3.3 Targeted survey methods

i Targeted flora surveys

Targeted flora surveys have been undertaken in accordance with OEH (2016c) and DoE (2013) guidelines, and included transects spaced at intervals of 10 m. Targeted surveys along roads were undertaken with an observer walking either side of the road 5 to 7 m from the road edge.

Areas with basalt derived soils along Lobs Hole Ravine Road in the south of the survey area, and areas dominated by Kangaroo Grass were targeted based on suitability of habitat for candidate species. As the likelihood of threatened flora species occurring in many montane PCTs is low, surveys focused on sub-alpine areas and suitable habitat, with targeted flora surveys in montane areas limited to key microhabitats, such as along riparian areas for *Cotoneaster Pomaderris*.

Targeted flora surveys were undertaken within the survey area between December 2017 and January 2018. Targeted flora survey locations are illustrated in Figure 6.1.



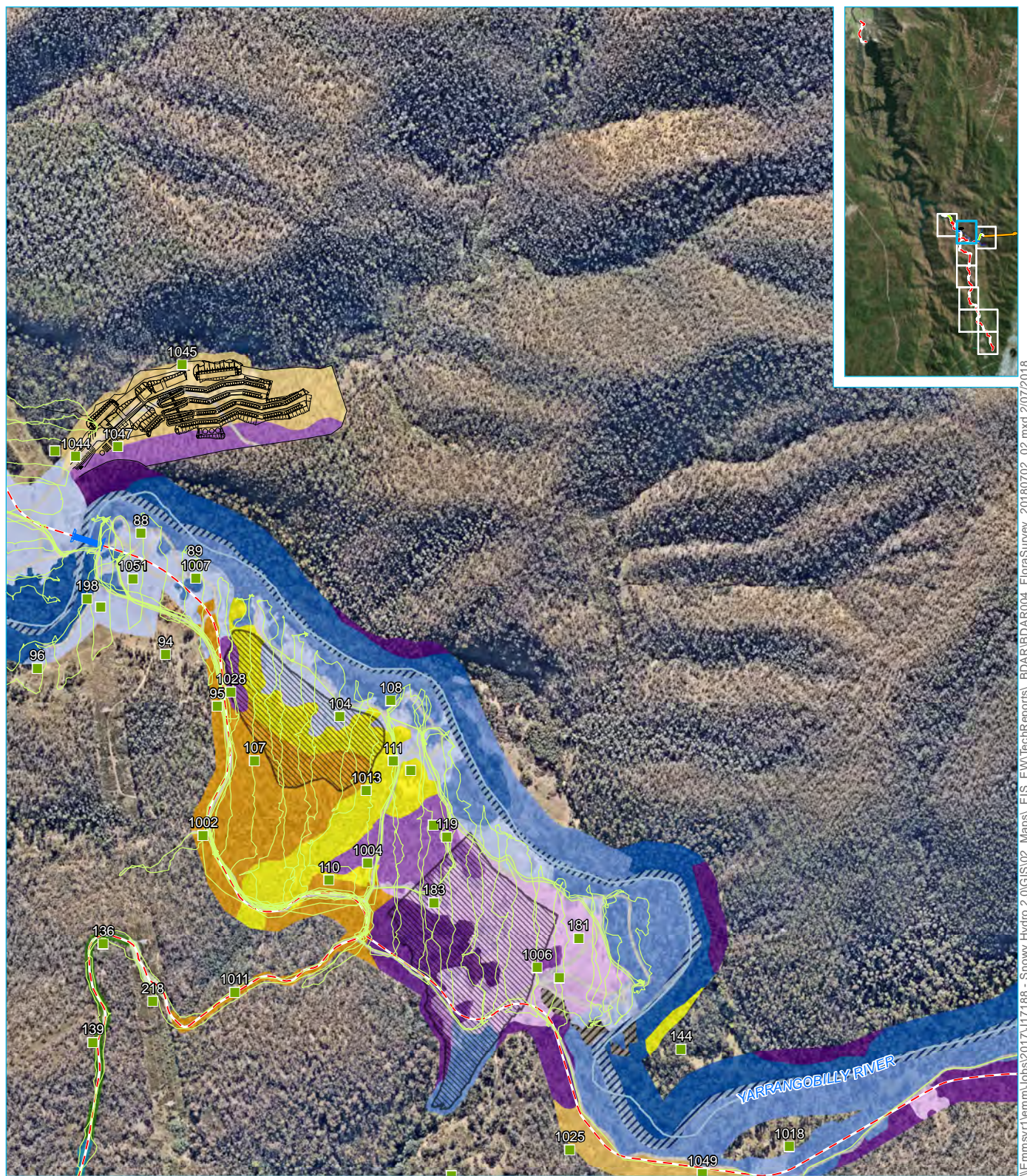
Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); Robert Bird (2018); DFSI (2017)

KEY

- Plot location
- Flora survey transect
- Exploratory tunnel
- - - Access road upgrade
- - - Access road extension
- Watercourse
- Cleared land
- Water
- PCT 296
 - Moderate/good - High
 - Moderate/good - Medium
 - Moderate/good - Derived grassland
- PCT 300
 - Moderate/good - High
- PCT 302
 - Moderate/good - High
 - Moderate/good - Medium
 - Moderate/good - Other
 - Low
- PCT 729
 - Moderate/good - High
 - Moderate/good - Medium
 - Moderate/good - Poor
 - Moderate/good - Other
 - Moderate/good - Derived grassland

Flora survey locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 6.1a



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

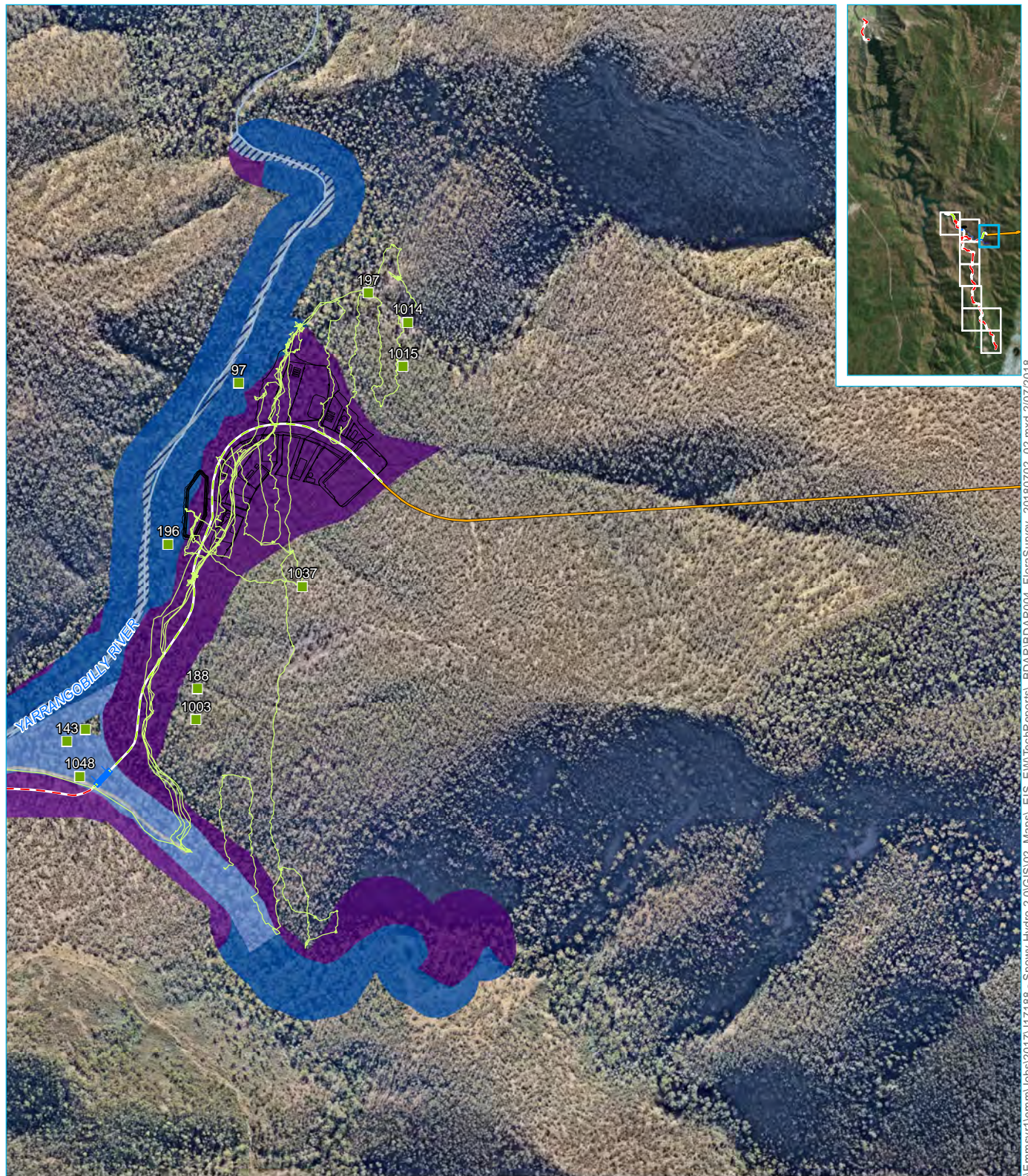
KEY

■ Plot location	PCT 296	■ Low
— Flora survey transect	■ Moderate/good - High	PCT 311
— Exploratory tunnel	■ Moderate/good - Medium	■ Moderate/good - High
— Access road upgrade	■ Moderate/good - Poor	PCT 729
— Access road extension	■ Moderate/good - Other	■ Moderate/good - High
— Permanent bridge	■ Moderate/good - Derived grassland	■ Moderate/good - Poor
— Accommodation camp conceptual layout	■ Low	■ Moderate/good - Other
■ On land rock management	PCT 302	■ Moderate/good - Derived grassland
— Watercourse	■ Moderate/good - High	PCT 999
■ Cleared land	■ Moderate/good - Medium	■ Moderate/good - High
■ Heavily disturbed land	■ Moderate/good - Poor	■ Moderate/good - Derived grassland
■ Water	■ Moderate/good - Other	
PCT 285	■ Moderate/good - Derived grassland	
■ Moderate/good - Poor		

Flora survey locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 6.1b





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

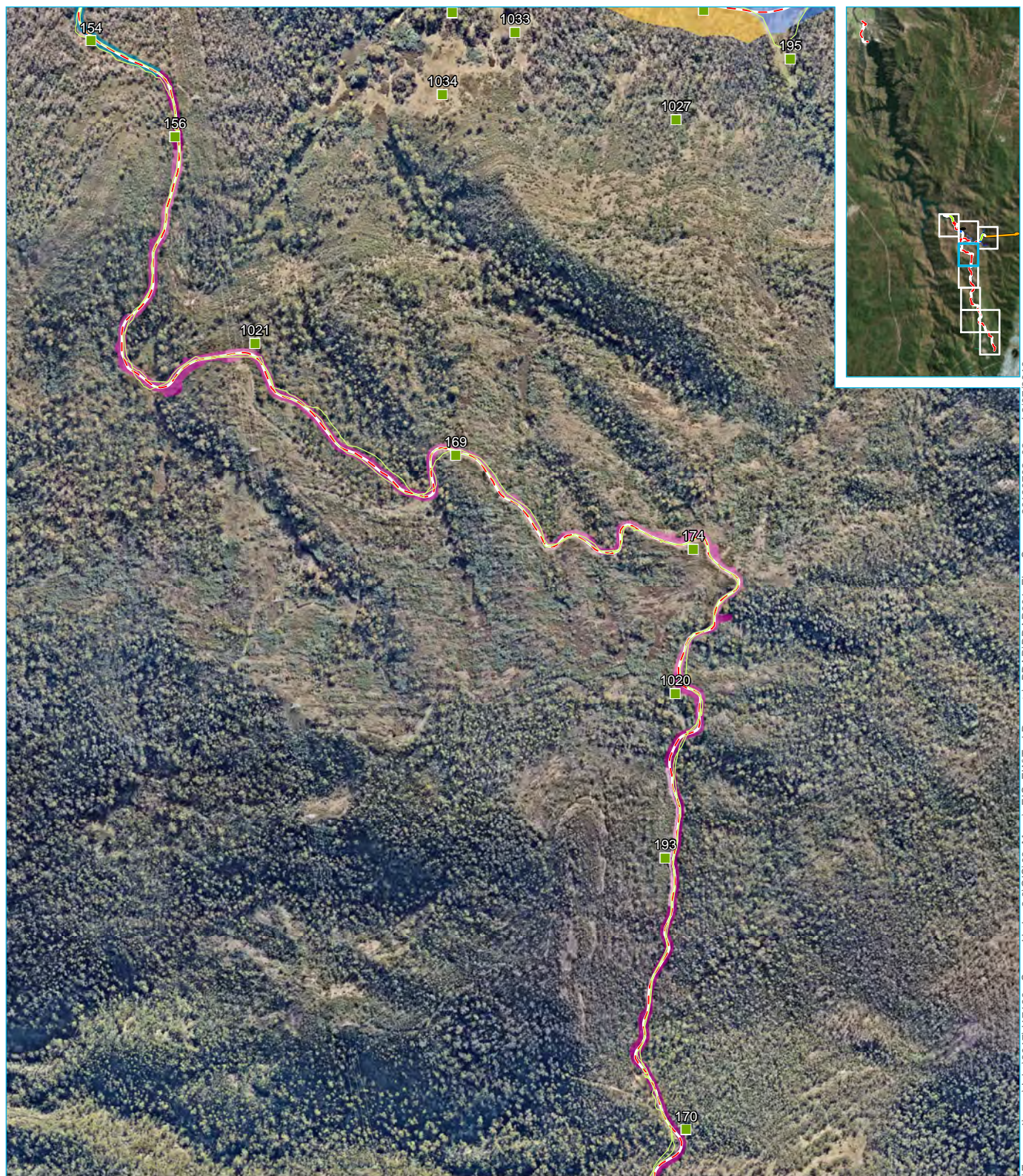
- Plot location
- Flora survey transect
- Exploratory tunnel
- - - Access road upgrade
- - - Access road extension
- Permanent bridge
- Portal construction pad conceptual layout
- Watercourse
- Cleared land
- Water
- PCT 296
- Moderate/good - High
- Moderate/good - Medium

- PCT 302
- Moderate/good - High
- Moderate/good - Other

Flora survey locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 6.1c





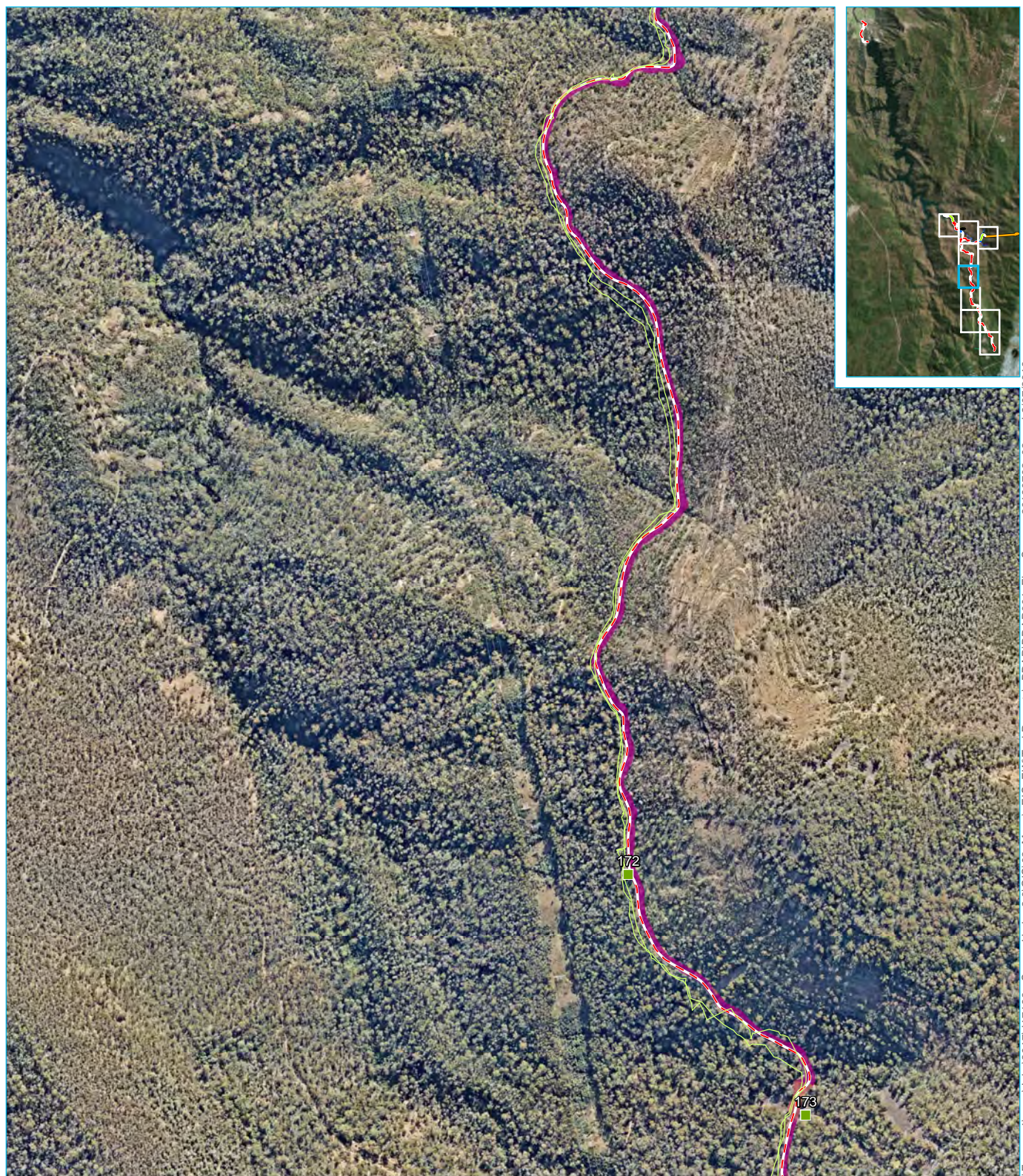
Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); Robert Bird (2018); DFSI (2017)

KEY

- | | |
|-----------------------------------|-----------------------------------|
| ■ Plot location | PCT 302 |
| — Flora survey transect | Moderate/good - Poor |
| — Exploratory tunnel | Moderate/good - Other |
| — Access road upgrade | Moderate/good - Derived grassland |
| — Access road extension | PCT 311 |
| ■ Cleared land | Moderate/good - High |
| PCT 296 | PCT 729 |
| Moderate/good - Medium | Moderate/good - Poor |
| PCT 300 | |
| Moderate/good - High | |
| Moderate/good - Medium | |
| Moderate/good - Other | |
| Moderate/good - Derived grassland | |

Flora survey locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 6.1d



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

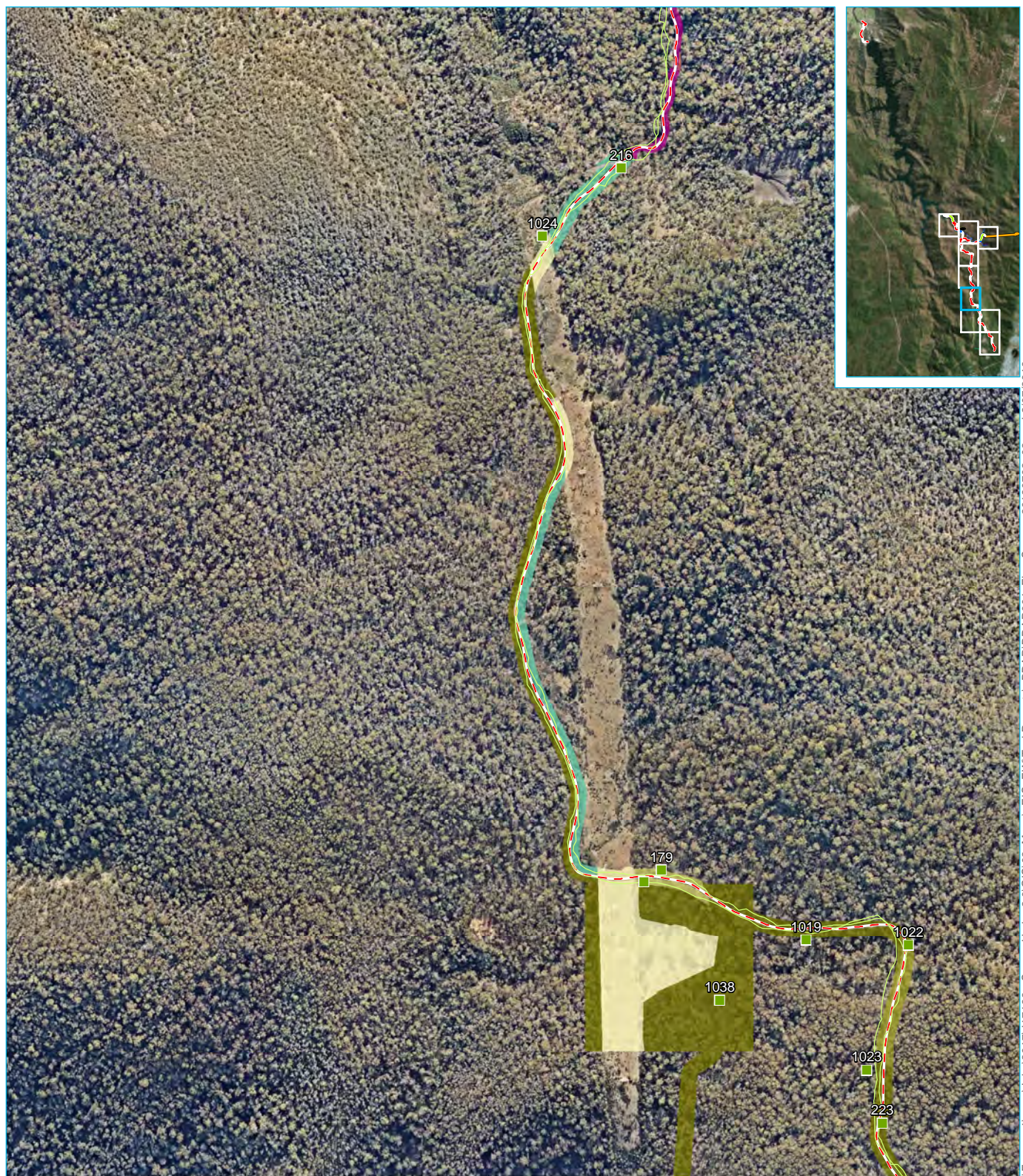
KEY

- Plot location
- Flora survey transect
- Exploratory tunnel
- - Access road upgrade
- - Access road extension
- Cleared land
- PCT 300
- Moderate/good - High
- PCT 643
- Low

Flora survey locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 6.1e





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

KEY

- Plot location
- Flora survey transect
- Exploratory tunnel
- - Access road upgrade
- - Access road extension
- Cleared land
- PCT 300
- Moderate/good - High
- PCT 643
- Low
- PCT 953
- Moderate/good - High
- PCT 1196
- Moderate/good - High
- Moderate/good - Medium
- Moderate/good - Poor
- Moderate/good - Derived grassland

Flora survey locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 6.1f



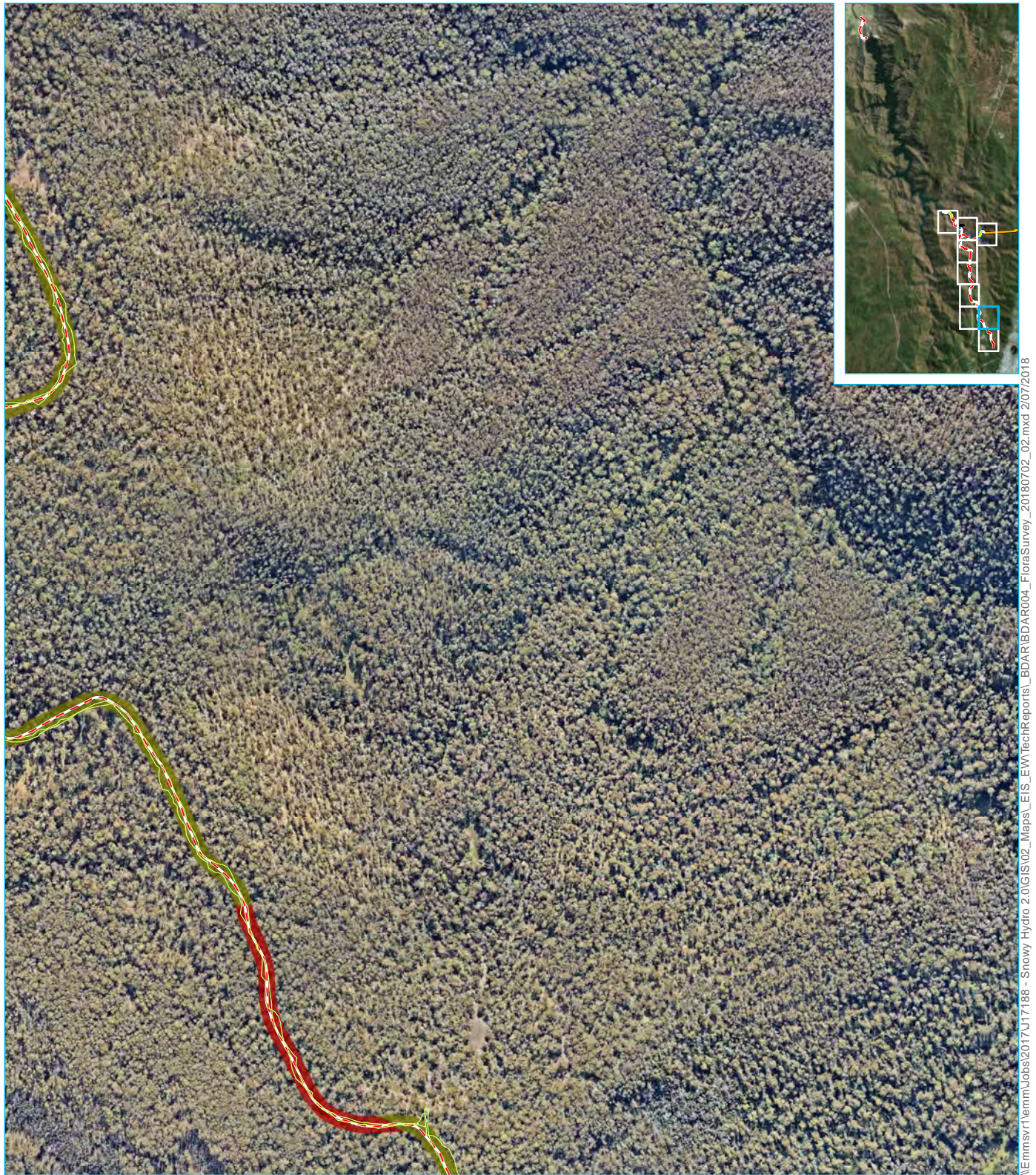
KEY

- Plot location
- Flora survey transect
- Exploratory tunnel
- - Access road upgrade
- - Access road extension
- PCT 296
- Moderate/good - High
- PCT 1196
- Moderate/good - High
- Moderate/good - Derived grassland

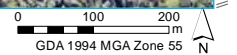
Flora survey locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 6.1g





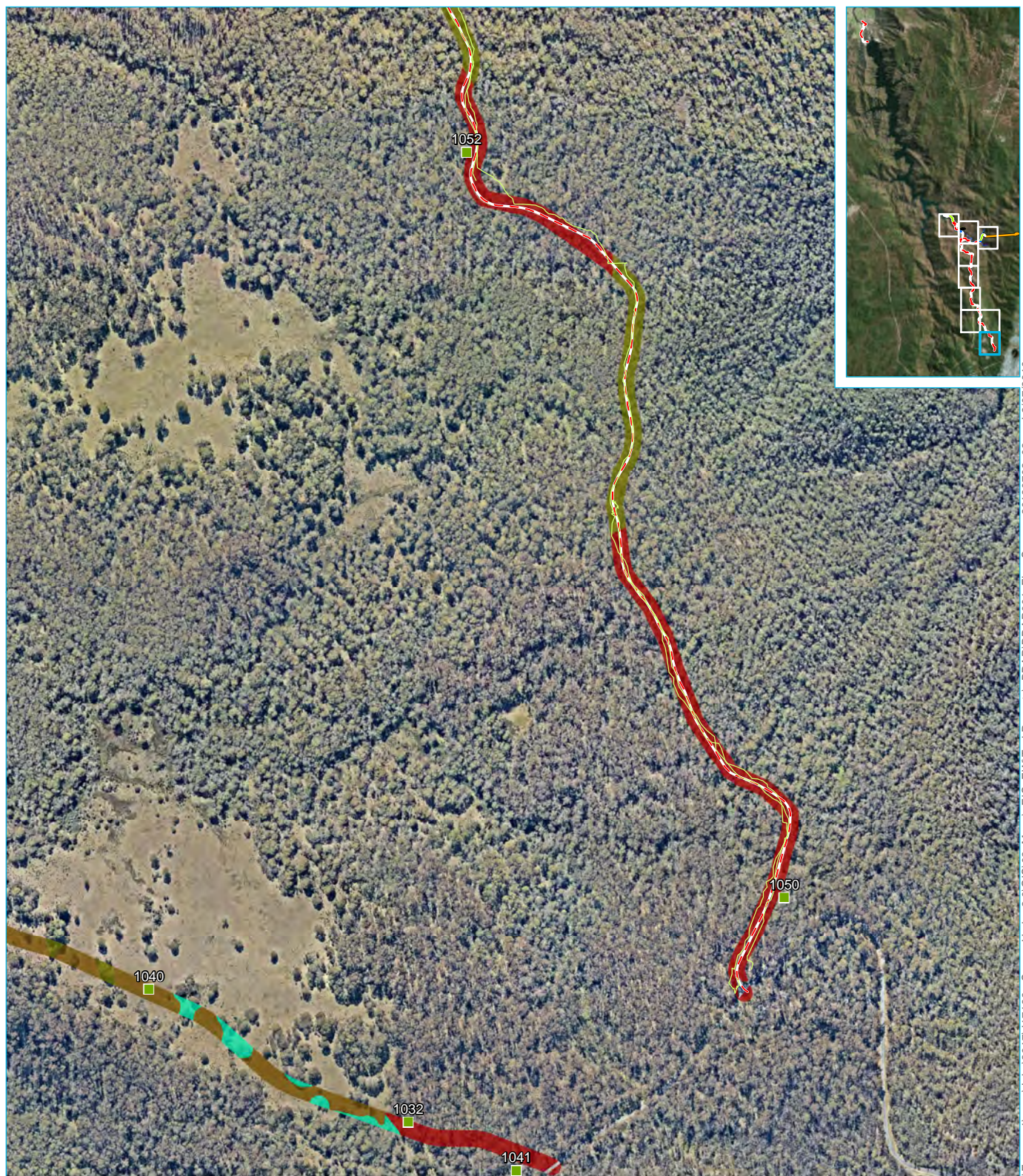
Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); Robert Bird (2018); DFSI (2017)



KEY

- Flora survey transect
- Exploratory tunnel
- Access road upgrade
- Access road extension
- PCT 639
- Moderate/good - High
- PCT 1196
- Moderate/good - High

Flora survey locations



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

KEY

- Plot location
- Flora survey transect
- Exploratory tunnel
- - Access road upgrade
- - Access road extension
- Cleared land
- PCT 639
- Moderate/good - High
- PCT 644
- Moderate/good - High
- PCT 1196
- Moderate/good - High
- PCT 1224
- Moderate/good - Poor

Flora survey locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 6.1i



ii Targeted fauna surveys

Targeted fauna surveys were conducted within the Exploratory Works survey area between December 2017 and May 2018 in accordance with various NSW (DEC 2004, DECC 2009) and Commonwealth (DSEWPac 2010a, 2010b, 2010c, 2011a, 2011b) guidelines.

Stratification units, as well as survey methods and effort are outlined for each fauna group below. Fauna survey locations are illustrated in Figure 6.2. A summary of fauna surveys, including sites and survey effort, is provided in Appendix C, while weather data for the survey period is provided in Appendix D.

In many circumstances the survey requirements outlined in the guidelines listed above have been exceeded to provide a robust level of assessment.

a. Diurnal birds

Bird surveys for both diurnal birds were undertaken for five species listed under the BC Act and three additional migratory species listed under the EPBC Act. Targeted bird species include:

- Gang-gang Cockatoo (breeding habitat);
- Pink Robin;
- breeding habitat for birds of prey, including:
 - Little Eagle;
 - Square-tailed Kite; and
 - White-bellied Sea-Eagle.
- Rainbow Bee-eater;
- Rufous Fantail; and
- Satin Flycatcher.

Stratification units and area of each survey unit in the survey area is shown in Table 6.4.

Table 6.4 **Stratification units and survey area – diurnal birds**

Vegetation class/survey area	Area (ha)¹
Montane Wet Sclerophyll Forests	0.61
Southern Tableland Dry Sclerophyll Forests	125.06
Southern Tableland Wet Sclerophyll Forests	20.84
Southern Tableland Dry Sclerophyll Forests	125.06
Subalpine Woodlands	28.89
Upper Riverina Dry Sclerophyll Forests	44.86
TOTAL	345.32

Note: 1. Area is the area of vegetation within the survey area, not the area of impact.

Bird survey methods and survey effort have been developed in accordance with DEC (2004) and DSEWPaC (2010a) guidelines. Methods include a mix of transect and areas searches, to record bird activity, and targeted nest searches for the Gang-gang Cockatoo, Pink Robin and birds of prey. Methods and survey effort are outlined in Table 6.5.

Table 6.5 **Methods and survey effort – diurnal birds**

Method	Survey description	Survey effort
Transects and area searches	<ul style="list-style-type: none"> Land based areas searches and transects. Surveyors walked transect (access tracks) or area searches within a 1-3 ha area (other areas). All calls and habitat features were investigated. Birds observed or heard were recorded. 	<p>DEC (2004) has not resolved bird survey requirements. DSEWPaC (2010a) was reviewed and sympatric species survey efforts indicated a requirement for 10 hours over 5 days (2 hours per day) for sites less than 50 ha. No survey effort for larger sites is provided.</p> <p>To date, 9 bird surveys have been undertaken with a total of 16 survey hours within or adjacent to the Exploratory Works survey area between December 2017 and 16 March 2018.</p>
Targeted nest searches	<ul style="list-style-type: none"> Observers travelled across available habitat, seeking out habitat features including nest trees and hollows. Resources will be marked, and watched to determine if they are being used by the target species. 	<p>DEC (2004) has not resolved nest search requirements. DSEWPaC (2010a) was reviewed and sympatric species survey efforts indicated 8 hours over 4 days (2 hours per day) for sites less than 50 ha.</p> <p>Survey effort is outlined above.</p>

b. **Nocturnal birds**

Bird surveys for nocturnal birds were undertaken to identify breeding habitat for three forest owl species listed under the BC Act. Targeted bird species include:

- Barking Owl;
- Powerful Owl; and
- Masked Owl.

Although breeding habitat is restricted within the Exploratory Works survey area (see Table 6.6), surveys were undertaken across all breeding and foraging habitat to determine if forest owls were active within the survey area. If found to be active surveys would focus on identifying breeding locations, if present. Stratification units and area of each survey unit in the survey area is shown in Table 6.6.

Table 6.6 **Stratification units and survey area – nocturnal birds**

Vegetation class/survey area	Area (ha)¹
Breeding habitat	
Subalpine Woodlands	28.89
Upper Riverina Dry Sclerophyll Forests	44.86
TOTAL	73.75
Foraging habitat	
Montane Wet Sclerophyll Forests	0.61
Southern Tableland Dry Sclerophyll Forests	125.06
Southern Tableland Wet Sclerophyll Forests	20.84
Southern Tableland Dry Sclerophyll Forests	125.06
TOTAL	271.57

Note: 1. Area is the area of vegetation within the survey area, not the area of impact.

Bird survey methods and survey effort have been developed in accordance with DEC (2004). Methods included call playback and spotlighting, with listening periods to listen for the call between roosting males and nesting females where appropriate. Methods and survey effort are outlined in Table 6.5.

Table 6.7 **Methods and survey effort – nocturnal birds**

Method	Survey description	Survey effort
Call playback and spotlighting	<p>DEC (2004) recommends call playback and spotlighting are undertaken to target these owl species</p> <ul style="list-style-type: none"> Commence surveys with a 10-15 minute listening period. This will target the male and female calling back and forth to one another and is useful in identifying nesting trees. This will be followed by spotlighting for 10 minutes in the immediate vicinity. Call playback is then undertaken with the call of each target species played intermittently for a 5 minutes period followed by a 10 minute listening period. Following call playback a further 10 minutes of spotlighting is undertaken. <p>If forest owls were found to be present within the survey area, surveys would try to identify nesting sites by listening to roosting males calling to nesting females on dusk. Females calls would be triangulated and nest searches undertaken in identified areas over several nights.</p>	<p>DEC (2004) recommends at least 5 visits for the Powerful Owl and Barking Owl, 6 visits for the Sooty Owl and 8 visits for the Masked Owl. Sites should be separated by 1 km.</p> <p>Based on the above, and availability of suitable habitat, up to 18 survey sites would need to be completed for the Masked Owl.</p> <p>To date, surveys have been completed at 29 sites across the Exploratory Works survey area, with 46 hours of survey completed.</p>

c. Small terrestrial mammals

Small terrestrial mammal surveys were undertaken to target three small terrestrial mammal species listed under the EPBC Act and/or BC Act:

- Eastern Pygmy-possum;
- Broad-toothed Rat; and
- Smoky Mouse.

Stratification units and area of each survey unit in the survey area are shown in Table 6.8.

Table 6.8 Stratification units and survey area – small terrestrial mammals

Vegetation class/survey area	Area (ha) ¹
Montane Wet Sclerophyll Forests	0.61
Southern Tableland Dry Sclerophyll Forests	125.06
Southern Tableland Wet Sclerophyll Forests	20.84
Subalpine Woodlands	28.89
Temperate Montane Grasslands	3.77
Upper Riverina Dry Sclerophyll Forests	44.86
TOTAL	224.03

Note: 1. Area is the area of vegetation within the survey area, not the area of impact.

Initially, surveys were undertaken across all vegetation classes within the Exploratory Works survey area, as the precise habitat requirements of the Smoky Mouse are not clear (Menkhorst and Broome 2008a, 2008b). The Broad-toothed Rat was deemed to have potential to occur in sub-alpine grassy woodlands in the upper reaches of Lobs Hole Ravine Road, and a small area of dense *Poa* spp. dominated grassland adjacent to the Mines Trail in Lobs Hole; both areas were considered marginal habitat for this species. The Eastern Pygmy-possum was surveyed across all PCTs within the survey area.

Methods and survey effort have been developed in accordance with DEC (2004) and DSEWPaC (2011a), modified as per Nelson et al. (2009), and included a mix of terrestrial trapping and remote camera surveys. Methods and survey effort are outlined in Table 6.9.

Table 6.9 Methods and survey effort- small terrestrial mammals

Method	Survey description	Survey effort
Trapping	<p>20 Elliot A traps placed 10 m apart in two parallel lines separated by 25 m (access roads) or 25 Elliot A traps placed 10 m apart in a 5 x 5 grid (other areas):</p> <ul style="list-style-type: none"> • Traps baited with a mixture of peanut butter, rolled oats and honey. • Traps checked early in the morning and closed for the day. • Traps opened and rebaited in the late afternoon. • Animals to be temporarily marked to allow mark-recapture data to be collected. 	<p>DSEWPac (2011a) specifies two sites per 5 ha stratification unit with replication across habitat types in areas of greater than 5 ha. No level of replication is specified. Consultation was undertaken with Linda Broome (OEH) to determine a suitable survey effort per stratification unit.</p> <p>This consultation determined that a suitable effort would be 25 Elliot A traps placed out for 4 nights = 100 trap nights, per 50 ha site, with additional replicates for every additional 100 ha. Based on the areas above this would require seven survey sites equating to 700 trap nights.</p> <p>Trapping was conducted between December 2017 and March 2018 at 9 sites, equating to 900 trap nights.</p>
Remote cameras	<p>Remote camera surveys were undertaken in accordance with the following guidelines:</p> <ul style="list-style-type: none"> • Cameras placed at least 100 m apart. • Cameras were attached to tree or stake and positioned approximately 25cm above ground with bait stations placed 1.5m away. • Bait stations were baited with a mixture of peanut butter, rolled oats and honey. • DSEWPac (2011a) recommends cameras are placed out for at least one week. However, Nelson et al. (2009) detected the Smoky Mouse on cameras on or before the tenth night of survey. As such, it was determined one week may not be sufficient to reliably detect the species, and surveys were extended to a minimum of 14 nights for Round 2 and above. 	<p>DSEWPac (2011a) recommends that for the Smoky Mouse two cameras are placed out for one week, in areas up to 5 ha. Based on the areas above this would require 46 survey sites. If surveys are undertaken for one week, as outlined in DSEWPac (2011a), this equates to 644 camera nights. No guidelines are available for the Broad-toothed Rat or Eastern Pygmy-possum.</p> <p>Remote camera surveys were undertaken between December 2017 and April 2018 at 95 sites (190 cameras) with a minimum of 14 nights per site and up to 25 nights for some sites. A total of 1,540 camera nights has been completed across the survey area.</p>

d. Large terrestrial mammals

Large terrestrial mammal surveys were undertaken to target the Spotted-tail Quoll. Stratification units and area of each survey unit in the Exploratory Works survey area are shown in Table 6.10.

Table 6.10 Stratification units and survey area – large terrestrial mammals

Vegetation class/survey area	Area (ha) ¹
Montane Wet Sclerophyll Forests	0.61
Southern Tableland Dry Sclerophyll Forests	125.06
Southern Tableland Wet Sclerophyll Forests	20.84
Subalpine Woodlands	28.89
Temperate Montane Grasslands	3.77
Upper Riverina Dry Sclerophyll Forests	44.86
TOTAL	224.03

Note: 1. Area is the area of vegetation within the survey area, not the area of impact.

All forest habitat within the Exploratory Works survey area was considered to have potential to support the species given the species is known to have home ranges of several hundred to several thousand hectares in size (DELWP 2016a, DEWHA 2009, DSE 2011a).

Methods and survey effort have been developed in accordance with DSEWPaC (2011a), specifically the species profile for the Spotted-tailed Quoll, and the Victorian Survey Standard for the Spot-tail Quoll (DSE 2011a). Surveys have been undertaken at a broad-scale, in line with the recommendations of DSE (2011a), and have included areas outside of the Exploratory Works survey area and project area. Methods and survey effort is outlined in Table 6.11.

Table 6.11 Methods and survey effort – large terrestrial mammals

Method	Survey description	Survey effort
Remote Cameras	<p>Remote camera surveys were undertaken in accordance with the following guidelines for each 100 ha site:</p> <ul style="list-style-type: none"> Two cameras placed out for one month. Cameras placed at least 500 m apart. Cameras will be set for 24 hour operation Cameras placed out in associated with bait stations filled with chuditch bait (meat meal, sardines, fish oil, chicken oil and rolled oats). Cameras were attached to either a tree or stake and placed approximately 1 m above the ground and 2-3 m from the bait station. 	<p>DSE (2011a) recommends two cameras per 100 ha sampling unit (or part thereof) placed out for 30 days. Based on the areas above, this equates to seven survey sites (five if two small stratification units less than 5 ha are excluded) and 420 camera nights (300 camera nights excluding small areas).</p> <p>Surveys were undertaken between February and April 2018 across eight survey sites (16 cameras), equating to 525 camera nights. Four sites (8 cameras) are located within the Exploratory Works survey area, equating to 288 camera nights.</p>

e. Arboreal mammals

Arboreal mammal surveys were undertaken within the Exploratory Works survey area to target four arboreal species listed under the EPBC Act and/or BC Act. Targeted arboreal mammal species include:

- Koala;
- Squirrel Glider;
- Brush-tailed Phascogale; and
- Greater Glider.

Stratification units and area of each survey unit in the survey area is shown in Table 6.12.

Table 6.12 Stratification units and survey area – arboreal mammals

Vegetation class/survey area	Area (ha) ¹
Montane Wet Sclerophyll Forests	0.61
Southern Tableland Dry Sclerophyll Forests	125.06
Southern Tableland Wet Sclerophyll Forests	20.84
Subalpine Woodlands	28.89
Upper Riverina Dry Sclerophyll Forests	44.86
TOTAL	220.26

Note: Area is the area of vegetation within the survey area, not the area of impact.

The Koala was deemed to have potential to occur in suitable Eucalypt forest and woodland below 800 m elevation (DSEWPaC 2012, DoE 2014a, TSSC 2012).

The Squirrel Glider has been recorded in the locality in Montane Wet Sclerophyll Forests, Southern Tableland Dry Sclerophyll Forests, Southern Tableland Wet Sclerophyll Forests, Upper Riverina Dry Sclerophyll Forests. Given the extent of hollows in areas of PCT 1196, it was also considered to have potential to occur in Montane Wet Sclerophyll Forests. These areas were included in survey; however, trees supporting suitably sized hollows for denning are limited to the habitat along the Yarrangobilly River and the upper sections of Lobs Hole Ravine Road. The Brush-tailed Phascogale occupies a broad range of habitat types. All stratification units were surveyed for these species.

The Greater Glider was considered to have potential to occur in taller, montane, moist eucalypt forests with old trees and abundant hollows (TSSC 2016) along the upper section of Lobs Hole Ravine Road, equating to Subalpine Woodlands.

Methods and survey effort have been developed in accordance with DEC (2004), DSEWPaC (2011a), the Victorian Survey Standard for the Greater Glider (DSE 2011b) and Biolink (2008) for the Koala. Methods and survey effort is outlined in Table 6.13.

Table 6.13 Methods and survey effort – arboreal mammals

Method	Survey description	Survey effort
Trapping	<p>Ten Elliot B or cage traps were placed at 2-4 m above the ground, 50 m apart in two parallel lines separated by 50 m:</p> <ul style="list-style-type: none"> • Traps were baited with a mixture of peanut butter, rolled oats and honey. • A mixture of water and honey was sprayed on tree trunk. • Traps were checked early in the morning and closed for the day. • Traps were re-opened and rebaited in the late afternoon. • Animals to be temporarily marked to allow mark-recapture data to be collected. • Trapping was undertaken in conjunction with terrestrial mammal trapping where suitable habitat occurs. 	<p>DEC (2004) requires 24 trap nights over 3-4 consecutive days per 50 ha of stratification unit. Based on the above stratification units, this would equate to six surveys and 144 trap nights.</p> <p>Surveys were undertaken between December 2017 and March 2018 at seven survey sites, equating to 280 trap nights.</p>

Table 6.13 **Methods and survey effort – arboreal mammals**

Method	Survey description	Survey effort
Spotlighting	<p>DSEWPaC (2011a) recommends two parallel 200 m transects per 5 ha site. No survey effort for larger sites is specified.</p> <p>In line with DSE (2011b) and DEC (2004), a survey effort of two parallel 2,000 m transects per 100 ha site (half the survey effort, but over a larger area) was deemed suitable in consultation with OEH. Surveys included:</p> <ul style="list-style-type: none"> • 2,000 m transects were undertaken by 2 observers (4,000 m total transect), with 25 m between transects. • Observers moved at a speed of 10 m per minute (ie 200 minutes for a 2,000 m transect). • All animals observed were recorded, including the distance of the animals from the observer. 	<p>DSEWPaC (2011a) recommends two parallel transects per 5 ha site, while DEC (2004) recommends 2 transects per 200 ha of stratification unit.</p> <p>Given the size of the survey area and the fact that no species specific guidelines are available for the Greater Glider a survey effort of two 2,000 m transects per 100 ha stratification unit, repeated on two separate occasions, was deemed appropriate based on DSE (2011b) and DEC (2004). Based on this, ten 2,000 m transects would be required to be repeated on two occasions (20 transects).</p> <p>Surveys were undertaken between December 2017 and March 2018, with twenty 2,000 m transects (minimum distance) completed. Survey guidelines have been exceeded.</p>
Regularised Grid Based (RGB) Spot Assessment Technique (SAT) (Koala)	<p>The RGB SAT method requires application of a uniform assessment method across a broad area. A 350 m x 350 m grid was applied to the survey area to identify survey locations. At each grid point, the SAT (Phillips and Callaghan 2011) was undertaken, as follows:</p> <ul style="list-style-type: none"> • Centre tree was located and marked with flagging tape. • The 29 nearest trees to the centre tree were also identified and marked. • Koala faecal pellets were searched for beneath each of the 30 trees within a distance of 100 cm. Initial inspections were checked in undisturbed ground surface, followed by a more thorough inspection involving disturbance of leaf litter and ground cover (if no faecal pellets were initially detected). • An average of approximately two person minutes per tree should be dedicated to the faecal pellet search. <p>Activity levels can be interpreted using Table 2 from Phillips and Callaghan (2011).</p>	<p>Grid points located below 800 m and in proximity to and surrounding the survey area were included for survey.</p> <p>A total of 71 grid locations have been surveyed across and adjacent to the survey area.</p>

f. Amphibians

Amphibian surveys were undertaken to target the Booroolong Frog. Stream lengths for all suitable watercourses within the Exploratory Works survey area are shown in Table 6.14.

Table 6.14 Stream lengths – amphibians

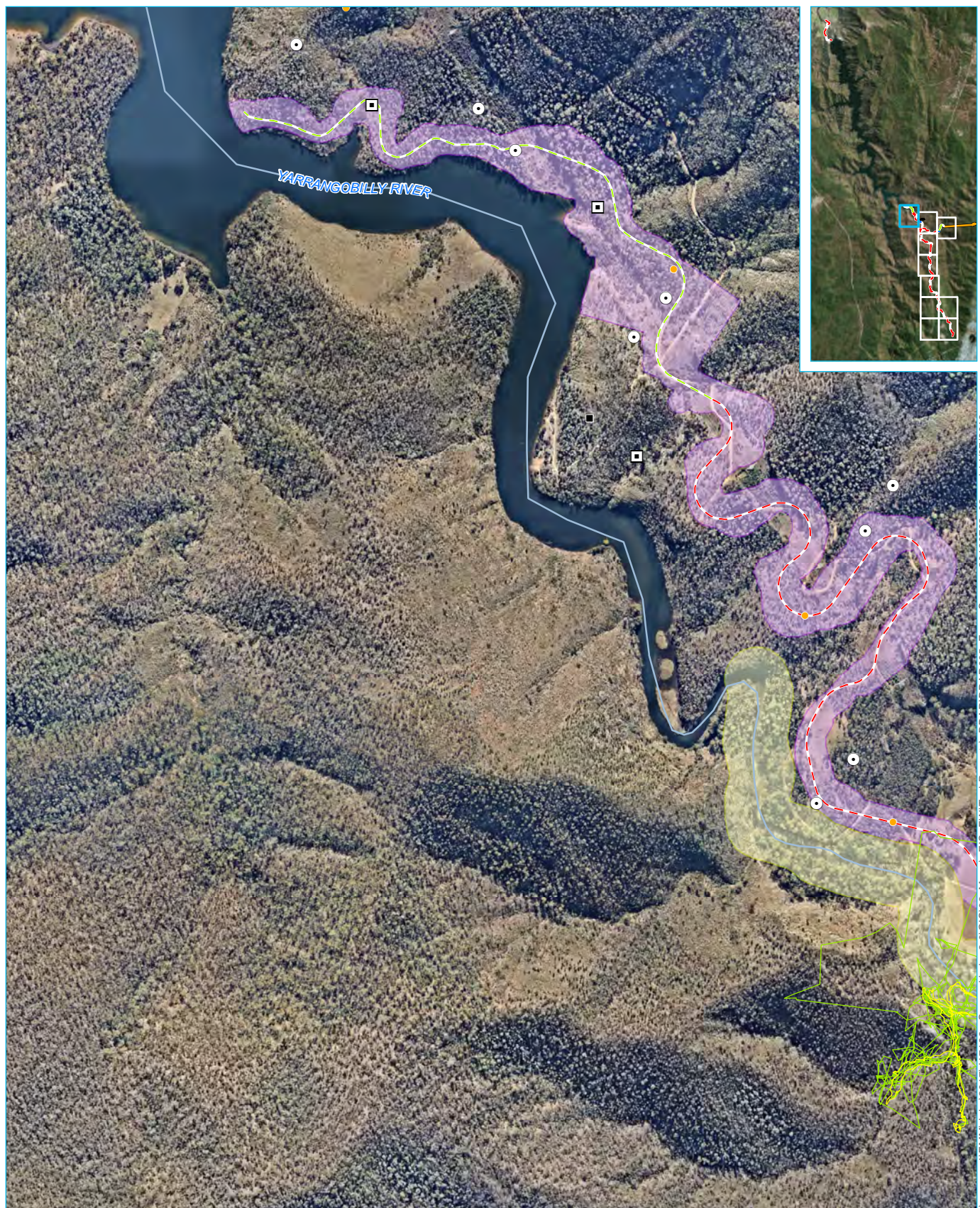
Waterway	Length (m)
Stable Creek	251
Sheep Station Creek	253
Wallaces Creek	918
Yarrangobilly River	4,692
TOTAL	6,114

All permanent and intermittent watercourses within the survey area which provided optimal to marginal habitat, as identified during the habitat assessment, were surveyed.

Methods and survey effort have been developed in accordance with DECC (2009) and DSEWPac (2010b). Methods and survey effort is outlined in Table 6.15.

Table 6.15 Methods and survey effort- amphibian

Method	Survey description	Survey effort
Habitat assessment	A habitat assessment was undertaken to identify suitable habitat along all watercourses within the survey area.	All streams will be assessed for suitable habitat.
Nocturnal searches (visual encounter surveys (VES))	<p>VES were undertaken in accordance with the following:</p> <ul style="list-style-type: none"> • Surveys were undertaken in temperatures of greater than 10°C, and not during rain. • Two observers walked a 200 m transect along a stream. • Using a spotlight and head torch searches were completed for surrounding vegetation, rocks and other microhabitats. • All frogs observed or heard were recorded. • Hygiene protocols were followed to prevent the spread of chytrid fungus, with full wash down between streams. 	<p>DECC (2009) and DSEWPac (2010b) specify a minimum survey effort of one 200 m transect per stream, repeated on four nights (two nights in DECC 2009). Based on the four streams within the survey area this would equate to 4 x 200m transects repeated on four nights, equating to 3,200 m of transect surveys.</p> <p>Surveys were undertaken in December 2017 and January 2018. All four watercourses have been surveyed for their entire length (rather than 200 m transects) to gain an understanding of the distribution of the species across these watercourses, with surveys repeated on four nights. Overall, a total of 48,912 m of transect surveys (two observers) have been completed.</p>
Egg mass and tadpole sampling surveys	<p>Egg mass and tadpole sampling were undertaken in accordance with the following:</p> <ul style="list-style-type: none"> • Egg mass will be detected during VES listed above. • Tadpole sampling will be undertaken using a dip net, with the net dragged along a transect for 1-2 minutes. • Samples will then be keyed out using Anstis (2013). 	DECC (2009) and DSEWPac (2010b) do not specify minimum survey requirements for tadpoles. One transect was undertaken per stream during VES surveys.



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

KEY

- | | |
|-------------------------|-----------------------|
| — Access road upgrade | Trapping |
| — Access road extension | ■ Unclassified |
| — Exploratory tunnel | Fauna survey transect |
| — Watercourse | — Frog survey |
| — Disturbance footprint | — Spotlighting |
| — Avoidance footprint | |
| ● Nocturnal bird survey | |
| ○ Remote camera - small | |
| □ Remote camera - large | |

0 100 200
m
GDA 1994 MGA Zone 55
N

Fauna survey locations

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 6.2a



6.3.4 Targeted survey results

i Threatened flora surveys results

No threatened flora species were recorded during targeted surveys within the Exploratory Works survey area. All candidate threatened flora species are considered to have a low likelihood of occurrence with the disturbance footprint following targeted surveys.

ii Threatened fauna surveys results

Ten threatened fauna species have been recorded within or adjacent to the Exploratory Works disturbance footprint (Figure 6.3):

- Seven threatened bird species:
 - Diamond Firetail (ecosystem credit species);
 - Dusky Woodswallow (ecosystem credit species);
 - Flame Robin (ecosystem credit species);
 - Scarlet Robin (ecosystem credit species);
 - Varied Sittella (ecosystem credit species);
 - Gang-gang Cockatoo;
 - Masked Owl;
- Two threatened mammal species:
 - Eastern Pygmy-possum;
 - Smoky Mouse; and
- One threatened amphibian, the Booroolong Frog.

Threatened fauna survey results are outlined for each survey group in the sections below. Ecosystem credit species are not discussed further in this section, as they are not candidate threatened species credit species.

a. Diurnal birds

One target species, the Gang-gang Cockatoo, was recorded within and adjacent to the Exploratory Works disturbance footprint (Figure 6.4). No other candidate species credit species were recorded, and all area considered a low likelihood of occurring in the disturbance footprint.

Gang-gang Cockatoo

The Gang-gang Cockatoo was found to be common throughout the Exploratory Works survey area, with the species observed at numerous locations foraging (Figure 6.4). The species was observed to be most common in sub-alpine woodlands (such as at the top of Lobs Hole Ravine Road) and riparian areas at lower elevations (close to the Yarrangobilly River). Targeted nest searches were undertaken across the Exploratory Works survey area. The Gang-gang Cockatoo was not observed nesting but was observed investigating hollows on two occasions; once along the Yarrangobilly River and once along the upper sections of Lobs Hole Ravine Road.

The Gang-gang Cockatoo nests in the trunks, limbs or dead spouts of tall living trees, in tall, mature sclerophyll forests, often near water (NSWSC 2005, 2008). Nests are located in hollows that are 10 cm in diameter or larger and at least 9 m above the ground in eucalypts (OEH 2018c). Suitable hollows are most common in the areas where the species was observed to be most common; along the upper reaches of Lobs Hole Ravine Road, in PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion, and along the Yarrangobilly River, in 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.

On this basis, all areas of PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion and 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 not in Low, Derived Grassland or Other condition classes have been considered breeding habitat on the basis of suitable hollows being located in these areas. This data was used to determine species polygons for the species (Figure 6.4).



Photograph 6.1 **Gang-gang Cockatoos**

b. Nocturnal birds

One target species, the Masked Owl, was recorded within or adjacent to the Exploratory Works disturbance footprint (Figure 6.5). The Powerful Owl is considered likely to forage within the disturbance footprint on occasion given the species large home range, provided a nesting pair is found within the locality. However, no evidence of nesting was observed and the species was not recorded during targeted surveys.

The Barking Owl is considered a low likelihood of occurring within the Exploratory Works survey area. The Barking Owl is considered scarce at higher elevations of the tablelands (NPWS 2003) and the species is known to respond strongly to call playback. Given the failure to record this species during targeted surveys it is considered unlikely to occur.

Masked Owl

The Masked Owl was recorded at two locations within and adjacent to the Exploratory Works disturbance footprint during targeted surveys; on the Yarrangobilly River in Lobs Hole and in the upper sections of Lobs Hole Ravine Road, near the intersection with Link Road (Figure 6.5). Both records were from the species being “called in” as a result of call playback.

The Masked Owl nests in large (greater than 90 cm diameter at breast height), old, hollow eucalypts. Nesting hollows are greater than 40 cm wide and 100 cm deep. Unlike other forest owls, there is no relationship with distance to watercourses and the species will breed in a variety of topographic positions (DEC 2006b). Suitable sized trees and hollows are restricted to the two areas where the species was observed; the upper sections of Lobs Hole Ravine Road in areas of PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion and along the Yarrangobilly River in 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.

On the basis of two observed sightings, and suitability of habitat for nesting, PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion and 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 have been used to determine species polygons for the Masked Owl (Figure 6.5). Areas without tree cover (condition classes Low and Derived Grassland) or areas with only regenerating trees (condition class Other) have been excluded due to the lack of suitable nest trees.



Photograph 6.2 **Masked Owl**

c. Small terrestrial mammals

Two target species, the Eastern Pygmy-possum and Smoky Mouse, were recorded within or adjacent to the Exploratory Works disturbance footprint (Figure 6.6). The Broad-toothed Rat was not recorded within the Exploratory Works survey area and is considered a low likelihood of occurring.

Eastern Pygmy-possum

The Eastern Pygmy-possum was recorded at numerous locations within or adjacent to the Exploratory Works disturbance footprint, within the upper reaches of Lobs Hole Ravine Road to Lobs Hole (Figure 6.6). The species has been recorded in the following PCTs:

- PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion;
- PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment;
- 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;
- PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion; and
- PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion.

The Eastern Pygmy-possum can be found in a broad range of habitats from rainforest through sclerophyll forest and woodland to heath, but in most areas woodlands and heath appear to be preferred. The species feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes and there is a strong association with Banksias (Tulloch and Dickman 2006) and a dense, flowering understorey (Harris et al. 2014, Law et al. 2017).

On this basis, the PCTs listed above, along with PCT 999 - Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion, were used to develop the species polygon on the basis of suitably dense understorey habitat with flowering Banksias (Figure 6.6). PCTs in Low or Derived Grassland condition classes were excluded as they do not provide a sufficiently dense understorey selected by the species.



Photograph 6.3 **Eastern Pygmy-possum (image courtesy of Lachlan Hall)**

Smoky Mouse

Extensive targeted surveys for the Smoky Mouse have been undertaken, with the species identified at 13 locations within and adjacent to the Exploratory Works disturbance footprint (one by terrestrial trapping and 12 by remote camera, Figure 6.6).

The species distribution within the survey area is predominantly associated with a single vegetation community (PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion) along the upper reaches of Lobs Hole Ravine Road, above 1,100 m. In this area vegetation consists of tall forests dominated by Mountain Gum and Snow Gum, with a moderate to dense shrubby midstorey dominated by shrubs from the plant family Fabaceae (with some *Epacridaceae* and *Mimosaceae*), and dense groundcover with abundant sub-shrubs, logs and leaf litter. At around 1,100 m, vegetation transitions to drier communities dominated by Peppermint, Brittle Gum and Candlebark with a moderate to sparse midstorey and sparse grassy groundcover. Soils also become much rockier and may be less suitable for burrowing. There is a single record from boulder streams aligned with PCT 643 - Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion.

A conservative assessment of habitat has been undertaken, with all vegetation not in Low or Derived Grassland conditions classes from the top of Lobs Hole Ravine Road (at the intersection with the Link Road) to around 1,100 m identified as potential habitat (Figure 6.6). This includes PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion, as well as PCT 639 - Alpine Ash - Snow Gum shrubby tall open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion excluding areas in Low or Derived Grassland condition classes, PCT 643 - Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion, PCT - 644 Alpine Snow Gum - Snow Gum shrubby woodland at intermediate altitudes in northern Kosciuszko NP, South Eastern Highlands Bioregion and Australian Alps Bioregion and PCT 953 - Mountain Gum - Snow Gum - Broad-leaved Peppermint shrubby open forest of montane ranges, South Eastern Highlands Bioregion and Australian Alps Bioregion.



Photograph 6.4 **Smoky Mouse**

d. **Large terrestrial mammals**

No Spotted-tail Quolls were recorded during targeted surveys.

The Spotted-tail Quoll is known to have home ranges of several hundred to several thousand hectares and occurs at low densities (DELWP 2016a, DEWHA 2009, DSE 2011a). The species is primarily forest-dependent, and occupies a wide range of habitat types, including rainforest, wet and dry sclerophyll forest, coastal heathland, scrub and dunes, woodland, heathy woodland, swamp forest, mangroves, on beaches and sometimes in grassland or pastoral areas adjacent to forested areas. Given this, the species has potential to occupy the Exploratory Works disturbance footprint at low densities, with large areas of suitable habitat present throughout the locality; the species is likely to be wide ranging. All areas of the survey area are deemed to provide suitable habitat, with suitable denning sites focused on boulderfields on Lobs Hole Ravine Road, and areas with a high density of hollow logs in sub-alpine areas at the top of Lobs Hole Ravine Road and along the Yarrangobilly River.

However, as the species is an ecosystem credit species for the purposes of the BAM a species polygon has not been developed.

e. Arboreal mammals

No arboreal mammals were recorded during targeted surveys.

Although there is some potential for these species to occur at low densities and/or utilise habitats within the Exploratory Works project area on occasion the species are not considered present for the purposes of this assessment. Habitat for the Greater Glider, which coincides with Smoky Mouse habitat, will not be impacted (see Section 7).

The Koala is rare in the KNP, with a single record within 10 km of the Exploratory Works survey area and a recent record in November 2016 from near Blowering Dam, east of Tumut (ABC News 2018). There is insufficient evidence to undertake a Koala habitat assessment in accordance with the Koala habitat assessment tool outlined in DoE (2014a). Therefore RGB SAT surveys and spotlighting were undertaken. The Koala was not observed during these surveys and is considered unlikely to occur for the purposes of this assessment.

f. Amphibians

Extensive targeted surveys were undertaken of all permanent to intermittent watercourses within the Exploratory Works survey area. The Booroolong Frog was recorded within the survey area along the Yarrangobilly River, from the full supply level (FSL) of Talbingo Reservoir to the upper reaches of the Yarrangobilly River, as well as along Wallaces Creek (Figure 6.7). It is likely that this population extends upstream to at least Blue Creek Firetrail (Dave Hunter OEH, pers. comm.).

The Yarrangobilly River is a major regional watercourse that flows into the Talbingo Reservoir. The Yarrangobilly River catchment is wholly within the KNP. Water quality sampling has been undertaken by EMM at four locations in the Yarrangobilly River and at three locations in Wallaces Creek, with samples obtained on three occasions between February to April 2018. All sampling was undertaken during base flow conditions. A summary of the water quality results is presented in Appendix E. Key results from water quality sampling are summarised as follows:

- pH ranged between 7.5 to 8.4, within the ANZECC (2000) guideline range of 6.8 to 8.5;
- electrical conductivity (an indicator of salinity) ranged between 32 to 185 $\mu\text{S}/\text{cm}$, within the guideline range of 30 to 350 $\mu\text{S}/\text{cm}$;
- suspended solids and turbidity were consistently either below detection limits or within the lower end of the guideline range. This is in line with expectations given the clear appearance of the water;
- phosphorus and nitrogen concentrations were below guideline values in all samples except for a single sample from the Yarrangobilly River that recorded a Nitrate concentration of 1.9 mg/L; and
- all dissolved metal concentrations were below guideline values following hardness adjustments with the exception of:
 - a single sample of Aluminium that was marginally elevated relative to the guideline value;
 - all samples of Barium were elevated relative to the low reliability trigger value; and
 - a single sample of Fluoride that was elevated relative to a low reliability trigger value.

These results indicate the Yarrangobilly River is in good condition, reflecting the predominantly undisturbed catchment contained within a national park.

The Yarrangobilly River provides optimal breeding habitat for Booroolong Frog, with a series of cobble banks and bedrock structures along stream margins, with slow-flowing water. These areas are connected by larger, slow-flowing pools. Breeding habitat in Wallaces Creek is much more limited, with only small sections providing suitable breeding habitat. It is likely this area provides sub-optimal breeding habitat as well as connective and dispersal habitat.

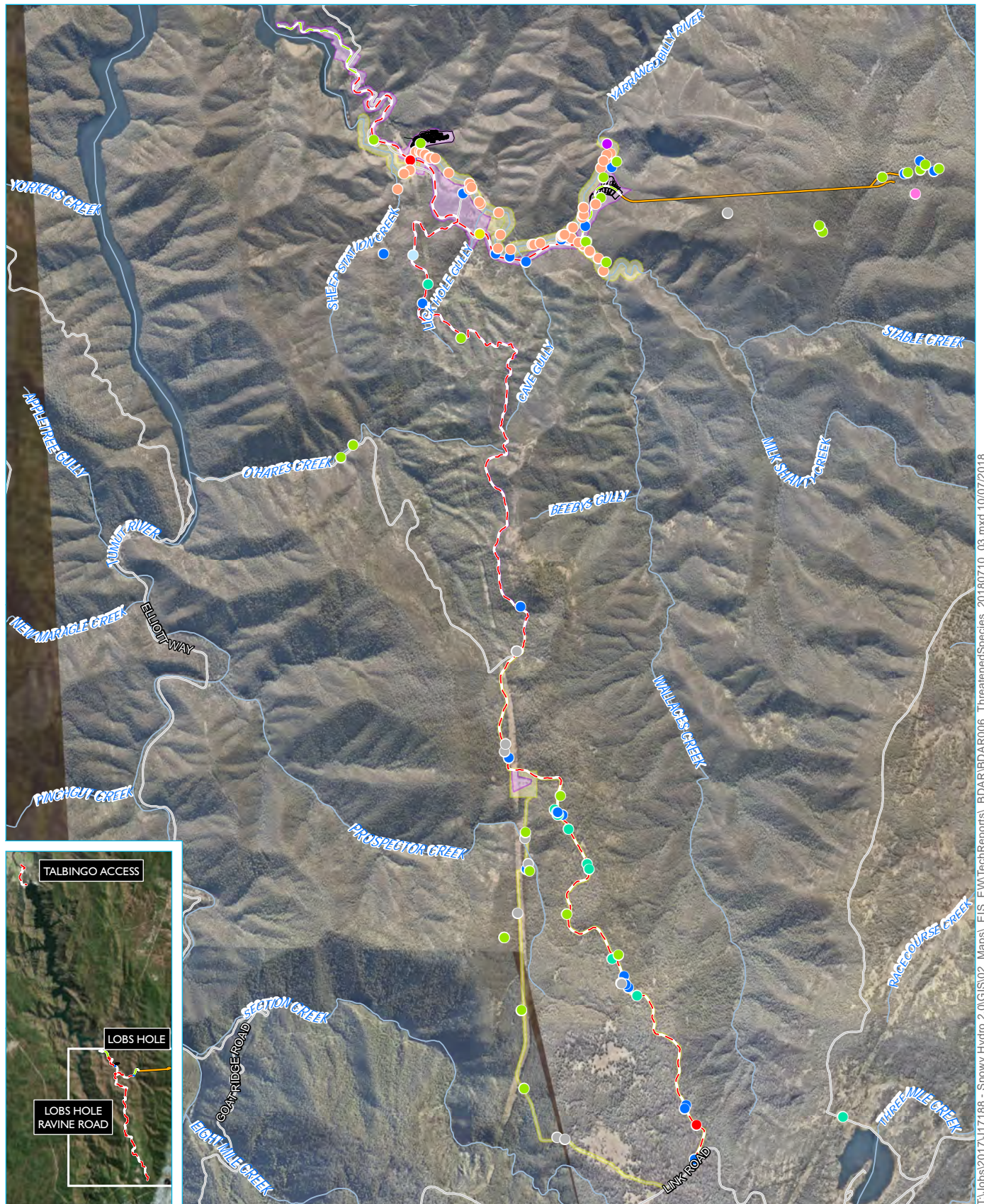
During the breeding season the species shelters under rocks or amongst vegetation near the ground on the stream edge (Anstis 2002, Robinson 1993). In winter, the frogs have been observed under rocks within the riparian zone (Anstis et al. 1998, OEH 2012). The Booroolong Frog is not known to move very far along the stream from where they are recorded (less than 50 m within a season) with maximum movements recorded being 300 m (Hunter 2001). During targeted surveys, the Booroolong Frog was observed up to 130 m from the Yarrangobilly River during a high rainfall event that saw key breeding habitat flooded. During this period the majority of frogs were observed within the riparian zone (ie within 50 m of the River, see Figure 6.7).

Based on the above information, the Yarrangobilly River and Wallaces Creek have been identified as breeding habitat, while areas within 50 m of this breeding habitat has been identified as potential dispersal and refuge habitat. This criteria was used to develop the species polygon for the Booroolong Frog (Figure 6.7).



Photograph 6.5

Booroolong Frog



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

KEY

- - - Access road upgrade
- - - Access road extension
- Exploratory tunnel
- Permanent bridge
- Portal construction pad and accommodation camp conceptual layout
- Local road or track
- Watercourse

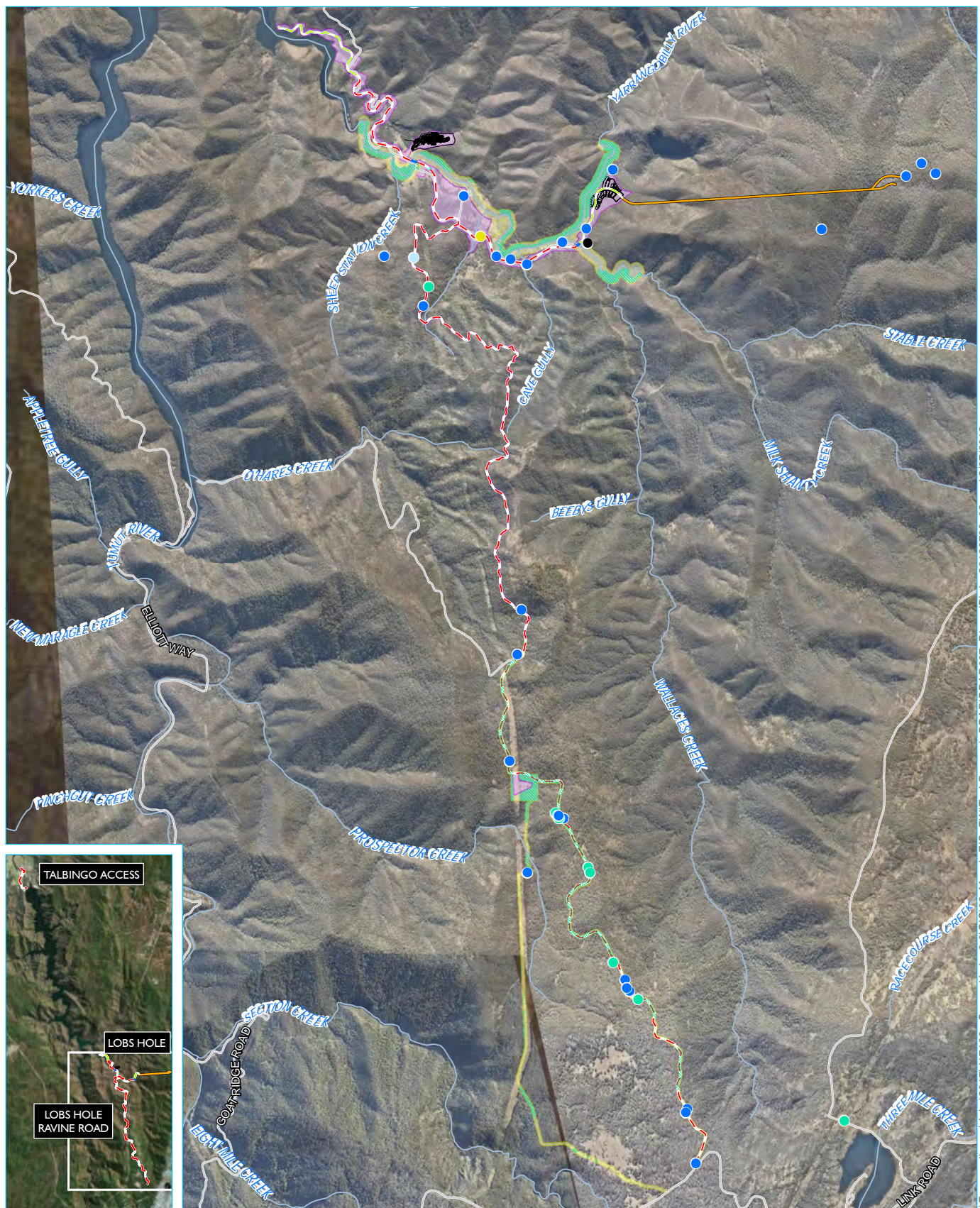
- Disturbance footprint
- Avoidance footprint
- Threatened fauna species
- Booroolong Frog (59)
- Diamond Firetail (1)
- Eastern Pygmy-possum (26)
- Flame Robin (10)
- Gang-gang Cockatoo (26)
- Masked Owl (2)

- Murray Crayfish (1)
- Satin Flycatcher (1)
- Scarlet Robin (1)
- Smoky Mouse (14)
- Varied Sittella (1)

Threatened species overview

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 6.3





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

KEY

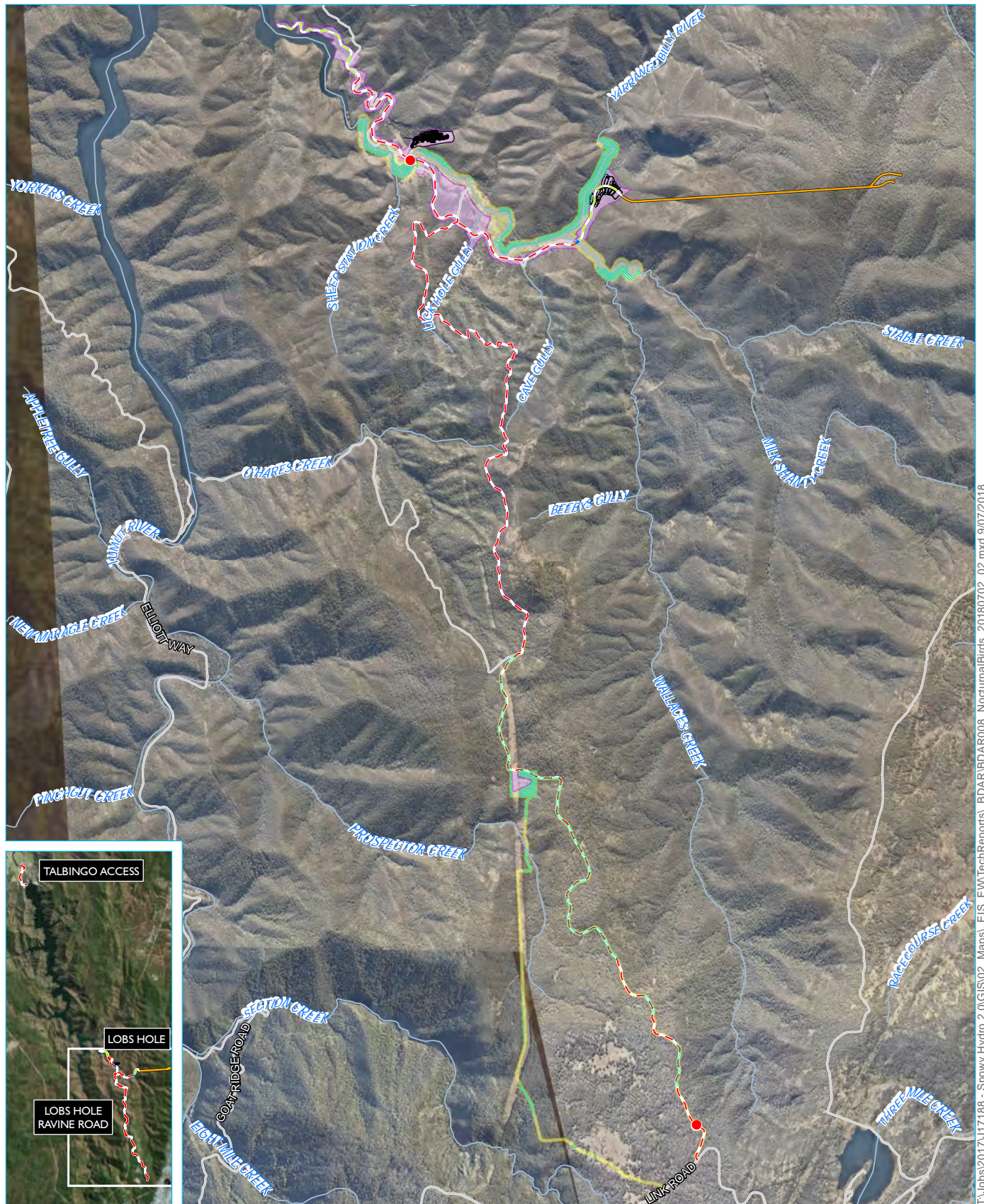
- - - Access road upgrade
- - - Access road extension
- - - Exploratory tunnel
- - - Permanent bridge
- - - Portal construction pad and accommodation camp conceptual layout
- - - Local road or track
- - - Watercourse

- - - Disturbance footprint
- - - Avoidance footprint
- Diurnal bird survey results
- Gang-gang Cockatoo (26)
- Diamond Firetail (ecosystem credit species) (1)
- Flame Robin (ecosystem credit species) (9)
- Scarlet Robin (ecosystem credit species) (1)
- Varied Sittella (ecosystem credit species) (1)
- Gang-Gang Cockatoo potential habitat

Diurnal bird survey results

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 6.4





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

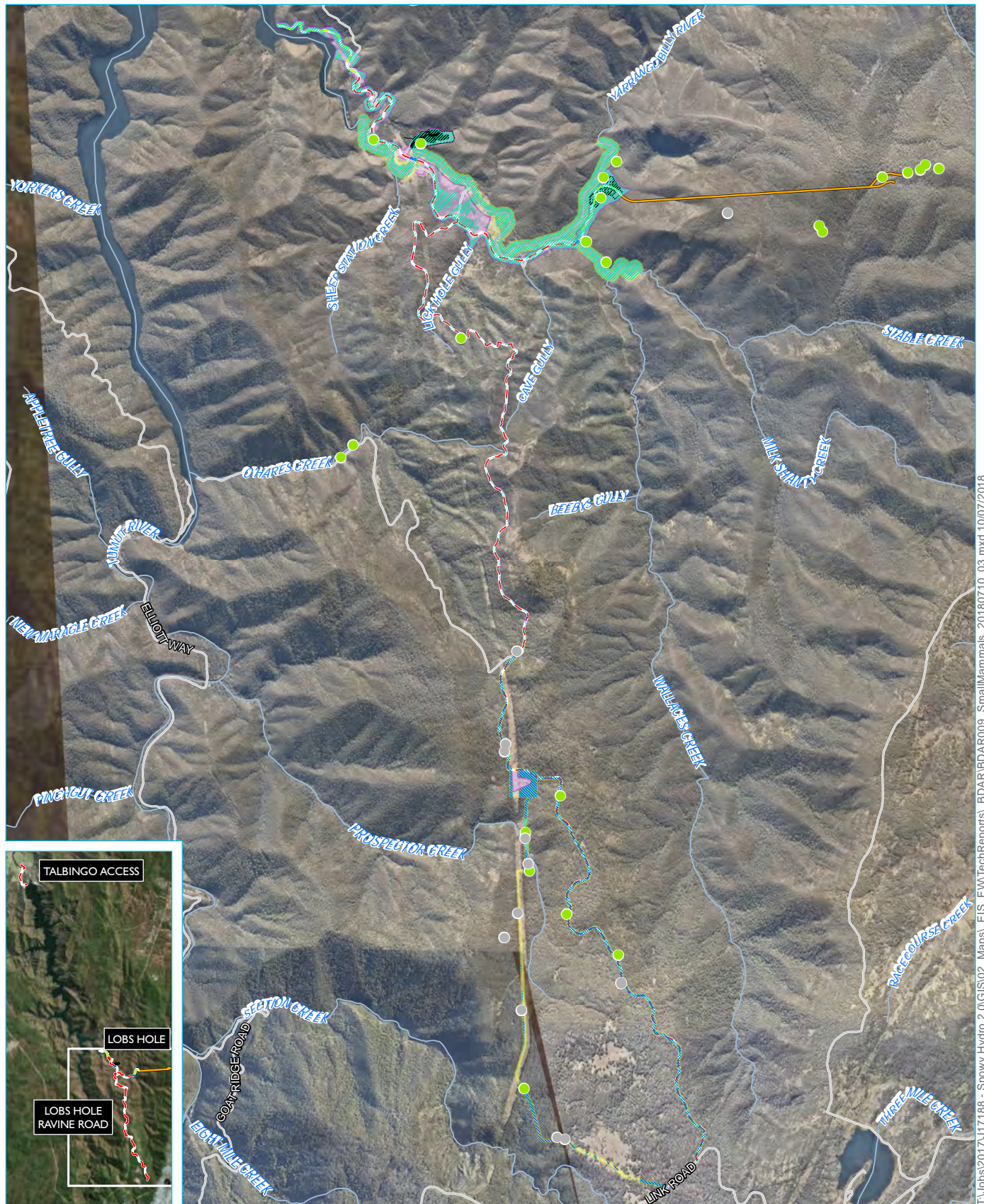
KEY

- - - Access road upgrade
- - - Access road extension
- Exploratory tunnel
- Permanent bridge
- Portal construction pad and accommodation camp conceptual layout
- Local road or track
- Watercourse
- Disturbance footprint
- Avoidance footprint
- Diurnal bird survey results
- Masked Owl (2)
- ▨ Masked Owl potential habitat

Nocturnal bird survey results

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 6.5





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

KEY

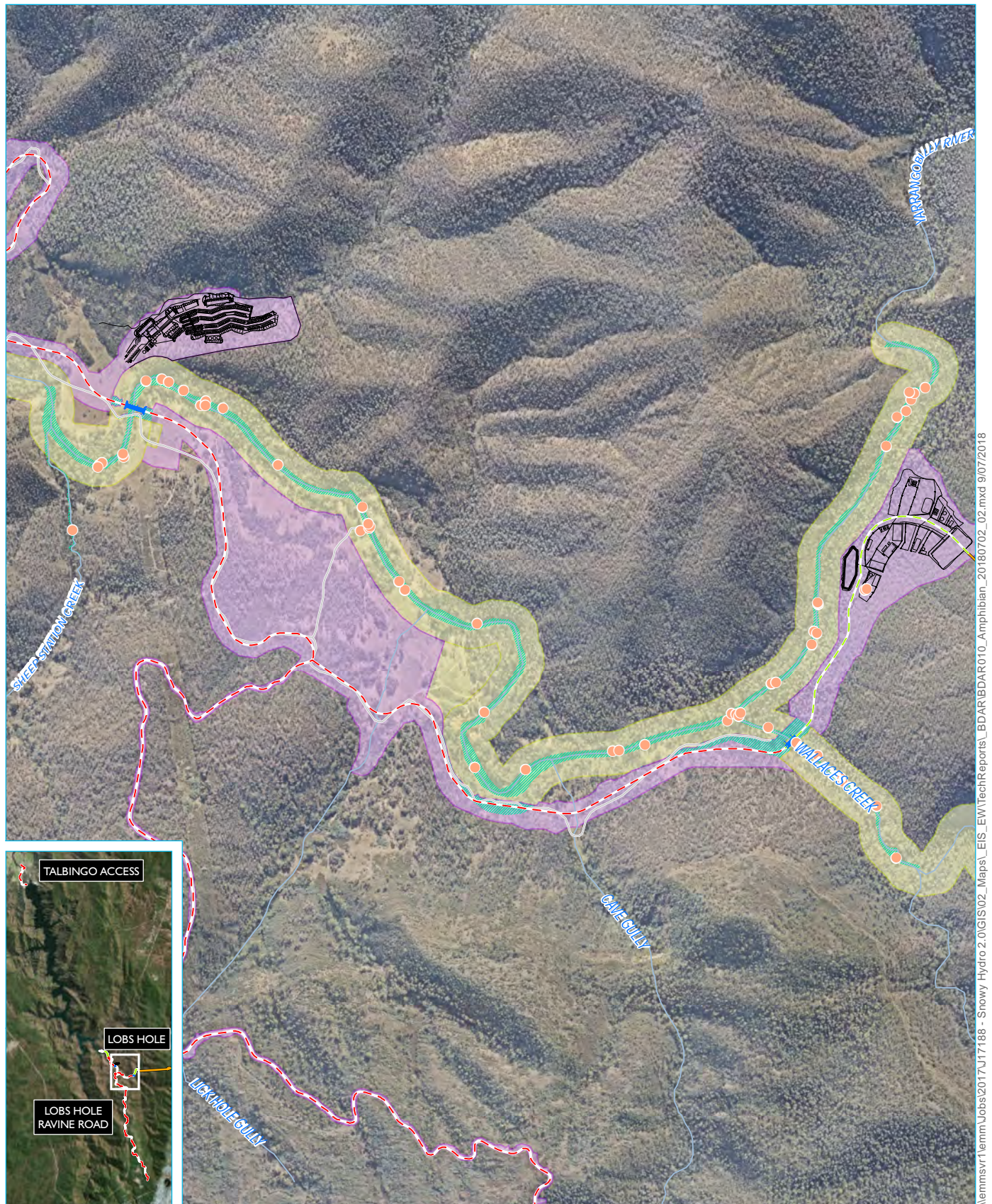
- - - Access road upgrade
- - - Access road extension
- - - Exploratory tunnel
- - - Permanent bridge
- - - Portal construction pad and accommodation camp conceptual layout
- - - Local road or track
- - - Watercourse

- Disturbance footprint
- Avoidance footprint
- Small terrestrial mammals survey results
- Eastern Pygmy-possum (26)
- Smoky Mouse (14)
- Eastern Pygmy-possum potential habitat
- Smoky Mouse potential habitat

Small terrestrial mammal survey results

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 6.6





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

KEY

- | | |
|--|--------------------------------------|
| — Access road upgrade | — Watercourse |
| — Access road extension | — Disturbance footprint |
| — Exploratory tunnel | — Avoidance footprint |
| — Permanent bridge | Amphibian survey results |
| — Portal construction pad and accommodation camp conceptual layout | ● Booroolong Frog |
| — Local road or track | ▨ Booroolong Frog - breeding habitat |

Amphibian survey results

Snowy 2.0
Biodiversity Development Assessment Report
Exploratory Works
Figure 6.7

6.3.5 Species credit species

A list of candidate species credit species predicted to occur within the Exploratory Works survey area, along with an assessment of whether the survey area provides suitable habitat, whether the species was recorded during targeted surveys and whether the species will be impacted by Exploratory Works is provided within Table 6.16.

Based on targeted surveys, the following species will be impacted:

- Gang-gang Cockatoo (breeding habitat only) – 0.9 ha;
- Eastern Pygmy-possum – 66.5 ha;
- Booroolong Frog – 2.0 ha;
- Smoky Mouse – 0.2 ha; and
- Masked Owl (breeding habitat only) – 0.9 ha.

These species will require offsets in accordance with the BAM (OEH 2017). Species polygons across the survey area are shown in Figure 6.4 to Figure 6.7.

Table 6.16 **Species credit species, habitat suitability and targeted survey results**

Scientific name	Common name	Biodiversity risk weighting	Habitat present within the Exploratory Works survey area	Recorded during field surveys	Impacted by development	Justification
Flora						
<i>Pomaderris cotoneaster</i>	Cotoneaster Pomaderris	2.00	Yes. Predominantly riparian zones.	No	No	Not recorded during targeted surveys.
<i>Thesium australe</i>	Austral Toadflax	1.50	Yes. Upper sections of Lobs Hole Ravine Road in damp sections of PCT 1196 and in Lobs Hole in damp areas such as PCT 285.	No	No	Not recorded during targeted surveys.
Fauna						
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo (Breeding)	2.00	Yes. Breeding habitat largely restricted to areas with suitably sized hollows in PCT 1196 along the upper section of Lobs Hole Ravine Road and in PCT 302 along the Yarrangobilly River. Species forages more broadly across the survey area.	Yes	Yes	All areas of PCT 1196 and PCT 302 not in Low, Derived Grassland or Other condition classes have been considered breeding habitat on the basis of suitable hollows being located in these areas. PCT 1196 will be largely avoided (see Section 7).
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	2.00	Yes. Species occurs in a broad range of habitats within the survey area, usually associated with a dense midstorey and/or feed species such as Banksias.	Yes	Yes	PCTs 296, 300, 302, 639, 644, 729, 999 and 1196 have been considered suitable habitat on the basis of suitably dense understorey habitat with flowering Banksias. PCTs in Low or Derived Grassland condition classes were excluded as they do not provide a sufficiently dense understorey selected by the species. PCTs 639 and 1196 will be largely avoided (Section 7).
<i>Litoria booroolongensis</i>	Booroolong Frog	2.00	Yes. Yarrangobilly River and Wallace's Creek.	Yes	Yes	The Yarrangobilly River and Wallaces Creek have been identified as breeding habitat, while areas within 50 m of this breeding habitat has been identified as potential dispersal and refuge habitat.

Table 6.16 **Species credit species, habitat suitability and targeted survey results**

Scientific name	Common name	Biodiversity risk weighting	Habitat present within the Exploratory Works survey area	Recorded during field surveys	Impacted by development	Justification
<i>Mastacomys fuscus</i>	Broad-toothed Rat	2.00	Yes. Sub-alpine grassy woodlands in the upper reaches of Lobs Hole Ravine Road, and a small area of dense <i>Poa</i> spp. dominated grassland adjacent to the Mines Trail in Lobs Hole.	No	No	The survey area contains marginal, atypical habitat. Not recorded during targeted surveys.
<i>Ninox connivens</i>	Barking Owl (breeding habitat only)	2.00	Yes. Suitable nesting habitat is limited to areas of mature trees along the Yarrangobilly River.	No	No	The Barking Owl is considered scarce at higher elevations of the tablelands (NPWS 2003). Given the species is known to respond strongly to call playback, but was not recorded during targeted surveys it is considered unlikely to occur.
<i>Ninox strenua</i>	Powerful Owl (breeding habitat only)	2.00	Yes. Suitable nesting habitat is limited to areas of mature trees along the Yarrangobilly River.	No	No	No evidence of nesting was observed and the species was not recorded during targeted surveys.
<i>Petaurus norfolcensis</i>	Squirrel Glider	2.00	Yes. Suitable feed and nesting trees are limited to the habitat along the Yarrangobilly River and the upper sections of Lobs Hole Ravine Road.	No	No	Not recorded during targeted surveys.
<i>Petroica rodinogaster</i>	Pink Robin	2.00	Yes. Tall, open eucalypt forest, particularly in densely vegetated gullies largely on upper sections of Lobs Hole Ravine Road and along the Yarrangobilly River. Some minor gullies along lower sections of Lobs Hole Ravine Road.	No	No	Not recorded during targeted surveys.
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	2.00	Yes.	No	No	Not recorded during targeted surveys.

Table 6.16 **Species credit species, habitat suitability and targeted survey results**

Scientific name	Common name	Biodiversity risk weighting	Habitat present within the Exploratory Works survey area	Recorded during field surveys	Impacted by development	Justification
<i>Phascolarctos cinereus</i>	Koala	2.00	Yes. Scarce in the KNP, but potential to occur in Eucalypt forest and woodland below 800 m elevation.	No	No	No evidence of use of the survey area found during SAT surveys.
<i>Pseudomys fumeus</i>	Smoky Mouse (breeding habitat only)	3.00	Yes. Tall forests dominated by Mountain Gum and Snow Gum, with a moderate to dense shrubby midstorey dominated by shrubs from the plant family <i>Fabaceae</i> (with some <i>Epacridaceae</i> and <i>Mimosaceae</i>), and dense groundcover with abundant sub-shrubs, logs and leaf litter.	Yes	No	PCTs 639, 643, 644, 953 and 1196 above 1,100 m elevation was mapped as potential habitat for this species, excluding areas in Low or Derived Grassland condition classes. Impacts to these areas have been largely avoided (see Section 7).
<i>Tyto novaehollandiae</i>	Masked Owl (breeding habitat only)	2.00	Yes. Breeding habitat containing suitable hollows limited to PCT 1196 along Lobs Hole Ravine Road and PCT 302 along the Yarrangobilly River.	Yes	Yes	All areas of PCT 1196 and PCT 302, excluding areas without tree cover (condition classes Low and Derived Grassland) or areas with only regenerating trees (condition class Other), have been considered to provide breeding habitat for the Masked Owl. PCT 1196 will be largely avoided (see Section 7).

