HISTORIC and NATURAL HERITAGE MANAGEMENT PLAN

SNOWY 2.0 – EXPLORATORY WORKS

Stage 1 – Exploratory Works Access Roads

December 2019

snowy 2.0

leed

Historic and Natural Heritage Management Plan

Rev 1

Report Snowy 2.0 - Exploratory Works - Historic and Natural Heritage Management Plan | Prepared for Snowy Hydro Limited | 16 December 2019

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Abbreviations and Glossary

AHMP	Aboriginal Heritage Management Plan
BCD	Biodiversity and Conservation Division
CSSI	Critical State Significant Infrastructure
DEC	Department of Environment and Conservation (now Office of Environment and Heritage)
DECC	Department of Environment and Climate Change (now Office of Environment and Heritage)
DPIE	NSW Department of Planning, Industry and Environment *formerly* NSW Department of Planning and Environment
EIS	Environmental Impact Statement Exploratory Works for Snowy 2.0
EMS	Environmental Management Strategy
EP&A Act	*Environmental Planning and Assessment Act 1979*
EWMS	Environmental Work Method Statement
HHIMS	Historic Heritage Information Management System
HNHMP	Historic and Natural Heritage Management Plan
KGAP	The Kosciusko National Park (KNP) Geodiversity Action Plan (2012 – 2017)
KGMP	The Kosciusko National Park (KNP) Geodiversity Monitoring Program
Lobs Hole	A former settlement location within Kosciuszko National Park, and primary location of Exploratory Works
MNES	Matters of National Environmental Significance
NHL	National Heritage List
NPWS	National Park and Wildlife Service
NPW Act 1974	*National Parks and Wildlife Act 1974*
MNES	Matters of National Environmental Significance
NHL	National Heritage List
NPWS	National Park and Wildlife Service
NPW Act 1974	*National Parks and Wildlife Act 1974*
OEH	Office of Environment and Heritage
Project, the	Exploratory Works for Snowy 2.0
REMM	Revised Environmental Management Measures
Snowy Hydro	Snowy Hydro Limited
Submissions Report or RTS	*Response to Submissions Exploratory Works for Snowy 2.0*

1 Introduction

1.1 Background

Snowy Hydro Limited (Snowy Hydro) is the proponent of the Snowy 2.0 project which is a pumped hydro-electric storage and generation project proposed to address increasing demands for renewable energy supplies. Snowy 2.0 involves linking Talbingo and Tantangara reservoirs within the existing Snowy Mountains Hydro-electric Scheme (Snowy Scheme) and building an underground power station between the two reservoirs.

Snowy Hydro will carry out Exploratory Works prior to the main construction works for the Snowy 2.0 project, to inform the detailed design and to reduce project risk. Exploratory Works are required to obtain detailed geological data for the proposed location of the underground power station. An exploratory tunnel is to be constructed to gain this information. The Exploratory Works will predominantly be in the Lobs Hole area of Kosciuszko National Park (KNP). If the Exploratory Works are not undertaken, risks to the design and construct elements of the power station cavern are significantly increased.

The *Environmental Impact Statement Exploratory Works for Snowy 2.0* (EIS) was prepared to assess the impact of these works on the environment, including an assessment of historic heritage impacts within Chapter 5.5 and Appendix P. MOD1 also identified historic and natural heritage values relevant to the modification area, assessed any impacts, and proposed any required mitigation measures within Chapter 6.2, 7.1 and Appendix C. The EIS and MOD1 identified that the Exploratory Works would cause impacts to historic heritage items. The presence of these does not pose a constraint to works, however, management and impact mitigation measures are required.

The historic heritage in the project area recorded during the EIA, is documented in the Historic Cultural Heritage Assessment Report (HCHAR) entitled:

> Julie Dibden and Andrew Pearce 2018 *Snowy 2.0 Exploratory Works Historic Cultural Heritage Assessment Report*. A report to Snowy Hydro Limited.

The HCHAR documents the initiatives built into the project design to avoid and minimise impacts to historic heritage and the mitigation and management measures proposed to address any residual impacts not able to be avoided.

The *Response to Submissions Exploratory Works for Snowy 2.0* (Submissions Report or RTS) included revised environmental management measures within Chapter 8. The management measures from that report have been addressed within this HNHMP.

1.2 Context

This Historic and Natural Heritage Management Plan (HNHMP or Plan) forms part of the Environmental Management Strategy (EMS) for the Snowy 2.0 - Exploratory Works project (the Project). The Exploratory Works is the first stage of Snowy 2.0, a pumped hydro-electric storage and generation project which will increase the hydro-electric capacity within the existing Snowy Mountains Hydro-electric Scheme. The second stage, or main project, will be subject to a separate Environmental Impact Statement in 2019.

The HNHMP has been prepared to address the requirements of the Infrastructure Approval (SSI 9208) issued for Snowy 2.0 Exploratory Works on 7th of February 2019, the *Environmental Impact Statement Exploratory Works for Snowy Hydro 2.0,* and the revised environmental management measures within the *Response to Submissions Exploratory Works for Snowy 2.0*.

This revision of the HNHMP has been prepared to address the requirements of the Exploratory Works for Snowy 2.0 Modification 1 Assessment Report (MOD1) and the REMMs within the Exploratory Works Modification 1 Response to Submissions Report which were approved by Department of Planning, Industry and Environment (DPIE) on 2 December 2019.

The original EIS Exploratory Works scope includes:

- an exploratory tunnel about 3.1 km long to the site of the underground power station;
- 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. This will provide the entrance structure to the tunnel and an area for infrastructure and equipment needed to support tunnelling activities;
- an accommodation camp for the Exploratory Works construction workforce;
- road works and upgrades to enable access and haulage routes during Exploratory Works. This includes upgrades to 26 km of existing roads and creating about 2 km of new roads;
- barge access infrastructure to enable access and transport by barge on Talbingo Reservoir. This includes one new barge ramp at Talbingo Spillway in the northern part of Talbingo Reservoir and one new barge ramp at Middle Bay near Lobs Hole at the southern part of Talbingo Reservoir;
- excavated rock management, including subaqueous placement within Talbingo Reservoir. Up to 750,000 m^3 of excavated rock will need to be tested for its geochemical properties (ie whether the rock is reactive or non-reactive) before being managed by a combination of the following options:
    - re-use - suitable material can be used as construction materials for roads or similar. Some materials will be provided to NPWS for use in road maintenance and upgrades in other areas of KNP;
    - on land placement - material will be temporarily placed in one of two on land emplacement areas.
    - subaqueous placement within Talbingo Reservoir – suitable material will be placed at a suitable location within Talbingo Reservoir, subject to a number of water quality controls and monitoring; and
- services infrastructure such as diesel-generated power, water and communication;
- post-construction revegetation and rehabilitation, management and monitoring.

Having regard to the design changes identified in Modification 1, the scope now comprises the following listed in Table 1.1 below:

Table 1.1 New scope items for EW (Stage 1 & 2) as a result of MOD1

Stage 1	
Lobbs Hole Substation	Additional disturbance area required for the construction power connection to an existing transmission line (Line 2) at Lobs Hole for power supply to the Exploratory Works accommodation camp and construction areas. This will provide a reliable and long-term source of construction power and will reduce the reliance on diesel generation and associated on-site storage requirements and emissions. Works in this area will include establishing a substation, connection infrastructure, access roads and ancillary construction areas; This will include: • construction of a 330/33 kV substation within Kosciuszko National Park and adjacent to Line 2, which forms a 330-kV connection between Upper Tumut Switching Station and Yass Substation; • geotechnical investigation works to inform the detailed design of the construction power substation; • replacement of one transmission support structure (Structure 54) within the existing transmission easement. This will involve removal of the existing structure and establishment of one new steel lattice tower, approximately 50 m in height; • short overhead 330 kV transmission line connections (approximately 100 m in length) between the substation and the new Structure 54; • 33 kV feeder connection between the substation and the Exploratory Works construction power network. This will be either overhead lines or underground cables; • establishment and upgrade of access tracks and roads to the new substation and transmission line structures; • installation of a fibre optic communication link into the new substation from the approved communication network; and • ancillary activities, including brake and winch sites, crane pads, site compounds and equipment laydown areas. (Illustrated Appendix F Figure 1i)
Camps Bridge and Wallaces Creek	• additional disturbance area around Camp Bridge and Wallaces Creek Bridge required for improved constructability of the crossings. Works within these areas will include vegetation clearing, levelling earthwork, erection of falsework, sediment controls, laydown, parking and movement of equipment; (Illustrated in Appendix F Figures 1h and 1i of this plan and Modification 1 Assessment Report Figure 3.9)
Lobs Hill Ravine Road and Construction Boundary Changes	• minor changes to the project boundary identified through detailed design including: – revised road upgrade for Lobs Hole/Ravine Road to improve access, drainage and safety; – minor additions to construction areas for design optimisation.

	• removal of dangerous trees on Lobs Hole Ravine Road. This will involve either complete or partial removal of up to 91 trees that have been identified to pose a safety risk to road users on Lobs Hole Ravine Road and Mine Trail Road; (Illustrated in Appendix F, Figures 1d, 1e, 1f and 1i)
Operating Hours	• modify operating hours from existing 7 am to 6pm to sunrise to sunset
Miscellaneous	• continued use of existing communications towers within KNP that were previously approved by the NPWS under a separate review of environmental factors (REF R – Wallaces Creek Geotechnical drilling) environmental impact assessment carried out under the NSW National Parks and Wildlife Act 1974 (NPW Act) and its regulation for the geotechnical investigation program; and • increase in peak traffic volumes. Additional vehicles will be required to access the site to facilitate construction of Exploratory Works, however no change in impacts to the road network are expected. (location of communications towers illustrated in Appendix F Figures 1a, 1f, 1l)
Stage 2	
Borehole drilling and geophysical surveys	• Borehole drilling and geophysical surveys for further geotechnical investigation of the Snowy 2.0 power station and power waterway at Marica, Talbingo and Tantangara; • clearing of up to 2.79 hectares (ha) of additional vegetation for access tracks and drilling pads. • About 1.33 ha within Smokey Mouse potential habitat; • trimming of overhanging dangerous branches on adjacent trees (these trees will not require removal); • mulching of trees and vegetation; • establishment of an additional 1 km of access tracks (4 m wide), including minor earthworks, • placement of geofabric (as required) and import of stabilised material; • establishment of eight drilling pads and boreholes at top of the cavern area, with an area of 900 m2 per pad, including minor earthworks, placement of geofabric (as required) and import of stabilised material (as required); • undertaking geophysical surveys near Talbingo and Tantangara reservoirs; • establishment of two drilling pads and boreholes at both Tantangara and Talbingo with an area of • 900 m2 per pad, including approximately 400 m of additional access tracks and minor earthworks (as required); • establishment of in-reservoir boreholes including one in Talbingo Reservoir and two in Tantangara Reservoir; • drilling of additional nested vertical boreholes at each of the drilling pads up to a depth of 1,100 m; • conversion of the investigation boreholes into monitoring bores; • undertaking geophysical surveys; and • rehabilitation of the drilling pads and access tracks following completion of

	works • ongoing maintenance of existing access tracks required for geotechnical investigations within KNP (Illustrated in (Illustrated in Appendix F Figure 1j, 1k, 1l, 1m and 1n)
Talbingo Laydown	Outside of KNP, SHL is proposing to add four laydown locations to facilitate the construction of the communications cable linking Lobs Hole with the Tumut 3 Power Station. These are proposed on existing hardstand areas along Talbingo Reservoir within Snowy Hydro owned land. (Illustrated in Appendix F, Figure 1o)
Tantangara Access	Two additional geotechnical boreholes are required to facilitate the detailed design of cuttings, bridge foundations, retaining wall foundations, and drainage structures near Nungar Creek (Illustrated in Appendix F, Figure 1m and 1n)

The Exploratory Works is estimated to take around 30 to 34 months to complete.

As with most of the existing Snowy Scheme, the majority of Snowy 2.0 is within Kosciuszko National Park. Snowy Hydro has been working with NSW National Parks and Wildlife Service (NPWS) since the announcement of Snowy 2.0 to ensure long term management objectives for Kosciuszko National Park are considered in project development.

The Project has been designed in a way that avoids and minimises impacts to Kosciuszko National Park where possible. This has included the planning of access roads and construction areas to avoid impacting the heritage listed Washington Hotel ruins at Lobs Hole, and Smoky Mouse habitat along Upper Lobs Hole Ravine Road. It also includes designing road upgrades to minimise impacts to geodiversity features including a block stream and a fossil outcrop along Lower Lobs Hole Ravine Road. The former copper mine at Lobs Hole is also considered a geo-heritage site, however it is also a source of known contamination and has therefore been avoided as much as possible to prevent disturbance.

While there are some unavoidable impacts during construction, the Exploratory Works will allow for a number of longer-term benefits and contributions to Kosciuszko National Park through a biodiversity offset program, improved access roads and recreational facility upgrades. The completion of Exploratory Works will also allow for the greater benefits of Snowy 2.0 to be realised.

1.3 Construction activities and sequencing

Exploratory Works will be delivered in three stages:

- **Stage 1a – Pre-construction Minor Works -** pending the approval process, works may commence in the first quarter of 2019. The scope of pre-construction minor works includes dilapidation studies, survey work, borehole installation, site office establishment, minor access roads, installation of monitoring equipment, installation of erosion and sediment controls, archaeological salvage and minor clearing;

- **Stage 1b – Exploratory Works Access Roads (EWAR)** - pending the approval process, works may commence in the first quarter of 2019. The scope includes roadworks and upgrades to enable access and haulage routes during Exploratory Works;

- **Stage 2 – Exploratory Works** - pending progress with Stage 1, works may commence in quarter three of 2019. The scope for Stage 2 will be the remainder of the Exploratory Works, including the exploratory tunnel, portal construction pad, accommodation camp and excavated rock management. Stage 2 also includes subaqueous emplacement within Talbingo Reservoir.

To present the staging of plans a separate Staging Report has been prepared and was submitted to Department of Planning and Environment. Timing of the Exploratory Work stages is presented below.

Figure 1 Timing of Exploratory Works stages

1.3.1 Exploratory Works Access Roads

The Exploratory Works Access Roads (EWAR) will provide early access to the tunnel portal located to the east of the Talbingo Reservoir, and to Talbingo Reservoir itself. The works include upgrades to and/or construction of the following roads:

- Ravine Road;
- Mine Trail Road;
- Lobs Hole Road;
- Wharf Road.

The EWAR scope includes but is not limited to the following:

- site survey and setting out the works including delineation of site boundaries;
- establishment of all site facilities required and removal upon completion, including all temporary safety and security measures required;
- locating and protecting all public and private utility services;
- maintenance of the existing roadway and associated infrastructure;
- clearing and grubbing of vegetation including creation of mulch and compost;
- establishment of short term and long-term (eg: detention and sedimentation basins) erosion and sedimentation control systems and devices;

- removal and disposal of existing infrastructure including pipes, culverts, drainage channels and other minor structures;
- excavation and stockpiling of topsoil;
- earthworks including excavation of cuttings, construction of fills including selected zone material, and placement of excess spoil in stockpile;
- progressive opening to traffic;
- treatment of cut and fill slope batter surfaces including slope retention systems where shown;
- construction of clean and dirty water drainage systems including culverts, open and subsoil drainage systems;
- construction of pavements including subgrades and pavements and road surfacing;
- design, supply, construction of temporary structures / bridges over Wallace Creek and the Yarrangobilly River and removal of completion;
- construction of permanent bridges over Wallace Creek and the Yarrangobilly River;
- installation of road furniture including but not limited to barriers, line marking, guide posts and road signs;
- placement / replacement of topsoil and revegetation and other surface treatments to disturbed earth surfaces including lining of open drains;
- clean up and restoration of work areas and areas disturbed by the contractor.

The works are proposed to commence in the first quarter of 2019.

The additional EWAR scope as a result of MOD1 will include:

- construction of a 330/33 kV substation within Kosciuszko National Park and adjacent to Line 2, which forms a 330-kV connection between Upper Tumut Switching Station and Yass Substation;
- geotechnical investigation works to inform the detailed design of the construction power substation;
- replacement of one transmission support structure (Structure 54) within the existing transmission easement. This will involve removal of the existing structure and establishment of one new steel lattice tower, approximately 50 m in height;
- short overhead 330 kV transmission line connections (approximately 100 m in length) between the substation and the new Structure 54;
- 33 kV feeder connection between the substation and the Exploratory Works construction power network. This will be either overhead lines or underground cables;
- establishment and upgrade of access tracks and roads to the new substation and transmission line structures;

- installation of a fibre optic communication link into the new substation from the approved communication network; and
- ancillary activities, including brake and winch sites, crane pads, site compounds and equipment laydown areas.
- minor changes to the project boundary identified through detailed design including:
  - additional disturbance area around Camp Bridge and Wallaces Creek Bridge required for improved constructability of the crossings. Works within these areas will include vegetation clearing, levelling earthwork, erection of falsework, sediment controls, laydown, parking and movement of equipment;
  - additional disturbance area required for the construction power connection to an existing transmission line at Lobs Hole. Works in this area will include establishing a substation, connection infrastructure, access roads and ancillary construction areas;
  - revised road upgrade for Lobs Hole/Ravine Road to improve access, drainage and safety; and
  - minor additions to construction areas for design optimisation.
- removal of dangerous trees on Lobs Hole Ravine Road. This will involve either complete or partial removal of up to 91 trees that have been identified to pose a safety risk to road users on Lobs Hole Ravine Road and Mine Trail Road;
- continued use of existing communications towers within KNP that were previously approved by the NPWS under a separate review of environmental factors (REF R – Wallaces Creek Geotechnical drilling) environmental impact assessment carried out under the NSW National Parks and Wildlife Act 1974 (NPW Act) and its regulation for the geotechnical investigation program; and
- increase in peak traffic volumes. Additional vehicles will be required to access the site to facilitate construction of Exploratory Works, however no change in impacts to the road network are expected.

This Plan identifies the project's environmental management measures in relation to historic and natural heritage management. This plan has been developed for Stage 1 and Stage 2 of the Exploratory Works project. However, it will be revised prior to the commencement of Stage 2 works to include further project specific details as they become available.

There will be some overlap of works as the Project transitions from Stage 1 to Stage 2 with, in some cases, a lag between Stage 1 works ceasing and Stage 2 commencing. The nature of heritage areas is such that the extent of a site is unknown until salvage work commences, which has led to some works lasting longer than first thought. This has been the case during Stage 1 works and will continue over Stage 2 works.

As the heritage scope is unchanged across both stages, this Plan has been updated to acknowledge the heritage works which have occurred during Stage 1 and will continue into Stage 2. While construction works will be quite distinct packages of work undertaken by different contractors, the heritage works will continue under the same team and methodology. Hence, this Stage 1 plan has been updated to continue

to cover all heritage works until the Stage 2 HNHMP has been approved. Tables 5.2 and 5.3 summarise the ongoing heritage works under both stages.

This scope of heritage works will continue to be covered under this management plan through the Stage 1 to Stage 2 interim period and Stage 2. Any new heritage items not included in this plan will fall under the Stage 2 HNHMP.

Any additional scope as a result of MOD1 will fall into line with the understanding that heritage works under Stage 1 will fall under this plan and continue into Stage 2 when it commences.

The timing of the preparation, consultation and submission of this plan is shown within Figure 4.3 of the EMS. Ongoing revisions to the HNHMP will occur in accordance with Section 1.6.1 of the Environmental Management Strategy (EMS). During Stage 1 of the work ongoing revisions to the HNHMP will occur in accordance with Section 1.6 of the EMS.

Table 1.2 Historic and natural heritage relationship to other plans

Heritage	Relevant plan	Timing of plan*	
		Stage 1	Stage 2
Historical heritage	This plan	P	R
Road construction – geodiversity management	This plan	P	R
Other construction including tunnelling activities – geodiversity management	This plan	P	R
Aboriginal heritage	Aboriginal Heritage Management Plan	P	R

* P – prepare, R – revise

Management measures identified in this Plan will be incorporated into site specific documents which are to be prepared by the Contractor. These site-specific documents will be prepared for construction activities and will detail the management measures which are to be implemented on the ground. Construction personnel will be required to undertake works in accordance with the mitigation measures identified in the site-specific documents.

1.4 Background

1.5 Environmental management system

The overall environmental management system for the Project is described in the EMS. This HNHMP forms part of Snowy Hydro Limited's environmental management framework for the Project, as identified in Figure 1.2 and as described in Section 4 of the EMS.

This Plan aims to transfer the relevant requirements of the Approval documents into a management plan which can be practically applied on the Project site.

Figure 1.2 EMS structure

1.6 Purpose and objectives

The key objective of the HNHMP is to describe the management and mitigation measures that are to be implemented during Stage 1 to ensure that impacts to historic and natural heritage are managed within the scope permitted by the Project Approval. To achieve this, Snowy Hydro and the Contractor will ensure that:

- appropriate measures are implemented to address the recommendations as set out in the HHCAR, the REMMs listed within the RTS, and the relevant Conditions of Approval, as detailed within Tables 2.1 and 2.2 of this Plan;
- appropriate measures are implemented during construction to avoid or minimise heritage impacts, as relevant;
- the management of impacts and impact mitigation to historic heritage values is carried out prior to the commencement of construction. Specific management and mitigation measures are listed for each individual heritage item in Table 5.2 and sites to be avoided are listed in Table 5.3;

- the location of the Ravine Cemetery is clearly identified on any plans associated with the project. The boundaries of the Cemetery should be survey ed and identified on the ground and the area should be marked as a *no go* zone so as to ensure that no inadvertent impacts occur in that area;
- when preliminary clearance of vegetation is made in the project area this is conducted in accordance with adequate supervision by the project archaeologist. Monitoring should be undertaken for the purposes of inspecting thickly vegetated areas for unrecorded heritage;
- a protocol for the management of potential burials in the project area is in place. The location of 16 graves of people listed as buried at Lobs Hole is unknown;
- adequate guidelines are set out for the management of movable heritage located anywhere in or near the Project area to ensure that it is not inadvertently impacted or removed;
- ensure appropriate measures are implemented during construction to avoid or minimise impacts to the geodiversity features of Kosciusko National Park; and
- ensure appropriate measures are implemented to address the relevant conditions of approval and the revised environmental management measures listed within the Submissions Report, as detailed within Table 2.1 and Table 2.2 of this Plan.

1.7 Plan preparation

In accordance with the requirements of Condition 14 of Schedule 3 of the Approval, the HNHMP has been prepared by a suitably qualified and experienced persons in accordance with guidelines made or approved under the *National Parks and Wildlife Act 1974* (NSW). The Historic Heritage component of this plan was prepared by Dr Julie Dibden of NSW Archaeology Pty Ltd. The Natural Heritage Management Plan had contributions from Dr Ian Percival (NSW Department of Planning - Retired).

1.8 Consultation

In accordance with condition 20 (b) of the Infrastructure Approval (SSI 9208) (Approval), the HNHMP has been prepared in consultation with the Heritage Division of the NSW Office of Environment and Heritage (OEH), and National Park and Wildlife Services (NPWS).

Preliminary consultation for the Historic and Natural Heritage Management Plan began in November 2018.

The MOD1 Assessment Report and associated technical studies were submitted by Snowy Hydro to DPIE in June 2019 and publicly exhibited in accordance with the EP&A Act between 26 June and 9 July 2019. Nine submissions were received during the public exhibition period, including one from a special interest group and two individual community submissions.

Table 1.3 Preliminary HNHMP consultations with stakeholder agencies

Date	Consultation	Outcomes
13th November 2018	Issued Geodiversity Management Plan and Historic Heritage Management Plan to OEH and NPWS	Sent as information to these Agencies for their review.
28th November 2018	Issued updated Plan to NPWS	Updated plans were sent to NPWS for further review.
7th December 2018	Received consolidated comments of OEH	Comments accepted and plans revised to address comments. Comments addressed: • protection of karst features; • References to the RTS; • Extent of value of fossils and their future protection; • Monitoring requirements; • Inclusion of tufa as potential impact; and • Unexpected finds protocol for karst features.
12th December 2018	Met with NPWS	Outlined the Project approval process and management plan development
16th January 2019	Re-issued draft HNHMP to NPWS (for distribution to OEH)	Latest revision to reflect revised comments and draft SSI 9208 conditions of consent
22nd January 2019	Met with NPWS	Discussed revisions to management plans and consultation and approval program
31st January 2019	Received comments from NPWS	Comments accepted and plans revised to address comments.
5th February 2019	Meeting with NPWS	Discussion with NPWS about current plans, latest comments and the ongoing consultation process.

12th February 2019	Updated HNHMP with Project Development consent conditions issued to NPWS	NPWS issued comments to Snowy Hydro with discussion on 25/02/19 – 27/2/19
4th June 2019	Workshops with Future Generation and NPWS and OEH	Discussion of updating Stage 1 plan as an interim measure prior to Stage 2 management plan approval.
10th October 2019	Updated HNHMP with changes due to MOD1 issued to NPWS	Comments received and plans updated to address.
24th October 2019	Updated HNHMP with changes due to MOD1 issued to DPIE Department of Environment and Heritage	No response received

In summary, the comments received to date related to:

- protection of karst features;
- References to the RTS;
- Extent of value of fossils and their future protection;
- Monitoring requirements;
- Inclusion of tufa as potential impact; and
- Unexpected finds protocol for karst features.

2 Environmental requirements

2.1 Legislation

Legislation relevant to historical heritage management includes:

- *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act);
- *Environmental Planning and Assessment Act 1979* (EP&A Act);
- *Heritage Act 1977* (Heritage Act); and
- *Heritage Regulation 2012.*
- *Protection of the Environment Operations Act 1997 (POEO Act);*
- *National Parks and Wildlife Act 1974.*

Relevant provisions of the above legislation are explained in the register of legal and other requirements included in Appendix A1 of the EMS.

2.2 Conditions of approval

Project approval for SSI 9208 was granted by DPE on 7th of February 2019 with the following historic and natural heritage management conditions included in the Infrastructure Approval. MOD1 was granted approval by DPIE on 2 December 2019. The relevant conditions are presented in Table 2.1.

Table 2.1 Conditions of approval relevant to natural and historical heritage management

Condition	Requirement	Where addressed
19	The Proponent must:	Section 5
	(a) minimise the impact of the development on the:	
	• fossiliferous beds and boulder streams on Lobs Hole Ravine Road;	Table 5.1 Section 5.3 Section 5.4
	(b) for the fossiliferous beds disturbed by the Lobs Hole Ravine Road upgrade works:	Section 5.3
	• retain a representative sample of spoil from the fossiliferous beds, and	
	• carry out scientific research on this sample of spoil;	
	(c) for the boulder streams disturbed by the Lobs Hole Ravine Road upgrade works: • undertake detailed mapping of the block stream extents and morphology; and • prepare a detailed archival record of the block streams, prior to disturbing the block streams; and	Table 5.1 Table 6.1 Appendix D
	(d) ensure the development does not adversely affect the tufa deposits at Lick Hole Gully and Cave Gully and the Former Copper Mine shown in Appendix 4; and	
	(e) carry out a detailed investigation of any unidentified karst features intercepted during the tunnel works.	Stage 2

Condition	Requirement	Where addressed
		Table 5.1
20	Prior to carrying out any development that could affect the historic or natural heritage items listed in conditions 16, 17 and 19 above, unless the Planning Secretary agrees otherwise, the Proponent must prepare a Historic and Natural Heritage Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:	This document fulfils C20 Tables 5.2 and 5.3 meet requirements of Tables 4-1 and 4-2 of consent
	(a) be prepared by a suitably qualified and experienced person/s whose appointment has been endorsed by the Planning Secretary;	Section 1.5
	(b) be prepared in consultation with the BCD and NPWS;	Section 1.6
	(c) describe the measures that would be implemented to:	Section 5
	• protect the historic heritage items outside the approved disturbance area;	
	• mitigate the impacts of the development on the historic heritage items listed in Table 4-1, including a detailed archaeological research design and excavation program for the proposed test excavations;	
	• protect or minimise the impacts of the development on the natural heritage items referred to in condition 19 above;	
	(d) include a detailed program for the archival recording of the history of settlement and mining in the Lobs Hole Ravine area;	Section 5.1 and Appendix B
	(e) include a program to:	Section 5
	• carry out scientific research on the representative sample of spoil from the fossiliferous beds disturbed by the Lobs Hole Ravine Road upgrade works and publicly report on the findings; and	Section 5
	• undertake the field mapping and photographic recording of the block streams disturbed by the Lobs Hole Ravine Road upgrade works;	Section 5 Table 5.1
	• carry out a detailed investigation of any unidentified karst features intercepted during the tunnel works and publicly report on the findings of this investigation; and	Section 5
	• provide educational interpretative signage of the fossiliferous beds and boulder streams;	
	(f) describe the measures that would be implemented to:	Section 6
	• manage the discovery of human remains and previously unidentified heritage items;	Section 5 and Appendix B
	• relocate moveable historic heritage items within the disturbance area;	
	• store and manage any salvaged heritage items; and	Section 5 and Appendix B
	• investigate any unidentified karst features discovered during the tunnel works	Section 5
•	• ensure workers on site receive adequate training and inductions on historic and natural heritage management.	Section 5 and 6
	(g) include a program to:	
	• undertake baseline monitoring of the condition of the historic and natural heritage	Section 3 and 6

Condition	Requirement	Where addressed
	items that must be protected; • monitor the impacts of the development on the historic heritage items referred to in condition 16 above; and • monitor the impacts of the development on the natural heritage items referred to in condition 19 above.	Section 5 and 6
20	The Proponent must implement the approved Historic and Natural Heritage Management Plan for the development.	Section 1.3

2.3 Revised environmental management measures

Environmental safeguards and management measures are included in the EIS in Section 6.3. During preparation of the Submissions Report, REMMs were developed and are included in Section 8 of the Submissions Report.

The environmental management measures relevant to this Plan are listed in Table 2.2 below. If additional measures are cross-referenced from another section of the EIS or Submissions Report, these measures are also included.

Table 2.2 Management measures relevant to historic and natural heritage management

Impact	Ref #	Environmental management measure	Where addressed
Historical Heritage	M1.5	The historical heritage management plan (HHMP) will be updated to account for the additional areas assessed for the proposed modification.	This plan
Loss of historic heritage	HER03	A Historic Heritage Management Plan (HHMP) will be prepared and implemented to guide the process for management and mitigation of impacts to historic cultural heritage. The HHMP will:	This plan
		Set out procedures to manage impacts, avoidance of impacts and impact mitigation in accordance with the HCHAR recommendations;	Section 5
		Set out an unexpected finds protocol and the procedure to be followed for monitoring to undertaken for the purposes of inspecting areas for unrecorded heritage, when preliminary clearance of vegetation is made;	Section 5.2.6
		Outline a protocol for the management of potential unmarked graves and other human skeletal material in the project area;	Section 5.2.7
		Set out guidelines for the management of movable heritage located anywhere in or near the project areas, to ensure that it is not inadvertently impacted or removed.	Section 5.2.5
Loss of historic cultural heritage	HER04	The following will occur to confirm the mitigation measures provided for the individual heritage items listed below where applicable:	Section 5.2
		1. Archival recording of the entire Lobs Hole historic landscape to capture the industrial, residential and agricultural features at the site. The recording would use photographic techniques and topographic survey. Orthographically corrected photographs would be the most effective way of doing this as it combines both techniques (the methods for archival recording will be developed in	Section 5.2.3

Impact	Ref #	Environmental management measure	Where addressed
		the HHMP phase);	
		2. with the data obtained from '1' (above), an analysis of the site would be made of the areas of potential relics and determine what the research potential is and if test excavation is justified;	Section 5.2 and Table 5.2
		3. if the answer is yes for archaeological potential, a research design and excavation method would be prepared to support and guide archaeological test excavation; this will determine what and how much of the site can provide information that no other source can before it is removed by the project; and	Section 5.2.3 and Appendix B
		4. ensuing from the above, a comprehensive historic document would be produced which would include, but not be limited to, the results of the archival recording and archaeological investigations, and the on-going oral and historical research.	Section 5.2 and Appendix B
		Specific management and mitigation measures are listed for each individual heritage items below. These shall be implemented prior to and during construction as applicable and include: • R1, R2 – archaeological research design, archival recording and archaeological test excavation within disturbance areas; • R3, R4, R5, R6, R7, R8, R10, R12, R13, R21, R23, R26, R30, R31, R33, R35, R36, R37, R43, R44, R46, R51, R52, R53, R54, R55, R56, R57, R58, R59, R62, R65, R67, R68, R70, R73, R75, R76, R77, R78, R79, R81, R82, R83, R84, R85, R86, R87, R94, R95, R97, R98, R101, R102, R103, R104, R105, R106, R107, R108, R110, R111, R112, R114, R115, R116, R117, R119, R120, R121 – archival recording; • R9, R74, R88 – archival recording and no-go buffer to be provided to avoid inadvertent impacts; • R11, R14, R49, R50, R100 – archival recording and implement measures to protect moveable heritage; • R15, R17, R22 – archival recording and include in the archaeological research design for the Pinbeyan Station Homestead; • R16, R18 – archival recording, implement measures to protect moveable heritage and include in the archaeological research design for the Pinbeyan Station Homestead; • R19 – avoid impacts; • R20 – archival recording, implement measures to protect fabric and moveable heritage, ensure no inadvertent impacts, determine curtilage around the item and prepare and archaeological research design to ascertain what, if any parts of the hotel complex are in the disturbance area and reassess the significance of component parts; • R24, R25, R27, R28, R29, R34, R38, R39, R40, R41, R42, R61, R63, R66, R69, R80, R90, R91, R92, R93, R96, R99, R122 – archival recording. Test excavation may be warranted; • R45 – archival recording and limit impacts as much as possible; • R47 – archival recording. Test excavation may be warranted. Avoid impacts as much as possible; • R48, R60 – archival recording. Test excavation may be warranted. Implement measures to protect moveable heritage; • R64 – archival recording program. Test excavation may be warranted. Ensure no inadvertent impacts;	Section 5.2, Table 5.2 and 5.3 and appendices

Impact	Ref #	Environmental management measure	Where addressed
		• R47 - archival recording. Test excavation may be warranted. Avoid impacts as much as possible; • R71, R72 - archival recording. Test excavation may be warranted. Avoid disturbance to the site if feasible; • R109, R118 – archival recording, avoid disturbance, ensure no inadvertent impacts; • R113 - archival recording. Avoid disturbance to the site if feasible; and • R128 – test excavation may be warranted.	
		A qualified heritage consultant is to undertake a pre-work condition assessment (including photographic records) for the Washington Hotel ruins. Following initial condition assessment, a monitoring regime is to be implemented to ensure vibration associated with the works avoid harm to pisé structure. Where possible, further avoidance is recommended for the Ravine cemetery.	Section 5.2, Table 5.2 and 5.3 and appendices
		A comprehensive research project on the history and heritage of the area will be undertaken to fill in the gaps in the existing history of settlement and mining and the archival recording of heritage items in the Lobs Hole Ravine area.	Section 5.2, Table 5.2 and 5.3 and appendices
Geodiversity Block streams	M1.14	Carry out field mapping of block stream extents and morphology within the construction footprint prior to works. Use this data to assist preparation of final design and construction plans which minimise potential impacts on these features and enable management of impacts during construction.	Section 5 Table 5.1
	M1.15	Consider visual amenity in the final road design and aim, where possible, to avoid the use of construction methods and materials that detract from the landscape values of the block streams and their surrounds.	Section 5 Table 5.1
	M1.16	In order to maintain feature integrity in a near-natural state, construction activities should, where practical: • minimise the extent of excavation into the upslope block streams; • minimise moving or damaging blocks in areas beyond the excavation zone; • minimise the use of outside materials onto the block streams (e.g. soil or fill); • minimise use of any stabilisation measures that permanently cover the block streams, for example with shotcrete or other construction materials which would preclude their future viewing and study.	Section 5 Table 5.1
	M1.17	Road design will incorporate adequate drainage controls to ensure water flow through the upslope block streams are not impeded as this may impact local stability of the features.	Section 5 Table 5.1
	M1.18	Erosion and sediment control measures will be implemented during and after construction with the aim to minimise adverse impacts on and around the block streams.	Section 5 Table 5.1
	M1.19	The proposed works should implement controls in accordance with the Biodiversity Management Plan to ensure they do not promote the spread of weeds near the boulder streams, and thereby reduce their visibility.	Section 5 Table 5.1
	M1.20	Care will be taken to minimise impacts on the downslope section of Block Stream B which features well-preserved evidence of ice age block flow in the form of ridges and other low relief surface topography.	Section 5 Table 5.1

Impact	Ref #	Environmental management measure	Where addressed
Geodiversity and karst features	GEO01	A safe and stable road can be constructed with minimal additional impacts to the periglacial deposits. Impact to the sites can be mitigated by ensuring widening the road is only done to the width needed to accommodate safe single lane access for construction vehicles, which, in the rock streams, would be minimal. Measures to avoid and minimise impacts to geodiversity features will be implemented as part of the EMS and include: • digging the road deeper into the rock stream should be avoided where practical, and excavations that take place to widen the road should be undertaken on the upslope side of the road; • appropriate drainage should be constructed under the road to ensure no build-up of water occurs above the road, within the rock stream, during heavy rain; • educational signage should be provided in a nearby suitably widened area to provide information on the periglacial rock stream geoheritage features; • if any works are required to stabilise upslope sections of rock stream it is recommended that open mesh wire fencing is used so the general public and scientists can see and appreciate the architecture of the deposit. Building a solid wall or spraying concrete on the upslope side should be avoided.	Section 5
	GEO02	A preferred road construction method that involves a cut of 2 m into the upslope of the fossil outcrop but minimises the volume of material for excavation. The report found that the additional road widening would be an acceptable impact to the geodiversity feature and could provide some benefits including making fossil materials available to research organisations and improving the safety and access to the features for the community. Measures to avoid and minimise impacts to geodiversity features will be implemented as part of the EMS and include: • representative excavated spoil is to be preserved off site so that palaeontologists (from various research organisations) can look through the fresh material and collect fossil specimens for scientific research and curation in their respective collections; and • depending on the option of road upgrades to be implemented, interpretive signs could be installed in an appropriate location near the cuttings to highlight features in the exposures, provided the fossils were protected from being easily collected.	Section 5

2.3.1 Kosciusko National Park Plan of Management

The *Kosciusko National Park Plan of Management* (KNP PoM) (DEC NSW 2006) has been prepared under the NSW *National Parks and Wildlife Act 1974* to provide a framework of objectives, principles and policies to guide the long-term management of the broad range of values contained in the park. This framework is translated into a suite of specific actions to be undertaken by the NPWS and other organisations.

The KNP PoM contains a set of actions concerning management of the geodiversity of the park. Actions for managing geodiversity include developing a geodiversity conservation strategy aimed at protecting all rocks, landforms and soils at risk of disturbance. A number of these actions have since been implemented, including the preparation and implementation of the *Kosciusko National Park Geodiversity Action Plan 2012-2017* which came into effect in 2012.

Management objectives in the KNP PoM relating to geodiversity have been developed for both 'Rocks and Landform' and 'Karst' categories. It is noted that in line with the management objectives of the KNP PoM (section 6.3.1 of the KNP PoM), the site location of assessed geodiversity features has not been published in this Plan. Relevant objectives and their actions are listed in Table 2.3.

Table 2.3 KNP PoM management objectives relevant to Exploratory Works

Management objective	Policies and actions
Rocks and Landform	
6.3.1 The rocks, landforms and geological processes of the park are protected and, where necessary, managed within the bounds of acceptable limits of disturbance.	1. Provide maximum protection to rocks, landforms and geological processes that are of national significance and sensitive to disturbance by current human activities. This will include items listed in Schedule 1. Such places will not be publicised or promoted unless management regimes are in place to protect them from likely damage associated with increased visitation.
6.3.2 Rehabilitation and construction works are undertaken in ways that protect significant rocks, landforms and geological processes.	1. Prohibit developments likely to significantly impact on the integrity of geodiversity features of national significance. 2. Assess potential impacts on geodiversity values as part of the approval process for proposed developments or activities, including restoration works. 3. Undertake the rehabilitation of disturbed sites in accordance with Section 11.2 (of the KNP PoM).
Karst	
6.4.1 The quality and quantity of air and water movement through the surface and subterranean environments of karst areas are maintained within the bounds of natural variability.	1. Minimise the use of earth-moving machinery in karst catchments. 2. Minimise surface and groundwater pollution within karst catchments.
6.4.2 Impacts associated with visitation to karst areas and features are managed within acceptable limits of disturbance.	1. Minimise adverse impacts of road drainage structures and materials used for roadworks and car parks in karst areas.

2.3.2 Kosciuszko National Park Geodiversity Action Plan

The *Kosciusko National Park Geodiversity Action Plan 2012-2017* (KGAP) was prepared in response to the issues and conservation strategies for geological and geomorphological features, as outlined in the KNP PoM. The KGAP outlines the condition and threats to key landforms, karst areas, rocks, minerals, fossils and soils within Kosciusko National Park. The focus of the KGAP is to guide the Office of Environment and Heritage (OEH) on how to better protect, conserve and promote the key features in the park, and to identify a range of actions for protecting, conserving and promoting these features to park visitors.

2.4 Licences and permits

There are no licences or permits relevant to the management of historic and natural heritage.

2.5 Guidelines

The Acts, guidelines, policies and standards relevant to this Plan include:

- *Altering Heritage Assets* (Heritage Office and DUAP 1996).
- *Assessing Heritage Significance* (NSW Heritage Office 2001).
- *Archaeological Assessment Guidelines* (NSW Heritage Office and NSW Department of Urban Affairs and Planning 1996).
- *Assessing significance for historical archaeological sites and relics* 2009, (NSW Heritage Council).
- *Stabilising stuff: A guide for conserving archaeological finds in the field,* (NSW Heritage Council, OEH, ICS 2012).
- *How to Prepare Archival Recording of Heritage Items* (Heritage Branch 1998).
- *Photographic Recording of Heritage Items Using Film or Digital Capture* (Heritage Branch 2006).
- *Exhumation of Human Remains* (NSW Department of Health 2008).
- *Skeletal Remains – Guidelines for the Management of Human Skeletal Remains under the Heritage Act 1977* (NSW Heritage Office 1998).
- *NSW Public Health Act 1991.*

3 Existing environment

3.1 Historical context

The alpine region and high country have a rich history beginning with the early explorer-settlers in the 1820s, the establishment of pastoralism and summer grazing in the 1830s, the gold rush at Kiandra in 1859-60 and early scientific exploration. Thereafter, throughout the twentieth century the Snowy Mountains Scheme was built, scientific research developed further, and tourism and recreation promoted. Other lesser known activities in the high country include timber harvesting and milling, and Eucalyptus oil distilling.

A detailed history of the study area is presented in the HCHAR prepared for the EIS. The following information is a brief summary only.

Lobs Hole (also known as Ravine) has been used since the early 1800s as a thoroughfare for the movement of stock, prospecting, grazing, horse breeding, settlement, refuge from the winters of Kiandra, horticulture, gardening and agriculture, copper mining and processing, recreation and so on. Lobs Hole was a popular recreational destination for Snowy Scheme workers, during and after the scheme's construction.

The project areas near the Talbingo Reservoir and Tumut 3 power station are located within an original valley context of very steep, forested simple slopes. The majority of the impacts would occur in areas where the original landform has largely been removed for the Talbingo reservoir and road (Murray Jackson Drive) construction, such as a new wharf location at the east side of the dam in current spillway.

3.2 Heritage Listings

There are no places within the project area that are listed on the World Heritage List (WHL) or Commonwealth Heritage List (CHL).

The *Australian Alps National Parks and Reserves* and the *Snowy Mountains Scheme* are listed on the National Heritage List (NHL) and are therefore, Matters of National Environmental Significance (MNES) needs to be addressed for the Exploratory Works. The project has been assessed according to the National Heritage values associated with the two National Heritage places against the significant impact criteria. The assessment has concluded that the action would not have a significant impact on either of the national heritage places.

Two historic sites listed in the Australian Heritage Database on the Register of the National Estate (Non-statutory archive) are in the project area. They are:

- Washington Hotel Ruin; and
- Lobbs Hole Copper Mine.

No items on the State Heritage Register are within the project area. A search of the State Heritage Inventory for the Snowy River, Tumut, Tumbarumba and Cooma Monaro local government heritage schedules reveals no items listed in their heritage schedules for project area.

The NSW Historic Heritage Information Management System (HHIMS) contains data and documents relating to heritage items on land managed by the NSW National Parks and Wildlife Service. Of the 315 items on the HHIMS for KNP, eleven are located within or near the project area.

In addition to the items listed within KNP on the HHIMS, there are various other sites and potential sites that are listed on an informal NPWS database. Eleven occur within the project area and these are the same items as listed on HHIMS.

There are no heritage items listed on the National Trust National Trust Register in the project area.

The Kosciuszko Huts Association (KHA) provides the most comprehensive mapping currently available for potential heritage items and places of heritage interest in KNP. Fourteen items listed on this database occur in the project area.

The field survey conducted for the EIS was undertaken across a broad area, larger than, but inclusive of all areas in which direct impacts would occur. The field survey sought to be as comprehensive as possible, however, at Lobs Hole many places are vegetated with thick forest undergrowth and impenetrable blackberry thickets which hampered access. Accordingly, the survey could not claim to be complete and the management strategies as set out in the document take this into consideration.

A total of 127 items were recorded during the fieldwork and research for this project, inclusive of previously listed items. The heritage at Lobs Hole includes a rich suite of material remains relating to settlement, agriculture and mining, including stone and earthen water races, a circular stone horse mill platform, rabbit netting fences, house and building platforms, shafts, adits, mullock heaps and beehive kilns used to manufacture bricks for the reverberatory furnace built by the Lobbs Hole Copper Mine NL.

The majority of the historic items are, however, in very poor condition. The derelict Washington Hotel is the best-known historic feature at Lobs Hole. An additional and previously unknown pisé building associated with the hotel was found during the EIS assessment and is believed likely to be the Washington Hotel stable. Many of the items used by the last people to live at Lobs Hole, the Yan family, have been found, including the remains of their bullock wagon.

At Talbingo Dam, the heritage items recorded in the project area relate to the Snowy Scheme construction and include survey markers, a quarry and laydown area.

The historic items located within the Project Area are listed in Table 4.2 below. Detailed information is provided in the HCHAR (EIS: Appendix P). The location of all historic items is shown on maps in Appendix A.

3.3 Natural heritage context

A geodiversity (natural history) review is included in Appendix I of the Snowy 2.0 Exploratory Works EIS.

Further to this, the Submissions Report included Chapter D, Geodiversity Assessments of Significance (assessment). The assessment was prepared to respond to matters raised by National Park and Wildlife Services regarding proposed improvements on the existing Lobs Hole Ravine Road and potential impacts to geodiversity within Kosciuszko National Park. The proposed improvements included the widening of Lobs Hole Ravine Road to safely allow the movement of trucks.

The findings of the geodiversity review and assessment are summarised within this section.

3.4 Geological sites or features within the Exploratory Works area

Kosciuszko National Park (KNP) contains the highest mountains on the Australian continent, unique glacial landscapes, and unusual assemblages of plants and animals, a number of which are found nowhere else.

The unique nature of the Kosciusko National Park Snowy mountains alpine region leads to the existence of unique natural landforms typically found in alpine and glacial regions.

3.4.1 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 2012). Periglacial features of the park include terracing, solifluction lobes, sliding and shattered boulders and block streams (also known as scree slopes or boulder streams).

Periglacial landform can be found in most areas above 1 000 metres and as far down as 600 metres. It is considered to be widespread across KNP. Block streams (or scree slopes) are listed under 'Rocks and Landforms' in Schedule 1 (Significant Natural and Cultural Features) of the KNP PoM.

3.4.2 Karst areas

Karst areas are landforms produced by the action of natural waters on soluble rocks (most commonly, limestone and dolomite) and are well known in the Yarrangobilly area. There are eight karst areas identified in the KNP PoM, and they are recognised as areas of local, regional, state or national significance.

There are three karst areas are in the vicinity of Exploratory Works:

- **Cooleman Plain karst area** - about 10 kilometres north of Tantangara Reservoir and 25 kilometres north east of the exploratory tunnel;
- **Yarrangobilly karst area** (which includes Yarrangobilly Caves) - about 6.5 kilometres north of the Snowy 2.0 main tunnel and 8.5 kilometres north east of the exploratory tunnel; and
- **Ravine karst area** - surrounds Lobs Hole Ravine Road about one kilometre south of the exploratory tunnel portal.

A groundwater assessment carried out for Exploratory Works considered Yarrangobilly Caves, a well visited geodiversity site that is also a groundwater dependent ecosystem. The assessment concluded that there would be no impact to the caves.

The Ravine karst area is the only karst area relevant to Exploratory Works.

The karst significance of Ravine resides in the tufa deposits and caves. The KNP PoM suggests that the tufa deposits and fossil sequence at Ravine are considered to have national or regional significance (DEC NSW 2006), preserving records of vegetation and climate change.

Ravine Basin Devonian sediments

The Devonian strata is of greater interest for its fossils than for its karst features. Fossiliferous rock is evident in the Lick Hole Formation outcrop within the Exploratory Works project area. This formation is not regionally, but locally significant for the following reasons:

- It is the only limestone of Devonian age in KNP, and so represents an important part of the geological history of the Snowy Mountains region in NSW.

- It contains microfossils (conodonts) and macrofossils (mainly brachiopods and corals) that enable precise correlation with strata of identical age (early Emsian Stage of the Early Devonian) and depositional environment (shallow marine conditions in a subtropical to warm temperate setting) elsewhere in south-eastern Australia.

- The fossiliferous rocks exposed in the road cutting are the type locality for several fossil species, including at least two brachiopods, two corals and a bryozoan.

However, an OEH assessment of karst values for the Ravine (unpublished), considered this formation (and associated fossils) to be of state significance due to the following:

- Some of the limestone horizons are rich in fossils and are the type site for nine species including a primitive lungfish, brachiopods and corals.

- The site is representative of an Early Devonian shallow marine environment containing age-diagnostic fossils that enable correlation in south eastern Australia.

The outcropping and potentially disturbed area of this formation is in an area adjacent to Lobs Hole Ravine Road. The outcrop at this location is in a disturbed condition and is exposed most likely as a result of previous road construction. As a result of this exposure from a road cutting, the following key observations have been made:

- The fossils found in the Lick Hole Formation occur in an artificial exposure (a road cutting, about 500 m in length) in which they are not evenly distributed.

- Based on the low dip of the beds and geological mapping in the vicinity, the fossiliferous beds extend into the ridge above the road. They also extend beneath the road surface (potentially up to a depth of over 500 m), based on the shallow dip of the bedding.

- The fossils are relatively unprotected at present – they continue to be subject to erosion and potential illegal collecting. Fossils such as complete brachiopod shells which occur at this site have a (small) value to collectors and dealers.

Tufa deposits

The Ravine karst area (Lobs Hole area) contains one of the largest tufa deposits in southern Australia (OEH 2012).

Tufa is a porous deposit of calcium carbonate, often with a spongy like appearance. The KGAP identifies three tufa deposits in the Exploratory Works project area (see map Appendix D):

- **Cave Gully Tufa deposit**: in a small gully one kilometre upstream of the Lobs Hole copper mine;

- **The Lick Hole Gully Tufa:** two tufa deposits near the headwaters of Lickhole Gully that are visible from Ravine Road. This formation is also one of two sites identified as 'Geological Sites of Significance' by the Geological Society of Australia (NSW Division) within KNP.

There is no signage at Ravine which identifies the significance of these features.

While the tufa deposits are within the Exploratory Works project area, they are not within the disturbance footprint. The tufa features identified in the Lobs Hole area are in avoidance areas and will not be disturbed by Exploratory Works.

3.4.3 Geoheritage site

The Ravine Copper Mine (Lobbs Hole Copper Mine) is identified as a geoheritage site in the KGAP. The Lobbs Hole Copper Mine items and features and those associated with other mines at Lobs Hole are listed as historic heritage items in HCHAR and will therefore be managed in accordance with the specific management measures proscribed for each of these.

Figure 3.1 Karst areas relative to the project works (EIS, EMM)

3.4.4 Rock streams (boulder scree)

Rock streams are remnants of rock glaciers that date to an extraordinarily cold and dry period in Australia between 22 and 16 thousand years ago and are found at various places throughout the southern highlands of Australia (Burrows et al. 2004). These boulder streams are sometimes referred to as 'fossil rock glaciers'. When active, they would have been 'cored' with ice, with the ice acting as a lubricant for the flow of the cobbles and boulders. When the climate began to warm significantly 16 thousand years ago the ice between the cobbles and boulders melted away and these boulders streams became static, with the angular shapes of the interlocking boulders impeding continued movement.

Rock streams typically have the following characteristics:

- They occur in alpine areas.
- They are often deposited on steep slopes.
- They often occur in shallow depressions in the landscape.
- They are relict features of a previous (colder) climate state.
- They are comprised of angular cobbles (between 6 and 25 cm in diameter) and boulders (>25 cm in diameter).

Periglacial (or near glacial conditions) deposits do occur in the high country up Australia's eastern highlands as far north as 30 degrees South, and are worth preserving, particularly in our national parks (Slee and Shulmeister, 2015). Rock streams are often periglacial in nature and can be found far from true glacial deposits. The rock streams along Lobs Hole Ravine Road were bisected by the existing Lobs Hole Ravine Road in the late 19th century (Figure 1).

While there are approximately 4,000 rock streams, boulder streams and similar features throughout the highlands of south-eastern Australia, each one has a story to tell about the glacial history of this part of the world (Slee and Shulmeister, 2015). Because of the altitude of most of these features the general public has little knowledge of their existence and significance.

The Rock stream sites are along Lower Lobs Hole Ravine Road, approximately eight kilometres from the intersection with Link Road and comprises angular rocks and small boulders layered on the steeply sloping ground in six landslide scree zones. The rocks are dark grey, fine grained and assumed to be Cainozoic basalt.

The rock stream is exposed from the surrounding dense vegetation, providing easy viewing upslope to the toe and higher levels of the scree. The initial damage to the large rock stream in the centre of Figure 3.2 was done in the late 19th century during the construction of the existing Lobs Hole Ravine Road. While similar damage would be avoided today, road upgrade works in this area will provide an opportunity to enhance this area as a geo-heritage education site. This could be achieved by providing a turnout and educational signage with information regarding the age and climate conditions that existed when the rock stream was formed.

Figure 3.2 **Upslope of one of the larger rock stream deposits along Lobs Hole Ravine Road relative to the project works**

Figure 3.3 **Downslope at the same feature**

4 Environmental aspects, impacts and risks

4.1 Environmental aspects

An environmental aspect is an element of an organisation's activities, products, or services that has or may have an impact on the environment (ISO 14001 Environmental management systems). The relationship of aspects and impacts is one of cause and effect.

Key aspects of the Project during Stage 1 that could result in impacts to historic and natural heritage are identified in Table 4.1. The extent of these impacts will depend on the nature, extent and magnitude of construction activities and their interaction with the natural environment (Column 2). This is further exacerbated by environmental factors (column 3).

The EIS Appendix I and Submission Report Chapter D determined that the following impacts may occur:

- Rock streams (boulder scree) - there is a minor encroachment on the rock stream in one section of Lower Lobs Hole Ravine Road, where the existing road has cut through the block. The EIS and Submissions Report determined that this geodiversity element will largely remain intact through the implementation of appropriate construction techniques and mitigations measures, and works will not further interrupt or impede natural land forming processes or access to the site;

- Ravine karst area (Lick Hole Formation) - road improvement will require the removal of fossiliferous rock on the upslope and downslope side of the road, and construction works and associated increased heavy vehicle traffic may result in indirect vibration impacts. The removal of approximately 8,020 m2 of fossil bed material to provide for road safety improvements to this section of Lobs Hole Ravine Road was considered acceptable provided appropriate mitigation measures are implemented;

- Geoheritage site - with the exception of an adit, the Lobs Hole Mine is in the avoidance area of the project and will not be disturbed as part of Exploratory Works.

The KGAP identifies three tufa deposits in the Exploratory Works project area:

- Cave Gully Tufa deposit: in a small gully 1 km upstream of the Lobs Hole copper mine. The KGMP recommends rapid assessments be completed every three years with no photo documentation required unless significant impacts are observed.

- The Lick Hole Gully Tufa: two tufa deposits near the headwaters of Lickhole Gully that are visible from Ravine Road. Rapid assessments are completed every three years, to monitor for weed cover. This formation is also one of two sites identified as ‘Geological Sites of Significance’ by the Geological Society of Australia (NSW Division) within KNP.

- At present, there is no interpretation signage at Ravine, which identifies or discusses the significance of these features. While the tufa deposits are within the Exploratory Works project area, they are not within the expected disturbance footprint.

Table 4.1 Aspects and Impacts to natural heritage items

Environmental Aspects (Construction activities that may impact heritage)	Environmental Impacts	Environmental Factors (Conditions)
Topsoil stripping Bulk earthworks Material stockpiles and emplacement areas Drilling and piling Blasting Minor widening of Lobs Hole-Ravine Road through areas of periglacial deposits Building a retaining wall/structure Stabilising upslope sections of rock stream	Partial loss of an element of geodiversity or historic heritage. Physical damage to geological features and attributes and historic heritage. Interruptions to natural land forming processes. Impeded or lost access to significant/interesting sites. Increase/decrease in erosion. Damage or removal to fossiliferous rocks. Damage to Tufa development feature Inadvertent or deliberate damage to historic heritage items The removal of historic heritage items via inadvertent damage or theft Damage to Tufa development	**Soil type** – more erodible soil types have an increased soil erosion potential. **Rainfall** – heavy rainfall increases soil entrainment. **Soil movement** – affecting karst features

A summary of expected impacts to historic heritage items is provided in Table 4.2 with MGA grid coordinates for each item included to assist with locating it in the landscape. The level of impacts has been categorised as:

- Yes
- No
- Within 20 m to alert the contractor that sites or features are located in proximity to construction activities

Direct impacts would occur to 58 items of historic heritage, although for some of these, impacts would be partial. Heritage items R45 and R81 are linear water races associated with the Lobbs Hole Copper Mine. Both are of local significance, but impacts would be limited and is not expected to occur over their full extent. A total of 49 historic heritage items are outside any areas of expected impacts. The location of all historic items is shown on maps in Appendix A.

Table 4.2 The known historic heritage items in the Project area and location in respect of proposed impacts

Item ID	Easting	Northing	MOD1 Survey Unit	Item	Impacts
R1	626705	6038252		Site of 1885 West Pinbeyan Station homestead	Yes

Item ID	Easting	Northing	MOD1 Survey Unit	Item	Impacts
R2	626715	6038275		metal water pipe	Yes
R3	626741	6038287		possible building structure	Within 20 m
R4	626733	6038280		rectilinear depression	Within 20 m
R5	626755	6038236		slag	No
R6	626746	6038225		stone flagging	No
R7	626730	6038227		depression	No
R8	626758	6038195		depression	No
R9	626708	6038205		Lobbs Hole Copper Mine Shafts	Within 20 m
R10	626770	6038145		Lobbs Hole Copper Mine	No
R11	626830	6038106		mullock	No
R12	626796	6038133		foundations for Pelton Wheel	No
R13	626831	6038155		tramway cutting	No
R14	626852	6038222		site of reverberatory furnace	No
R15	626789	6038361		stone channel	No
R16	626734	6038350		pile of rocks and drums	Yes
R17	626691	6038278		levelled area	Yes
R18	626690	6038313		fallen fence	Yes
R19	626732	6038249		levelled pad	No
R20	625925	6038961	RSU11	Washington Hotel (and 20 m buffer)	Within 20 m
R21	625911	6038981		depression and debris	Within 20 m
R22	625956	6038975		potential earthen feature	Yes
R23	626002	6038989		excavation	Yes
R24	626016	6038968		depression	Yes
R25	626047	6038931		building platform	Yes
R26	625979	6038930		mound	Yes
R27	625991	6038951		depression with rock	Yes
R28	625907	6038986	RSU11	pisé ruin	Within 20 m
R29	626088	6038941		mound of stone and brick	Yes
R30	626095	6038927	RSU10	rectilinear earth feature	Yes
R31	626062	6038842		water race	Within 20 m
R32	-	-		no recording	-
R33	626646	6038298		excavation and bricks	Yes
R34	626490	6038585		mound of stone	Yes
R35	626527	6038599		rabbit proof fence	Within 20 m
R36	626532	6038628		hole	No

Item ID	Easting	Northing	MOD1 Survey Unit	Item	Impacts
R37	626531	6038635		flying fox	No
R38	626528	6038648		Yarrangobilly Stream Gauging Station 2	No
R39	625976	6038938		excavation	Yes
R40	626491	6038602		cutting for building platform	Yes
R41	626209	6038818		parallel stone alignment	Yes
R42	626188	6038847		Rosie Cook's place	Yes
R43	626478	6038738		rabbit proof fence	No
R44	627856	6037972		Stable Creek Stream Gauging Station	No
R45	627647	6038043		Lobbs Hole Copper Mine water race	Yes
R46	626107	6038720		large excavation	Yes
R47	626113	6038505		Ravine Public School site	Yes
R48	626537	6037912		excavation possible shed	No
R49	626513	6037876		circular stone wall	No
R50	626514	6037905		shed with bullock wagon frame	No
R51	626509	6038767		adit in cliff	No
R52	624491	6040711		survey mark	No
R53	624526	6040729		old road	No
R54	627715	6038092	RSU2	site of bridge	Within 20 m
R55	627688	6038087		brick hearth	Yes
R56	626685	6037837		excavated ditch	No
R57	626619	6037937		old road alignment	No
R58	626380	6038765		large metal pipes	No
R59	626093	6038964		domestic metal glass etc	Within 20 m
R60	626039	6038901		police station site	Within 20 m
R61	626045	6038939		well	Yes
R62	626737	6038586		possible shaft	No
R63	626217	6038815		pile of shale	Yes
R64	626238	6038828		water race	Within 20 m
R65	625525	6038178		Thomas house	No
R66	626460	6038554		house platform	Yes
R67	626662	6038515		Lobs Hole Central Mine	No
R68	627128	6038321		mine shaft	No
R69	626599	6038259		brick kiln	Yes
R70	625696	6039199		concrete fire place	Within 20 m
R71	626420	6038250		butcher shop	Yes

Item ID	Easting	Northing	MOD1 Survey Unit	Item	Impacts
R72	626171	6038205		stone furnace	Within 20 m
R73	626662	6038457		rabbit proof fence	No
R74	626744	6038106	RSU4	metal water pipe	Within 20 m
R75	627179	6037852		mine shaft on ML 31	No
R76	626640	6038115		scatter of tin, glass and brick	Within 20 m
R77	626736	6038258		site of meteorological station	No
R78	626550	6038172		pine tree	Yes
R79	625868	6038969	RSU12	bridge remains	No
R80	627183	6037988		Elizabeth Frazer's orchard	Within 20 m
R81*	627896	6037989		Yarrangobilly River water race/road	Yes
R82	627798	6038271		front seat of car; ~1960s	Yes
R83	625128	6039972		pile of sheet metal	No
R84	624902	6040416		possible old road	Yes
R85	624700	6040451		possible old road	Yes
R86	624690	6040465		possible old road	Yes
R87	626299	6039170		tree with scar and axe marks	No
R88	625486	6039372		artificial mound of stone	No
R89	626537	6038353		artificial mound of stone	Yes
R90	626546	6038283		Lick Hole Gully Adit	Yes
R91	626515	6038289		Mine Shaft (No. 4)	Yes
R92	626513	6038227		building platforms	Yes
R93	626523	6038217		fence	Yes
R94	626566	6038210		road alignment	Yes
R95	626392	6038391		road alignment	Yes
R96	626561	6038284		open cut in Lick Hole Gully	Yes
R97*	626590	6038331		exotic trees	Yes
R98	626626	6038244		excavated pit	Yes
R99	626569	6038268		well	Yes
R100	626592	6038452		single furrow plough	Yes
R101	625702	6039152		possible building site	Yes
R102	625532	6039232	RSU13	stone culverts	Yes
R103	626561	6038555		levelled platform	No
R104	626390	6037729		Lick Hole Gully water race	No
R105	626379	6037706		ditch	No
R106	626620	6038040		old road	No

Item ID	Easting	Northing	MOD1 Survey Unit	Item	Impacts
R107	626599	6038069		building platform	Within 20 m
R108	626554	6038042		old road	Yes
R109	626523	6037987		house platform with wooden cross	Within 20 m
R110	626499	6037952		building platform	No
R111	626479	6037940		path to creek	No
R112	626731	6038521		Potentially shaft	No
R113	626477	6038196		shed platforms	Within 20 m
R114	626598	6038246		excavation	Yes
R115	626458	6037920		stone lined channel	No
R116	626591	6038482		house site	Within 20 m
R117	626667	6038456		Possible shaft	No
R118	625668	6039652		Ravine Cemetery	No
R119	626503	6038615		SH weather station	Yes
R120	626676	6037857		building platform	No
R121	626009	6038927		depression	Yes
R122	626004	6038907		fireplace platform	Yes
R123	618004	6057994		survey marker	No
R124	616528	6057468		SMA laydown area	Yes
R125	616791	6058053		SMA quarry	Yes
R126	616837	6058123		SMA survey marker	Yes
R127	616848	6058165		SMA survey marker	Yes
R128*	626099	6038011		First school at Lobbs Hole	No

Notes: * denotes that the location is nominal

4.2 Environmental risk assessment

The environmental aspects and impacts for historic heritage are further considered within Appendix A3 of the EMS. This includes a risk assessment process. The risk assessment is based on (1) the likelihood of an impact occurring as a result of the aspect; and (2) the consequences of the impact if the event occurred.

5 Environmental management measures

5.1 Management measures

A range of environmental requirements and control measures are identified in the EIS, Submissions Report and the conditions of approval. Safeguards and management measures will be implemented to avoid, minimise or manage impacts to historic heritage during construction.

Table 5.1 General historic heritage mitigation management measures

ID	Measure / Requirement	Stage	When to implement	Responsibility	Source document
General – Historic Heritage					
HN01	Training will be provided to all project personnel, including relevant sub-contractors on historic heritage requirements from this plan through inductions, toolboxes and targeted training. Training would describe the heritage values of the project area and the procedures to be followed in the event of discovery of artefacts or bones (potential human remains). Training will include details of the likely presence of unrecorded historic heritage (due to thick vegetation cover) and historical unmarked graves. Training would include reference to the protection of historic heritage located outside of the approved disturbance zones.	Stage 1 Stage 2	Pre-construction and construction	Contractor	Good Practice
HN02	For areas avoided by construction, exclusion zones would be put in place by an archaeologist to ensure Historic items and archaeological deposits are not incidentally damaged or moved. These would be fenced with parawebbing or some other similar fencing that would exclude entry by people or plant to avoid incidental impacts on the site. Signage would be installed as required.	Stage 1 Stage 2	Pre-construction and construction	Contractor	Condition 20
HN03	If any part of the project (such as an ancillary facility) is in an area which has not been subject to historic heritage field survey and assessment, an assessment by the project archaeologist will be undertaken before that part of the project proceeds.	Stage 1 Stage 2	Pre-construction and construction	Contractor	Condition 20
HN04	If the project design changes and further impacts are proposed to any historic items or sites which are currently outside of the identified impacted area the changes will be referred to the project archaeologist for review. This may warrant the implementation of additional impact mitigation strategies.	Stage 1 Stage 2	Pre-Construction and construction	Contractor	Good practice
HN05	A comprehensive research project and the archival (and test and salvage) recording of heritage items in the Lobs Hole Historic Landscape will be undertaken to fill in the gaps in the existing history of settlement and mining in the area. The archaeological research design is included in Appendix B. The archival report would be written in accordance with the methodology outlined in Appendix B: Reporting. It would comply with the relevant Heritage Office guidelines including Archaeological Assessment Guidelines (NSW Heritage Office and NSW Department of Urban Affairs and Planning 1996), Assessing significance for historical archaeological sites and relics 2009, (NSW Heritage	Stage 1 Stage 2	Pre-construction and construction	Snowy Hydro	REMM HER04 EIS Appendix P

ID	Measure / Requirement	Stage	When to implement	Responsibility	Source document
	Council) and How to Prepare Archival Recording of Heritage Items (Heritage Branch 1998). The report would be provided in electronic and hard copy within one year of the completion of works to the NSW Heritage Office, the NSW NPWS, the department and relevant local libraries including those in Cooma and Tumut.				
HN06	Salvage excavation and systematic collection of previously recorded artefacts that would be impacted by the project, along with any other impacted sites that are identified prior to or during construction, would be undertaken in accordance with the archaeological research design in Appendix B. The location of excavations would be within the area of the site to be impacted. For all salvaged material, suitable storage would be agreed upon with OEH	Stage 1 Stage 2	Pre-Construction and construction	Snowy Hydro	REMM HER04 EIS Appendix P Refer also to Section 5.2 and Table 5.2 (details of heritage activities below).
HN07	The location of the Ravine Cemetery will be clearly identified on the sensitive area plans. The boundaries of the Cemetery should be surveyed and identified on the ground. The area should be marked as a no go zone so as to ensure that no inadvertent impacts occur in that area.	Stage 1 Stage 2	Pre-construction and construction	Contractor	REMM HER03 EIS Appendix P
HN08	The location of 16 graves of people listed as buried at Lobs Hole is unknown. Unexpected find of skeletal remains will be managed in accordance with section 5.2 vii.	Stage 1 Stage 2	Pre-construction and construction	Contractor	REMM HER03 EIS Appendix P
HN09	Baseline monitoring of the condition of the historic heritage items that must be protected will be undertaken	Stage 1 Stage 2	Pre-construction and construction	Snowy Hydro	REMM HER03 EIS Appendix P
HN010	Monitoring of heritage items outside the disturbance area will occur	Stage 1 Stage 2	Pre-construction and construction	Snowy Hydro	REMM HER03 EIS Appendix P
Vegetation clearance monitoring and salvage					
HN09	Vegetation clearance would be supervised and monitored by the project archaeologist. If required, salvage excavations and/or archival recording is to be undertaken for any heritage items identified. Any archival recording will be undertaken in accordance with section 5.2 iii. Salvage excavations will be undertaken in accordance with the archaeological research design included in Appendix B.	Stage 1 Stage 2	Pre-Construction and construction	Snowy Hydro	REMM HER03 EIS Appendix P
General – Natural Heritage					
HN10	Protection measures will be installed to protect identified periglacial features and limit direct and indirect impacts to the karst features as far as possible.	Stage 1 Stage 2	Pre-construction / Construction	Contractor	Good practice

ID	Measure / Requirement	Stage	When to implement	Responsibility	Source document
	Exclusion zones will be installed around tufa features within the Lobs Hole area (Cave Gully and Lick Hole tufa deposits) where these are in close proximity to the Exploratory Works.				
HN11	Erosion and sediment control measures will be installed in accordance with the Surface Water Management Plan. Measures will be installed in the Ravine karst catchment to assist with minimising impacts from sediment laden waters.	Stage 1 Stage 2	Pre-construction / Construction	Contractor	Good Practice
HN12	Road sections within the fossiliferous beds and boulder streams on Lobs Hole Ravine Road; will be designed so as to minimise the impact of the development.	Stage 1 Stage 2	Pre-construction / Construction	Snowy Hydro	Condition 18
HN13	Schedule 1 items listed in the KNP PoM will not be publicised or promoted during the Exploratory Works unless management regimes are in place to protect them from likely damage associated with increased visitation and site personnel.	Stage 1 Stage 2	Construction	Contractor	KNP PoM 6.3.1 item 1
HN14	The use of earth-moving machinery in the Karst catchment will be minimised where possible.	Stage 1 Stage 2	Construction	Contractor	KNP PoM 6.4.1 item 8
HN15	Adverse impacts of road drainage structures and materials used for roadworks and car parks will be minimised during construction where possible.	Stage 1 Stage 2	Construction	Contractor	KNP PoM 6.4.2 item 2
Fossiliferous rock					
HN16	Representative excavated spoil is to be preserved off site so that palaeontologists (from educational research bodies and institutions such as: Geoscience Australia in Canberra, ANU also in Canberra, the Geological Survey of NSW based in Sydney and Maitland, and the Australian Museum in Sydney) could look through the fresh material and collect fossil specimens for scientific research and curation in their respective collections. The methodology for engaging these institutions will be via letter informing them of the availability of the material from the Project. In case of no uptake from these letters, Snowy Hydro, in consultation with NPWS, will store the excavated material (as per Section 5.3) in a suitable container for 1 year after excavation to be made available for any institutions or research bodies or Agencies if required.	Stage 1	Construction	Snowy Hydro Contractor	REMM GEO02
HN17	Where practicable and in consultation with NPWS, interpretive signs may be	Stage 1	Construction	Snowy Hydro	REMM GEO02

ID	Measure / Requirement	Stage	When to implement	Responsibility	Source document
	installed in in an appropriate location near the fossil area cuttings to highlight features in the exposures, provided the fossils were protected from being easily collected.				
Rock streams (boulder scree)					
HN18	Prior to disturbing the block streams impacted on Lobs Hole Ravine Road for upgrade works: • undertake detailed mapping of the block stream extents and morphology; and • prepare a detailed archival record of the block streams,	Stage 1	Construction	Contractor	Condition 19c
HN19	Digging the road deeper into the rock stream should be avoided where practical, and excavations that take place to widen the road should be undertaken on the upslope side of the road as per Section 5.4 and Figure 5.2 below and thereby minimise impacts on the downslope section of Block Stream B which features well-preserved evidence of ice age block flow in the form of ridges and other low relief surface topography.;	Stage 1	Construction	Contractor	REMM GEO01 M1.20
HN20	Construction activities should, where practical: • minimise the extent of excavation into the upslope block streams; • minimise moving or damaging blocks in areas beyond the excavation zone; • minimise the use of outside materials onto the block streams (e.g.soil or fill); • minimise use of any stabilisation measures that permanently cover the block streams, for example with shotcrete or other construction materials which would preclude their future viewing and study.	Stage 1	Construction	Contractor	M1.16
HN21	The proposed works should implement controls in accordance with the Biodiversity Management Plan to ensure they do not promote the spread of weeds near the boulder streams, and thereby reduce their visibility.	Stage 1	Construction	Contractor	M1.19
HN22	If any works are required to stabilise upslope sections of rock stream, open mesh wire fencing will be used where practicable, so the general public and scientists can see and appreciate the architecture of the deposit. Building a solid wall or spraying concrete on the upslope side should be avoided at all times unless deemed required by a geotechnical engineer; Any construction needs to be designed to fit in with the landscape.	Stage 1 Stage 2	Construction	Contractor	REMM GEO01 M1.15
HN23	Appropriate drainage should be constructed where practicable, under the road to ensure no build-up of water occurs above the road, within the rock stream,	Stage 1 Stage 2	Construction	Contractor	REMM GEO01 M1.17

ID	Measure / Requirement	Stage	When to implement	Responsibility	Source document
	during heavy rain;				
HN24	Erosion and sediment control measures will be implemented during and after construction with the aim to minimise adverse impacts on and around the block streams.	Stage 1 Stage 2	Construction	Contractor	M1.18
HN25	Where practicable and in consultation with NPWS, educational signage should be provided in a nearby suitably widened area to provide information on the periglacial rock stream geoheritage features;	Stage 2	Post construction	Snowy Hydro	REMM GEO01
Tufa Deposits					
HN22	Designate avoidance areas for all tufa located within the Project footprint and implement monitoring programs to ensure the tufa deposits at the former copper mine, Lick Hole Gully and Cave Gully shown in Appendix D are not impacted by the works; For areas avoided by construction, exclusion zones would be put in place to ensure natural heritage items are not incidentally damaged or moved. These would be fenced with nightline, flagging or para-webbing or some other similar fencing that would exclude entry by people or plant to avoid incidental impacts on the site. No-go Signage would be installed as required.	Stage 1	Construction	Contractor	Condition 19 (c)
HN23	Carry out a detailed investigation of any unidentified karst features intercepted during the tunnel works.	Stage 2	Construction	Stage 2 Contractor	Condition 19 (d)
Monitoring					
HN24	The effectiveness of controls will be monitored in accordance with the monitoring requirements detailed in Section 6.	Stage 1 Stage 2	Construction	Contractor	Condition 20
HN25	Baseline and ongoing monitoring of tufa deposits shown in Figure 4.6 of the SSI 9208 consent conditions and Appendix D of this plan – this will be undertaken with the use of a drone or other form of remote monitoring methodology prior to, throughout and post construction	Stage 1 Stage 2	Construction	Contractor	Condition 20 (c)

5.2 Specific historic heritage management measures

The specific management measures for each heritage item are provided in Table 5.2. Table 5.3 highlights those sites to be avoided. These have been refined during the final project approval process in consultation with the Department of Planning and reflect the conditions of approval. Where inconsistencies exist between Table 5.2 and Table 2.2, the measures in Table 5.2 prevail.

Detailed measures for the protection of items and the mitigation and amelioration of impacts are presented in the following sections and address:

- vegetation clearance;
- archival recording;
- archaeological research design and excavation method instructions;
- archaeological excavation background;
- moveable heritage;
- unexpected finds; and
- the discovery of human remains.

Vibration-related impacts are noted in this plan and addressed in detail in the Noise and Vibration Management Plan.

NOTE. Timing and completion of the management measures described in this document must be incorporated into the project program as some activities will require substantial time-frames to complete.

5.2.1 Vegetation clearance

Where vegetation clearance is proposed and where items of heritage are visible, vegetation clearance (including weeds) must be undertaken carefully. This management measure must be included in the Vegetation clearing procedure.

Vegetation clearance must:

- be undertaken under the supervision of a project archaeologist;
- be undertaken prior to the start of the archaeological excavation program;
- be undertaken by cutting the plant at the base where it meets the ground surface;
- not involve removal by pulling roots out of the soil;
- can be undertaken through chemical spraying of exotic species; and

- not disturb the ground surface.

5.2.2 Archival recording

For sites nominated for archival recording the following will be undertaken.

The entirety of the Lobs Hole Cultural Precinct will be archivally recorded prior to, during and at the completion of works. This is to ensure that a record of the pre-project environment is retained before it is destroyed.

Archival recording will be undertaken at the following times:

1. prior to any more works starting in the Lobs Hole Historic Landscape to capture the place in its pre-Project form;

2. after vegetation clearance is complete;

3. during the archaeological excavation program;

4. during construction; and

5. after construction.

Archival recording will comprise:

- a photographic record taken in digital capture in RAW and jpg or RAW and tiff formats;
- the photographic record will be prepared in accordance with the NSW Heritage Council guidelines
    - *Photographic recording of heritage items using film or digital capture* (Heritage Information Series) 2006; and
    - *How to prepare archival records of heritage items* (Heritage Information Series) 1998.
- the record will include:
    - general views inside and to the Lobs Hole Historic Landscape;
    - detailed photographs of each item in the Lobs Hole Cultural Precinct;
    - aerial photographs using drone technology of each item in the Lobs Hole Cultural Precinct;
    - topographic survey using digital surveying techniques (eg total station);
    - a photographic plan; and
    - a historical summary of the Lobs Hole Heritage Landscape and any other site of significance that will be impacted by the project.

5.2.3 Archaeological research design and excavation method

Archaeological excavation will be undertaken in accordance with an archaeological research design and excavation method. This is a requirement of the conditions of approval and is best practice. The purpose of the document is to provide a framework to guide the approach and ensure that a suitable level of recording is being undertaken. In addition to the introduction and project background, the archaeological research design and excavation method will include:

- historical research to supplement the existing history
- comparative analysis if sources exist;
- the results of the field survey;
- a site evaluation including a comparative analysis (if similar sites exist), archaeological potential and archaeological significance;
- research questions to guide data collected from the excavation; and

  the proposed excavation method.

5.2.4 Archaeological excavation

Archaeological excavation will take the form of test excavation initially, with the possibility of salvage excavation if the results of the test indicate it is necessary to avoid total loss of information.

A broad framework for the archaeological research design has been prepared to physically investigate the relics. The research questions that have been posed aim to provide answers predicated on the basis that the archaeological resource is able to provide these answers, and which will contribute to the understanding of the development of the project, the locality, the activities that occurred at Lobs Hole and the nature of the features themselves.

The research design is included within Appendix B.

5.2.5 Moveable heritage

Moveable heritage includes those items that can be moved from the site prior to impacts. The methodology for procedures relating to Moveable Heritage is outlined in Appendix B. Snowy Hydro will take responsibility for moveable heritage items.

5.2.6 Unexpected finds

Unexpected finds may not be significant and therefore would not be classified as relics requiring management. Relics may appear as structure (or ruins) comprised of bricks, sandstone, timber and accumulations of artefacts such as broken ceramic and glass.

A ‘relic’ under the Heritage Act is defined as any deposit, object or material evidence that:

- relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement; and
- is of State or local heritage significance.

If relics are discovered during project activities the following steps will be taken:

- all work in a 10 m radius of the discovery will cease. If it was deemed necessary, the Excavation Director and/or Heritage Project Manager would ensure a larger area was defined;
- the project archaeologist will be consulted to assess the find;
- if the archaeologist determines that the find is a relic, the Heritage Division, OEH will be notified under Section 146 of the *Heritage Act 1977* (the Heritage Act). In addition, the DPE, Snowy Hydro and NPWS would be notified;
- archaeological investigation of new finds must occur in accordance with professional standards as outline in the conditions of approval.

5.2.7 Discovery of human skeletal remains

If a burial site or human skeletal material is exposed during works, all relevant procedures for excavation and removal will be undertaken in accordance with the *Policy Directive –Exhumation of Human Remains (NSW Department of Health 2008); Skeletal Remains – Guidelines for the Management of Human Skeletal Remains under the Heritage Act 1977* (NSW Heritage Office 1998) and the *Aboriginal Cultural Heritage Standards and Guidelines Kit* (NPWS 1997).

Human skeletal remains must be handled in accordance with the *NSW Public Health Act 1991.* Management of the remains is to be determined through liaison with the appropriate stakeholders (NSW Police Force, forensic anthropologist, OEH, Heritage Division, DP&E, registered Aboriginal parties, the project archaeologist, etc.)

The process below is to secure the skeletal remains until the remains are managed by the relevant authorities and stakeholders.

The following process is to be followed:

- as soon as remains are exposed, work is to halt immediately, establish a buffer area to ensure the remains are not to be touched or interfered with in any way;
- contact the ER who will contact local police (and OEH if the find is skeletal material);
- a physical or forensic anthropologist should inspect the remains in situ, and make a determination of ancestry (Aboriginal or non-Aboriginal) and antiquity (pre-contact, historic or forensic);
- if the remains are identified as forensic the area is deemed as crime scene; or
- if the remains are identified as Aboriginal, the site is to be secured and the OEH and all registered Aboriginal parties are to be notified in writing; or

- if the remains are non-Aboriginal (historical) remains, the site is to be secured and the Heritage Division is to be contacted.

Any human skeletal remains uncovered during project activities will be removed in a sensitive and dignified manner. Approval from NSW Health, under the NSW Public Health Act 1991, will be required prior to removing/exhuming any skeletal remains. Controlled excavation and removal by the site archaeologists and other appropriate specialists (forensic anthropologist, registered Aboriginal parties, NSW Police Force, as appropriate) will be undertaken in accordance with relevant guidelines and any requirements of the OEH, DP&E and NSW Health.

Table 5.2 Site-specific historic heritage mitigation management measures

ID	Item Name	Significance	Complex	Impacts	Management measure	Stage
R1	1885 West Pinbeyan Station homestead site	Contributory	West Pinbeyan Station homestead site	Direct impact	Archival recording Test excavation Salvage if warranted	2
R2	Metal water pipe	Contributory	West Pinbeyan Station homestead site	Direct impact	Archival recording Test excavation Salvage if warranted Implement measures to protect moveable heritage	2
R3	Possible building structure	Contributory	West Pinbeyan Station homestead site	Potential direct impacts (within 20m)	Archival recording Test excavation, Salvage if warranted and impacts expected	2
R4	Rectilinear depression	Contributory	West Pinbeyan Station homestead site	Potential direct impacts (within 20m)	Archival recording Test excavation, Salvage if warranted and impacts expected	2
R5	Slag	NA	Lobs Hole Copper Mines	No impact	Archival recording	2
R6	Stone flagging	Contributory	West Pinbeyan Station homestead site	No impact	Archival recording Ensure no inadvertent impacts	2
R7	Depression	NA	Lobbs Hole Historic Landscape	No impact	Archival recording	2
R8	Depression	NA	Lobbs Hole Historic Landscape	No impact	Archival recording Ensure no inadvertent impacts	2
R10	Lobbs Hole Copper Mine	Contributory	Lobs Hole Copper Mines	No impact	Archival recording Ensure no inadvertent impacts	2
R11	Mullock	Contributory	Lobb Hole Copper Mines	No impact	Archival recording Ensure no inadvertent impacts	2
R12	Foundations for Pelton Wheel	Contributory	Lobb Hole Copper Mines	No impact	Archival recording Ensure no inadvertent impacts	2
R13	Tramway cutting	Contributory	Lobs Hole Copper Mines	No impact	Archival recording Ensure no inadvertent impacts	2

ID	Item Name	Significance	Complex	Impacts	Management measure	Stage
R15	Stone channel	Contributory	Potential Yan Farm infrastructure	No impact	Archival recording Implement measures to protect moveable heritage	2
R16	Pile of rocks and drums	Contributory	Lobbs Hole Historic Landscape	Direct impact	Archival recording Salvage if warranted Implement measures to protect moveable heritage	2
R17	Levelled area	Contributory	West Pinbeyan Station homestead site	Direct impact	Archival recording Test excavation Salvage if warranted	2
R18	Fallen fence	Contributory	Yan Farm infrastructure	Direct impact	Archival recording	2
R19	Levelled pad	Contributory	West Pinbeyan Station homestead site	No impact	Archival recording	2
R21	Depression and debris	Contributory	Ravine township	Potential direct impacts (within 20m)	Archival recording Test excavation, Salvage if warranted and impacts expected	1
R22	Potential earthen feature	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	1
R23	Excavation	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	1
R24	Depression	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	1
R25	Building platform	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	1
R26	Mound	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	1

ID	Item Name	Significance	Complex	Impacts	Management measure	Stage
R27	Depression with rock	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	1
R28	Pisé ruin – possible stable	Contributory	Ravine township	Potential direct impacts (within 20m) Within modification construction footprint (previously within 20 m)	Archival recording Test excavation, Salvage if warranted and impacts expected No change to approved management: Increased construction footprint in this area is now very likely to impact this site.	1
R29	Mound of stone and brick	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	1
R30	Rectilinear earth feature	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	1
R31	Water race	Contributory	Ravine township	Potential direct impacts (within 20m) Within modification construction footprint (previously within 20 m)	Archival recording Test excavation, Salvage if warranted and impacts expected No change to approved management: Increased construction footprint in this area is now very likely to impact this site.	1
R33	Excavation and bricks	Contributory	Uncertain	Direct impact	Archival recording Test excavation Salvage if warranted	2
R34	Mound of stone	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	2
R35	Rabbit proof fence	Contributory	Yan Farm infrastructure	Potential direct impacts (within 20m)	Archival recording Test excavation, Salvage if warranted and impacts expected	2
R36	Hole	NA	SMA	No impact	Archival recording	2

ID	Item Name	Significance	Complex	Impacts	Management measure	Stage
R37	Flying fox	NA	SMA	No impact	Archival recording	2
R38	Yarrangobilly Stream Gauging Station 2	NA	SMA	No impact	Archival recording	2
R39	Excavation	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	1
R40	Cutting for building platform	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	2
R41	Parallel stone alignment	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	2
R42	Rosie Cook's place	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	2
R43	Rabbit proof fence	Contributory	Yan Farm infrastructure	No impact	Archival recording	2
R44	Stable Creek Stream Gauging Station	NA	SMA	No impact	Archival recording	2
R45	Lobbs Hole Copper Mine water race	Contributory	Lobs Hole Copper Mines	Direct impact	Archival recording Test excavation Salvage if warranted	1
R46	Large excavation	NA	Lobbs Hole Historic Landscape	Direct impact	Archival recording Test excavation Salvage if warranted	2
R47	Ravine Public School site	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	1
R51	Adit in cliff Coronation Mine	NA	Lobs Hole Copper Mines	No impact	Archival recording	2

ID	Item Name	Significance	Complex	Impacts	Management measure	Stage
R52	Survey Mark	NA	SMA	No impact	Archival recording	2
R53	Old road	NA	Lobs Hole Historic Landscape	No impact	Archival recording	2
R54	Site of bridge	NA	SMA	Potential direct impacts (within 20m) Within 5 m of modification construction footprint (previously with 20 m)	Archival recording Test excavation Salvage if warranted and impacts expected No change to approved management: Increased construction footprint in this area is now very likely to impact this site.	1
R55	Brick hearth	NA	Lobs Hole Historic Landscape	Direct impact	Archival recording Test excavation Salvage if warranted	1
R59	Domestic metal glass etc	Contributory	Ravine township	Potential direct impacts (within 20m)	Archival recording Test excavation Salvage if warranted and impacts expected	2
R60	Police Station site	Contributory	Ravine township	Potential direct impacts (within 20m)	Archival recording Test excavation Salvage if warranted and impacts expected	1
R61	Well	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	1
R62	Possible shaft	Unverified	Lobs Hole Copper Mines	No impact	Archival recording	2
R63	Pile of shale	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	2
R64	Water race	Contributory	Ravine township	Potential direct impacts (within 20m); Direct impact north end	Archival recording Test excavation Salvage if warranted and impacts expected	2

ID	Item Name	Significance	Complex	Impacts	Management measure	Stage
R65	Thomas house	Contributory	Ravine township	No impact	Archival recording	2
R66	House platform	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	2
R67	Lobbs Hole Central Mine	Contributory	Lobs Hole Copper Mines	No impact	Archival recording	2
R68	Shaft and mullock	Contributory	Lobs Hole Copper Mines	No impact	Archival recording	2
R69	Brick kiln	Contributory	Lobs Hole Copper Mines	Direct impact	Archival recording Test excavation Salvage if warranted Implement measures to protect moveable heritage	2
R70	Concrete fire place	NA	Lobs Hole Historic Landscape	Potential direct impacts (within 20m)	Archival recording Test excavation Salvage if warranted and impacts expected	2
R71	Butcher shop	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted Implement measures to protect moveable heritage	1
R72	Stone furnace	Contributory	Lobs Hole Historic Landscape	Potential direct impacts (within 20m)	Archival recording Test excavation Salvage if warranted and impacts expected	1
R73	Rabbit proof fence	Contributory	Yan Farm infrastructure	No impact	Archival recording	2
R75	Mine shaft on ML 31	Contributory	Lobs Hole Copper Mines	No impact	Archival recording	2
R76	Scatter of tin, glass and brick	Contributory	Struggle St	Potential direct impacts (within 20m)	Archival recording Test excavation Salvage if warranted and impacts expected	2
R77	Site of meteorological station	NA	SMA	No impact	Archival recording	2
R78	pine tree	NA	Lobs Hole Historic	Direct impact	Archival recording	1

ID	Item Name	Significance	Complex	Impacts	Management measure	Stage
			Landscape			
R79	bridge remains	NA	SMA	No impact Within 20 m of modification construction footprint (previously over 20 m)	Archival recording Archival recording is still appropriate. As the modification footprint is now with 20 m of the remains, a no-go buffer should be employed.	2
R80	Elizabeth Frazer's orchard	Contributory	Struggle St	Potential direct impacts (within 20m)	Archival recording Test excavation Salvage if warranted and impacts expected	2
R81	Yarrangobilly River water race/road	Contributory	Lobs Hole Copper Mines	Direct impact	Archival recording Test excavation Salvage if warranted	1
R82	Front seat of car; ~1960s	NA	Lobs Hole Historic Landscape	Direct impact	Archival recording	2
R83	Pile of sheet metal	NA	Lobs Hole Historic Landscape	No impact	Archival recording	2
R84	Possible old road	Contributory	Lobs Hole Historic Landscape	Direct impact	Archival recording Test excavation Salvage if warranted	2
R85	Possible old road	Contributory	Lobs Hole Historic Landscape	Direct impact	Archival recording Test excavation Salvage if warranted	2
R86	Possible old road	Contributory	Lobs Hole Historic Landscape	Direct impact	Archival recording Test excavation Salvage if warranted	2
R87	Tree with scar and axe marks	Contributory	Lobs Hole Historic Landscape	No impact	Archival recording	2
R89	Artificial mound of stone	NA	Lobs Hole Historic Landscape	Direct impact	Archival recording Test excavation Salvage if warranted	2

ID	Item Name	Significance	Complex	Impacts	Management measure	Stage
R90	Lick Hole Gully Adit	Contributory	Lobs Hole Copper Mines	Direct impact	Archival recording Test excavation Salvage if warranted	2
R91	Mine Shaft (?No. 4)	Contributory	Lobs Hole Copper Mines	Direct impact	Archival recording Test excavation Salvage if warranted	2
R92	Building platforms	Contributory	Yan Farm infrastructure	Direct impact	Archival recording Test excavation Salvage if warranted	1
R93	Fence	Contributory	Yan Farm infrastructure	Direct impact	Archival recording Test excavation Salvage if warranted	1
R94	Road alignment	Contributory	Lobs Hole Historic Landscape	Direct impact	Archival recording Test excavation Salvage if warranted	2
R95	Road alignment	Contributory	Lobs Hole Historic Landscape	Direct impact	Archival recording Test excavation Salvage if warranted	2
R96	Open cut in Lick Hole Gully	Contributory	Lobs Hole Copper Mines	Direct impact	Archival recording Test excavation Salvage if warranted	2
R97	exotic trees	Contributory	Lobs Hole Historic Landscape	Direct impact	Archival recording	2
R98	Excavated pit	Contributory	Lobs Hole Historic Landscape	Direct impact	Archival recording Test excavation Salvage if warranted	2
R99	Well	Contributory	Yan Farm infrastructure	Direct impact	Archival recording Test excavation Salvage if warranted	2

ID	Item Name	Significance	Complex	Impacts	Management measure	Stage
R100	Single furrow plough	Contributory	Yan Farm infrastructure	Direct impact	Archival recording Test excavation Salvage if warranted	2
R101	Possible building site	Contributory	Lobs Hole Historic Landscape	Direct impact	Archival recording Test excavation Salvage if warranted	1
R102	Stone culverts	NA	Lobs Hole Historic Landscape	Direct impact Within Exploratory Works approved construction footprint, but now outside modified footprint	Archival recording Test excavation Salvage if warranted No changes to approved management.	2
R103	Levelled platform	Contributory	Yan Farm infrastructure	No impact	Archival recording	2
R104	Lick Hole Gully water race	Contributory	Yan Farm infrastructure	No impact	Archival recording	2
R105	Ditch	Contributory	Lobs Hole Historic Landscape	No impact	Archival recording	2
R106	Old road	Contributory	Struggle St	No impact	Archival recording	2
R107	Building platform	Contributory	Struggle St	Potential direct impacts (within 20m)	Archival recording Test excavation Salvage if warranted and impacts expected	2
R108	Old road	Contributory	Struggle St	Direct impact	Archival recording Test excavation Salvage if warranted	2
R109	House platform with wooden cross	Contributory	Struggle St	Potential direct impacts (within 20m)	Archival recording Test excavation Salvage if warranted and impacts expected	2
R110	Building platform	Contributory	Struggle St	No impact	Archival recording Avoid impacts if possible	2
R111	Path to creek	Contributory	Struggle St	No impact	Archival recording	2

ID	Item Name	Significance	Complex	Impacts	Management measure	Stage
R112	Possible shaft	Contributory	Lobs Hole Copper Mines	No impact	Archival recording	2
R113	Shed platforms	Contributory	Yan Farm infrastructure	Potential direct impacts (within 20m)	Archival recording Test excavation Salvage if warranted and impacts expected	2
R114	Excavation	Contributory	Lobs Hole Historic Landscape	Direct impact	Archival recording Test excavation Salvage if warranted	2
R115	Stone lined channel	Contributory	Struggle St	No impact	Archival recording	2
R116	house site	Contributory	Ravine township	Potential direct impacts (within 20m)	Archival recording Test excavation Salvage if warranted and impacts expected	2
R117	Possible shaft	Contributory	Lobs Hole Copper Mines	No impact	Archival recording	2
R119	SH weather station	NA	Snowy Hydro	Direct impact	Currently in use. Relocate if impacts are proposed.	2
R120	Building platform	Contributory	Struggle Street	No impact	Archival recording	2
R121	Depression	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	1
R122	Fireplace platform	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	1
R123	Survey marker	NA	SMA	No impact	Archival recording	2
R124	SMA laydown area	NA	SMA	Direct impact	Archival recording	2
R125	SMA quarry	NA	SMA	Direct impact	Archival recording	2
R126	SMA survey marker	NA	SMA	Direct impact	Archival recording	2
R127	SMA survey marker	NA	SMA	Direct impact	Archival recording	2
R128	First school at Lobs Hole	Contributory	Ravine township	No impact	Archival recording	2

Table 5.3 Site specific historic heritage Avoidance sites

ID	Item Name	Significance	Complex	Impacts	Management measure	Stage
R9	Lobbs Hole Copper Mine shafts	Local	Lobs Hole Copper Mines	Potential direct impact (within 20m)	Include in a no-go buffer Archival recording	2
R14	Site of reverberatory furnace	Contributory	Lobs Hole Copper Mines	No impact	Archival recording Implement measures to protect moveable heritage	2
R20	Washington Hotel	Local	Ravine Township	Potential direct impacts (within 20m) Proposed modification is within 20 m of item.	Prework condition assessment by qualified heritage consultant Archival recording Ensure no inadvertent impacts Determine curtilage around the item Assess the significance of component parts Test excavation Salvage if warranted No change as a result of MOD1	1
R48	Excavation possible shed	Contributory	Yan Farm infrastructure	No impact	Include in a no-go buffer Archival recording Implement measures to protect moveable heritage	2
R49	Circular stone wall	Contributory	Yan Farm infrastructure	No impact	Include in a no-go buffer Archival recording Implement measures to protect moveable heritage	2
R50	Shed with bullock wagon frame	Contributory	Yan Farm infrastructure	No impact	Include in a no-go buffer Archival recording Implement measures to protect moveable heritage	2
R56	Excavated ditch	Contributory	Struggle Street	No impact	Include in a no-go buffer Archival recording Implement measures to protect moveable heritage	2
R57	Old road alignment	Local	Struggle Street	No impact	Include in a no-go buffer Archival recording Implement measures to protect moveable heritage	2
R58	Large metal pipes	N/A	Lobs Hole Historic Landscape	No impact	Include in a no-go buffer Archival recording Implement measures to protect moveable heritage	2
R74	Metal water pipe	Contributory	Lobs Hole Copper Mines	Within modification construction footprint (previously	Archival recording Ensure no inadvertent impacts This site will be impacted and archival recording remains a suitable level of management.	1

ID	Item Name	Significance	Complex	Impacts	Management measure	Stage
				within 20 m) Potential direct impacts (within 20m)		
R88	Artificial mound of stone	Contributory	Lobs Hole Historic Landscape	No impact	Archival recording Ensure no inadvertent impacts	2
R118	Ravine cemetery	Contributory	Ravine township	Direct impact	Archival recording Test excavation Salvage if warranted	2

5.3 Management of Fossiliferous material

5.3.1 Option 2

Three options were proposed for construction of the road within the fossiliferous material section of Ravine Lobs Hole Road. Option 2 was chosen as the preferred methodology and results in a 2 – 2.5 m cut into the existing face of the fossiliferous material.

The outcomes of Option 2 are:

- No valley side fill,
- All road widening is achieved via excavating the ridge side of the present road cuttings;
- The width of excavation is approximately 2 – 2.5 m.

This option also results in the best opportunity to save potentially scientifically valuable fossiliferous limestone, rather than have it simply buried or used as fill, and the excavation can be more carefully controlled from the existing road surface to ensure that fossils are relatively undamaged in the process.

The management of this removed fossiliferous materials is outlined below in Section 5.3.2.

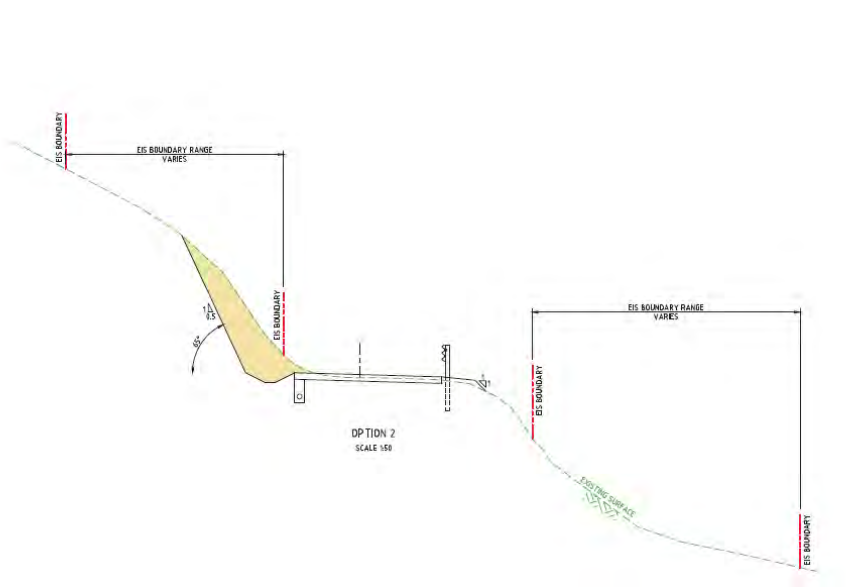


Figure 5.1 **Option 2 for cutting into the fossiliferous material upslope of the existing road Karst areas relative to the project works (EIS, EMM)**

5.3.2 Retention of fossiliferous material sample

The representative sample of spoil from the fossil-bearing beds is to be taken from the initial stages of excavation into the rubbly limestone and shale that forms the face of the existing cuttings, as it is from these beds that fossil specimens have previously been collected. It will be a lot easier for palaeontologists to sort through this weathered material to obtain further fossils for study, compared to sampling from the fresh limestone beds that have not been exposed, as that research will involve time-consuming methods such as slicing the rock with diamond saws to extract the fossils.

In accordance with correspondence with Dr. Ian Percival, a minor amount of relatively fresh limestone (up to twenty (bread) loaf-sized blocks) should be included in the representative sample of largely weathered rock, in order to maximise abundance and diversity of fossil specimens, potentially leading to the discovery of new fossils. This fresh limestone will be obtained as excavation proceeds into the hillside behind the existing cuttings.

Dr. Percival concluded that the total representative sample size required to be maintained is determined by the extent of the weathered zone into the hillside on the upside of the existing cuttings. With this as the dependent factor, Dr Percival stated that the representative sample size need not be greater than a bucket load from an excavator and could be as little as half to one-third that volume, depending on the weathering extent.

To take an entirely representative sample of the fossiliferous beds exposed in these cuttings, it would be most appropriate (if practicable) to take several smaller samples along the length of the exposures, from the top, middle and lowermost cuttings. If this approach is taken, the locations of samples should be clearly identified and under no circumstances should the samples be mixed or amalgamated.

Excavation of the representative sample(s) from the face of the existing cuttings must be carefully controlled to ensure that fossils are relatively undamaged in the process. Prying off the rocks vertically from the face of the cuttings might be the best approach.

5.4 Road design for protection of Rock stream (boulder rock scree)

Road works will occur adjacent to rock streams in three sections on Lobs Hole Ravine Road. Road works in these sections will involve building a retaining wall/structure to avoid earthworks/disturbance downslope into the rock streams. To do this, the road needs to be built up vertically in this area. The retaining wall will be anchored into the existing road surface to provide for stability and safety. The road will be slightly widened in this area resulting in some encroachment, principally through fill, on the rock stream on the upslope. This is shown in Figure 5.2.

5.4.1 The approved fill option

This option involved carrying out the approved program of road works in the boulder streams sections. This method involved building a retaining wall on the downslope side of the road and raising the road level with fill. This would result in covering boulders on the upslope side of the road with fill and is shown in Figure 3.2 below.

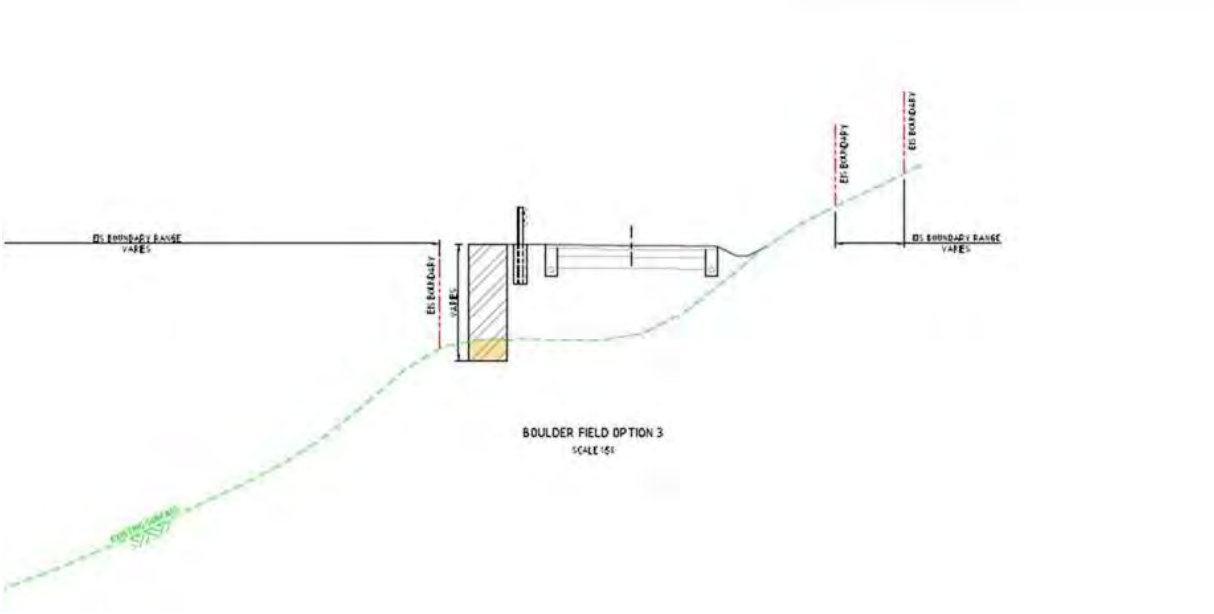


Figure 5.2 Indicative cross-section of construction in rock stream area on Lobs Hole Ravine Road

5.4.2 Preferred option – wide cut

The wide cut option involves cut on the upslope and extends beyond the approved Exploratory Works disturbance footprint. The wide cut option was developed (and continues to be developed) through detailed design to accommodate transport of the largest required oversize deliveries for Exploratory Works including transformers required for the Lobs Hole substation. An indicative cross-section for the wide cut option is provided in Figure 5.3 below:

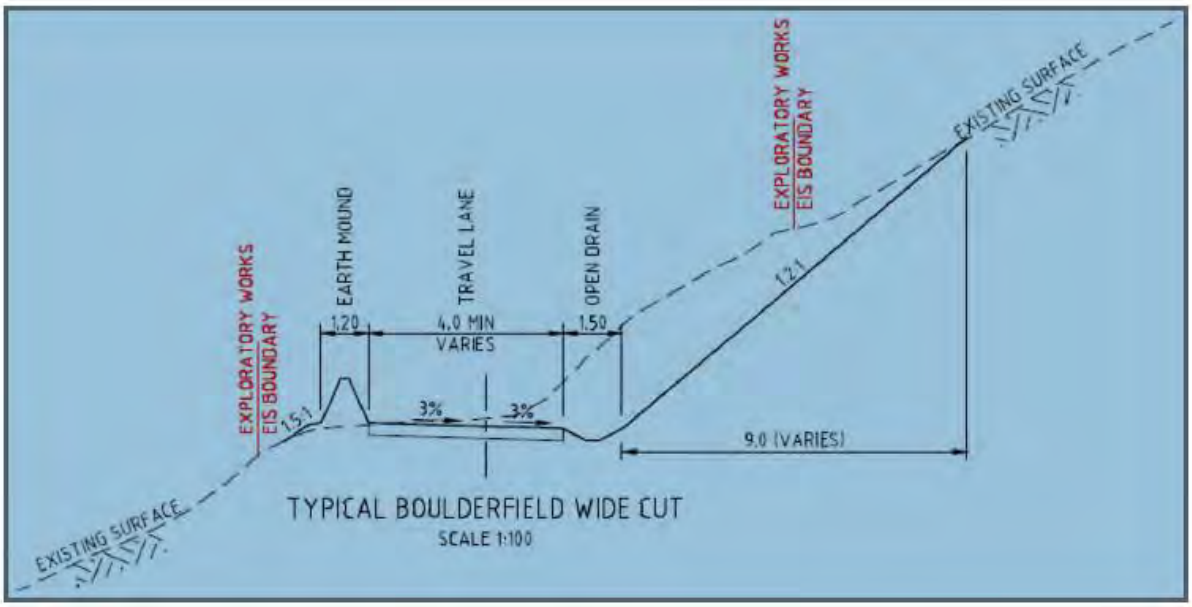


Figure 5.3 **Indicative cross-section of construction in rock stream area – wide cut option on Lobs Hole Ravine Road**

The wide cut option was identified as the preferred option for the boulder stream works. This option provides adequate access for all Exploratory Works construction traffic and could be completed safely and efficiently. It was determined that stabilisation of the road and boulder stream could be achieved by establishing batter slopes at a suitable angle of repose and wire mesh used (as required) to secure surface boulders. The use of wire mesh to secure surface boulders will maintain the visibility of the boulder streams and minimise impacts to the geodiversity values of the boulder streams.

Figure 5.4 Revised boulder stream works – additional cut

6 Compliance management

6.1 Monitoring

Monitoring will be undertaken for environmental aspects of the Project to confirm the adequacy of implementation of the management measures and will highlight any non-conformances or potential non-conformances across the life of the Project. Specific monitoring programs have been developed for high risk aspects of the Project and these are included within the relevant management plans.

The monitoring programs have been developed to address the requirements of the conditions of the Infrastructure Approval. In general these require that:

- baseline data available, additional data to be obtained and timing;
- the parameters to be monitored and the location and frequency;
- the reporting of monitoring and analysis results against relevant criteria;
- methods that will be used to analyse the monitoring data; and
- procedures to identify and implement additional mitigation measures where results of monitoring are unsatisfactory; and
- any consultation to be undertaken in relation to the monitoring programs.

6.2 Historic Heritage Monitoring and inspection

Weekly environmental inspections of the historic heritage in project will occur in accordance with Section 7 of the EMS. The monitoring should review the heritage located in each area in which works are scheduled to occur, are occurring and have occurred, in order to ensure that appropriate management and mitigation strategies are implemented, in accordance with this HNHMP.

The weekly monitoring would ensure that the project archaeologist is engaged in accordance with appropriate scheduling and time frames as set out in Table 5.1 to:

- supervise and monitor vegetation clearance prior to construction, if required;
- conduct archival recording, test excavation and salvage excavations where and as required;
- assist in the establishment of *no-go* zone to ensure that no inadvertent impacts occur to historic heritage which may be outside the immediate project area; and
- otherwise to ensure that the procedures as set out in this HNHMP are adequately implemented.

6.3 Natural Heritage Monitoring and inspection

The KNP geodiversity monitoring program (KGMP) included within the KGAP responds to the actions identified in the KGAP and outlines the methods and timeframes for the features listed. The KGAP also

states that a reasonable portion of the park's geodiversity is of a sufficient scale, level of abundance and degree of robustness to not warrant its routine monitoring.

It is not proposed to undertake the KGMP as part of the Exploratory Works Geodiversity Monitoring Program. This monitoring program is intended to compliment the actions of the KGMP and it will be undertaken during construction to confirm that management measures are implement and are effective in minimising potential impacts to geodiversity within KNP. The biodiversity, soil, surface water and ground water monitoring programs are also being implemented during construction.

The geodiversity monitoring program is provided in Table 6.1.

Table 6.1 Geodiversity monitoring program

Activity	Location	Frequency	Responsibility
Rapid condition assessment	Approved geodiversity disturbance areas – Block streams and Devonian sediment areas	Prior to disturbance and then yearly until completion	Contractors Environmental Site Representative
	Tufa deposits at former copper mine, Lick Hole Gully and Cave Gully	Prior to disturbance and then 6-monthly until completion	Contractors Environmental Site Representative
Environmental site inspection	Site wide including works near geodiversity and Karst features	Weekly	Contractors Environmental Site Representative

In the event of incidents or non-conformance occurring in relation to geodiversity these will be managed in accordance with Section 7 of the EMS.

Weekly environmental inspections of the project will occur in accordance with Section 7 of the EMS.

6.4 Training

The construction contractor will consult with the project archaeologist to provide input to induction training on the following matters:

- the identification of historic objects and historic burials and skeletal material;
- historic heritage awareness including likely presence of unmarked grave; and
- the HNHMP procedures to be followed prior to and during the construction of the project, including the Unexpected finds procedure.

All site personnel will undergo site induction training relating to Historic, Natural and Aboriginal heritage management issues. The induction training will address elements related to Historic and heritage management including but not limited to:

- existence and requirements of this HNHMP;
- relevant legislation;

- the management and mitigation of impacts to historic and natural heritage;
- the unexpected find procedure;
- roles and responsibilities for historic and natural heritage management: and
- procedures in the event of an incident (e.g. damage to karst).
- Targeted training in the form of toolbox talks or pre-start briefs will also be provided to personnel with a key role in construction activities which may impact on historic and natural heritage features.

Further details regarding the staff induction and training are outlined in Section 4.4 of the EMS.

6.5 Auditing

Audits will be undertaken to assess the effectiveness of the management measures, compliance with this HNHMP, the draft baseline conditions, EIS, Submissions Reports and other relevant approvals, licences and guidelines.

6.5.1 Internal audits

Internal auditing will be undertaken on a minimum six-monthly basis throughout the Project or more frequently where required based on the environmental risk. The Contractor will submit an integrated audit schedule to Snowy Hydro for acceptance at the commencement of the project. The audit schedule will be maintained by the Contractor for the duration of the project and updated on minimum six-monthly basis or when any change is made to the schedule.

An audit checklist will be developed by the Contractor and amended as necessary to reflect changes to this EMS, subsequent approvals and changes to Acts, regulations or guidelines. The Contractor will submit the completed audit checklists/reports to Snowy Hydro. The findings arising from internal audits will be recorded as corrective actions and managed to close out in agreed time frames.

6.5.2 External audits

An independent audit, commissioned and paid by the proponent, will be conducted within one year of the commencement of construction and every three years thereafter, unless the Planning Secretary directs otherwise. The audit is to be carried out in accordance with the Independent Audit requirements (DPE 2018, by a suitably qualified lead auditor and an experienced independent team of experts, whose appointment has been endorsed by the Secretary. Within 12 weeks of commissioning this audit, or as otherwise agreed by the Secretary, the Proponent must submit a copy of the audit report to DPIE, together with a response to any recommendations and a timetable for implementation.

As deemed necessary by Snowy Hydro, Snowy Hydro will conduct an audit of the EMS, management plan or contract requirements, including the EPL on the Contractor. Snowy Hydro will provide the Contractor with a copy of the audit reports, identifying non-compliance and corrective actions required.

Audit findings will be recorded in the quality system database by the Contractor for action and close out. The action register will detail the source of the action (e.g. audit, inspection or other), the action required, target close out date, actual close out date and the person responsible for the action item. These action

items will be implemented to the satisfaction of the Secretary. Further details are provided in Section 7 of the EMS.

6.5.3 Compliance reporting

Reporting will include monthly internal project reports and six-monthly compliance reports as required by the conditions of approval. The six-monthly reports will track compliance against the conditions and the revised environmental management measures and will be reported in accordance with, the relevant Compliance Reporting requirements (DPE 2018) as per, Schedule 4, Conditions 7 and 8.

. Reporting requirements and responsibilities are documented in the Sections 7 of the EMS.

6.5.4 Archaeological reporting

The archaeological excavations will be recorded in accordance with the methods as outlined in Appendix B and recorded in an excavation report (or more than one depending on suitability). The excavation report will describe the aims of the excavation, the methods and the findings using text, high resolution photography, drawings and survey. An artefact analysis will be prepared and will inform the findings in the report(s).

The report would be provided in electronic and hard copy to Snowy Hydro, NSW Heritage Office, DPE, NPWS and local libraries within one year of completion of the project.

6.5.5 Public interpretation

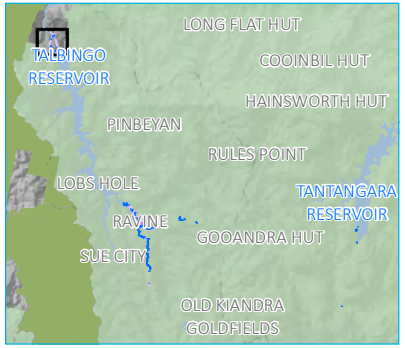
Snowy Hydro will prepare an interpretation plan that is based on the findings of the archaeological excavation report in consultation with the National Parks and Wildlife Service, the Heritage Council of NSW and the Department of Planning and Environment.

The main purpose public interpretation is to inform the visiting public about the rich cultural history of the Snowy Mountains and Lobs Hole Ravine. An interpretive display can also be developed for online access and information about the heritage management activities can be provided as updates on the Snowy Hydro website as works progress.

The interpretive plan would be prepared within one year of completion of the Snowy 2.0 project.

Appendix A

Location mapping of known heritage items



KEY

- Historic site
- Historic site - In impact area
- Heritage survey unit
- EW Disturbance footprint
- MOD 1 Disturbance footprint
- Waterbody
- Main road
- Local road
- Vehicular track
- Watercourse

Source: EMM (2019); Snowy Hydro (2019); LPI (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011); NSW Archaeology (2019)

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0 250 500 m

GDA 1994 MGA Zone 55

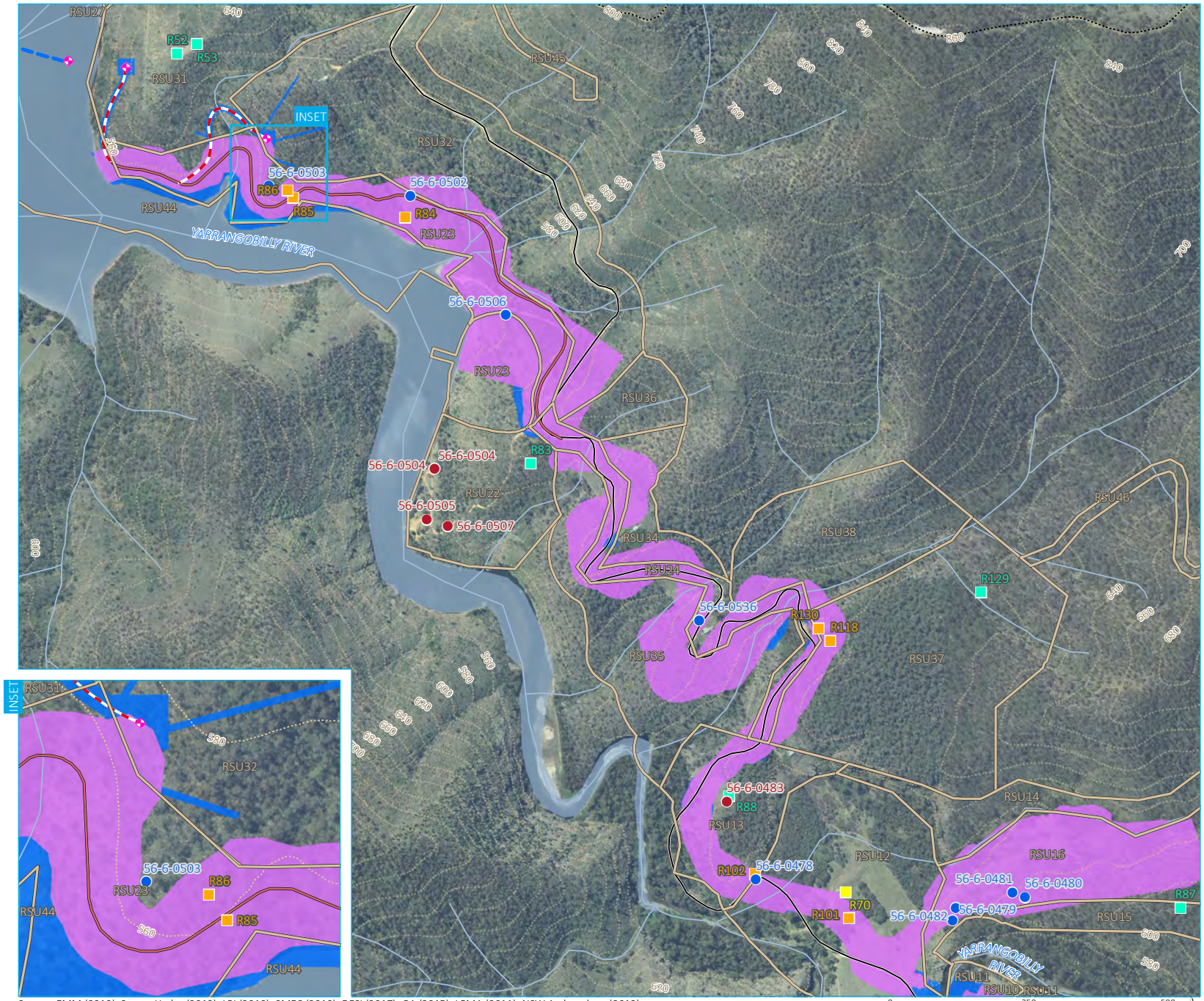
N

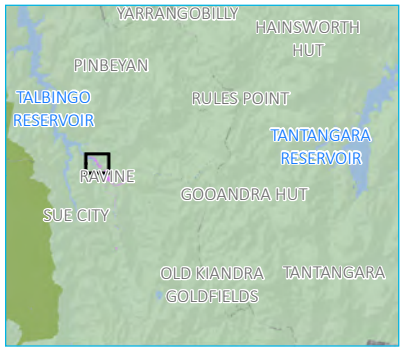
Aboriginal and historic heritage sites - Talbingo

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure A 1

snowy2.0

EMM creating opportunities





KEY

- Proposed borehole
- AHIMS
- AHIMS - In impact area
- Historic site
- Historic site - Within 20 m of impact area
- Historic site - In impact area
- Heritage survey unit
- EW Disturbance footprint
- MOD 1 Disturbance footprint
- Waterbody
- Proposed access track
- Approved access as part of EW EIS
- Boat access
- Local road
- Vehicular track
- 20 m contour
- Watercourse

Aboriginal and historic heritage sites - Lobs Hole (1)

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure A 2

Source: EMM (2019); Snowy Hydro (2019); LPI (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011); NSW Archaeology (2019)

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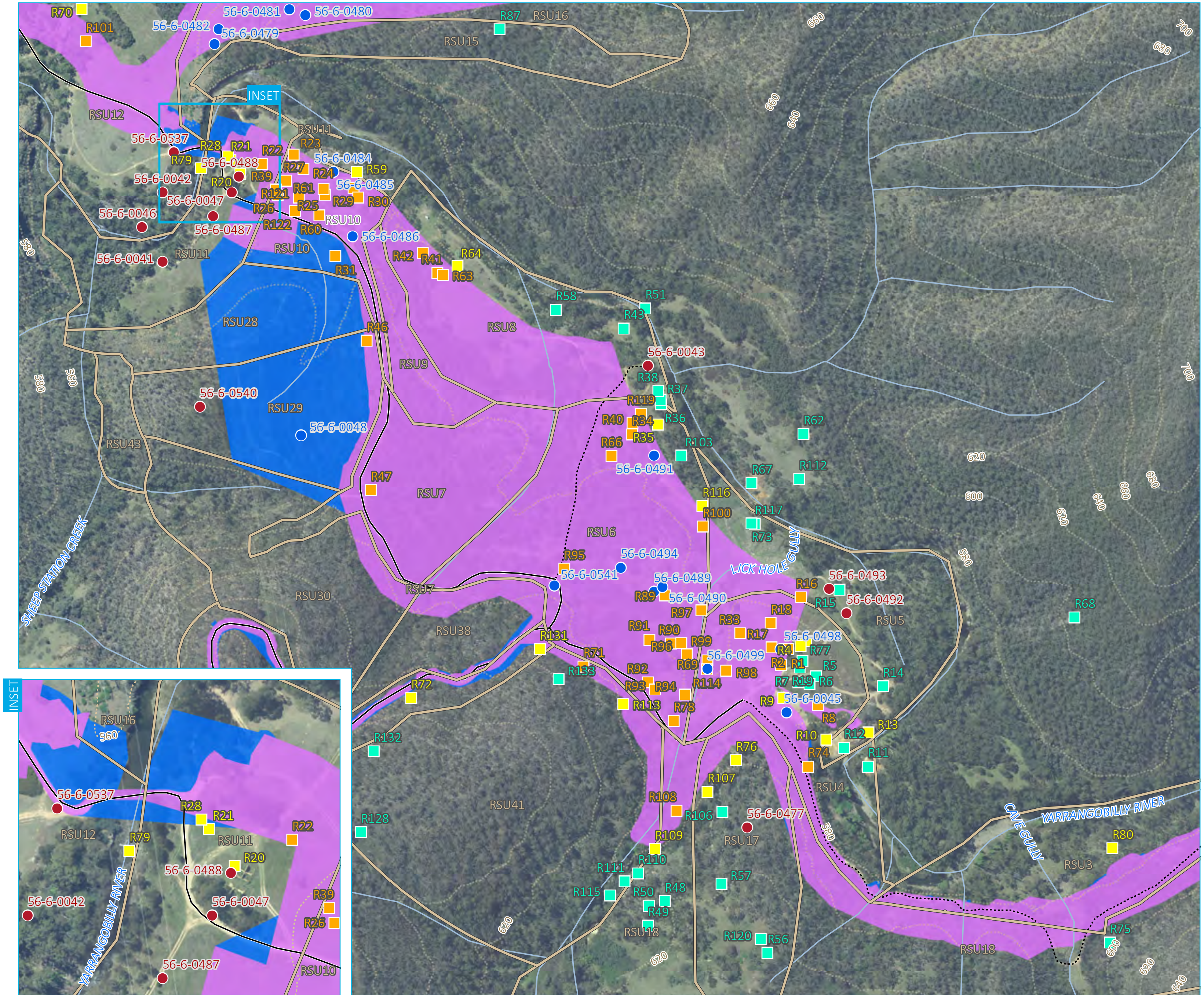
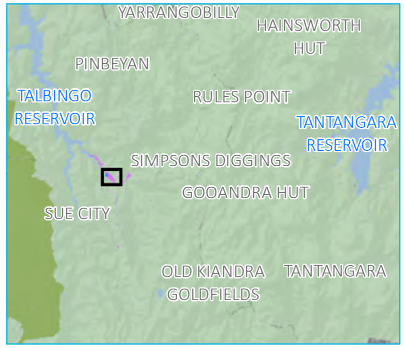
0 250 500 m

GDA 1994 MGA Zone 55

N





KEY

- AHIMS
- AHIMS - In impact area
- Historic site
- Historic site - Within 20 m of impact area
- Historic site - In impact area
- Heritage survey unit
- EW Disturbance footprint
- MOD 1 Disturbance footprint
- Local road
- Vehicular track
- 20 m contour
- Watercourse

Aboriginal and historic heritage sites - Lobs Hole (2)

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure A 3

Source: EMM (2019); Snowy Hydro (2019); LPI (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011); NSW Archaeology (2019)

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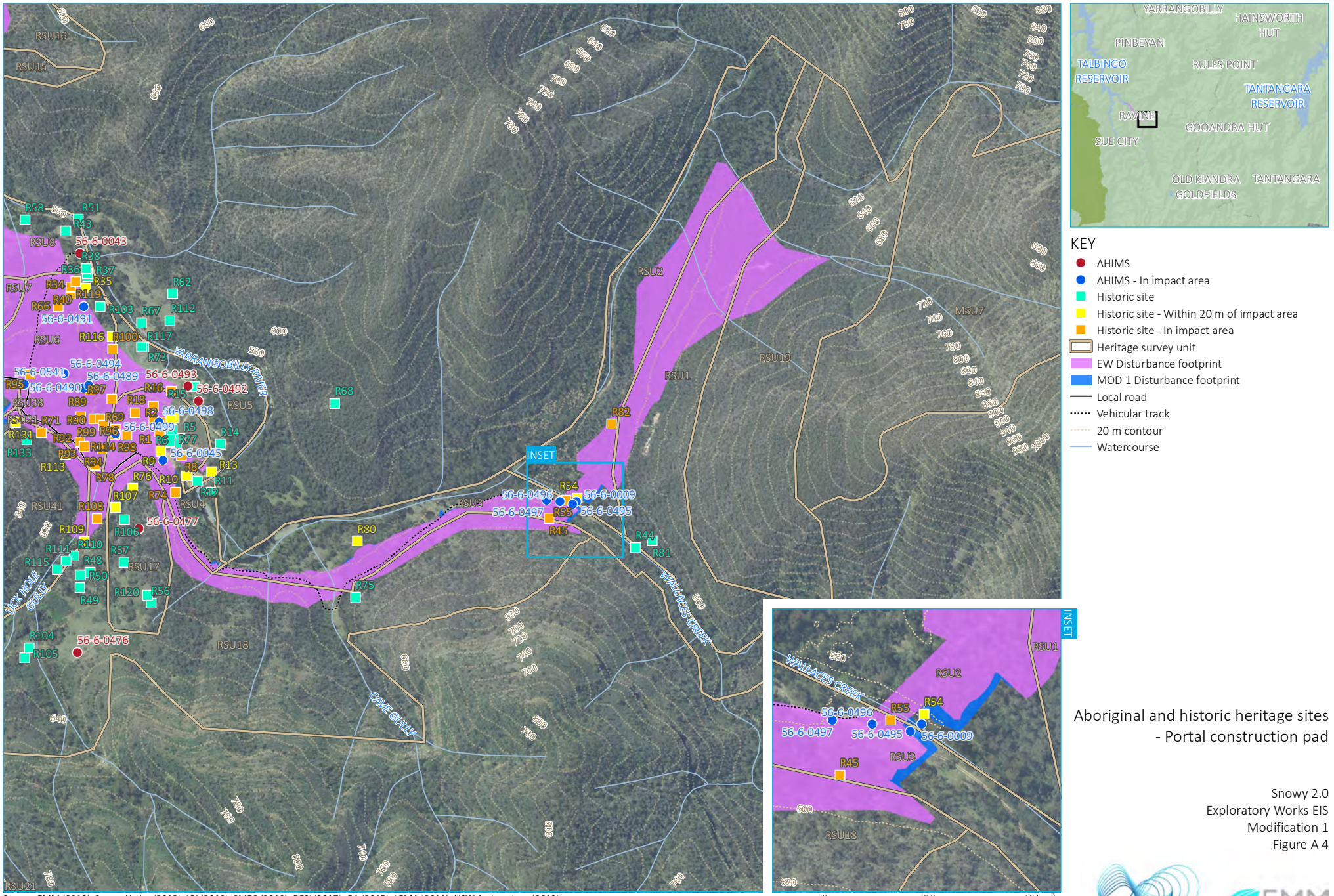
0 250 500 m

GDA 1994 MGA Zone 55

N



KEY

- AHIMS
- AHIMS - In impact area
- Historic site
- Historic site - Within 20 m of impact area
- Historic site - In impact area
- Heritage survey unit
- EW Disturbance footprint
- MOD 1 Disturbance footprint
- Local road
- Vehicular track
- 20 m contour
- Watercourse

0 250 500 m

GDA 1994 MGA Zone 55

N

Aboriginal and historic heritage sites - Portal construction pad

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure A 4

Source: EMM (2019); Snowy Hydro (2019); LPI (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011); NSW Archaeology (2019)

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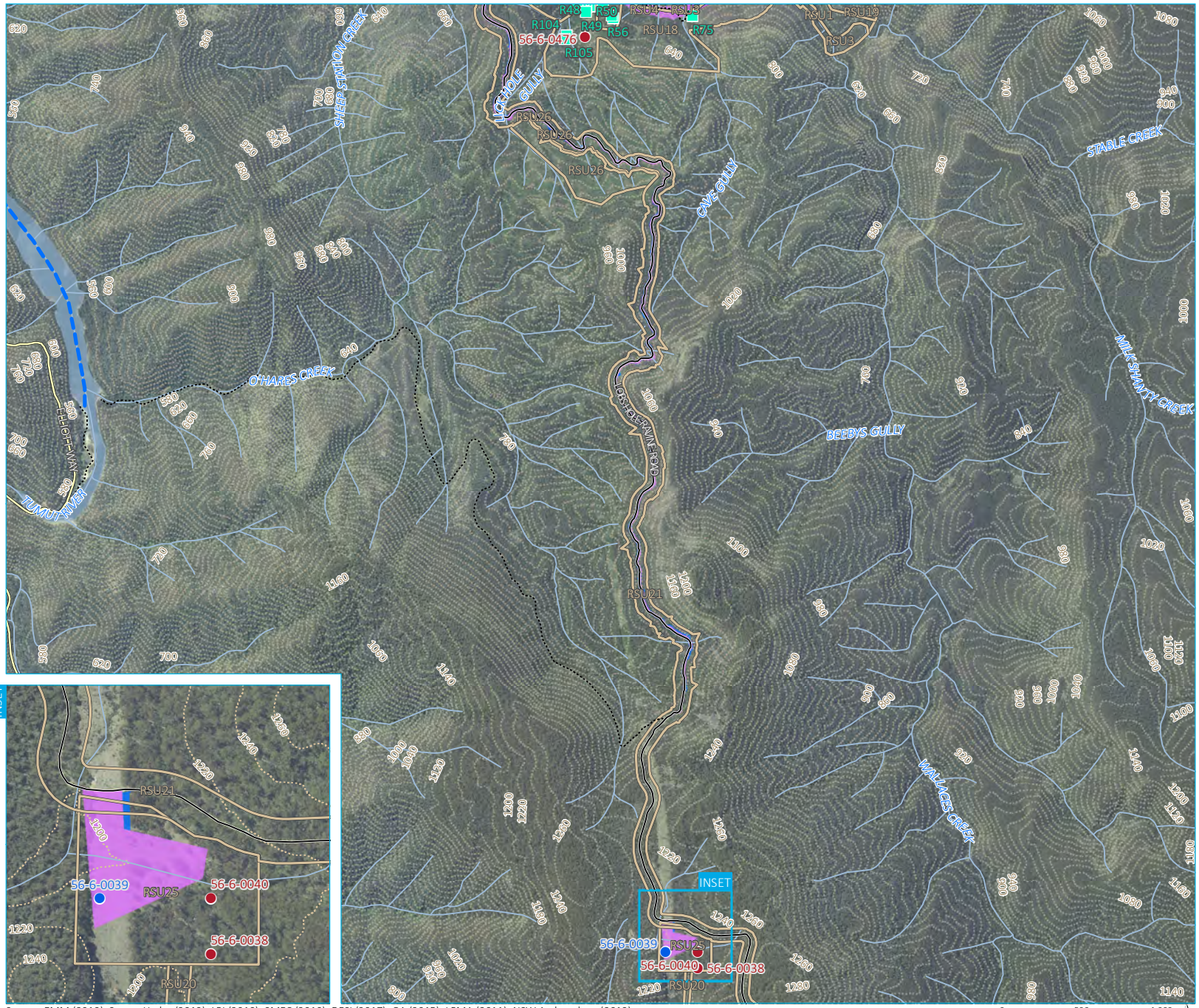

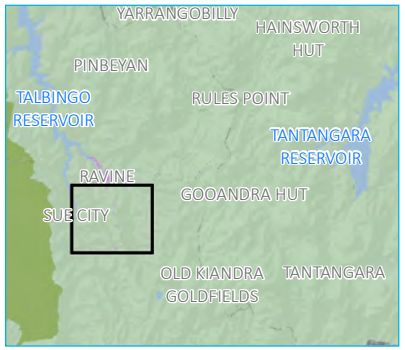

KEY

- AHIMS
- AHIMS - In impact area
- Historic site
- Heritage survey unit
- EW Disturbance footprint
- MOD 1 Disturbance footprint
- Waterbody
- Boat access
- Main road
- Local road
- Vehicular track
- 20 m contour
- Watercourse

Aboriginal and historic heritage sites - Lobs Hole Ravine Road

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure A 5

Source: EMM (2019); Snowy Hydro (2019); LPI (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011); NSW Archaeology (2019)

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0 500 1,000 m

GDA 1994 MGA Zone 55

N

Appendix B

Archaeological research design and methods

An archaeological research design is a theoretical framework to support archaeological field investigations with the aim of extracting information that is relevant to the development and function of the site. This research design is based on the outcomes of the historic research and the existing environment as described in the EIS, Appendix P, and seeks to develop questions that will contribute to current and relevant knowledge about the Lobs Hole Historic Landscape, including contributions that can be made through both historical research and archaeological investigations.

Given the complexity of the Lobs Hole Historic Landscape, and uncertainties surrounding the nature and extent of archaeological remains that may be encountered during mitigation works, the research design below takes the approach of a series of methodological toolboxes. Each toolbox outlines different components relating to particular tasks or aspects of the mitigation measures, analysis, research, reporting and data archiving. Notes are also provided on what individual components might entail and the situations in which they would be implemented.

A master sheet has also been developed that can be used to help track which aspects of the methodology have been implemented at individual items, and which things still need to be completed at any given point in the project. This master sheet can also serve as a "ready reckoner" of when the field component of mitigation measures is complete, and all necessary data checks made prior to issuing construction clearance.

The heritage impact mitigation works will be project managed by Dr Julie Dibden, NSW Archaeology Pty Ltd. The Primary Excavation Director for the archival and excavation works will be Dr Rebecca Parkes who is recognised by the NSW Office of Environment and Heritage as a S140 Excavation Director.

Master sheet overview of mitigation measures, data and associated analysis/reporting

ID:	Complex/Type/Feature:	Impacts:	Conditions of Consent/Management Measures:

CODE	TASK	CONDUCTED (Y/N/TBC)	Components (Y/N/TBC)																					
			i	ii	iii	iv	v	vi	vii	viii	ix	x	xi	xii	xiii	xiv	xv	xvi	xvii	xviii	xix	xx	xxi	xxii
A	Vegetation clearance																							
B	Archival recording																							
C	Excavation: exploratory/salvage																							
D	Moveable heritage																							
E	Unexpected finds																							
F	Human skeletal remains																							
G	Finds collection																							
H	Samples collection																							
I	Materials conservation																							
J	Post fieldwork analysis of finds/samples																							
K	Maps, plans and other illustrations																							
L	Research questions																							
M	Historical research																							
N	Reporting																							
O	Recording forms																							
P	Data checks and backups																							

(Y=Complete; N=NA; TBC=To be completed)

Vegetation Clearance

Vegetation clearance is required in some areas at Lobs Hole for the following reasons:

- To reveal historic features that are otherwise obscured so that they may be identified, assessed and included in the impact mitigation program; and/or
- To provide access to historic features in order to conduct archival recording/salvage excavations/salvage of removable heritage.

All vegetation clearance in the vicinity of known or suspected heritage items will be supervised by an archaeologist.

CODE	Component	Notes – decision making criteria for utilisation
A-i	Mechanical	Mechanical clearing of vegetation (e.g. slashing or mulching) may provide the most effective means of vegetations clearance at sites where surface features are limited in extent and/or hand clearing is impracticable. Mechanical clearing must not involve removal of roots or other disturbance to potential subsurface deposits.
A-ii	Hand	Hand clearing of vegetation (i.e. with powered or unpowered hand tools) is likely to be necessary in some form at most items/complexes. In particular, it should be implemented in and around visible surface features. As with mechanical clearing, it must not involve removal of roots or other disturbance to potential subsurface deposits.
A-iii	Chemical	Chemical spraying of grasses and weeds on and around sites may provide a useful means of clearing vegetation in instances where vegetation control is part of a longer-term management strategy and/or in advance of some heritage mitigation works. Chemical spraying would be undertaken by hand. It would not typically be implemented where artefacts or structural features are present at surface, particularly if mitigation works are anticipated in the days following chemical treatment.

Archival Recording

Archival recording will be implemented either as a standalone mitigation measure, where inadvertent impacts may occur or in combination with other mitigation measures such as excavation. Where it is implemented in combination with excavation, it will at a minimum be conducted prior to excavation and at the completion of excavation. Additional archival recording may also be warranted during excavation (e.g. to record contexts/components that will need to be removed in order to continue investigations). Where necessary, surveyors will be used to provide benchmarks ahead of survey, and/or assist with accurately locating and recording some site components (i.e. tying the surveys into appropriate map datums).

CODE	Component	Notes – decision making criteria for utilisation
B-i	Lidar	Lidar data has already been collected across the project. This data will be reviewed, and where possible, incorporated into the archival recording and/or to search for and locate historical features where vegetation has impeded survey. Additional targeted Lidar survey would typically only be employed in scenarios where vegetation significantly impedes alternative survey techniques and/or where it may assist in assessing the presence or extent of an item/complex prior to vegetation clearance.
B-ii	Drone imagery (video/still photography)	Drone imagery, including video and still photographs, will be collected to supplement other recording techniques. It is anticipated that drone deployment will not be practicable at all sites (e.g. where trees/vegetation would impede flight and imagery capture). Furthermore, some items (e.g. small discrete features) may be more quickly and effectively recorded using alternative techniques. However, where practicable **and** warranted, drone photogrammetry will be used to collect 3D survey data.
B-iii	SLR camera – RAW format	Overall views and detailed views of all item/complex features will be collected in RAW format at all sites where archival recording is implemented. All photos will be entered in to a photography log recording subject, camera location and direction of view. Tripod and/or photographic board will be utilised as necessary.
B-iv	Generic digital images	Generic digital images may also be collected. Examples will include general excavation recording (e.g. beginning/end of context) and where photogrammetry can be achieved without the use of a drone (e.g. for elevations of standing items). All photos will be entered in to a photography log recording subject, camera location and direction of view. Tripod and/or photographic board will be utilised as necessary.
B-v	Total station survey	Total station survey will be used to map features, contexts and excavation grids in three dimensions. Depending upon the nature of the site and use/applicability of alternative survey techniques, total station survey may comprise the primary means of site recording, be used to supplement other techniques, or may not be implemented (e.g. where vegetation makes survey impracticable, or where an item can be more effectively recorded using other techniques).
B-vi	Dumpy level survey	Dumpy level survey may be implemented in preference to total station survey where the focus is on recording levels for features that have been mapped by alternative means (e.g. tape and compass), across transects through features, and/or to supplement the recording of excavation levels.

B-vii	Tape and compass survey	Tape and compass style survey may be used to supplement or replace other survey techniques as required (e.g. spatially link items/features that cannot be comprehensively mapped via total station or drone).
B-viii	GPS	GPS point(s) and/or path(s) will be collected at all items/complexes in order to cross-check site locations and assist with site recording (e.g. mapping where photographs are taken from).
B-ix	Elevation(s)	Where items/complexes include upright components (e.g. walls) elevations will be recorded utilising one or more of the above techniques.
B-x	Site plan/sketch/measured drawings	Site plans and/or sketches will be produced at all items/complexes to assist with site interpretation and tracking what techniques and data relate to which features. Where necessary, detailed measured drawings will also be undertaken to supplement other recording techniques.

Excavation: Exploratory/Salvage

The scope of archaeological excavation will ultimately be determined by the nature and extent of archaeological remains, and the ability of those remains to address one or more the identified research questions. As such, the methodological approach to excavation includes components that will apply to all sites where excavation is conducted (e.g. establish site grid, removal of turf, bagging finds by context and grid square, record keeping etc). It also includes details of where mechanical excavation versus hand excavation would be implemented, triggers for changing to by hand excavation, scenarios where arbitrary contexts might be implemented, and strategies for exploring deposits through trenches/sondages.

CODE	Component	Notes – decision making criteria for utilisation
C-i	Excavation grid	An alpha-numeric excavation grid, with 1m squares as a base unit, will be established such that it encompasses the entire area to be investigated, and includes scope to be expanded if and when required. This grid will be used to assist in mapping features and recording the locations of artefacts and samples.
C-ii	Surface collection	Where artefacts are present at surface, and do not extend below surface, they will be collected and bagged/tagged by material type (e.g. metal, ceramic, glass, bone). Bags/tags will be labelled with project name, item code/name, date, grid square, context (in this instance – surface) and material. Where necessary/appropriate, additional inert materials/containers will be used to protect finds prior to bagging/tagging.
C-iii	Turf/topsoil removal	The turf layer and/or upper topsoil (i.e. top 2-5cm) will be removed across the entire item/area/feature being investigated. This will typically be the first step of physical excavation at all sites. Decisions regarding whether or not to initially adopt a more exploratory based approach versus broad area salvage will depend upon whether features and/or intact archaeological deposits are identifiable following turf removal (e.g. discernible structural/soil features or in-situ items).
C-iv	Clean up/clearing	Following removal of turf/topsoil, and depending upon the technique employed for that removal, it may be necessary to clear back loose soil or clean up partially exposed features using trowels, hoes, brooms or other similar hand tools. This will also typically need to be employed upon completion of each excavation context, prior to photography, and as part of general clean-up around structural remains. In some instances, excavation may proceed straight from turf removal to final clean-up (e.g. where a brick, concrete, stone or other solid floor is encountered directly below surface).
C-v	Section/trench through item/feature	Excavation will proceed by arbitrary trench (stratigraphic and/or arbitrary contexts) for the purposes of exploring the nature and extent of deposits and/or sectioning features. Where this approach is used in an exploratory phases, broad area salvage by stratigraphic context will commence if and when intact archaeological deposits are identified.

C-vi	Stratigraphic context	Broad area salvage will typically proceed by identification and excavation of stratigraphic contexts (e.g. structural components/features, cuts, fills, deposits etc.) defined by differences in composition/texture/colour/inclusions. Each new context will be identified by a unique number/code and entered into the in-field interpretation of the Harris Matrix. Excavation would cease when sterile deposits are encountered and/or where the nature and extent of deposits have been established and sufficient information has been gathered to address the relevant research questions, as determined by the Excavation Director in consultation with the Project Director.
C-vii	Arbitrary context	In instances where no stratigraphic change is discernible, and/or where an exploratory trench/sondage is being conducted, excavation will proceed by arbitrary context with a maximum depth of 10cm before commencing a new context. Each arbitrary context will be assigned a unique number/code and entered into the in-field interpretation of the Harris Matrix.
C-viii	Mechanical excavation	Mechanical excavation would typically be implemented in the following instances: • Removal of turf/topsoil where surface features and/or tree roots are not present. • Excavation of exploratory trenches to identify locate archaeological deposits/features. • Benching out deep excavations. • Geomorphological trenches. All mechanical excavation will be supervised by an archaeologist who has visual and radio contact with the operator in order to halt mechanical work as required. Mechanical excavation will not be used to conduct excavation of a stratigraphic context. However, it may be employed to remove overburden on top of such a context.
C-ix	Hand excavation	All stratigraphic contexts will be excavated by hand using hand tools such as trowels, brushes, hand picks, hoes etc. Hand excavation will also be employed during turf removal in and around identifiable surface features. Where excavation is conducted by arbitrary context, hand excavation will typically be employed where substantial intact archaeological deposits are being sectioned.
C-x	Sieving	Sieving would typically be conducted without the aid of water and would commence once the presence of archaeological features and deposits have been identified (i.e. it would not normally be conducted in association with turf/topsoil removal). However, at sites that are particularly deflated or disturbed, and/or artefacts are clearly present at surface, sieving of some or all of the topsoil deposits may be necessary during turf removal.
C-xi	Record keeping	In addition to the archival recording that accompanies excavation, record keeping will, in all instances, include the following components as a minimum: context recording forms, context log, Harris Matrix, photographic log, sections drawing(s).

Moveable Heritage

Certain historic items occur in the Exploratory Works footprint. These would be removed to ensure their long-term protection. They would be either returned to Lobs Hole at the completion of the Snowy 2.0 project or otherwise stored in a museum context.

CODE	Component	Notes – decision making criteria for utilisation
D-i	Archival recording	Each item subject to removal from the site will be archivally recorded in the first instance, as per the methodologies set out above. This would include at a minimum locational recording using GPS, photography and *in situ* site plan. Additional survey utilising other recording techniques will be implemented where additional levels of detail are required, or where the item is associated with other items/complexes.
D-ii	Bag/tag	For smaller moveable heritage items, these would be bagged/boxed with details of their item code and GPS location. Larger moveable heritage items would be labelled with Tyvek labelling so that their long-term identification is secured.
D-iii	Storage	Initially, the movable heritage will be stored in the heritage works compound at Lobs Hole. The longer-term storage of larger items would be the responsibility of Snowy Hydro, and it is expected that items would be stored at their Lower Tumut works depot in a secure compound.
D-iv	Return to site	It is likely that larger items would be returned to Lobs Hole at the completion of Snowy 2.0 works where they could be included within the rehabilitation and redevelopment of the valley.
D-v	Long term curation off-site	If the return of larger movable heritage to Lobs Hole was found to not be feasible, long-term curation within a museum context, a NPWS or Snowy Hydro facility would be the preferred alternative.

Unexpected Finds

In the unlikely event that unexpected finds are revealed during construction and/or heritage impact mitigation works, the following processes will be implemented.

CODE	Component	Notes – decision making criteria for utilisation
E-i	Stop work	All works would cease in the immediately vicinity of the unexpected find. A temporary no-go zone would be established. The environment manager would be informed immediately.
E-ii	GPS	The locational data relevant to the unexpected find would be recorded via whatever means appropriate.
E-iii	Establish nature and extent	The nature and extent of the unexpected find would be established by the heritage team.
E-iv	Assessment of significance	Following from the above, the significance of the find would be determined. An appropriate management measure would be formulated.
E-v	Notify Snowy Hydro, OEH Heritage Office , NPWS and DPE	In the event that the find is assessed to meet the NSW criteria for heritage significance, OEH would be notified of the unexpected find, its nature, significance and the recommended management measures.
E-vi	Implement management measures	The management measures would be implemented in accordance with advice received from OEH.

Human Skeletal Remains

CODE	Component	Notes – decision making criteria for utilisation
E-i	Stop work	All works would cease in the immediately vicinity of the skeletal remains. A temporary no-go zone would be established. The environment manager would be informed immediately. Contact will also be established with the local police.
E-ii	GPS	The locational data relevant to the find would be recorded via whatever means appropriate.
E-iii	Establish nature and extent	A physical or forensic anthropologist should inspect the remains in situ and make a determination of ancestry (Aboriginal or non-Aboriginal) and antiquity (pre-contact, historic or forensic). In the event that the area is deemed a crime scene, site management will lie with the NSW Police/Coroner.
E-iv	Notify Snowy Hydro, OEH Heritage Office , NPWS and other stakeholders	In the event that the remains do not constitute a crime scene, OEH will be notified. Registered Aboriginal parties will also be notified in the event that the remains are identified as Aboriginal.
E-v	Implement management measures	Any human skeletal remains uncovered during project activities will be removed in a sensitive and dignified manner. Approval from NSW Health, under the NSW Public Health Act 1991, will be required prior to removing/exhuming any skeletal remains. Controlled excavation and removal by the site archaeologists and other appropriate specialists (forensic anthropologist, registered Aboriginal parties, if relevant, NSW Police Force, as appropriate) will be undertaken in accordance with relevant guidelines and any requirements of the OEH, DP&E and NSW Health.

Finds Collection

The following table outlines an overview of the "in-field" tasks and methods applicable to finds.

CODE	Component	Notes – decision making criteria for utilisation
G-i	Collect	Where archaeological salvage is being conducted, all surface artefacts will be collected and bagged in accordance with the excavation methodology (refer to task C-ii). All finds recovered from excavated deposits will also be retained, except for the scenario outlined below in Task G-ii.
G-ii	Sample	In instances where numerous highly fragmented remains are encountered (e.g. hundreds of fragments of the same material without diagnostic features), a representative sample of the material will be collected. In that instance, records will be kept regarding the distribution of such finds, approximate numbers/weights of the items not retained, together with an estimate of the sample size as a percentage of the overall amount encountered within a given context/square. Sampling will not be implemented in situations where the Excavation Director identifies a potential for conjoining items.
G-iii	Bags/Containers/Tags	All collected finds will be bagged/tagged with project name, item code/name, date, grid square, context ID and material. Where necessary/appropriate, additional inert materials/containers will be used to protect finds prior to bagging/tagging. Bagged artefacts will be stored in suitably sized containers/boxes with other items of the same material (i.e. separate boxes for each material/sample type). Items/artefacts that are too large, or impractical to bag, will be tagged and stored in a suitably sized container/box. All boxes will be labelled with their contents (e.g. project name, item code, material). Bagged finds on site will be monitored through the day for condensation, and where necessary aired prior to transport. Finds that are wet/damp at the end of the day, will be air dried prior to storage for cataloguing, except where such actions would destabilise/endanger the find (refer to methodology toolbox: I - Materials Conservation).
G-iv	Cleaning (dry)	In most cases, excessive loose dirt will be gently removed from finds (e.g. with a brush) prior to bagging. However, where finds are fragile and/or the dirt has been bonded to the find, no attempt will be made to clean the find in the field.
G-v	Cleaning (wet)	Cleaning with the aid of liquids (e.g. water) will not typically be undertaken in the field, except where it has been necessary to implement wet sieving. In such instances, finds will be dried prior to bagging/storage.
G-vi	Photograph	Where possible (i.e. where finds are encountered during excavation rather than at the sieves), diagnostic and special finds will be photographed in-situ prior to their removal. Non-diagnostic finds may also be photographed in-situ where their distribution/context is informative.
G-vii	Plotting finds	The locations of special finds (e.g. unusual/rare items) will be plotted in three dimensions wherever possible (i.e. when encountered during excavation rather than at the sieves). Non-diagnostic finds will not typically be plotted in, except where a sample of such items is collected, and the broader extent of the material is recorded.
G-viii	Aboriginal objects	Any Aboriginal objects encountered during the historic heritage mitigation program will be handled in accordance with the

		Aboriginal Heritage Management Plan.

Samples collection

NB - The collection of samples does not necessarily imply that the sample will be analysed. Some samples may be later evaluated to be unsuitable in terms of the purposes for which they were collected, and/or samples may be archived for future analysis/research.

CODE	Component	Notes – decision making criteria for utilisation
H-i	Geological samples	Geological samples (e.g. fossils, ore deposits or masonry) may be collected for future analysis and/or for the purposes of archiving samples.
H-ii	Soil samples	Soil samples will be collected during excavations where the Project Director/Excavation Director/Geomorphologist deem that samples have the potential to address one or more of the identified research questions. It is anticipated that soil sample collection will be conducted as a matter of course during broad area salvage excavation, and on a case by case basis where excavation does not proceed to broad area salvage.
H-iii	Radiometric dating samples	It is anticipated that material culture finds (e.g. nails, glass, ceramics etc) will be sufficient in most cases for determining site chronology. However, where alternative means of dating the site are unavailable **and** determining site age will assist in addressing one or more of the research questions, radiometric dating samples such as charcoal will be collected. Decisions regarding when and where to collect such samples will be made in consultation with the Project Director/Excavation Director/Geomorphologist.
H-iv	Material samples (e.g. brick, mortar, wood etc)	Where possible/available, material samples, particularly samples of building materials, will be collected from all excavations.

Materials Conservation

Materials conservation will be conducted in accordance with the OEH (2012) *Stabilising Stuff: A Guide for Conserving Archaeological Finds in the Field* and/or in accordance with the advice of specialist conservators.

CODE	Component	Notes – decision making criteria for utilisation
I-i	Specialist Advice	Prior to commencement of excavation, advice will be sought from a specialist materials conservator regarding the equipment, storage facilities and standard procedures that might be anticipated on the basis of: features/materials known to be present, the environmental context of the item/complex, and potential/predicted finds. Any additional equipment that may be required will be planned/resourced as appropriate.
I-ii	In field conservation	Where necessary, a specialist materials conservator will be contacted and/or brought into the field to assist with stabilising excavated finds and/or in-situ remains. Removal of fragile items from an excavated context will not be conducted until all necessary equipment is at hand/specialist intervention organised/strategies are in place for stabilisation and storage of the item (e.g. fridge, freezer, drying facilities etc).
I-iii	Post excavation conservation	Prior to analysis of finds, advice will be sought from a specialist materials conservator regarding techniques for handling/cleaning/stabilising/storing fragile finds. Where necessary, the specialist will assess the assemblage and advise on appropriate conservation measures (preventive, stabilisation, storage etc).
I-iv	Long-term conservation	The archaeological team will liaise and work with a specialist materials conservator to develop any necessary long-term plans associated with curation and interpretation of the finds.
I-v	Monitoring	The condition of all collected/excavated finds will be monitored at regular intervals throughout the project to ensure that the implemented conservation strategies are functioning as intended. Advice will be sought from a specialist materials conservator for any issues/concerns identified regarding the stability of stored finds.

Post Fieldwork Analysis of Finds/Samples

CODE	Component	Notes – decision making criteria for utilisation
J-i	Sorting	All artefacts will be sorted by material and according to type/function.
J-ii	Cleaning	Where necessary, artefacts will be cleaned prior to analysis and in accordance with appropriate conservation techniques/advice.
J-iii	Weighing	All artefacts/finds will be weighed. Diagnostic items will be weighed individually. Non-diagnostic items will be counted and weighed in bulk by material/type. NB – large items of moveable heritage will only be weighed where such data is relevant to their interpretation.
J-iv	Quantitative data	Other quantitative data regarding dimensions (e.g. length, breadth, thickness, diameter, cross section type etc) will be recorded and entered into the artefact catalogue.
J-v	Qualitative data	Descriptive data and notes will be recorded for all diagnostic finds and where appropriate for non-diagnostic finds.
J-vi	Photography	High quality digital images will be taken for representative diagnostic finds, either individually or as collections from a given square/context.
J-vii	3D scan/photogrammetry	3D scans/photogrammetry will be undertaken for diagnostic finds and/or items of moveable heritage where that level of recording will augment interpretation/curation of finds.
J-viii	Residue/pollen analysis	Samples/finds with potential for residue or pollen analysis will be assessed and analysed in accordance with their ability to answer identified research questions. Items not analysed will be curated appropriately in order to facilitate any future analysis.
J-ix	Radiometric dating	Samples collected for radiometric dating will be assessed and analysed in accordance with their ability to answer identified research questions.
J-x	Other specialist analysis	Other specialist analysis (e.g. analysis of composition/material/type for samples or finds) will be undertaken where such analysis will substantially assist with answering research questions.
J-xi	Conjoining	Conjoining of broken/damaged finds may be undertaken where it will assist with analysis or interpretation of finds. Specialist advice/assistance will be sought from a materials conservator prior to undertaking conjoining.
J-xii	Finds catalogue	All data collected during analysis will be entered into finds catalogue/database that will be appended to the final report and included in the digital archive.
J-xiii	Analysis	Broader analysis will include reviews of the horizontal and vertical distribution of finds/materials/types with reference to information regarding function/age/discard/context etc. The extent and direction of such analysis will be in accordance with the identified research questions and the ability of the assemblage(s) to address those questions. This level of analysis will include both intra and inter-site comparisons.

Maps, plans and other illustrations

Various levels of mapping will be produced for all items and complexes, as outlined below. In addition to the standard digital (e.g. PDF) and hard copies contained in the final report, a series of archival hard copies of all plans will be produced on archival quality paper and accompanied by digital archives of all images/illustrations.

CODE	Component	Notes – decision making criteria for utilisation
K-i	Shapefile of item/complex	Shapefile(s) will be generated for all items/complexes.
K-ii	Location overview map	Location overview maps will be generated for all items/complexes. These maps will typically show the locations of multiple items/complexes, together with their relationship to the project footprint.
K-iii	2D Site plan	Two-dimensional site plans will be prepared in digital format for all items/complexes where archival recording has been conducted. The scale and level of detail will be appropriate to the size, complexity and significance of the item/complex. Where excavation has been conducted, separate site plans will be produced for different phases of excavation (e.g. prior to turf removal, following turf removal, different phases of site use/occupation, and final excavation plans. The locations of all features, elevations and sections that appear in separate illustrations/plans will be indicated and cross referenced to the relevant plan.
K-iv	3D Site plan	Where three-dimensional data (e.g. Lidar, photogrammetry or total station survey) has been collected, additional 3D mapping will be prepared of relevant items/complexes.
K-v	Feature(s) detail plan	Where individual feature(s) have been recorded in detail within an item/complex, additional plans will be produced of those feature(s) and cross referenced to the relevant site plan.
K-vi	Elevation(s)	Where an item/complex, or components thereof, contains standing elements (e.g. walls), digital elevation drawings will be produced, and cross referenced to the relevant site plan.
K-vii	Section(s)	A minimum of one section drawing will be produced in digital format for all excavated sites. Where excavation has proceeded to broad area salvage, representative sections of all relevant components of the excavation will be produced. All section drawings will be cross referenced to the relevant site plan(s).
K-viii	Harris Matrix	A Harris Matrix will be prepared for each excavated item/complex that shows the relationships between all identified contexts in terms of their relevant phasing and periods.
K-ix	Archival photography plan	In addition to the abovementioned illustrations, a separate digital photography plan will be produced for all items/complexes where archival recording was conducted. The photography plan will show the location and direction of all SLR RAW format photographs within the archival photography database. Where necessary, multiple archival photography plans will be produced for a given item/complex in order to map all relevant photographs.

K-x	Archival photography database	The RAW images from archival photography will be filed according to item/complex under their original image number/code. A database will be produced that includes details of the original image number/code, sequential item codes as shown in the archival photography plan, notes/descriptions and other relevant metadata. Hard copies of the database, thumbnail style images of all photographs, and representative full-sized images will also be included in the final report(s).

Research Questions

The following research questions will be used to inform decisions made regarding the level of investigation, analysis and reporting applicable to any given item/complex. In some cases, an item may not have any potential to answer or address these questions. In that instance, investigation may not proceed beyond a base level archival recording. Other items/complexes may have the potential to address multiple research questions, or in some very rare instances, all of the identified questions. In that instance, the level of recording, investigation, salvage, analysis and reporting will tend to be higher and more complex. NB – Questions i through xviii outline the more generic questions that might be asked, while questions xix through xxii focus in on specific aspects of research relating to Lobs Hole.

CODE	Question(s)
L-i	What features are present at the item/complex?
L-ii	What can be inferred regarding site formation processes?
L-iii	Are there relatively intact archaeological deposits present? If so, what are the horizontal and vertical extents of those deposits?
L-iv	What evidence is there of the function of the item/complex?
L-v	Is there evidence of different activity areas within the item/complex?
L-vi	What evidence is there of the relationships between items/complexes?
L-vii	Are different phases of use evidenced? If so, how?
L-viii	Can the phase(s) of use be dated? – i.e. can the decade(s) of use be determined?
L-ix	What is the overall chronology of the item/complex?
L-x	Is there evidence that links the item/complex to particular individuals or groups?
L-xi	Is there any evidence of environmental/landscape change? If so, is there evidence of cultural causes or responses?
L-xii	What evidence is there of how the item/complex was constructed/modified/abandoned?
L-xiii	What can be inferred regarding age, gender, ethnicity and social status? Are there demographic patterns associated with particular areas, periods or site types?
L-xiv	To what extent were goods and materials produced/resourced locally? Are there patterns in what was produced/resourced locally, and is there evidence of this changing over time?
L-xv	To what extent were goods and materials sourced externally? e.g. from elsewhere in Australia or internationally. Are there patterns in what was sourced externally, and is there evidence of this changing over time?
L-xvi	How does the archaeological evidence compare with the known, albeit limited historical record?
L-xvii	How do the locations and layouts of items/complexes compare with official records? e.g. How does the gazetted town plan of Ravine compare with the archaeological evidence?
L-xviii	What spatial patterns are there in terms of particular site types or chronological periods? What can be inferred from these?
L-xix	What was the nature of the early occupation and use of the West Pinbeyan run? Who held the leases before 1890, and for how long? Who were the managers before Charles Blackman and what was the nature of the pastoral activities? What was the nature of the transition into lease and freehold occupation after the Robertson Land Acts?

L-xx	What further historical account of the earliest copper mining at Lobs Hole can be made? The development of copper mining at Lobs Hole was substantially related to the endeavours and dreams of one man, Julius Forsstrom. However, there were many outfits who sought to become a player at Lobs Hole. How significant or otherwise was Lobs Hole copper mining in the development the Australian economy in the late 1880s.
L-xxi	What further information can be found about the interdependent relationship between the historic occupation of Kiandra and Lobs Hole. Was Lobs Hole integral to the occupation of Kiandra during the late 1800s/early 1900s, or incidental?
L-xxii	How did people live, work and play at Lobs Hole during the heyday of the copper mining and what was the nature of transition in the early 1900s to the single family farming enterprise (the Yan farm) which lasted until the 1960s. What was the nature of the Yan farming? Was is largely a self-sufficient enterprise or was a surplus exported and sold outside Lobs Hole.

Historical Research – Includes research already conducted and any additional research that may be conducted as part of mitigation management

CODE	Component	Notes – decision making criteria for utilisation
M-i	Oral history	A program of oral history recording has been ongoing throughout the development of the Snowy 2.0 project. This will continue in order to compile as comprehensive a historic overview of the Lobs Hole as feasible. It is via oral history recordings that numerous primary sources and photographs have been found to date.
M-ii	Title searches/Crown plans	The review of title searches/crown plans etc will continue throughout the historical research program. Crown plans may indicate the presence of historic buildings, sheds and other features that may now only exist archaeologically. Crown plans will be obtained if available in order to evaluate the nature and extent of the occupation of the Ravine township.
M-iii	Trove/Online research	The Trove/online research will continue throughout the historical research program. Our Online research has contributed significant information in regard to the historic occupation of Lobs Hole and the potential to reveal further contributory material exists.
M-iv	Historic maps	The compilation and review of historic maps will continue throughout the historical research program. Historic maps will be utilised to understand the nature of transport and the movement of people and stock within the local area.
M-v	Aerial images	The review of historic aerial imagery will continue throughout the historical research program. Historic aerial imagery has the potential to reveal further evidence of previous clearance, land use, historic features, tracks and items.
M-vi	Historic photos	Our historic photo collection is comprised of imagery gathered from numerous sources. Additional photographs will be pursued during our Online research, oral history recordings and other.
M-vii	Primary Sources	Further research of primary documents relating to the occupation of Lobs Hole will be conducted. In particular, research regarding the leasehold of the West Pinbeyan Run and Lobs Hole mining will be undertaken. The early phases (pre-1880s) of both activities is to date poorly understood.
M-viii	Secondary Sources	The use of secondary sources has been largely exhausted but will continue to be pursued, as relevant.
M-ix	Comparative analysis	Additional research into archaeological investigations and heritage assessments of similar site types and complexes (both nationally and internationally) may also be undertaken to assist with site interpretations and assessments.

Reporting

The results of the historical mitigation program and investigations conducted for Exploratory Works will be documented in a report(s) in accordance with the relevant Conditions of Consent. The tasks outlined below provide an indicative overview of the reporting components.

CODE	Component	Notes – decision making criteria for utilisation
N-i	Aims/Objectives	The aims and objectives of the heritage mitigation works will be set out, including all research questions and any modifications to the aims and objectives that arose during fieldwork.
N-ii	Description/Inventory	An overview of all identified heritage items/complexes, including items identified during the EIS and any items identified in the course of Exploratory Works and the associated mitigation program. Additional details/descriptions will be provided in the appendices.
N-iii	Methodology	The methodology section will detail all aspects of the field investigations and post-excavation analysis procedures that were undertaken.
N-iv	Maps/Plans/Sections/Photographs	All of the maps, plans, sections and representative photographs (refer to Table K) produced for each item/complex will be incorporated into the body/appendices of the report.
N-v	History	A revised and expanded history will be prepared that incorporates any additional information identified through further historical research (refer to Table M). Any newly identified historical themes will be added to the historical themes overview.
N-vi	Results	All field results, including summaries of post-excavation analysis, will be documented. Where necessary, additional detail will be provided in the appendices.
N-vii	Discussion/Research questions	The field results and post-excavation analysis will be explored and discussed with reference to the identified research questions. Summaries of responses to all research questions will be documented, including explanations where particular questions could not be satisfactorily addressed.
N-viii	Significance assessments	The heritage significance of items/complexes will be reviewed and updated as appropriate in the light of the results of the heritage mitigation program.
N-ix	Interpretation	Interpretation strategies will be developed with respect to particular themes, locations, chronological periods, site types etc.
N-x	Digital archive	Digital archives will be prepared of all data including plans, maps, photographs, artefact catalogues, historical documents/resources.
N-xi	Archival recordings – hard copies	Hard copies of all material produced for archival recordings will be prepared on appropriate archival quality paper.

Recording Forms

The following is an overview of the standard recording forms that will be used and their application. These forms are in addition to the site plans and data collected as part of archival recording. These

CODE	Component	Notes – decision making criteria for utilisation
O-i	Feature plan	Where an item/complex contains one or more identifiable features, a feature plan will be completed including information regarding feature ID code, materials/contexts present, dimensions, associated records/finds etc.
O-ii	Context form	A context form will be completed for all contexts identified during excavation. It will include space to record item code, context code, excavation grid squares, excavation method, sieving details; plan in the extent of the context, locations of associated features/contexts/finds; record total station/levelling data, photographs, context description, interpretation and other standard excavation field data. These forms will be completed by the excavator(s) and reviewed by the Excavation Director/Project Director/Site Supervisor.
O-iii	Context log	A log will be kept of all context IDs allocated at a given excavation, including brief description/interpretation, associated grid squares, excavator(s) and dates of excavation commencement/completion. This log will be maintained and updated by the Excavation Director/Project Director/Site Supervisor.
O-iv	Photograph log	A photographic log will be kept for all images taken during fieldwork. It will include information regarding date, camera, item/complex code, image number (from camera), image details/description, direction and any necessary cross-referencing to a photographic plan. This log will be maintained and updated by the Excavation Director/Project Director/Site Supervisor.
O-v	Finds Log	A log will be kept of all finds including the types of material collected, numbers of bags for a given square/context, current storage location, notes on necessary conservation actions/interventions, as well as details of whether analysis is complete. This log will be maintained and updated by the Excavation Director/Project Director/Site Supervisor.
O-vi	Samples log	A log will be kept of all samples including the types of material collected, number of samples, weights, provenance, current storage location, notes on necessary conservation actions/interventions, as well as details of whether analysis is complete. This log will be maintained and updated by the Excavation Director/Project Director/Site Supervisor.
O-vii	In-field Harris Matrix	A preliminary in-field Harris Matrix will be prepared for each excavation. This document will be maintained and updated by the Excavation Director/Project Director/Site Supervisor.
O-viii	Moveable heritage	A log will be kept of all moveable heritage, including records of data associated with the item, the original location of the item, the current location of the item, and strategies for either returning the item or securing an off-site curation location.
O-ix	Unexpected finds	A log will be kept of all unexpected finds including date and circumstances of discovery, GPS location and any other associated data (e.g. photographs), assessment of nature/extent/significance, and implemented management measures.
O-x	Human skeletal remains	A log will be kept of all human skeletal remains encountered, including date and circumstances of discovery, GPS location and any other associated data (e.g. photographs), communications with police/OEH/other stakeholders, nature and extent of the

		remains, and implemented management measures.

Data checks and backups

NB - Clearance notification to proceed with impacts/works will not be issued until these steps have been completed for a given item/complex.

CODE	Component	Notes on implementation
P-i	Check paper/digital records	All paper and digital records will be checked over at the end of the day and/or completion of work at a given item/complex. Where appropriate, they will be cross-checked with other relevant records (e.g. photo log against photos). Any identified errors or omissions will be addressed the following day, or at the next available opportunity to visit the site.
P-i	Copy/scan paper records	All completed and cross-checked paper records will be copied or scanned each day.
P-i	Create local backup	Local backups will be created daily for all digital data.
P-i	Create master backup	At a minimum, master backups (i.e. copies of files to NSW Archaeology office server/hard drive) will be made once a week.

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Appendix C

Feature photographs

Photograph 0.1 **Large area of a boulder stream – looking uphill**

Photograph 0.2 **Scree boulders**

Photograph 0.3 **Lower Lobs Hole Ravine Road – cut into the lower end of the block stream**

Photograph 0.4 **Boulder stream terminated by Lobs Hole Ravine Road**

Ravine Karst outcrop

Photograph 0.5 **Devonian Lick Hole Formation outcrop in a road cutting of Lobs Hole Ravine Rd.**

Photograph 0.6 **Stratification of the Lick Hole Formation**

Photograph 0.7 **In situ calcareous fossils of the Lick Hole Formation (note: fossils are about 2 to 3 cm in diameter and 4 to 10 cm in length, and are presumed to be corals)**

Photograph 0.8 **Loose calcareous fossils of the Lick Hole Formation**

Appendix D

Tufa deposit location Map

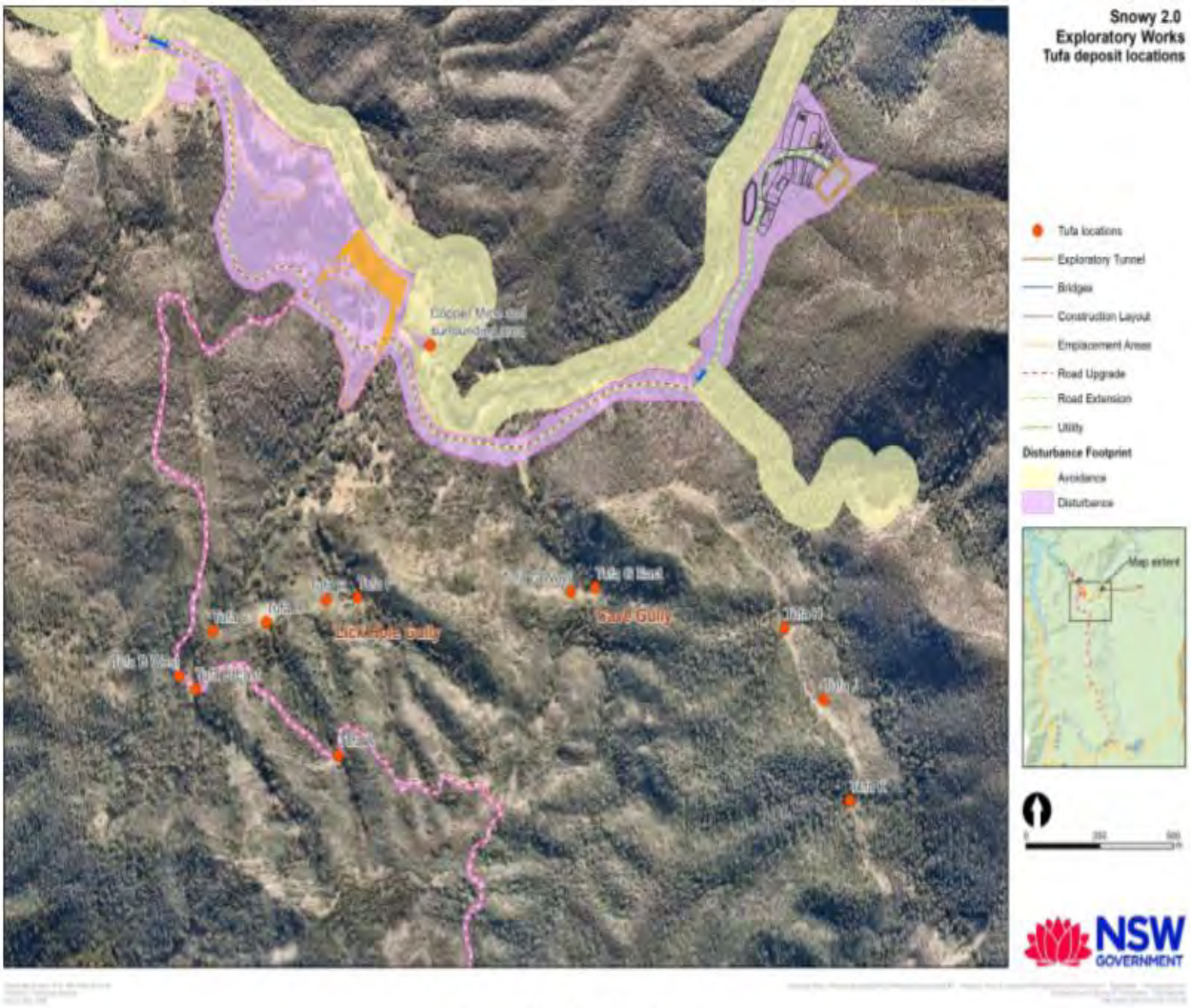


Figure 4-6: Tufa deposit locations

Appendix E

SSI 9208 Consent Conditions Table 3-3 Historic Heritage Items – Avoid Impact and Table 3-4 Historic Heritage Items – Impact Mitigation

Table 3-3 – Historic Heritage Items – Avoid impact

ID	*Item Name*	*Significance*	*Complex*	*Impact*	*Management measure*
R9	Lobbs Hole Copper Mine Shafts	Local	Lobbs Hole Copper Mine	Potential direct impact (within 20 m)	Include in a no-go buffer Archival recording
R14	Site of reverberatory furnace	Contributory	Lobbs Hole Copper Mine	No impact	Archival recording Implement measures to protect moveable heritage
R20	Washington Hotel	Local	Ravine Township	Potential direct impact (within 20 m)	Archival recording Ensure no inadvertent impacts Determine curtilage around the item Assess the significance of component parts Test excavation Salvage if warranted
R48	Excavation possible shed	Contributory	Yan Farm Infrastructure	No impact	Include in a no-go buffer Archival recording Implement measures to protect moveable heritage
R49	Circular stone wall	Contributory	Yan Farm Infrastructure	No impact	Include in a no-go buffer Archival recording Implement measures to protect moveable heritage
R50	Shed with bullock wagon frame	Contributory	Yan Farm Infrastructure	No impact	Include in a no-go buffer Archival recording Implement measures to protect moveable heritage
R56	Excavated ditch	Contributory	Struggle Street	No impact	Include in a no-go buffer Archival recording Implement measures to protect moveable heritage
R57	Old road alignment	Local	Struggle Street	No impact	Include in a no-go buffer Archival recording Implement measures to protect moveable heritage
R58	Large metal pipes	N/A	Lobs Hole historic landscape	No impact	Include in a no-go buffer Archival recording Implement measures to protect moveable heritage
R74	Metal water pipe	Contributory	Lobbs Hole Copper Mine	Potential direct impact (within 20 m)	Archival recording Ensure no inadvertent impacts
R79	Bridge remains	N/A	SMA	Potential direct impact (within 20 m)	Include in a no-go buffer Archival recording
R88	Artificial mound of stone	Contributory	Lobs Hole historic landscape	No impact	Archival recording Ensure no inadvertent impacts
R118	Ravine cemetery	Contributory	Ravine Township	Direct impact	Archival recording Test excavation Salvage if warranted

Table 3-4 – Historic Heritage Items – Impact mitigation

ID	*Item Name*	*Significance*	*Complex*	*Impact*	*Management measure*
R1	1885 West Pinbeyan Station Homestead	Local	West Pinbeyan Station Homestead	Direct impact	Archival recording Test excavation, salvage if warranted
R2	Metal water pipe	Contributory	West Pinbeyan Station Homestead	Direct impact	Archival recording Test excavation. salvage if warranted Implement measures to protect moveable heritage
R3	Possible building structure	Contributory	West Pinbeyan Station Homestead	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts are expected
R4	Rectilinear depression	Contributory	West Pinbeyan Station Homestead	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts are expected
R5	Slag	N/A	Lobbs Hole Copper Mine	No impact	Archival recording
R6	Stone flagging	Contributory	West Pinbeyan Station Homestead	No impact	Archival recording
R7	Depression	N/A	Lobs Hole historic landscape	No impact	Archival recording
R8	Depression	N/A	Lobs Hole historic landscape	No impact	Archival recording
R10	Lobbs Hole Copper Mine	Contributory	Lobbs Hole Copper Mine	No impact	Archival recording
R11	Mullock and metal ore bucket	Contributory	Lobbs Hole Copper Mine	No impact	Archival recording
R12	Foundations for Pelton Wheel	Contributory	Lobbs Hole Copper Mine	No impact	Archival recording
R13	Tramway cutting	Contributory	Lobbs Hole Copper Mine	No impact	Archival recording
R15	Stone channel	Contributory	Yan Farm Infrastructure	No impact	Archival recording
R16	Pile of rocks and drums	Contributory	West Pinbeyan Station Homestead	Direct impact	Archival recording Test excavation, salvage if warranted. Implement measures to protect moveable heritage
R17	Levelled area	Contributory	West Pinbeyan Station Homestead	Direct impact	Archival recording Test excavation, salvage if warranted
R18	Fallen fence	Contributory	Yan Farm Infrastructure	Direct impact	Archival recording Test excavation, salvage if warranted
R19	Levelled pad	Contributory	West Pinbeyan Station Homestead	No impact	Archival recording
R21	Depression and debris	Contributory	Ravine Township	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts are expected

ID	Item Name	Significance	Complex	Impact	Management measure
R22	Potential earthen feature	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R23	Excavation	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R24	Depression	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R25	Building platform	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R26	Mound	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R27	Depression with rock	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R28	Pisé ruin	Contributory	Ravine Township	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts are expected
R29	Mound of stone and brick	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R30	Rectilinear earth feature	Contributory	Ravine Township	Direct impact	Archival recording Test excavation Salvage if warranted
R31	Water race	Contributory	Ravine Township	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts are expected
R33	Excavation and bricks	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R34	Mound of stone	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R35	Rabbit proof fence	Contributory	Yan Farm Infrastructure	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts are expected
R36	Hole	N/A	SMA	No impact	Archival recording
R37	Flying fox	N/A	SMA	No impact	Archival recording
R38	Yarrangobilly Stream Gauging Station 2	N/A	SMA	No impact	Archival recording
R39	Excavation	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R40	Cutting for building platform	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R41	Parallel stone alignment	Contributory	Ravine Township	Direct impact	Archival recording Test excavation Salvage if warranted
R42	Rosie Cook's place	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R43	Yan's farm - rabbit proof fence	Contributory	Yan Farm Infrastructure	No impact	Archival recording
R44	Stable Creek stream gauging station	N/A	SMA	No impact	Archival recording

ID	Item Name	Significance	Complex	Impact	Management measure
R45	Lobbs Hole Copper Mine water race	Contributory	Lobbs Hole Copper Mine	Direct impact	Archival recording Test excavation, salvage if warranted
R46	Large excavation	N/A	Lobs Hole historic landscape	Direct impact	Archival recording Test excavation, salvage if warranted
R47	Ravine Public School site	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R51	Adit in cliff Coronation mine	N/A	Lobbs Hole Copper Mine	No impact	Archival recording
R52	Survey mark	N/A	SMA	No impact	Archival recording
R53	Old road	N/A	Lobs Hole historic landscape	No impact	Archival recording
R54	Site of bridge	N/A	SMA	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts are expected
R55	Brick hearth	N/A	Lobs Hole historic landscape	Direct impact	Archival recording Test excavation, salvage if warranted
R59	Domestic metal glass	Contributory	Ravine Township	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts are expected
R60	Police Station site	Contributory	Ravine Township	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts are expected
R61	Well	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R62	Possible shaft	Unverified	Lobbs Hole Copper Mine	No impact	Archival recording
R63	Pile of Shale	Unverified	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R64	Water race	Contributory	Ravine Township	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts expected
R65	Thomas house	Contributory	Ravine Township	No impact	Archival recording
R66	House platform	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R67	Lobbs Hole Central Mine	Contributory	Lobbs Hole Copper Mine	No impact	Archival recording
R68	Shaft and mullock	Contributory	Lobbs Hole Copper Mine	No impact	Archival recording
R69	Brick kiln	Contributory	Lobbs Hole Copper Mine	Direct impact	Archival recording Test excavation, salvage if warranted Implement measures to protect moveable heritage
R70	Concrete fire place	Contributory	Lobs Hole historic landscape	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts are expected
R71	Butcher shop	Contributory	Ravine Township	Direct impact	Archival recording Test excavation,

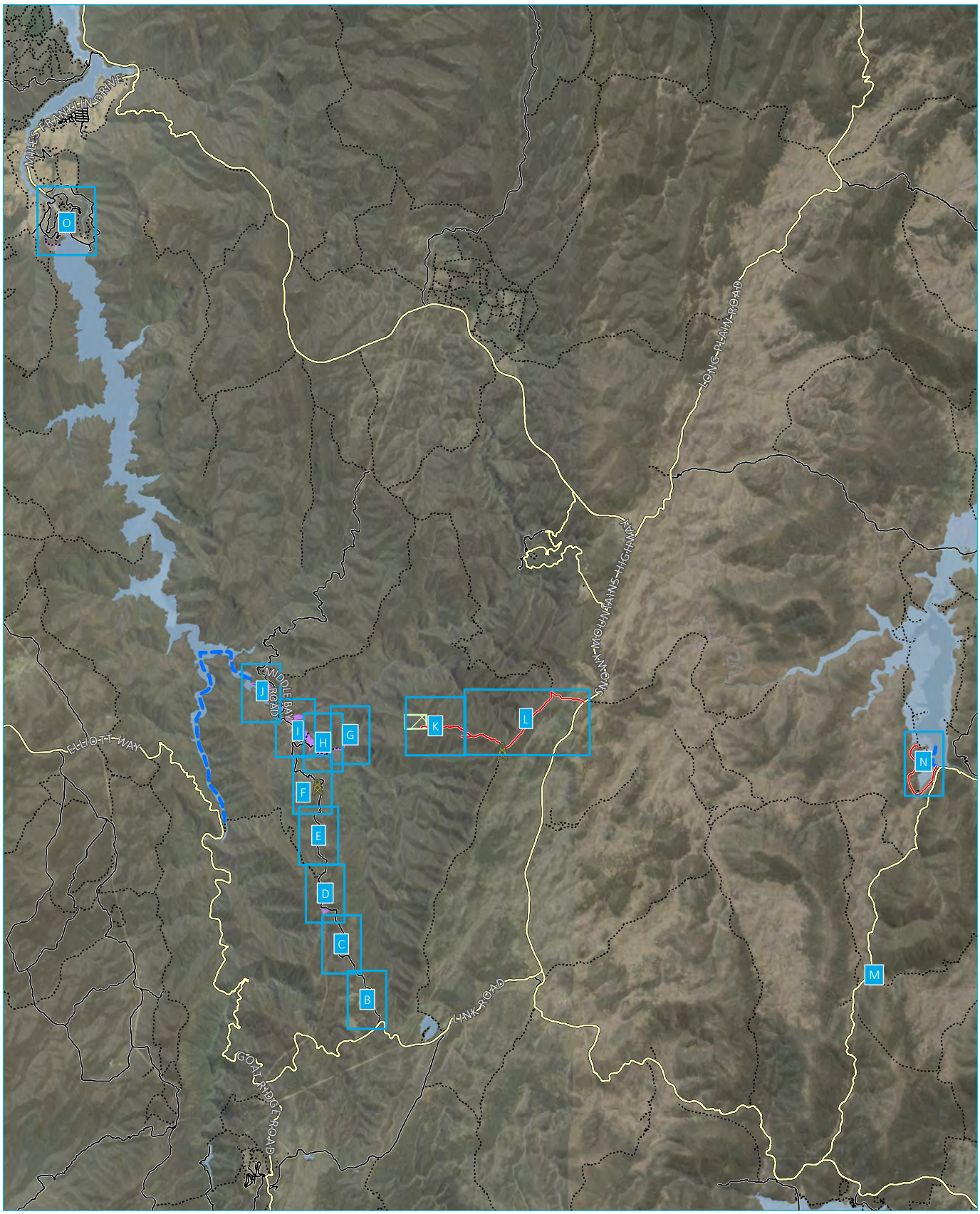
ID	Item Name	Significance	Complex	Impact	Management measure
					salvage if warranted. Implement measures to protect moveable heritage
R72	Stone furnace	N/A	Lobs Hole historic landscape	Potential direct impact (within 20 m)	Archival recording Test excavation, Salvage if warranted and impacts are expected
R73	Rabbit proof fence	Contributory	Yan Farm Infrastructure	No impact	Archival recording
R75	Mine shaft on ML 31	Contributory	Lobbs Hole Copper Mine	No impact	Archival recording
R76	Scatter of tin, glass and brick	Contributory	Struggle Street	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts are expected
R77	Site of meteorological station	N/A	SMA	No impact	Archival recording
R78	Pine tree	N/A	Lobs hole historic landscape	Direct Impact	Archival recording
R80	Elizabeth Frazer's orchard	Contributory	Struggle Street	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts expected
R81	Yarrangobilly River water race/road	Contributory	Lobbs Hole Copper Mine	Direct impact	Archival recording Test excavation, salvage if warranted
R82	Front seat of car ~ 1960s	N/A	Lobs Hole historic landscape	Direct impact	Archival recording
R83	Pile of sheet metal	N/A	Lobs Hole historic landscape	No impact	Archival recording
R84	Possible old road	Contributory	Lobs Hole historic landscape	Direct impact	Archival recording Test excavation, salvage if warranted
R85	Possible old road	Contributory	Lobs Hole historic landscape	Direct impact	Archival recording Test excavation, salvage if warranted
R86	Possible old road	Contributory	Lobs Hole historic landscape	Direct impact	Archival recording Test excavation, salvage if warranted
R87	Tree with scar and axe	Contributory	Lobs Hole historic landscape	No impact	Archival recording
R89	Artificial mound of stone	Contributory	Lobs Hole historic landscape	Direct impact	Archival recording Test excavation, salvage if warranted
R90	Lobbs Hole Copper Mine - Lick Hole Gully Adit	Contributory	Lobbs Hole Copper Mine	Direct impact	Archival recording Test excavation, salvage if warranted
R91	Mine Shaft (? No. 4)	Contributory	Lobbs Hole Copper Mine	Direct impact	Archival recording Test excavation, salvage if warranted
R92	Building platforms	Contributory	Lobs Hole historic landscape	Direct impact	Archival recording Test excavation, salvage if warranted
R93	Fence	Contributory	Lobs Hole historic landscape	Direct impact	Archival recording Test excavation, salvage if warranted

ID	Item Name	Significance	Complex	Impact	Management measure
R94	Road alignment	Contributory	Lobs Hole historic landscape	Direct impact	Archival recording Test excavation, salvage if warranted
R95	Road alignment	Contributory	Lobs Hole historic landscape	Direct impact	Archival recording Test excavation, salvage if warranted
R96	Open Cut in Lick Hole Gully	Contributory	Lobbs Hole Copper Mine	Direct impact	Archival recording Test excavation, salvage if warranted
R97	Exotic trees	Contributory	West Pinbeyan Station Homestead	Direct impact	Archival recording
R98	Excavated pit	Contributory	Lobbs Hole Copper Mine	Direct impact	Archival recording Test excavation, salvage if warranted
R99	Well	Contributory	Yan Farm Infrastructure	Direct impact	Archival recording Test excavation, salvage if warranted
R100	Single furrow plough	Contributory	Yan Farm Infrastructure	Direct impact	Archival recording Test excavation, salvage if warranted
R101	Possible building site	Contributory	Lobs Hole historic landscape	Direct impact	Archival recording Test excavation, salvage if warranted
R102	Stone culverts	Contributory	Lobs Hole historic landscape	Direct impact	Archival recording Test excavation, salvage if warranted
R103	Levelled platform	Contributory	Yan Farm Infrastructure	No impact	Archival recording
R104	Lick Hole Gully water race	Contributory	Yan Farm Infrastructure	No impact	Archival recording
R105	Ditch	Contributory	Lobs Hole historic landscape	No impact	Archival recording
R106	Old Road	Contributory	Struggle Street	No impact	Archival recording
R107	Building platform	Contributory	Struggle Street	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts expected
R108	Old road	Contributory	Struggle Street	Direct impact	Archival recording Test excavation, salvage if warranted
R109	House platform with wooden cross	Contributory	Struggle Street	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts are expected
R110	Building platform	Contributory	Struggle Street	No impact	Archival recording Avoid impacts if possible
R111	Path to creek	Contributory	Struggle Street	No impact	Archival recording
R112	Possible shaft	Contributory	Lobbs Hole Copper Mine	No impact	Archival recording
R113	Shed platforms	Local	Yan Farm Infrastructure	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts are expected
R114	Excavation	Contributory	Lobs Hole historic landscape	Direct impact	Archival recording Test excavation, salvage if warranted
R115	Stone lined channel	Contributory	Struggle Street	No impact	Archival recording

ID	Item Name	Significance	Complex	Impact	Management measure
R116	House site	Contributory	Ravine Township	Potential direct impact (within 20 m)	Archival recording Test excavation, salvage if warranted and impacts are expected
R117	Possible shaft	Contributory	Lobbs Hole Copper Mine	No impact	Archival recording
R119	SH weather station	N/A	Snowy Hydro	Direct impact	Weather station in use but can be relocated
R120	Building platform	Contributory	Struggle Street	No impact	Archival recording
R121	Depression	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R122	Fireplace platform	Contributory	Ravine Township	Direct impact	Archival recording Test excavation, salvage if warranted
R123	Survey marker	N/A	SMA	No impact	Archival recording
R124	SMA laydown area	N/A	SMA	Direct impact	Archival recording
R125	SMA quarry	N/A	SMA	Direct impact	Archival recording
R126	SMA survey marker	N/A	SMA	Direct impact	Archival recording
R127	SMA survey marker	N/A	SMA	Direct impact	Archival recording
R128	First school at Lobs Hole	Contributory	Ravine Township	No impact	Archival recording

Appendix F

Project Boundary



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Source: EMM (2019); Snowy Hydro (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 5 10 km

GDA 1994 MGA Zone 55

N

KEY

- Proposed temporary communications upgrade location
- Existing access track
- Boat access
- Main road
- Local road
- Vehicular track
- Map index
- EW approved construction footprint
- EW modification construction footprint (additional)
- Boreholes requiring on-site adjustment
- Waterbody

Exploratory Works project boundary - overview

Snowy 2.0
Exploratory Works EIS
Modification 1
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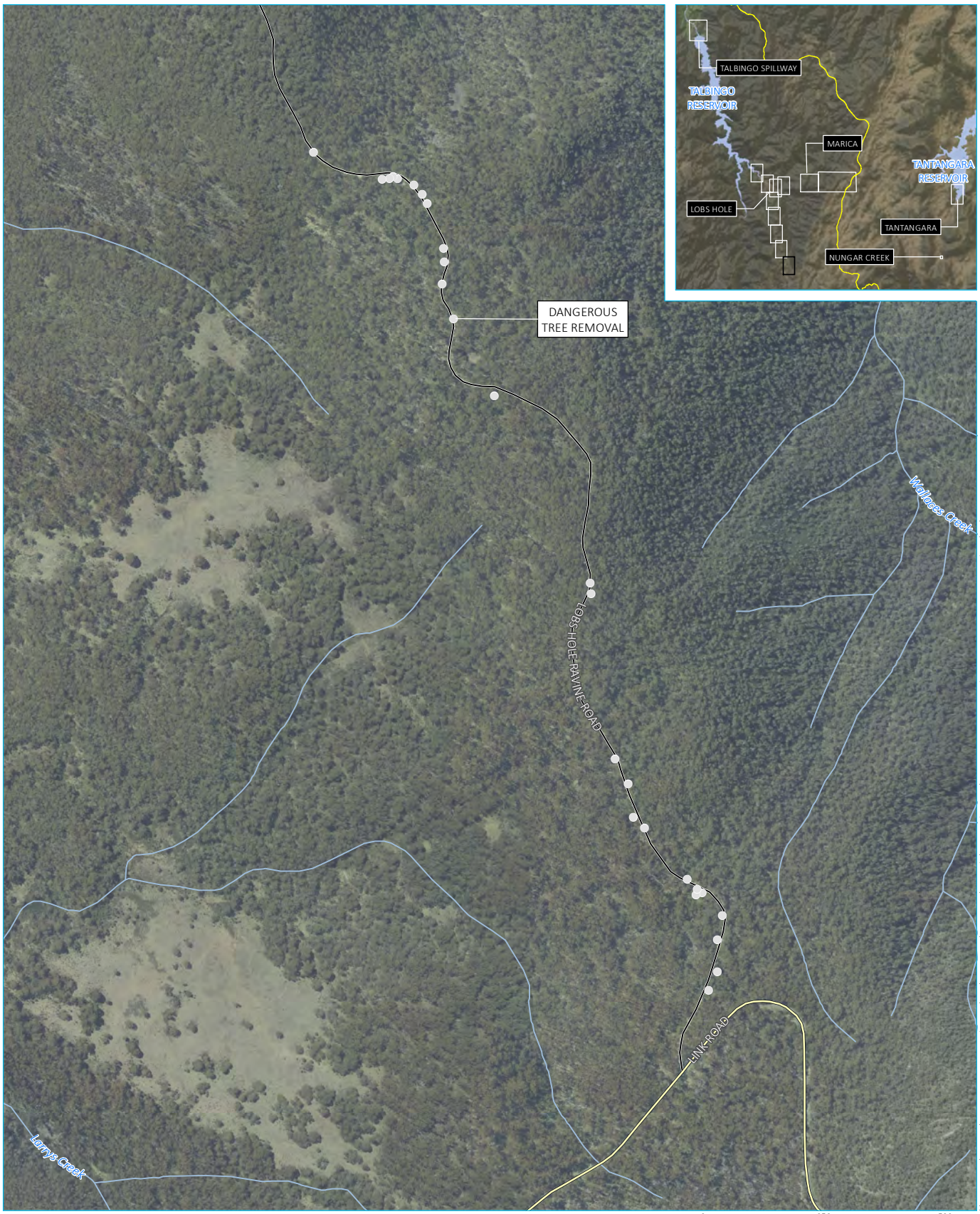

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Dangerous tree
- Main road
- Local road
- Watercourse/drainage line

Exploratory Works project boundary
- Lobs Hole Ravine Road (Upper) 1

Snowy 2.0
Exploratory Works EIS
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EMM creating opportunities

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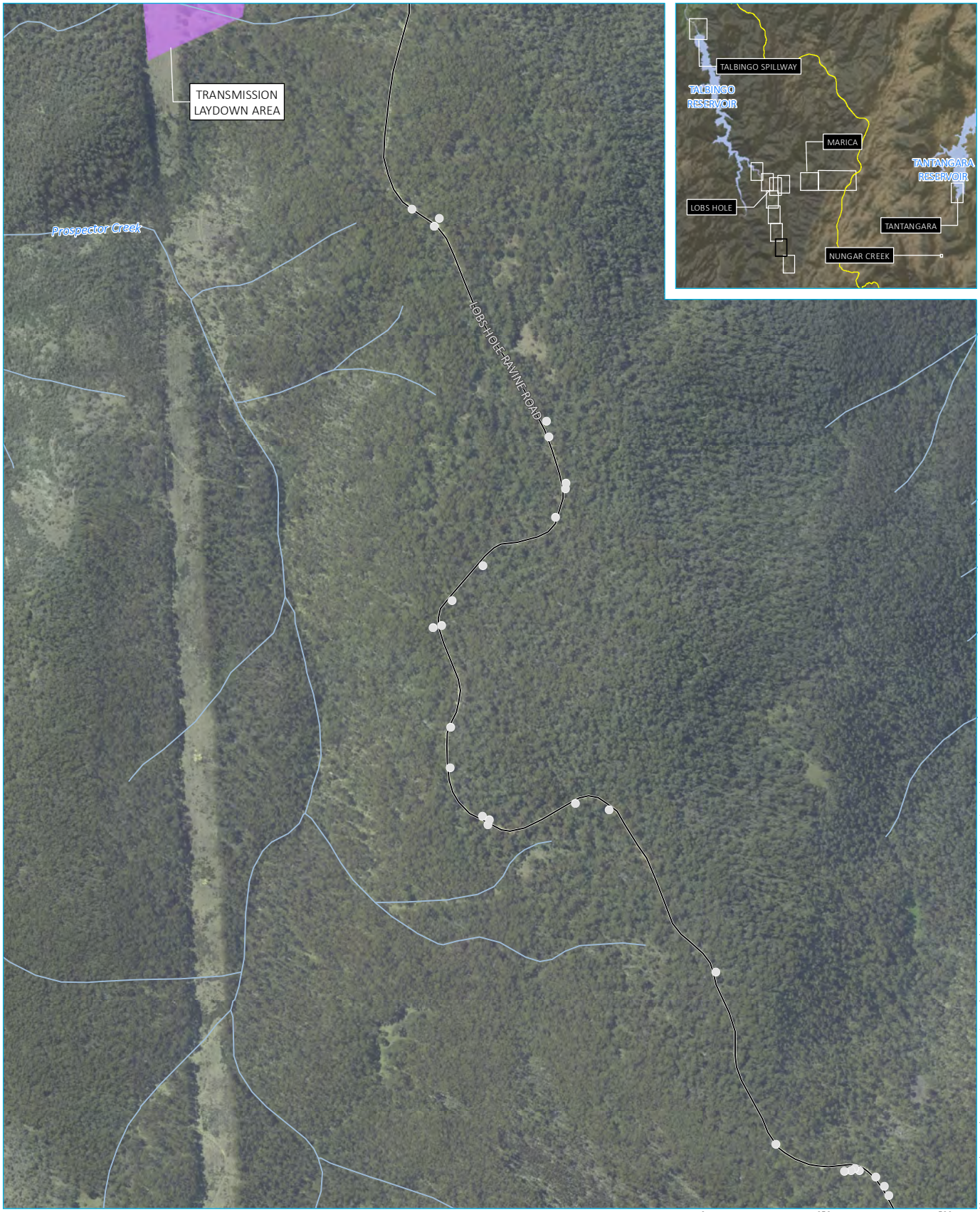

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous tree
- Local road
- Watercourse/drainage line
- EW approved construction footprint

0 250 500 m

GDA 1994 MGA Zone 55

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Exploratory Works project boundary
- Lobs Hole Ravine Road (Upper) 2

Snowy 2.0
Exploratory Works EIS
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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Dangerous tree
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)

Exploratory Works project boundary - Lobs Hole Ravine Road (Upper) 3

Snowy 2.0
Exploratory Works EIS
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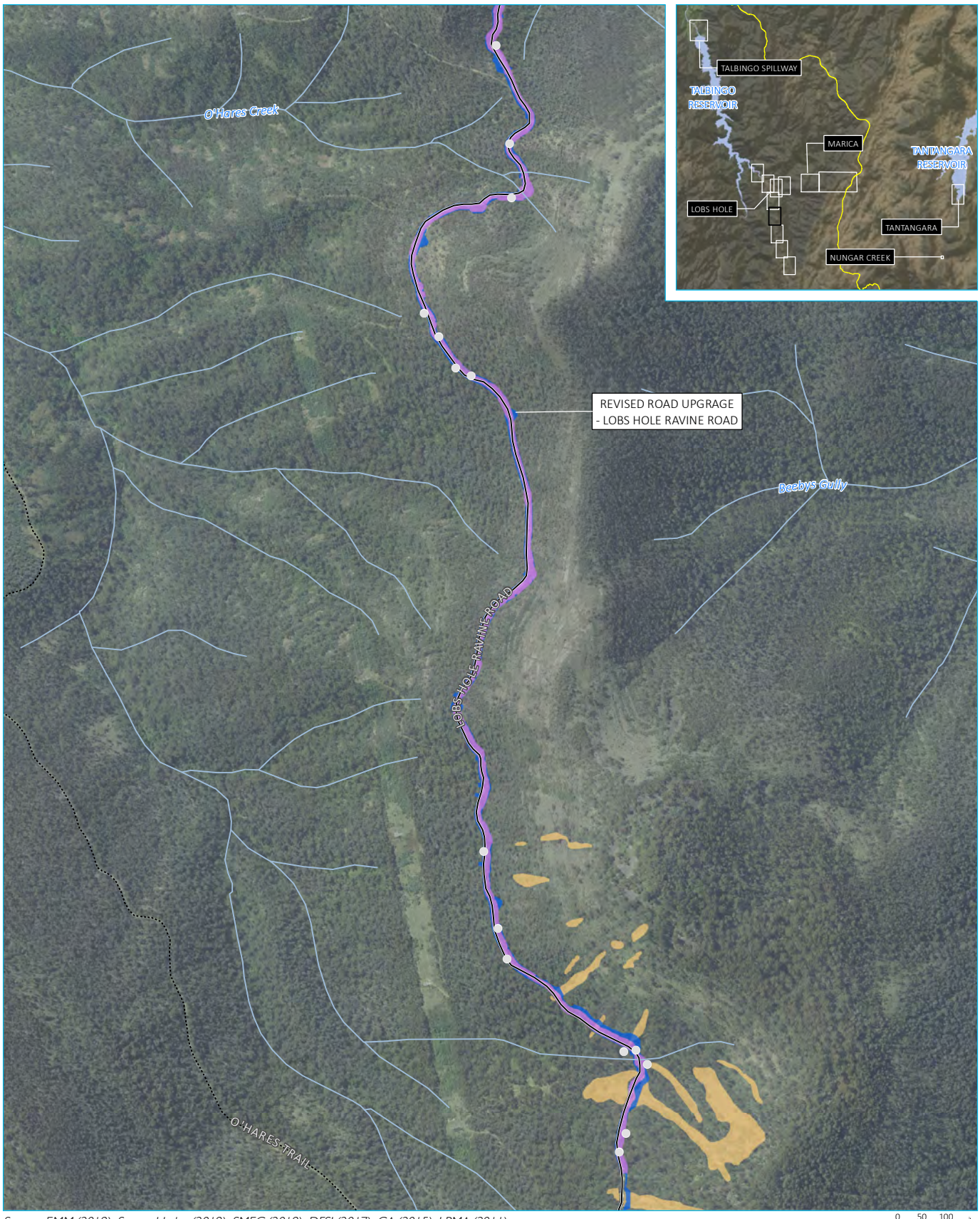

Source: EMM (2019); Snowy Hydro (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 50 100 m

GDA 1994 MGA Zone 55

N

KEY

- Dangerous tree
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Boulder stream

Exploratory Works project boundary
- Lobs Hole Ravine Road (Lower) 1

Snowy 2.0
Exploratory Works EIS
Modification 1
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EMM creating opportunities

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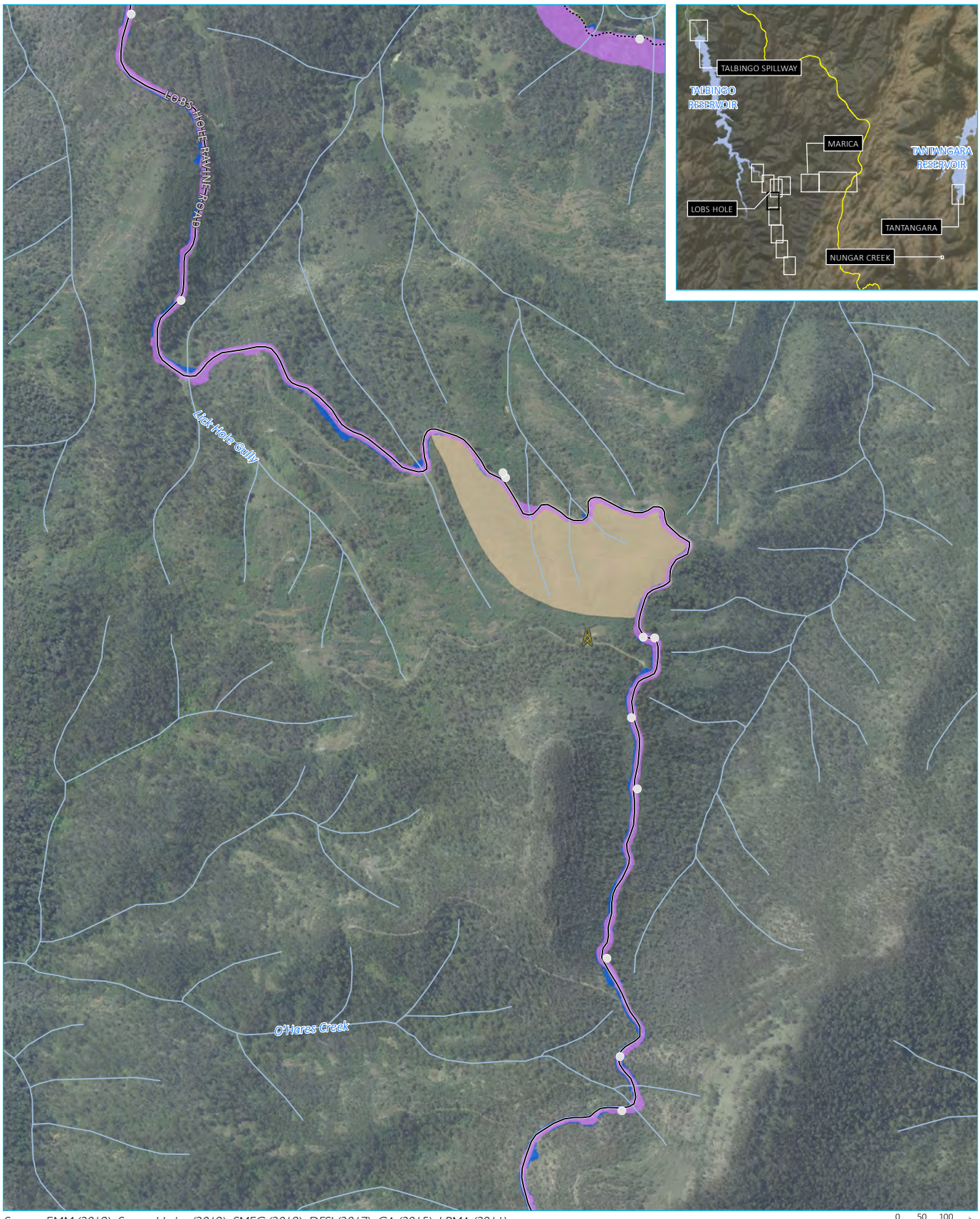

Source: EMM (2019); Snowy Hydro (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 50 100 m

GDA 1994 MGA Zone 55

N

KEY

- Dangerous tree
- Existing temporary communications
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Fossil area

Exploratory Works project boundary
- Lobs Hole Ravine Road (Lower) 2

Snowy 2.0
Exploratory Works EIS
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EMM creating opportunities

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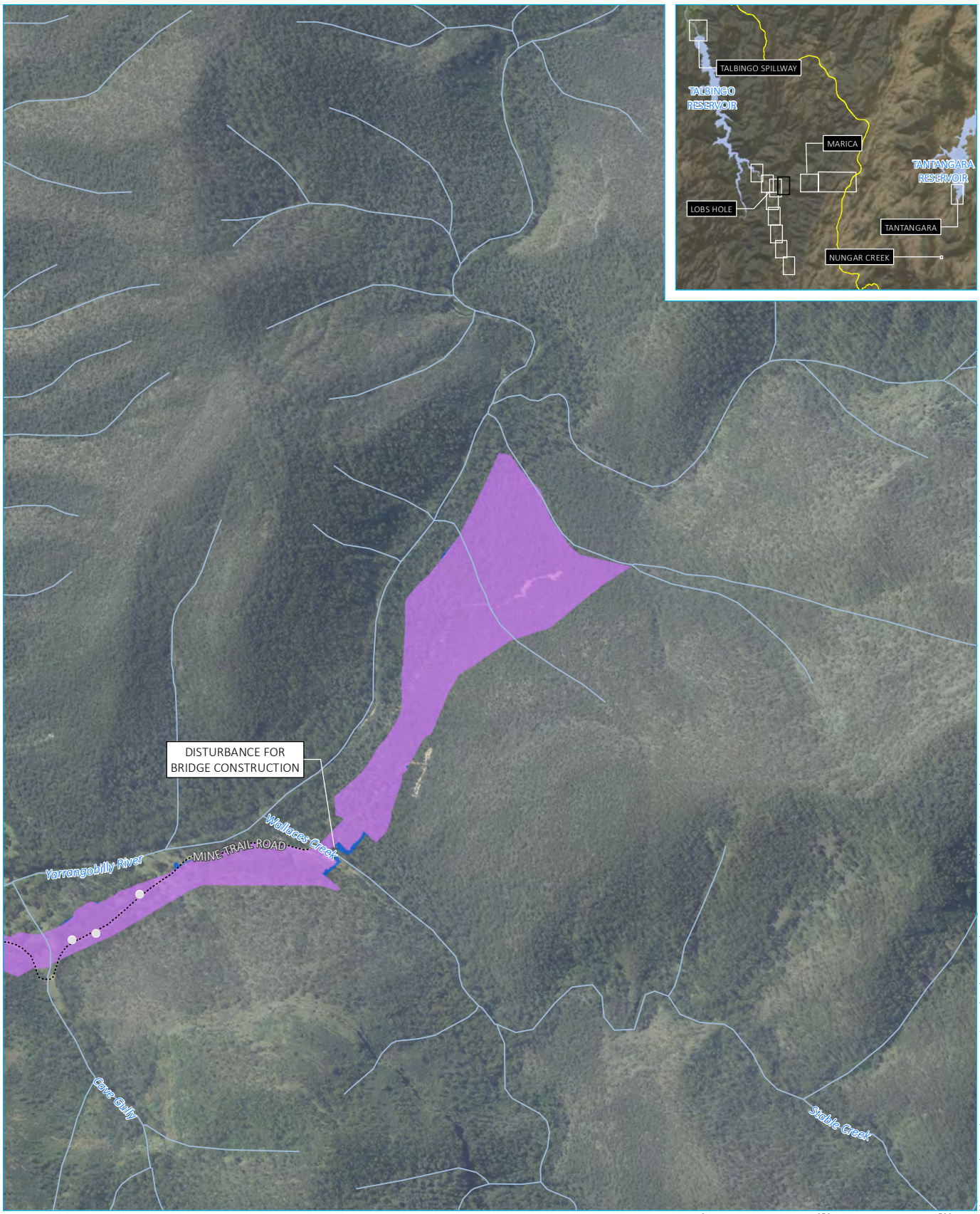

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Dangerous tree
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)

Exploratory Works project boundary
- Mine Trail Road 1

Snowy 2.0
Exploratory Works EIS
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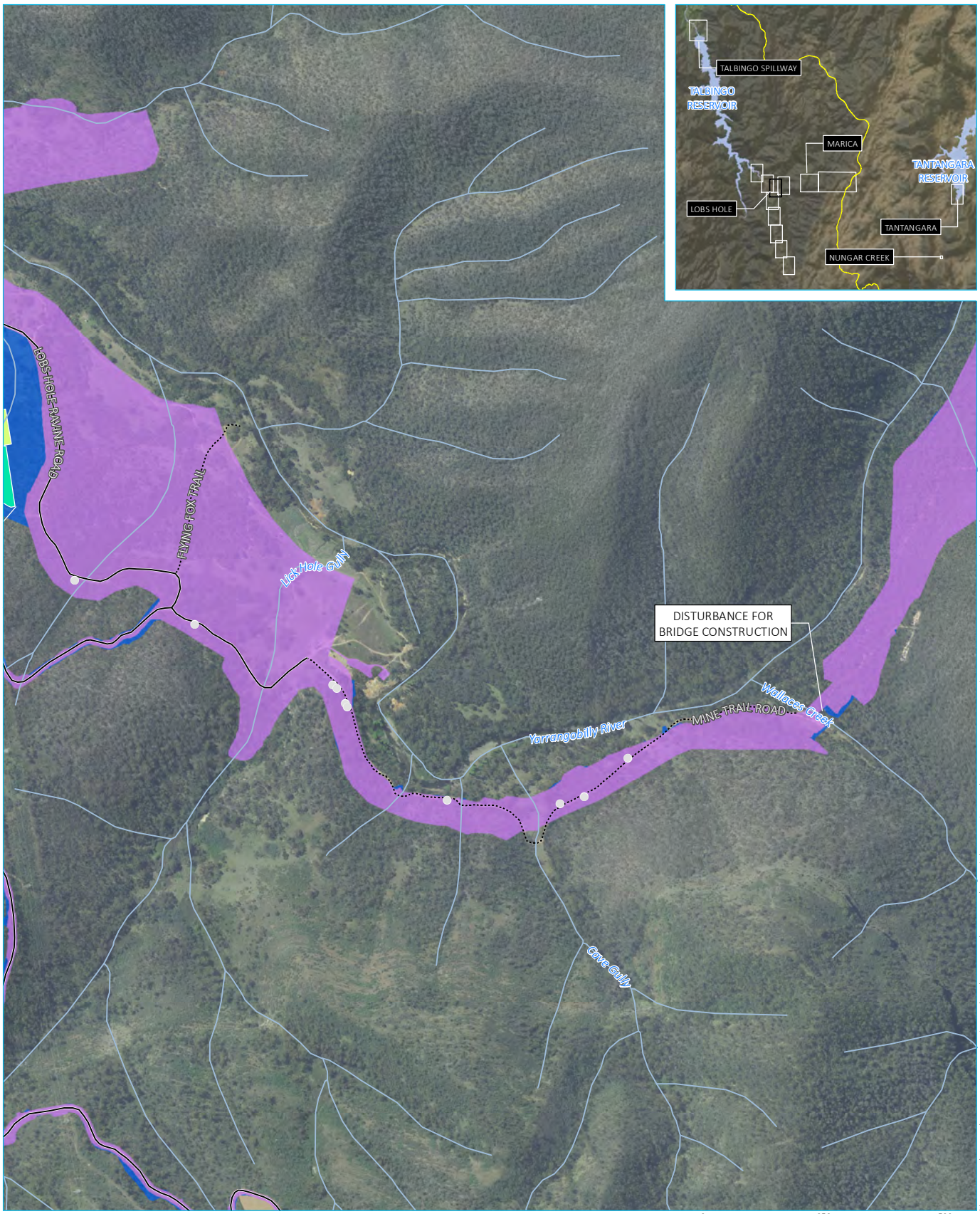

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Dangerous tree
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Indicative laydown area
- Proposed substation
- Fossil area

Exploratory Works project boundary
- Mine Trail Road 2

Snowy 2.0
Exploratory Works EIS
Modification 1
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EMM creating opportunities

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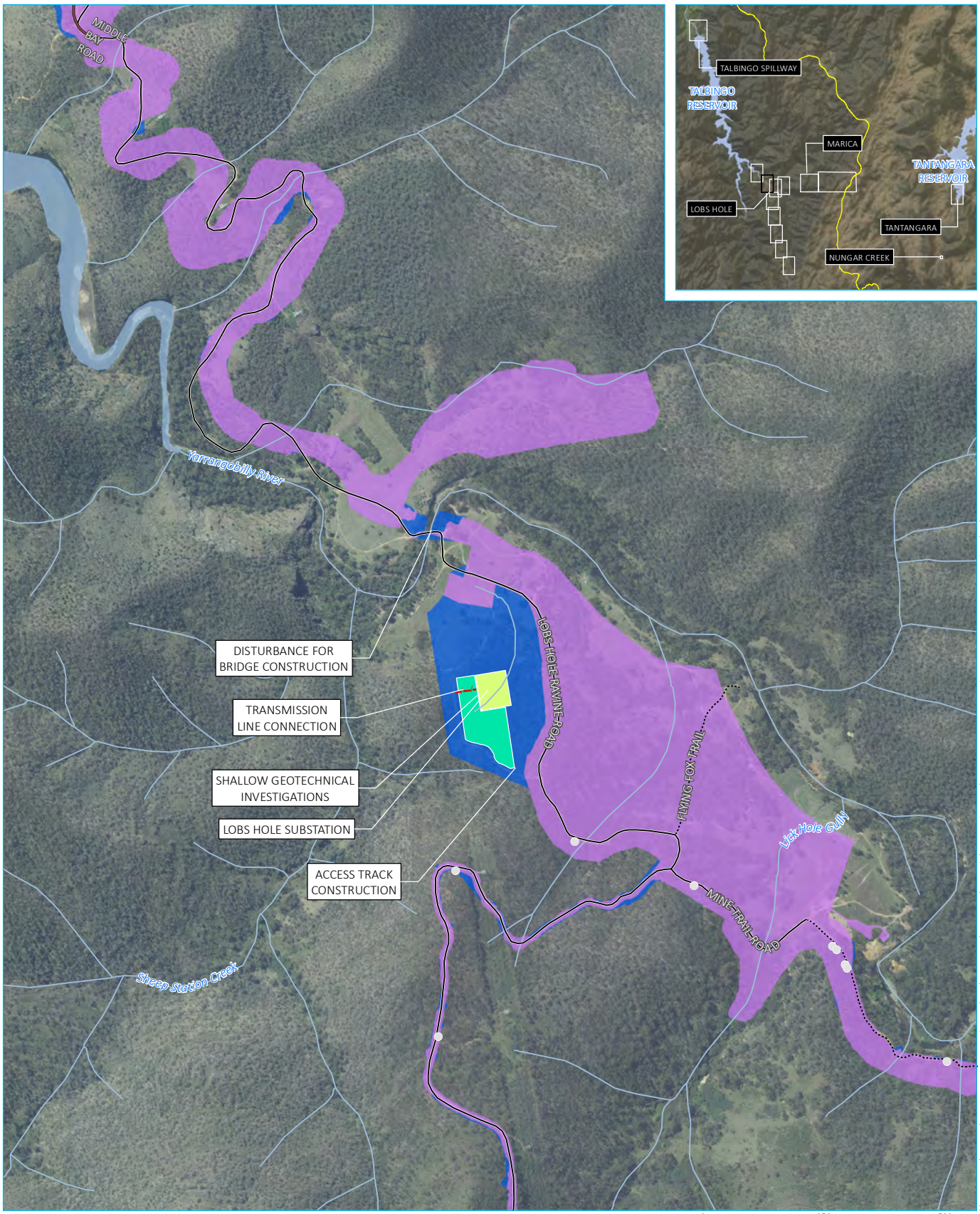

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Dangerous tree
- Approved EW access
- Transmission line connection
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Indicative laydown area
- Proposed substation
- Waterbody

Exploratory Works project boundary - Lobs Hole

Snowy 2.0
Exploratory Works EIS
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EMM creating opportunities

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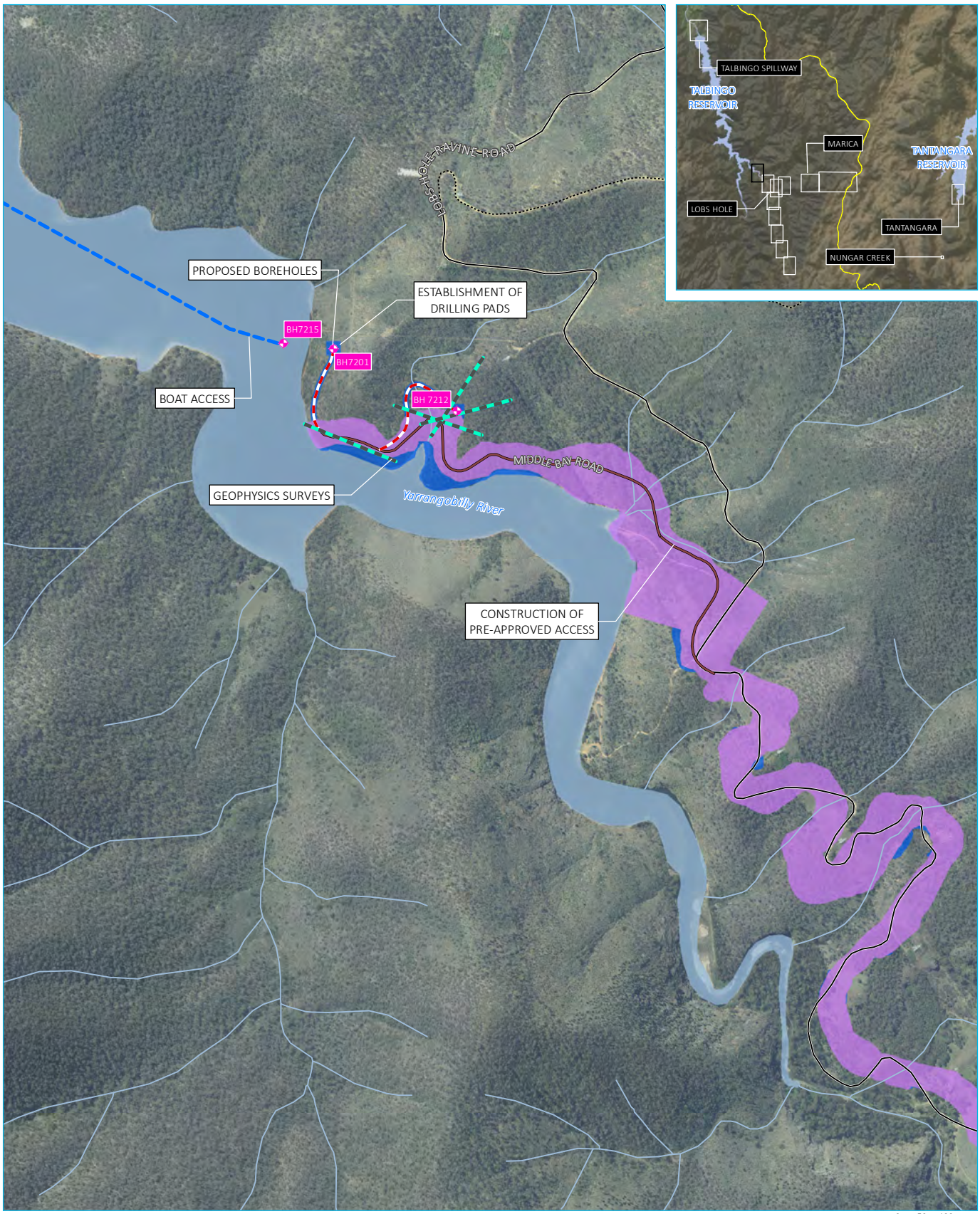

Source: EMM (2019); Snowy Hydro (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 50 100 m

GDA 1994 MGA Zone 55

N

KEY

- Proposed borehole
- Proposed geophysics
- Proposed access track
- Approved EW access
- Boat access
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Waterbody

Exploratory Works project boundary - Lobs Hole Ravine Road

Snowy 2.0
Exploratory Works EIS
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EMM creating opportunities

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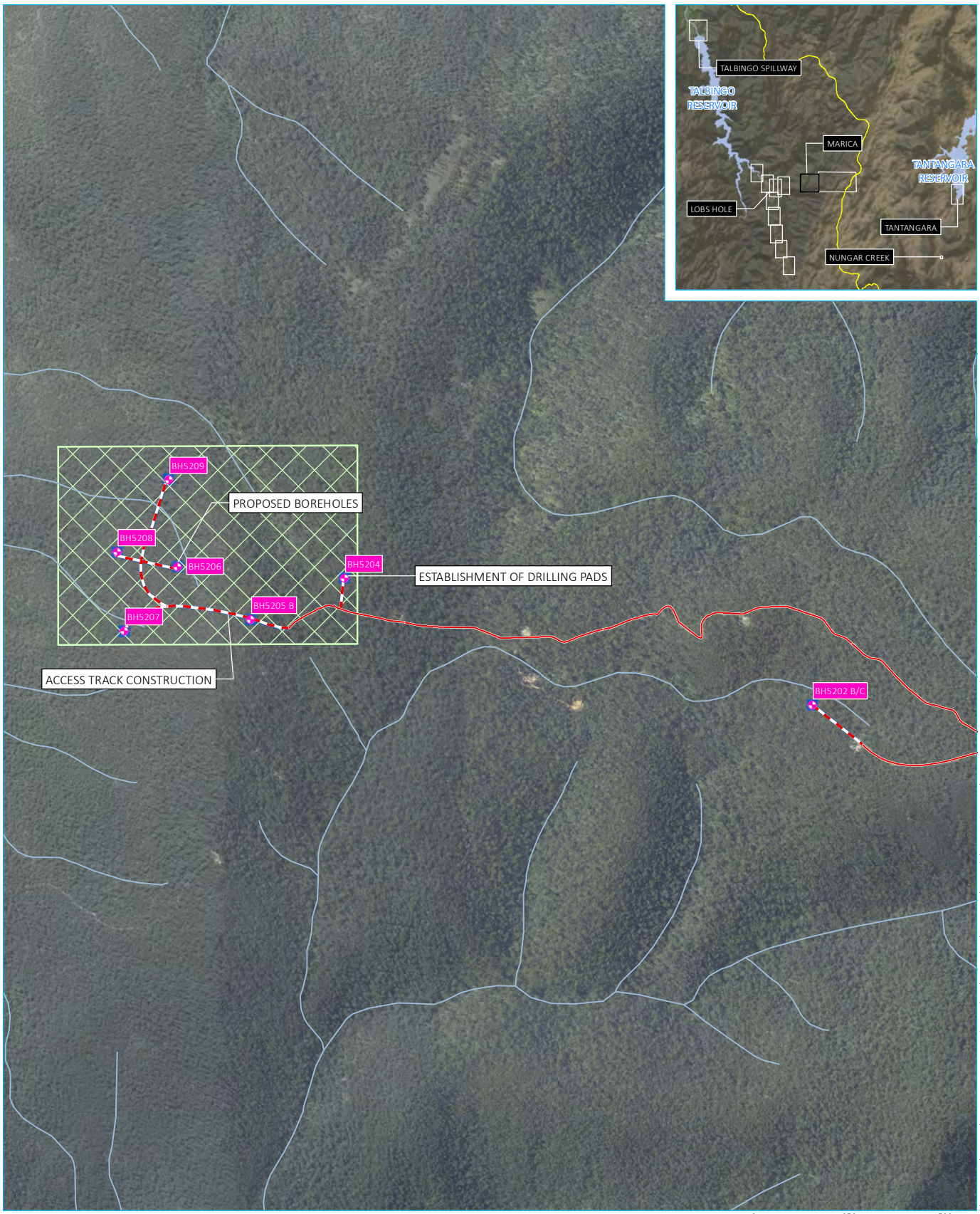

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Proposed borehole
- Existing access track
- Proposed access track
- Watercourse/drainage line
- EW modification construction footprint (additional)
- Boreholes requiring on-site adjustment

Exploratory Works project boundary - Marica 1

Snowy 2.0
Exploratory Works EIS
Modification 1
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EMM creating opportunities

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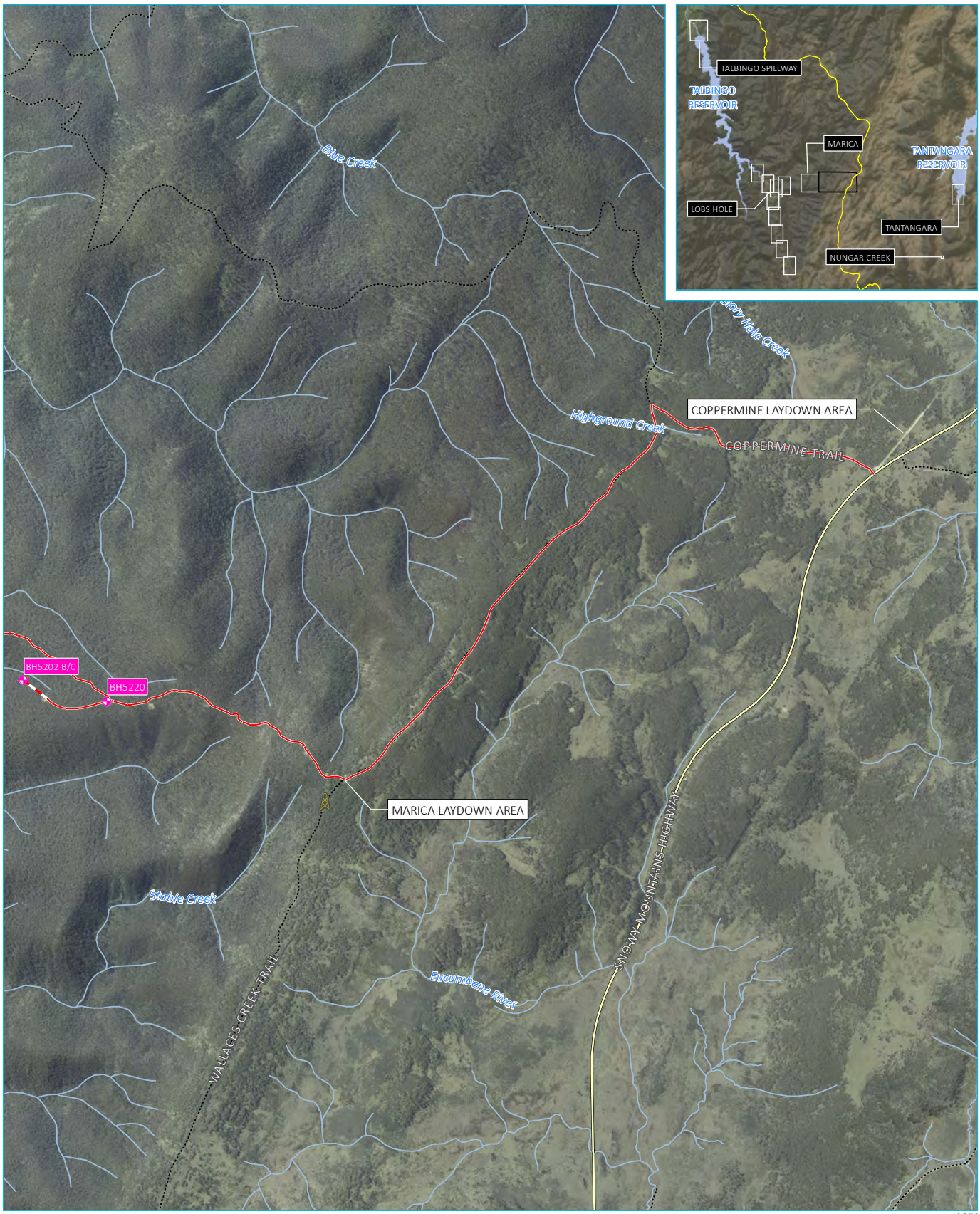

Source: EMM (2019); Snowy Hydro (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 500 1000 m

GDA 1994 MGA Zone 55

N

KEY

- Proposed borehole
- Existing temporary communications
- Existing access track
- Proposed access track
- Main road
- Vehicular track
- Watercourse/drainage line
- EW modification construction footprint (additional)

Exploratory Works project boundary - Marica 2

Snowy 2.0
Exploratory Works EIS
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EMM creating opportunities

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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 50 100 m

GDA 1994 MGA Zone 55

N

KEY

- Proposed borehole
- Main road
- Watercourse/drainage line
- Proposed work area

Exploratory Works project boundary - Nungar Creek

Snowy 2.0
Exploratory Works EIS
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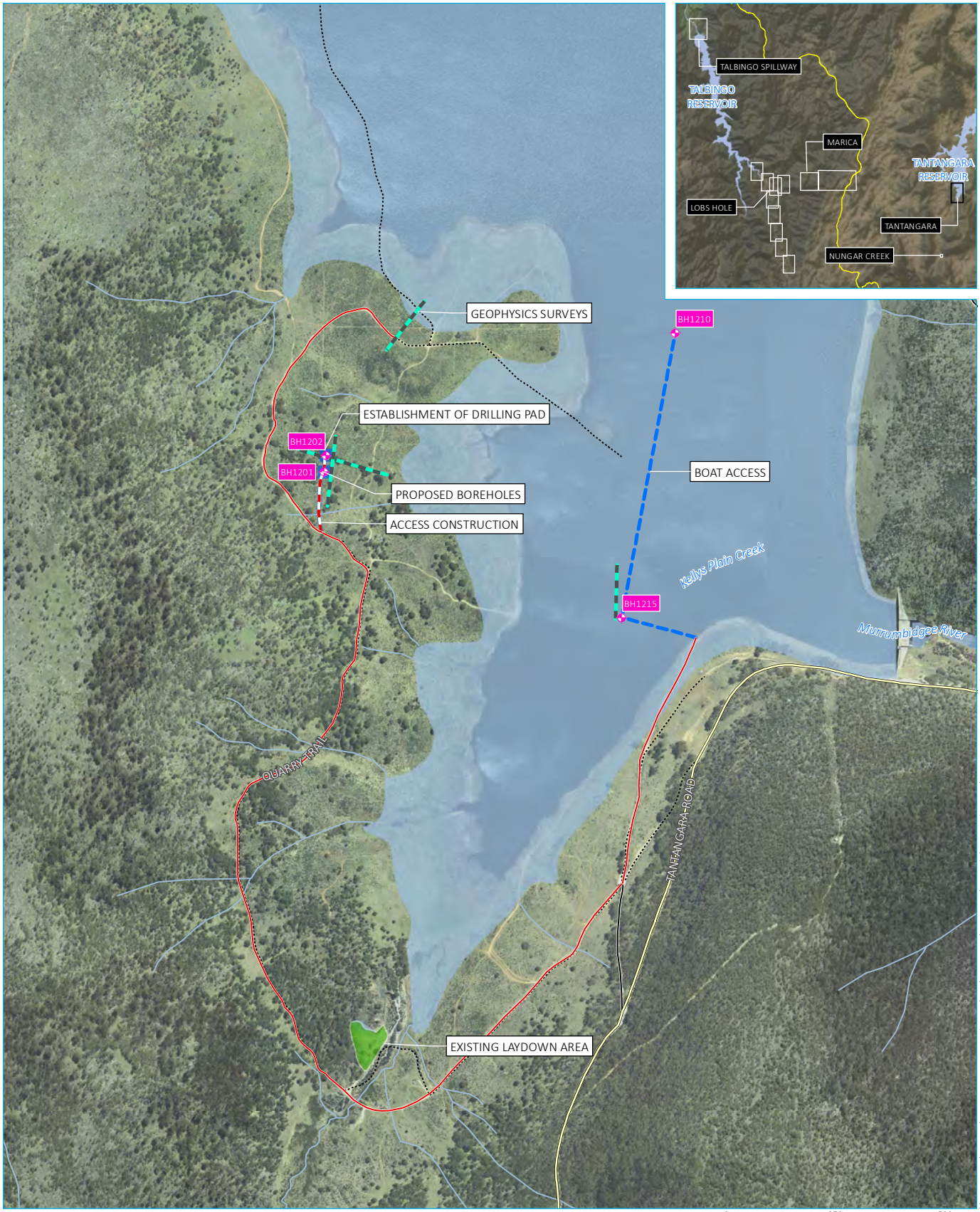

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Proposed borehole
- Proposed geophysics
- Existing access track
- Proposed access track
- Boat access
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- EW modification construction footprint (additional)
- Existing laydown area
- Waterbody

Exploratory Works project boundary - Tantangara Reservoir

Snowy 2.0
Exploratory Works EIS
Modification 1
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EMM creating opportunities

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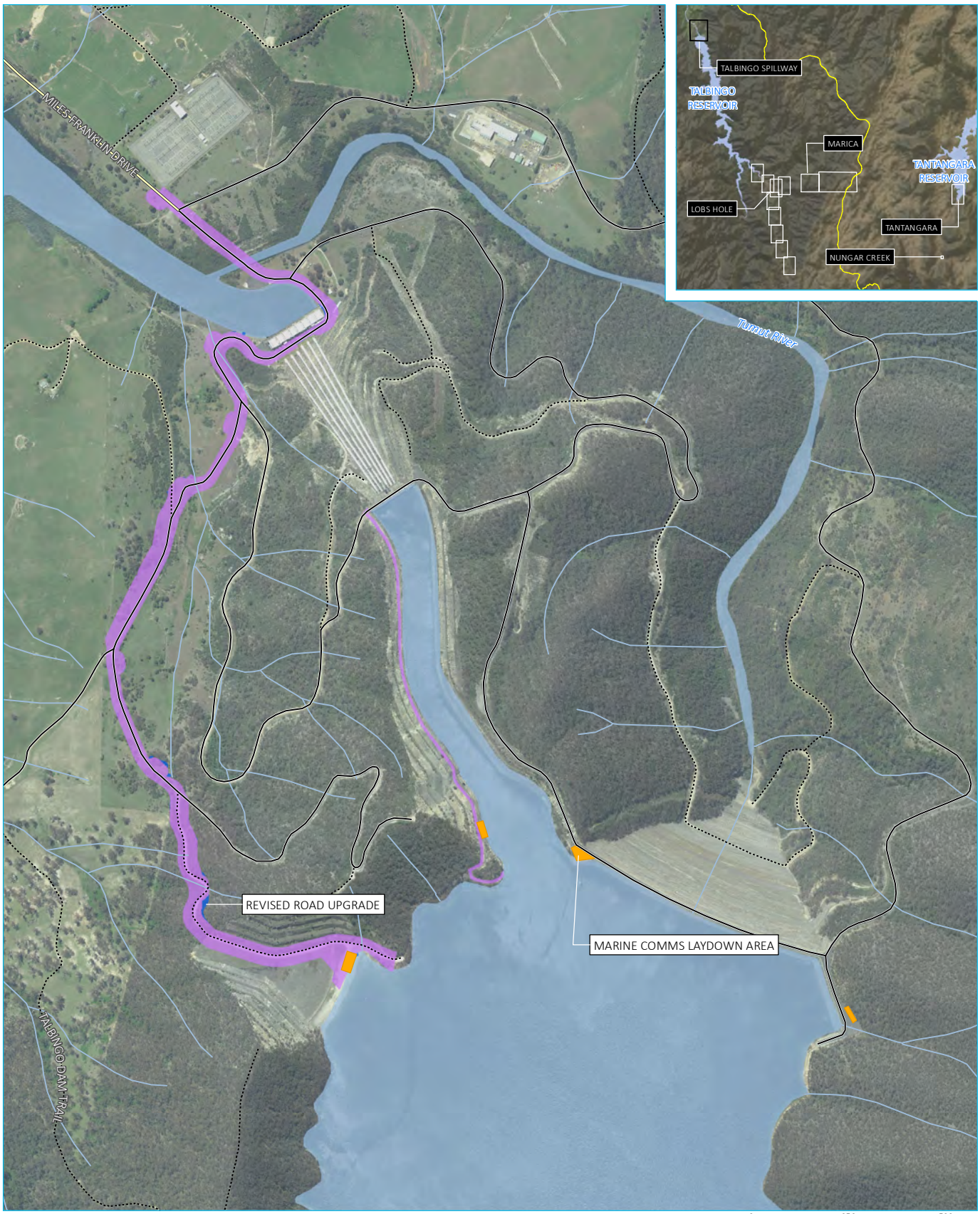

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Marine comms laydown (proposed)
- Waterbody

Exploratory Works project boundary
- Talbingo spillway

Snowy 2.0
Exploratory Works EIS
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