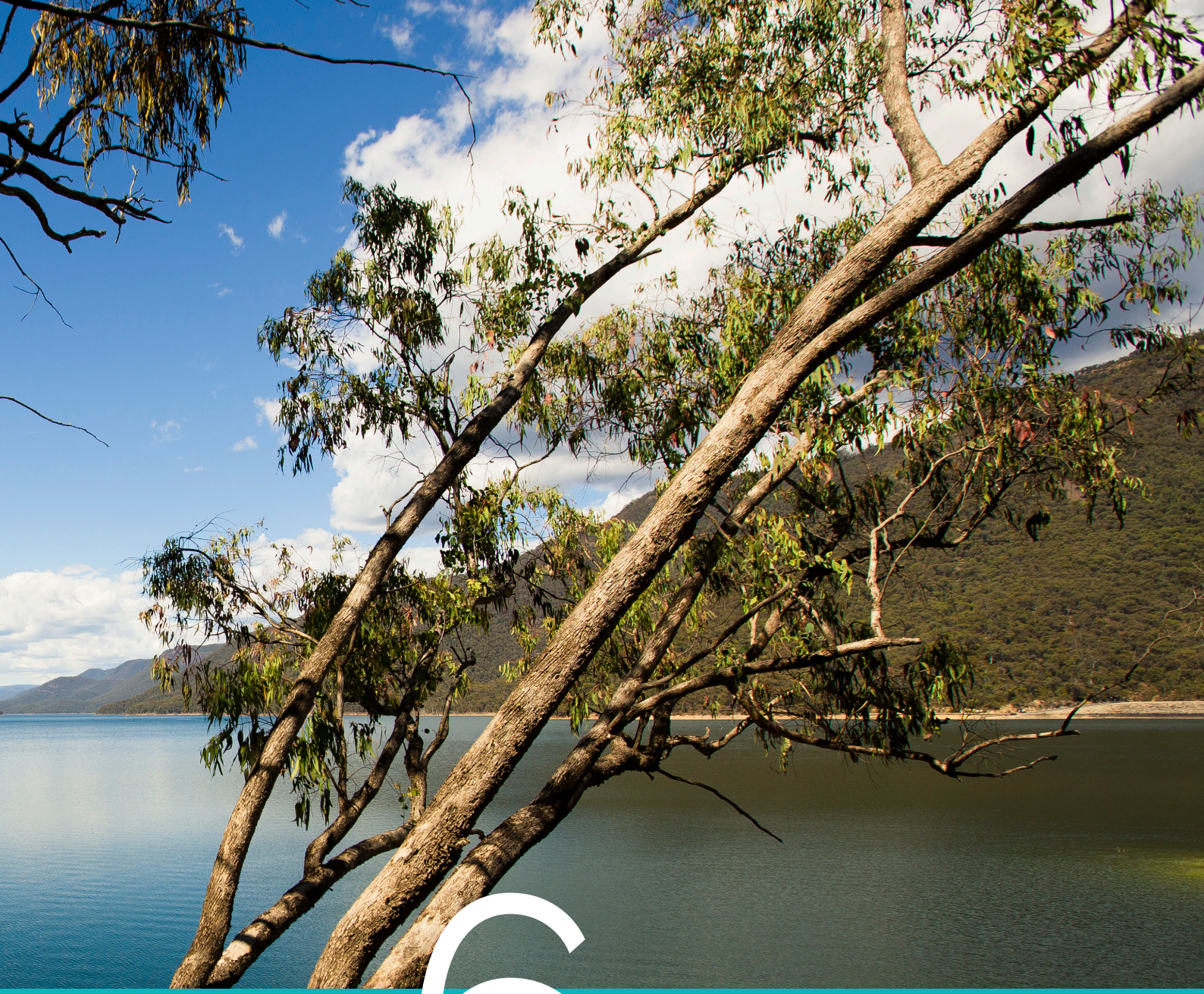


CHAPTER 6

# ASSESSMENT OF IMPACTS

CHAPTER 6.1

# OVERVIEW

# 6 Assessment of impacts

## 6.1 Overview

This chapter provides a summary of the environmental, social and economic impacts of the Snowy 2.0 Main Works. Impacts have been assessed with technical specialist reports prepared where appropriate. Specialist technical reports are provided as appendices to this EIS with the key impacts, outcomes and mitigation measures summarised in this section. Mitigations measures have been identified to minimise, avoid and manage predicted impacts. A consolidated list of all mitigation measures contained in this EIS is provided in Appendix G.

CHAPTER 6.2

# WATER

## 6.2 Water

The water assessment (Appendix J) supports the EIS for Snowy 2.0 Main Works. Appendix J consists of an overarching water assessment and a number of technical annexures that present detailed information on the existing water environment, monitoring and available data, groundwater and surface water modelling undertaken for the project, flood risk assessments, water management measures and predicted residual impacts.

The water assessment and technical annexures provide further information for all matters presented in this chapter. The water assessment concludes that although local effects will occur as a result of the project, the regional effects on the catchment surface water flows, catchment water quality and regional groundwater resources are insignificant.

### 6.2.1 Existing environment

#### i Setting and terrain

The project is in the Australian Alps in southern NSW, generally between Talbingo and Tantangara reservoirs, which are part of the existing Snowy Scheme. With the exclusion of Rock Forest, the landform of the Snowy 2.0 Main Works project area can be described as two distinctive terrains; an incised ravine and a plateau.

The ravine extends from Talbingo Reservoir in the west to the Snowy Mountains Highway in the east. The ravine is characterised by deep gorges and steep sloping ridges, the product of incision from river flow, historic glaciation and structural movement. The project areas of Talbingo Reservoir, Lobs Hole and Marica are all within the ravine.

The plateau extends from the Snowy Mountains Highway in the west to Tantangara Reservoir in the east. The plateau is typical of elevated alpine environments, dominated by low energy streams, gently rolling hills and mostly flat floodplains.

#### ii Climate

The general project area has an alpine climate that is characterised by cool summers and cold, damp, and snowy winters. The highest and most consistent rainfall generally occurs in winter to early spring, with mean annual rainfall generally increasing with elevation. Data from existing rainfall gauges indicate that median rainfall ranges from around 920 mm/year in the lower areas of the ravine to around 1,350 mm/year in the headwater catchments, with the spatial variation in median rainfall generally reflecting the variation in topography across the project area.

Summer and autumn are generally drier and experience greater variation in monthly rainfall depths. Summer rainfall is typically of higher intensity and of shorter duration than winter rainfall.

From late autumn to early spring, rainfall is generally of lower intensity, but more persistent, and at higher elevations can occur within the project area, falling as snow. Snow is therefore expected to occur during winter across elevated areas of the plateau, whilst generally not expected to occur regularly in the lower elevation areas within the ravine.

The temperature records from gauges within the vicinity of the project area show a correlation of higher mean monthly temperatures at lower altitudes (ie Talbingo Reservoir and Lobs Hole) and lower mean monthly temperatures at higher altitudes (ie plateau and Rock Forest).

The alpine climate across the project area is an important consideration for water impact mechanisms and water management aspects of Snowy 2.0 Main Works.

### iii Watercourses and water quality

Watercourses vary according to soil type, geology, topology, elevation, climate and range from small ephemeral watercourses to regional rivers with perennial flow regimes. All water courses are defined as receiving baseflow from groundwater (gaining streams). The key watercourses and the baseline water quality and flood characteristics are described below for the ravine, plateau and Rock Forest, as well as the baseline water quality for Talbingo and Tantangara reservoirs.

The NSW Water Quality and River Flow Objectives (DECCW 2006) provides Water Quality Objectives (WQO) consistent with ANZECC/ARMCANZ (2000) water quality guidelines for the protection of the aquatic environment. The WQOs are 'primarily aimed at maintaining and improving water quality, for the purposes of supporting aquatic ecosystems, recreation and where applicable water supply and the production of aquatic foods suitable for consumption and aquaculture activities' (DECCW 2006). Different WQOs apply to rivers and reservoirs and these are referenced within the following sections.

#### a Ravine

Within the ravine, the Yarrangobilly River is the major regional watercourse that flows into Talbingo Reservoir, downstream of Lobs Hole. Its catchment has an area of 271 $km^2$ that is wholly within the KNP. The Yarrangobilly River has a number of tributaries within the ravine, including Wallaces Creek, Stable Creek, Sheep Station Creek and Highground Creek. The key watercourses in the ravine are shown in Figure 6.1. Stream flows in the Yarrangobilly River and its major tributaries are continuous all year round during normal rainfall conditions. The majority of annual stream flow occurs in late winter and early spring, which is typical for rivers in the Australian Alps.

At Lobs Hole the Yarrangobilly River emerges from a deeply incised gorge and follows a relatively narrow floodplain through to Talbingo Reservoir. In flood, flows along the Yarrangobilly River through Lobs Hole are predominantly confined to the main river channel and immediate overbank areas for floods up to about the 5% annual exceedance probability (AEP) event, with more extensive inundation of the floodplain occurring for larger events.

Baseline water quality monitoring was undertaken in the ravine between February 2018 and May 2019, predominantly during dry weather conditions, with wet weather monitoring events also undertaken in March and May 2019. Baseline water quality characteristics for watercourses within the ravine can generally be described as follows:

- Yarrangobilly River and Wallaces Creek have similar water quality during dry weather conditions. Key characteristics include:
  - pH ranges between 6.2 to 8.5, with occasional lower and upper bound exceedances;
  - low concentrations of suspended solids and low turbidity;
  - carbonate and salinity vary seasonally, with higher levels occurring in summer/autumn; and
  - aluminium concentrations in the Yarrangobilly River exceed WQO values frequently in winter/spring and occasionally in summer/autumn and copper concentrations in Wallaces Creek occasionally exceed WQO values.
- The water quality during dry weather conditions in minor watercourses in Lobs Hole is generally poorer than larger watercourses, with elevated suspended sediment, nutrients and some metals (aluminium and copper).

- Receiving water quality during wet weather conditions (informed by data from wet weather events with moderate rainfall) is generally poorer relative to baseflow conditions with higher turbidity, lower pH, higher nutrients and potential for non-trivial concentrations of some metals such as aluminium and copper.

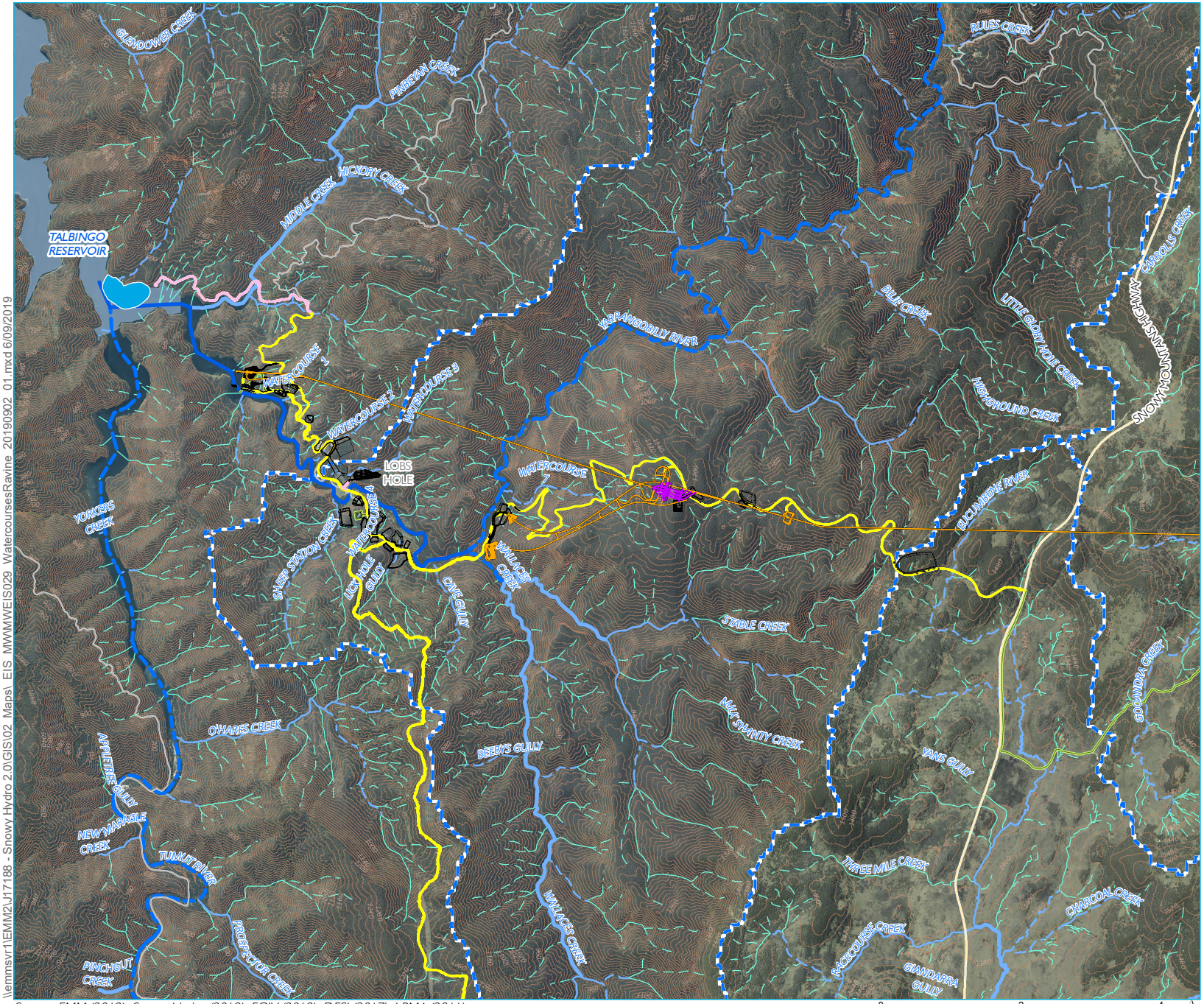
### b Plateau

The plateau is within the upper reaches of the Murrumbidgee and Eucumbene River catchments, wholly within KNP. The headwaters of the Eucumbene River are in the western plateau, and the river flows in a southerly direction to Lake Eucumbene. The Murrumbidgee River flows from north of the plateau in a south easterly direction into Tantangara Reservoir.

A number of perennial waterways are present across the plateau, that either flow north into the Murrumbidgee River or directly into Tantangara Reservoir, including Gooandra Creek, Tantangara Creek, Nungar Creek and Kellys Plain Creek. The key watercourses across the plateau are shown in Figure 6.2.

Baseline water quality monitoring was undertaken between February 2018 and August 2019 in the Murrumbidgee and Eucumbene rivers, Tantangara, Gooandra, Nungar and Kellys Plain creeks and other minor watercourses. Water quality characteristics for watercourses across the plateau are described as follows:

- The Murrumbidgee and Eucumbene rivers, Tantangara, Gooandra, Nungar and Kellys Plain creeks have similar water quality during dry weather conditions, key characteristics include:
    - pH that generally ranges between 6.2 and 8.5, with occasional lower and upper bound exceedances;
    - carbonate and salinity vary seasonally, with higher levels occurring in summer/autumn;
    - low concentrations of suspended solids and low turbidity;
    - oxidised nitrogen concentrations exceed WQO values frequently in summer/autumn and occasionally in winter/spring; and
    - aluminium concentrations exceed the WQO value on a frequent basis. Copper, iron and zinc concentrations exceed WQO values on an occasional basis.
- The water quality of minor watercourses in the vicinity of the proposed surface works near Tantangara Reservoir is generally poorer than larger watercourses, with elevated suspended sediment, nutrients and some metals (aluminium and iron).
- The water quality during wet weather conditions is poorly understood. It is expected that concentrations of suspended sediment and some metals may be higher during these events than during dry weather concentrations.




KEY

- Catchment area

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements

- Temporary construction compounds and surface works
- Temporary access road
- Indicative rock emplacement area

Existing environment

- Main road
- Local road
- 20m contour
- Waterbodies

Strahler stream order

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7

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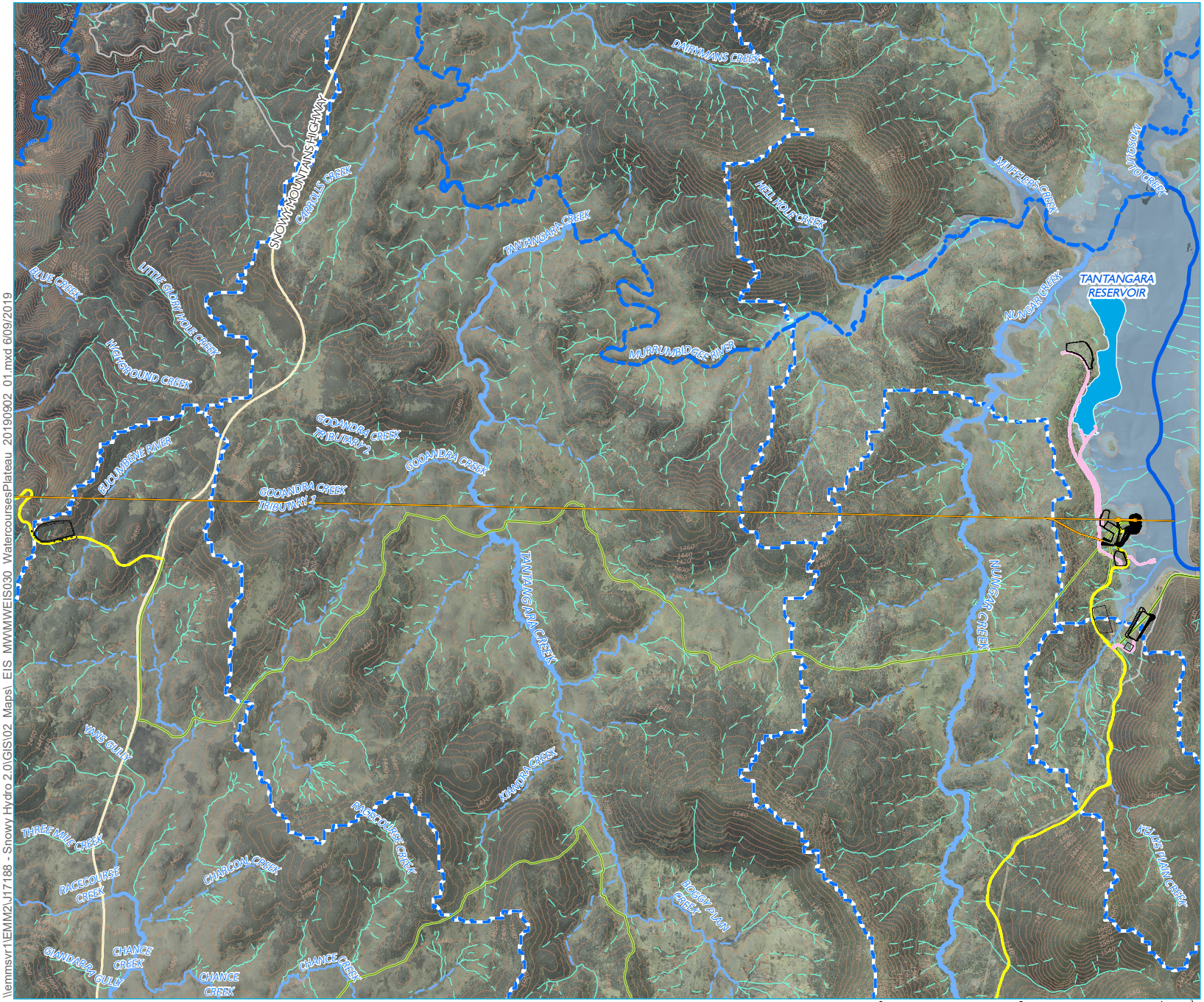
*Source: EMM (2019); Snowy Hydro (2019); FGJV (2019); DFSI (2017); LPMA (2011)*

Watercourses - Ravine

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.1

snowy 2.0

EMM creating opportunities




KEY

- Catchment area

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements

- Temporary construction compounds and surface works
- Temporary access road
- Indicative rock emplacement area

Existing environment

- Main road
- Local road
- 20m contour
- Waterbodies

Strahler stream order

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7

Source: EMM (2019); Snowy Hydro (2019); FGJV (2019); DFSI (2017); LPMA (2011)

0 2 4 km

GDA 1994 MGA Zone 55

N

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# Watercourses - Plateau

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.2

snowy 2.0

EMM creating opportunities

### c Rock Forest

Rock Forest is in the headwaters of the Goorudee Rivulet catchment, outside of KNP and is nearby to two watercourses, being Camerons Creek and an unnamed 3rd order watercourse. The watercourses at Rock Forest are shown in Figure 6.3.

Five water quality samples were collected from Camerons Creek between February and May 2019. Some samples were collected from a standing pool due to a lack of streamflow. The water quality is characterised as having a neutral pH, low salinity and moderate turbidity. Ammonia, oxidised and total nitrogen, total phosphorus, aluminium and iron exceeded WQO values in at least four of out five samples. Copper occasionally exceeded the WQO values.

The locations, existing flow regimes and water quality of watercourses that traverse the project area are important considerations for direct potential surface works impacts and groundwater drawdown impact mechanisms from Snowy 2.0 Main Works.


KEY

Snowy 2.0 Main Works construction elements

Temporary construction compounds and surface works

Existing environment

Main road

Local road

20 m contour

Waterbodies

Strahler stream order

0

1

2

3

4

5

6

7

\\emmsvr1\EMM2\J17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWEIS031 WatercoursesRockForest 20190902 01.mxd 6/09/2019

*Source: EMM (2019); Snowy Hydro (2019); FGJV (2019); DFSI (2017); LPMA (2011)*

0 0.5 1 km

GDA 1994 MGA Zone 55

N

Watercourses - Rock Forest

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.3

snowy 2.0

EMM creating opportunities

### iv Reservoir water quality

A description of Talbingo and Tantangara reservoirs, including details of the existing storages and typical operational characteristics, is contained in Section 2.4.2.

Water quality monitoring was undertaken between February 2018 and May 2019 in both Talbingo and Tantangara reservoirs. Baseline water quality characteristics in both reservoirs is generally similar and is described as follows:

- pH was similar in both reservoirs - between 6.3 and 8.2, with occasional lower and upper bound exceedances;
- electrical conductivity is low in both reservoirs, generally within or below the default guideline value range, but is approximately 30% lower in Tantangara Reservoir;
- the turbidity is low in both reservoirs, at the lower end of the default guideline value range, but is marginally higher in Tantangara Reservoir than in Talbingo Reservoir;
- the dissolved oxygen concentration (measured as percent saturation) is higher in Talbingo Reservoir than in Tantangara Reservoir but is generally within the default guideline value range;
- the nutrient concentrations (total nitrogen, oxidised nitrogen, ammonia and total phosphorus) were generally low in both reservoirs, but some nutrient concentrations exceeded the default guideline values;
- metal concentrations were generally low in both reservoirs, with the following potential exceptions which would need to be confirmed by further monitoring:
    - in Talbingo Reservoir, copper and zinc concentrations frequently exceeded WQO values in summer/autumn and occasionally in winter/spring;
    - in Talbingo Reservoir, chromium (total) and lead concentrations occasionally exceeded WQO values in summer/autumn;
    - in Tantangara Reservoir, aluminium concentrations frequently exceeded WQO values and copper, iron and zinc frequently exceeded WQO values during summer/autumn; and
    - in Tantangara Reservoir, chromium (total), cobalt and lead occasionally exceeded WQO values during summer/autumn.
- very limited data are available regarding reservoir water quality during and following wet weather conditions. There is potential for elevated turbidity, nutrients and some metals to occur near watercourse inflow locations for several weeks following a substantial runoff event.

The locations, existing functions and water quality in Talbingo and Tantangara reservoirs are important considerations for direct potential surface works impact mechanisms from Snowy 2.0 Main Works, including excavated rock emplacement.

### v Geology and hydrogeology

The project area is within the south-eastern portion of the Lachlan Fold Belt (LFB) of NSW. The geology between Talbingo and Tantangara reservoirs is structurally deformed with numerous folds and several major faults associated with the north-south trending Long Plain Fault (LPF) zone.

The project intercepts two major structural blocks, which form the two distinct geological terrains; being the Tumut Block in the west (the ravine), and the Tantangara Block in the east (the plateau). The ravine and plateau are separated by an escarpment caused by movement on the LPF.

Within the Tumut Block, the key geological formations include Boraig Group, Byron Range Group, Ravine Beds and Yarrangobilly Limestone. Within the Tantangara Block, the key geological formations include Tertiary Basalt, Kellys Plain Volcanics, Boggy Plain Suite, Peppercorn Formation, Tantangara Formation, Temperance Formation, Shaw Hill Gabro and the Gooandra Volcanics. The key geological formations of the ravine and plateau are shown in Figure 6.4.

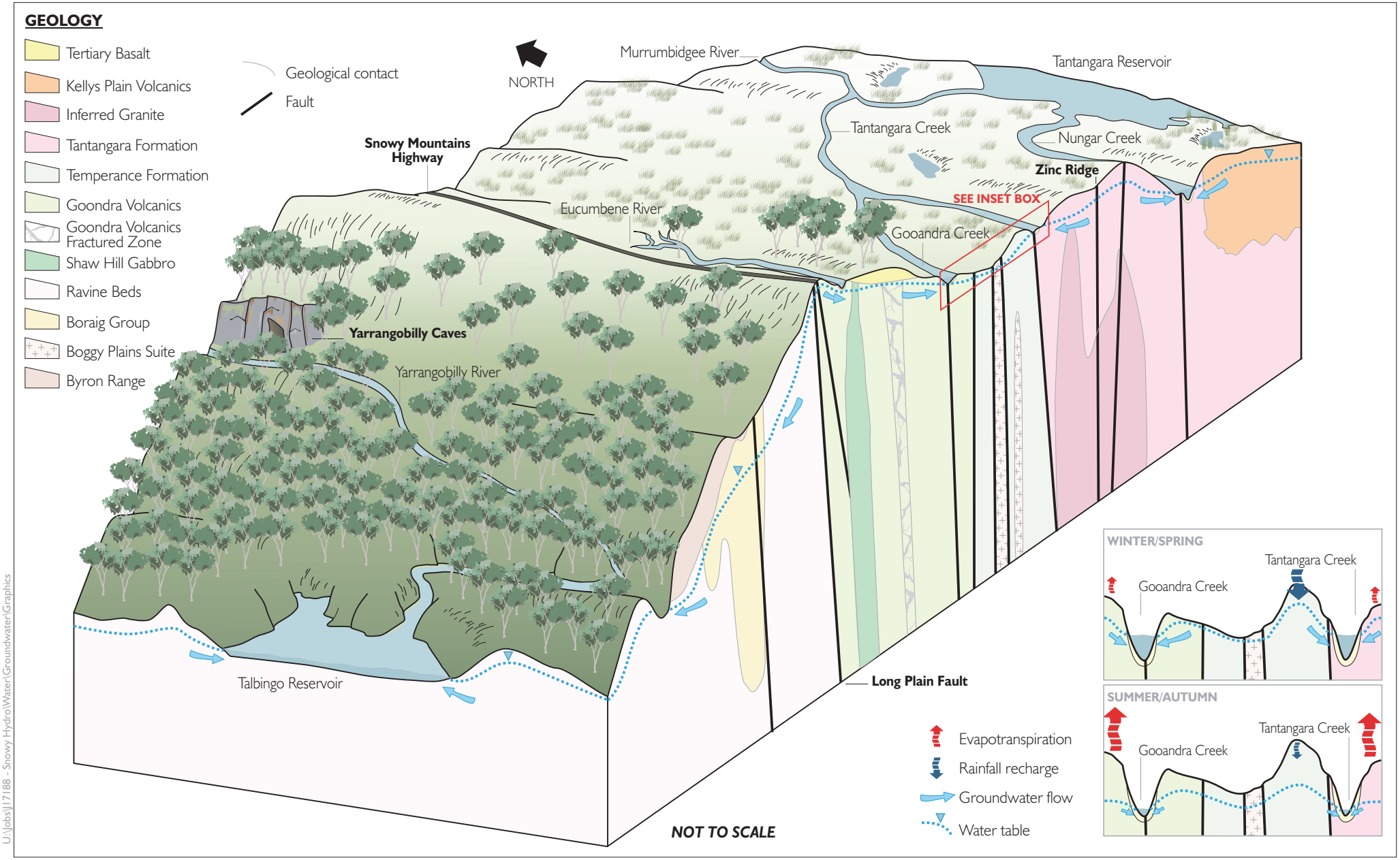
Hydrogeology across the project area has been informed by a groundwater monitoring network, designed specifically to investigate the hydrogeological conditions of the project area, and developed in consultation with DPIE Water, NRAR and WaterNSW.

The hydrogeological units of the project are:

- alluvium, colluvium and weathered rock: these shallow units are generally recharged by moderate to high rainfall, flooding for alluvial areas and snow melt;
- shallow weathered fractured rock: these units have low to moderate permeability and are recharged by moderate to high rainfall and snow melt (occurring when soil moisture conditions are exceeded); and
- deep fractured rock: recharged by infiltration of rainfall migrating from shallow groundwater systems. Permeability is generally lowest in the central section of the plateau and higher in the east and western areas of the plateau. There is downward flow of groundwater in recharge areas and upward flow in discharge areas.

Hydrogeological characterisation within the project can be summarised as follows and represented in Figure 6.4:

- groundwater levels generally are a muted version of the topography. Measurements from the groundwater monitoring network vary from approximately 1,470 m AHD in the topographically elevated terrain adjacent to the LPF, to approximately 570 m AHD in the topographically lower terrain near Lobs Hole. Groundwater levels may fall outside of this measured range in areas of higher relief and in some of the lower drainage lines, such as the interface between the Yarrangobilly River and Talbingo Reservoir where levels are likely at or close to surface levels of about 545 m AHD;
- groundwater levels within the ravine do not typically show an obvious response to rainfall or flow events within the Yarrangobilly River, indicating there is not a strong connection between the surface and the regional groundwater system;
- groundwater levels on the plateau within the Gooandra Volcanics, Tertiary basalt, Tantangara Formation, Temperance Formation, Boraig Group, Kellys Plain Volcanics and Boggy Plain Suite generally show a moderate to strong response to rainfall events, indicating a moderate to strong connection between surface and the regional groundwater system;
- vertical groundwater flow within the Ravine Beds is downwards, with groundwater in the upper horizons of the unit recharging the deeper horizons;
- vertical groundwater flow within the Gooandra Volcanics, Tantangara Formation and Temperance Formation is variable and complex with the direction of vertical flow (ie upwards versus downwards) varying with location and depth within these groundwater systems;

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Snowy 2.0 conceptual geological block diagram

Snowy 2.0
Environmental Impact Statement
Figure 6.4

- watertables oscillate between wet winter/spring recharge periods and dry summer periods when there is negligible recharge; and
- differences between water levels within the Tertiary basalt and underlying Gooandra Volcanics suggests that the Tertiary basalt is a perched groundwater system.

The geology and hydrogeology of the regional project have been carefully considered and conservative assumptions have been made to consider potential worst-case scenarios for understanding and predicting impacts to the regional groundwater system. In reality, such averaged conditions are unlikely to occur throughout, and the typical nature of fractured rock groundwater systems means that highly localised conditions are expected to exist.

### vi High priority GDEs

There are no identified High Priority GDEs within the project area. The Yarrangobilly Caves is the only High Priority GDE listed within the Water Sharing Plan (WSP) for the LFB Murray Darling Basin (MDB) Fractured Rock groundwater source within the groundwater model domain. The Yarrangobilly Caves are approximately 5 km north of the nearest infrastructure feature of Snowy 2.0 Main Works and are shown conceptually on Figure 6.4. Modelling demonstrates that there are no predicted impacts to any High Priority GDE's (including the Yarrangobilly Caves) as a result of Snowy 2.0 Main Works.

### vii Soils

The complex geology has resulted in a diverse soil landscape. Soils vary significantly across the bioregions in relation to altitude, temperature and rainfall. The soils and land assessment (Appendix N.2) describes soils within the project area as likely to have low to moderate erodibility, with some localised areas of highly erodible and dispersive soils.

Due to timing and approval limitations for disturbance activities within KNP only limited, targeted soil sampling in Lobs Hole was able to be carried out for the assessment. From this data, as well as available disturbed area runoff samples also from Lobs Hole, the runoff water quality from existing disturbed areas is characterised as being mildly acidic and having elevated turbidity and concentrations of suspended solids and nutrients, indicating that poor water quality may be expected from some soils disturbed by construction activities.

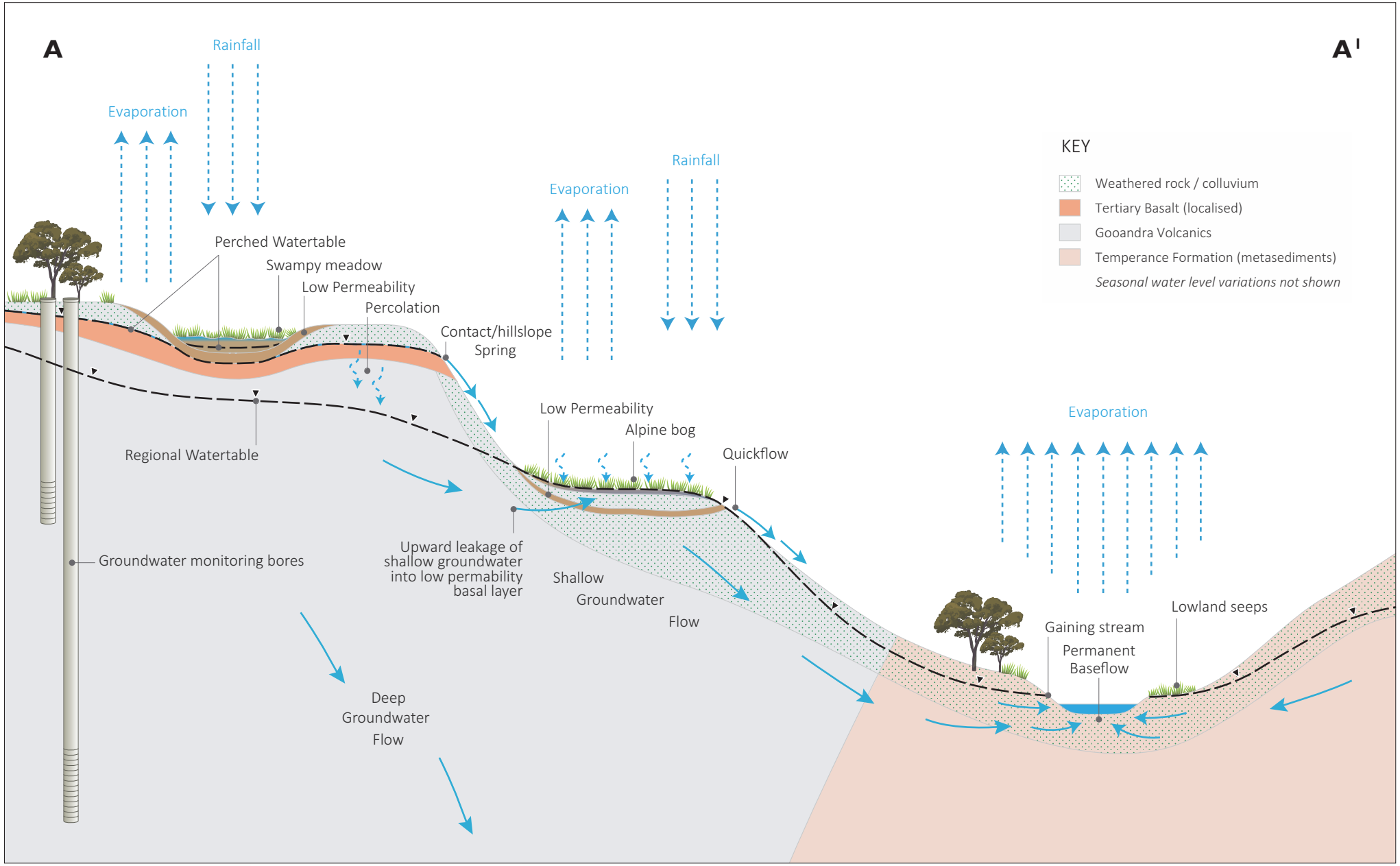
Rock Forest is on the lower to mid-slopes of gently undulating to undulating rises of sandstone and the soils are likely to be Kandosols and Dermosols that have moderately deep gradational profiles of clay loam over light clays.

The soils of the project area are important considerations for the construction of surface infrastructure, the proposed management approach and the assessment of residual water quality risks.

### viii Conceptual model

The information presented in the preceding sections provided the basis for the development of the conceptual hydrogeological model of the project area. The conceptual model provides the basis for the numerical model design and communicates how the groundwater and surface water systems work and interact and the manner in which water becomes available for ecosystems. The conceptual model presents the current understanding of the key processes of the hydrogeological system including the influence of stressors and assists in the understanding of possible future changes that may occur due to Snowy 2.0 Main Works.

Streams in the area are all strongly gaining systems (ie streams that receive groundwater baseflow into them continually throughout the year). A diagram conceptualising groundwater occurrence and flow on the plateau is presented in Figure 6.5.




Conceptual understanding of un-impacted gaining stream - plateau

Snowy 2.0
Environmental Impact Statement
Figure 6.5

### 6.2.2 Community and stakeholder views

All key regulators have been consulted throughout project development. A summary of the key points raised by these stakeholders relevant to the water assessment and/or potential water related impacts from the construction or operation of the project is provided below.

- NSW EPA
    - water management framework – ensuring that the assessment of water impacts is consistent with the statutory framework; and
    - water quality – potential changes to existing receiving water quality parameters caused by surface disturbance, excavated rock management and the management of captured surface or groundwater.
- DPIE Water
    - groundwater numerical modelling – ensuring that modelling and reporting included suitable information and justification for programs, processes and data, including permeability and conductance values, evapotranspiration, assessment of climate change and uncertainty analysis.
    - groundwater drawdown and baseflow reduction - potential resultant impacts to GDEs and streams;
    - excavated rock emplacement;
    - impacts to waterfront land; and
    - water take / licensing – ensuring licence requirements (by water source) are assessed as per the NSW Aquifer Interference Policy (AIP) - ie for direct tunnel inflow, and indirect take from overlying systems.
- OEH and NPWS
    - ensuring a suitable baseline assessment of groundwater dependent stygofauna is undertaken as part of the Snowy 2.0 Main Works EIS.

### 6.2.3 Avoidance and minimisation through design

The project has responded to the key existing environment water risks and stakeholder concerns identified in the preceding sections. The following are the key project refinements made to avoid or minimise potential water impacts from Snowy 2.0 Main Works.

- the majority of groundwater inflow during tunnel construction is expected to occur via discrete and local fractures and fissures – mitigation and management of these discrete intervals will occur during construction. This reduction of groundwater inflow will be required to enable safe tunnel construction and this is anticipated to reduce actual tunnel inflows to below modelled predictions, which are based on a conservative approach of simulating an unlined tunnel construction design;
- the process and wastewater systems have been designed to ensure that water is treated to reasonable and feasible standards prior to discharge to reservoirs;

- the process and wastewater systems have been designed to discharge treated water to Talbingo and Tantangara reservoirs to avoid discharge to any sensitive creeks or rivers within the ravine or plateau;
- the majority of the project surface elements have been designed to be greater than 40 m from waterways to minimise disturbance of riparian zones and associated ecological impacts;
- the location and design of temporary and permanent surface elements avoids flood prone land (ie. land susceptible to flooding by the probable maximum flood (PMF)) where possible, or otherwise attempts to minimise exposure to flooding to reduce residual flood impacts and risks;
- the Talbingo Reservoir excavated rock emplacement will encapsulate finer TBM material with coarser drill and blast material, will include a geotextile layer, and will then be armoured with rocks with a diameter greater than 200 mm to minimise the loss of fines from the placement; and
- the Tantangara Reservoir excavated rock emplacement will be constructed as a series of cells that encapsulate TBM material within drill and blast material that would be constructed above the reservoir water level using standard 'dry' earthmoving equipment and techniques.

### 6.2.4 Predicted impacts

The key aspects of Snowy 2.0 Main Works that present a risk of impact to water resources, water users and sensitive receiving environments include:

- underground excavations that intercept groundwater;
- construction and use of site infrastructure;
- on-site water management and discharge;
- in reservoir works; and
- excavated rock placement.

The key impacts are described below by impact mechanism, and where appropriate by area, within the ravine, plateau, Rock Forest and Talbingo and Tantangara reservoirs as applicable. The key water-related impact mechanisms are:

- impacts to groundwater quantity, including levels and flow;
- impacts to surface water quantity, including flows and availability;
- impacts to surface water quality (excluding reservoirs);
- impacts to reservoir water quality; and
- impacts to flooding regimes.

### i Impacts to groundwater quantity, including levels and flow

For the purposes of modelling groundwater, a conservative approach of simulating all excavations as fully drained (during construction) and unlined was adopted. The majority of the intercepted geological units have very low hydraulic conductivity values, and hence are predicted to contribute minimal relative inflow. However, the hydraulic properties for the Gooandra Volcanics and the Kellys Plain Volcanics are two orders of magnitude higher than adjacent geological units in the area.

The model predictions are considered conservative due to the design scenario assumptions (unlined and unmitigated) and the adoption of conservative hydraulic parameters (as per field measurements). Therefore, it is considered that the predicted inflow (and subsequent impacts) will be lower than predicted due to mitigation and management measures committed to during construction (ie pre-grouting and segmental lining).

Groundwater flow into the tunnel is expected to occur primarily as a function of secondary porosity (ie via fractures and along bedding planes). The groundwater model assumes significant connection between the tunnel and the watertable in the Gooandra Volcanics and the Kellys Plains Volcanics. However, it is expected that although parts of this unit will behave like this (ie along fault zones with enhanced permeability), the entire unit may not, and other sections of the geological unit will be much less permeable. Modelling has therefore adopted conservative hydraulic parameters due to the limited hydraulic testing undertaken throughout the unit. With additional field testing, there is potential for the modelled hydraulic parameters to be constrained, potentially reflecting a more realistic fractured rock environment.

The model cannot simulate individual fractures because the locations and conductivity of individual fractures are not known until the tunnel intersects them. Because the exact locations and extent of inflow mitigation strategies are not yet known the groundwater modelling adopted a conservative approach of simulating all excavations as non-mitigated/controlled. Attempts to 'constrain' the model to simulate unknown geological occurrences or design elements are not in-line with the Australian Groundwater Modelling Guidelines (a core requirement of NSW Governments AIP for groundwater modelling) and have therefore not been undertaken. The modelling results are therefore conservative for two reasons:

- modelling does not consider actual design, management or mitigating activities. In reality during construction the discrete fractures that yield excess water will be grouted and will reduce the actual overall tunnel inflow volume; and
- hydraulic parameters within the numerical model for the Gooandra Volcanics and the Kellys Plain Volcanics are conservative and assumes significant connection to the water table based on limited pumping test data. However, in reality the entire unit is unlikely to behave like this, with some parts expected to be much less permeable.

Therefore, the model predictions of tunnel inflow, baseflow reduction and water table drawdown are likely to be over estimating project impacts. The results of this conservative model approach need to be considered within this overall context to accurately assess the project on its true merits for impacts to water resources.

The combination of hydraulic head measurements, baseflow calculations and hydraulic property testing were used to inform calibration of the model in both steady state and transient modes. Calibration achieved a scaled root mean square statistic of 3.6% for the steady state model, and 3.9% for the transient model, which are good results.

To meet the objectives regarding both the project and environmental impacts, two predictive scenarios were produced during numerical modelling:

- a transient simulation: which considers excavation sequencing and climatic seasonality; and

- a steady state simulation: used to predict operational long term steady state impacts under a long term constant average climate.

### a Ravine and plateau

Groundwater is expected to enter underground excavations during construction. Higher inflows are expected in the geological formations with higher vertical connectivity, primarily the Gooandra Volcanics and Kellys Plain Volcanics.

During operation, the tunnel will become a throughflow system, and will continue to draw water into it (eg primarily act as a 'sink'), with a very minor volume of groundwater re-entering the groundwater system. The tunnel inflow will be at a reduced rate compared to the peak inflows during construction.

The numerical groundwater model predicts that total inflow to excavations is expected to increase throughout the construction period as tunnelling progresses, with a peak at 160 L/s (5 GL/year) in the final year of construction. The gradual increase in construction inflows is a function of the excavation sequencing approach (ie more excavated areas are available for water to drain into). Once the tunnel becomes operational it will be fully saturated with water, and the overlying geology will begin to re-pressurise (and overlying groundwater levels will begin to recover). This recovery of overlying pressures and levels will not go back to 'pre-project' levels but will re-establish as a new (lower level) equilibrium. The steady state model simulates the long-term operational inflow and overlying groundwater levels.

Tunnel inflows will therefore taper following construction as the tunnel floods and enters the operational stage. Inflow during operations is predicted to reduce to approximately 85 L/s (2.7 GL/year).

The groundwater inflow to underground excavations during construction and operation is predicted to create depressurisation and drawdown of the watertable. Spatially, groundwater drawdown is predicted across the plateau; near the Tantangara adit in the east (Kellys Plain Volcanics), and from Gooandra Creek west to the LPF (Gooandra Volcanics). The spatial extent and level of predicted groundwater drawdown in both a steady state and operational scenario (ie worst case drawdown extents) are shown in Figure 6.6. It should be noted that the impact predictions are indicative and conservative, due to the model simulating unmitigated design (ie fully unlined tunnel without consideration of construction management) and the adoption of potentially conservative hydraulic parameters for the Gooandra Volcanics and the Kellys Plain Volcanics.

Figure 6.6 shows that watertable drawdown is predicted to be in excess of 50 m directly above the tunnel alignment in areas of high vertical hydraulic conductivity (Gooandra Volcanics). At a distance of approximately 2 km either side of the tunnel alignment the drawdown reduces to 0.5 m in the western plateau.

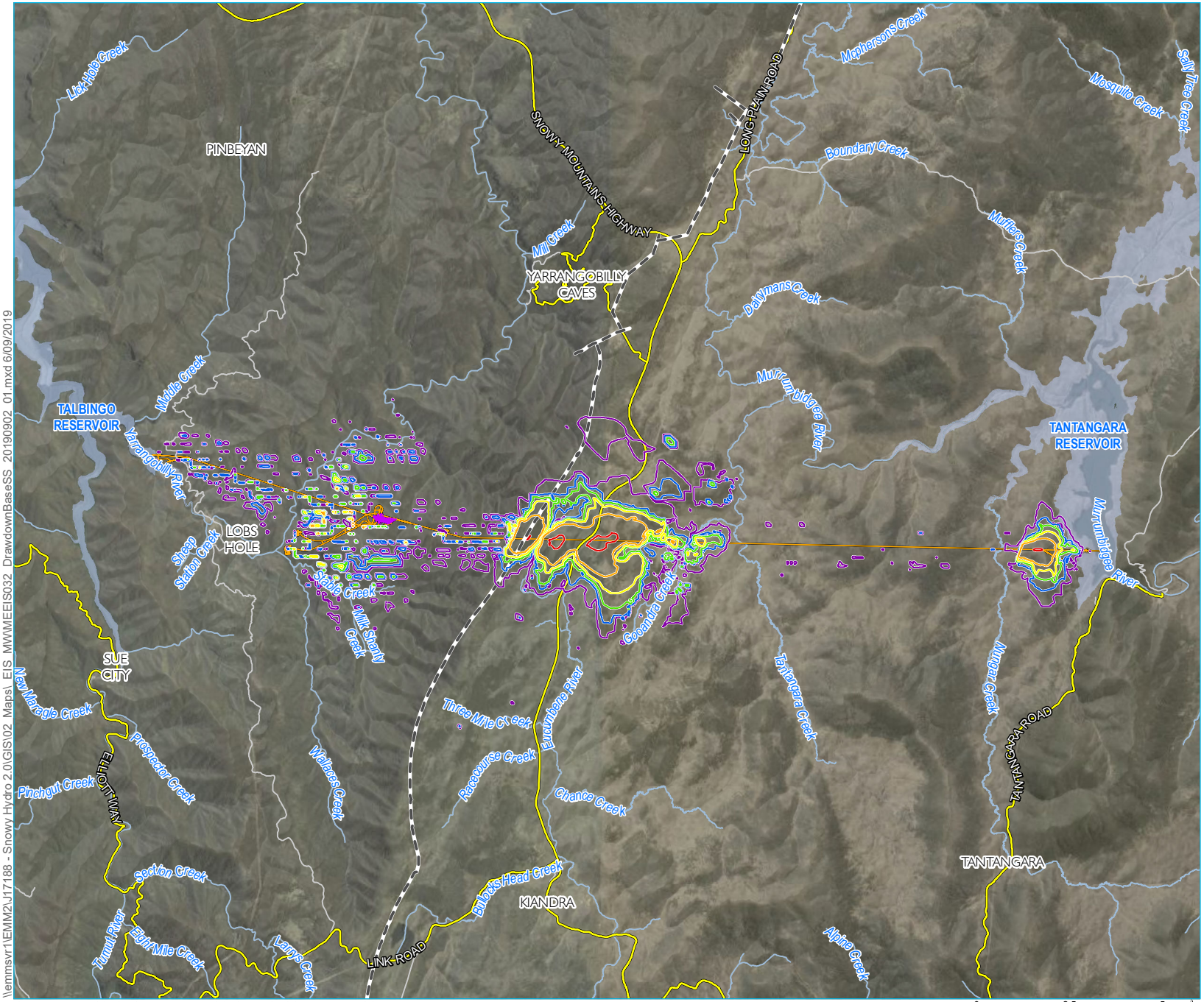
Figure 6.6 also shows that predicted drawdown in the ravine (where geological formations have low vertical connectivity) is localised with no significant cones of depression.

Due to the environmental and ecological significance of the Yarrangobilly Caves, detailed investigations were undertaken that included water level and quality monitoring programs (including detailed isotopic investigations) with a focus on understanding surface water-groundwater interaction. The groundwater model domain was also extended to ensure the Yarrangobilly Caves were included in numerical model predictions.

As shown in Figure 6.6, the predicted 0.5 m drawdown contour remains several kilometres away from the Yarrangobilly Caves. The numerical model therefore demonstrates that there are no predicted impacts to any High Priority GDE's (including the Yarrangobilly Caves) as a result of Snowy 2.0 Main Works.

### b Rock Forest

There will be no underground or significant excavations at Rock Forest that would impact groundwater quantity, levels or flow during Snowy 2.0 Main Works and therefore no groundwater impacts are predicted.




KEY

Modelled drawdown (m)

- 0.5
- 2
- 5
- 10
- 20
- 50
- Long Plain Fault

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station

Existing environment

- Main road
- Local road
- Perennial watercourse
- Scheme storage

Predicted steady state drawdown

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.6

*Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)*

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### ii Impacts to surface water quantity, including flows and water availability

Streamflow regime changes were estimated using a catchments model, which was developed in parallel to the numerical groundwater model. The volumetric impacts to surface water systems are largely a result of decreased groundwater levels which decrease the available groundwater baseflow to streams.

Reduction to available baseflow is considered a localised impact, as:

- it is limited to those sections of watercourses directly overlying the water table drawdown areas;
- watercourses remain gaining (ie groundwater baseflow reduces, but even impacted streams continue to receive groundwater baseflow (Figure 6.7)); and
- local lateral inflow to watercourses is a major component of stream flow, which continues to occur outside of the drawdown area (Figure 6.8).

The predicted baseflow effects are based on the numerical groundwater model predictions of inflow. Proposed localised mitigation and management of tunnel inflows during construction will reduce tunnel inflows and therefore are likely to reduce the level and extent of baseflow impact to impacted streams.

In addition, as additional field data becomes available the adoption of potentially less conservative hydraulic parameters for sections of the Gooandra Volcanics and the Kellys Plain Volcanics can be adopted which may reduce predicted impacts to baseflow further.

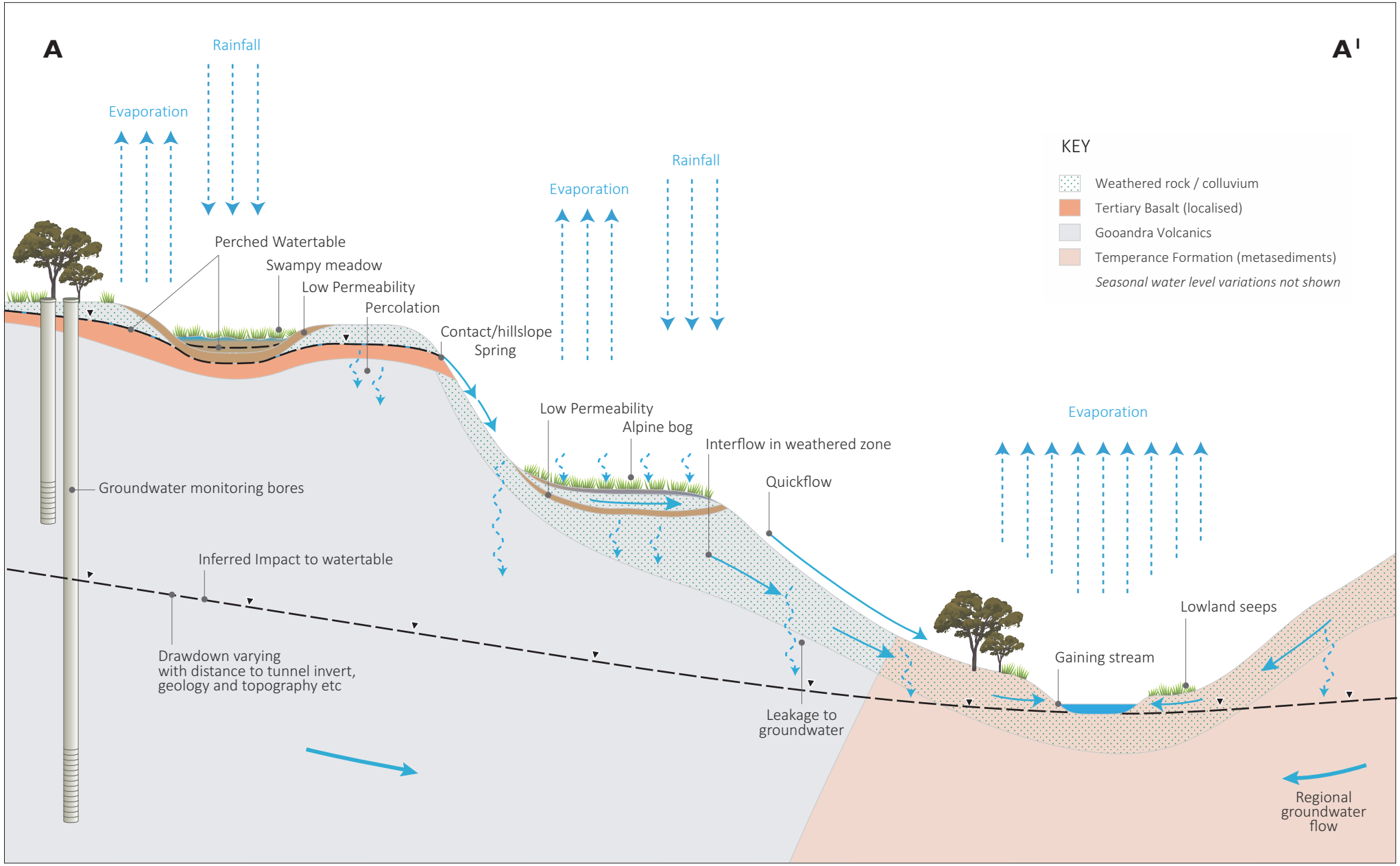
#### a Modelled impacts during construction

The groundwater model predicted that impacts to creek and river baseflow would develop over time, with the greatest impacts to baseflow predicted to occur post-construction. During construction the groundwater model predicted that:

- baseflow to Gooandra Creek may decline by up to 20%, beginning in year 4 of construction. This is expected to cause no discernible changes to streamflow through winter months, however during the March – April period in the final two years of construction, available groundwater for baseflow may reduce and potentially cause flows within the Gooandra Creek catchment to cease under dry climatic conditions; and
- during construction baseflow to the upper reaches of the Eucumbene Creek may decline by up to 5%, beginning in year 5 of construction. This is not expected to cause discernible changes to streamflow during the construction period.

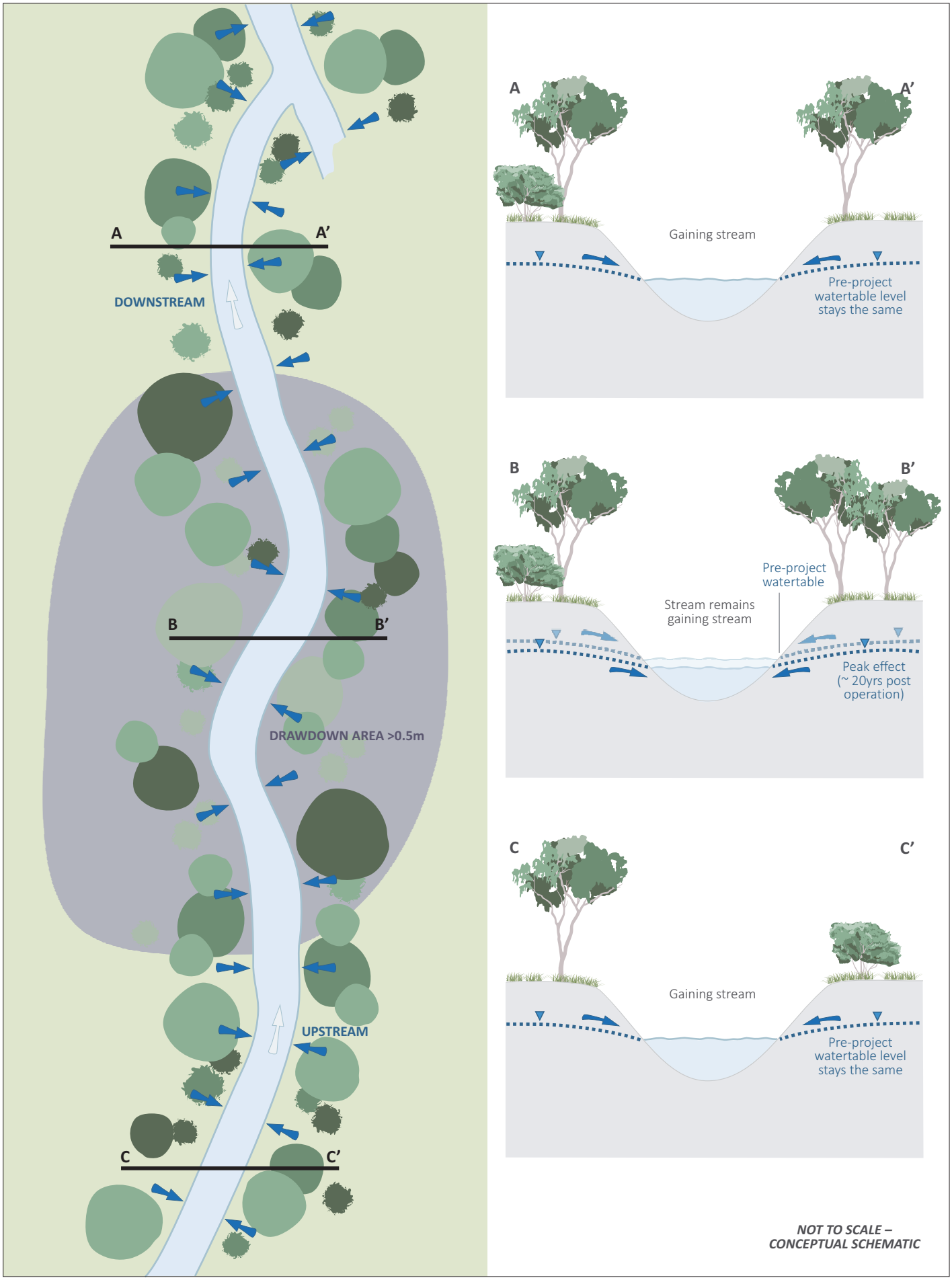
Immediately downstream of the localised area of impact, the percentage impact reduces significantly during construction, offset by contributions at creek and river confluences, and more information is provided on this in the next section.

As discussed earlier, the unmitigated modelled approach to construction and operations does not reflect the approach proposed for construction management (ie excludes pre-grouting and segmental lining) and as such, predicted localised impacts to baseflow are expected to reduce. The regional effects on the catchment surface water flows are considered insignificant.




Conceptual understanding of potential drawdown impacts on gaining streams – plateau

Snowy 2.0
Environmental Impact Statement
Figure 6.7




Changes to baseflow in effected watercourses

Snowy 2.0

Environmental Impact Statement

Figure 6.8

### b Modelled impacts during operation

Modelling results indicate a lag between maximum tunnel inflow and maximum baseflow impacts occurring; with peak impacts expected to occur following completion of the construction phase (ie in the operational phase of the project).

#### Baseflow impacts to Gooandra Creek

- within the localised area of impact, the long-term baseflow is conservatively predicted to decline by 28.8% in Gooandra Creek (again noting that the modelled predictions are based on an unmitigated scenario); and
- immediately downstream of the impact area, where the Gooandra Creek catchment and adjoining catchments enter the Tantangara Reservoir, the percentage impact of baseflow reduction is predicted to be 0.7% and as such, is considered insignificant at a broader regional scale.

#### Baseflow impacts to Eucumbene River

- within the localised area of impact, the long-term baseflow is conservatively predicted to decline by 12.5% in the upper reaches; and
- immediately downstream of the impact area, just upstream of where the river enters the Eucumbene Reservoir, the percentage impact of the baseflow reduction is only 0.6% and considered insignificant at a broader regional scale.

The groundwater model predicts that each creek would continue to receive baseflow discharge; no creek sub-catchment was predicted to change from 'gaining' to 'losing' during long term operations**.** Subsequently, it is expected that impacts will be limited to baseflow reductions (ie no streamflow losses), and the quickflow component of streamflow (surface runoff in response to rainfall) will not be affected by groundwater drawdown.

Freshes and floods are important for stream health and are primarily driven by quickflow response to heavy rain. The frequency of freshes and floods is not predicted to be affected by the predicted changes to baseflow.

The water licencing requirement for the changes to baseflow is to attribute it to the water source from which it derives (as per the AIP). Due to the streams remaining gaining (even under peak impact), the source of water is therefore groundwater and it is proposed to be licenced as such.

#### Streamflow impacts

Streamflow impacts were predicted to be directly experienced at sites immediately downstream of the impacted headwater sub-catchments in Gooandra Creek and the Eucumbene River (Figure 6.6). This is particularly the case in dry climatic conditions and during summer and autumn, when groundwater baseflows provide the majority of total flow. The streamflow impacts due to reduced available groundwater for baseflow immediately lessen in the river reaches immediately downstream of these sites, because they receive flow from unaffected catchment areas and from unaffected lateral baseflow that is not impacted by the project (Figure 6.8).

Proposed localised mitigation and management of tunnel inflows during construction (ie pre-grouting and segmental lining) will reduce tunnel inflows and are therefore likely to reduce the level of baseflow impact to these streams.

River flow objectives, as defined by the NSW Government for the management of environmental flows and set out aspects of flow considered to be critical for the protection or restoration of river health, ecology and biodiversity, were utilised to define high flows, low flows and very low flows. In addition to these flow categories, a 'no flow' category was also assessed such that zero flow was assumed to occur for modelled flows less than 0.1 ML/day.

Using these flow categories, the percentage of modelled days within each flow category under the construction phase and under the operating phase of Snowy 2.0 Main Works were calculated for the impacted surface water reporting sites in Gooandra Creek and Eucumbene River.

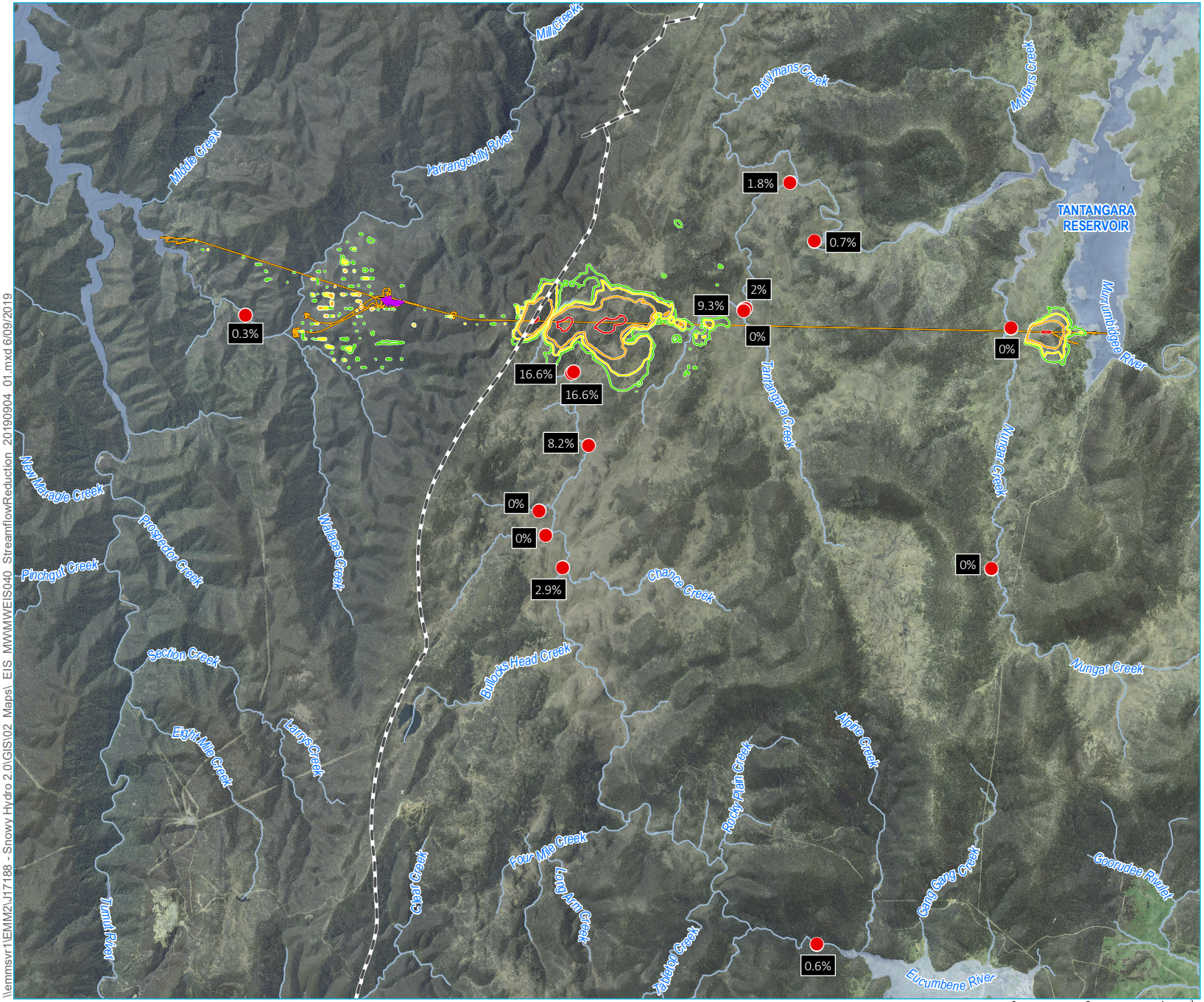
The model predicts the following impacts to streamflow regimes during the operational phase of Snowy 2.0 Main Works:

- Gooandra Creek is likely to change from a perennial streamflow regime to ephemeral (days with 'no flow' increase from 0% to 9%);
- in Gooandra Creek, days with no flows and very low flows increase, particularly in summer and autumn and the number of days with low, medium and high flows decrease correspondingly;
- flows from the unaffected Tantangara Creek catchment area would alleviate impacts in the river reaches downstream of Gooandra Creek ; and
- the streamflow regime in the headwaters of the Eucumbene River could change from perennial to ephemeral (days with 'no flow' increase from 0% to approximately 20-25%), however this impact does not continue downstream, as flows from the catchment area unaffected by the project alleviate the impact.

### iii Impacts to surface water quality (excluding excavated rock emplacement)

The key water cycle interfaces, showing the locations of the key aspects of the water management system relative to key construction phase project areas and activities are provided in Figure 6.10.

Surface water quality impacts have the potential to occur to both watercourses and to reservoirs.




KEY

- Reporting points

Modelled drawdown (m)

- 5
- 10
- 20
- 50
- Long Plain Fault

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Perennial watercourse
- Scheme storage

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

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# Long term total streamflow reduction

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.9

snowy 2.0

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### a Impacts to watercourses

It is proposed to discharge all treated process and wastewater directly to Talbingo and Tantangara reservoirs, hence stormwater discharges are considered the only discharge mechanism that could impact watercourses. A residual water quality impact assessment was undertaken factoring in all construction activities, discharge characteristics, area, locations and duration of disturbance.

This assessment indicated that there is potential for measurable changes in water quality to occur during construction and that changes will most likely occur for several days during and shortly after wet weather conditions. Only minor changes are predicted during operations.

Factoring all of the above, the potential for changes from stormwater discharge is considered proportionally greater:

- during the initial 1.5 years of construction when the greatest area of disturbance and poorest water quality will occur due to surface construction activities;
- in watercourses that have small catchment areas relative to the disturbance within the catchment; and
- in summer and autumn during moderate rainfall conditions, when discharges from the stormwater system may occur but there is insufficient rainfall to generate runoff from the broader catchment.

The potential for changes from stormwater discharge is considered proportionally lower:

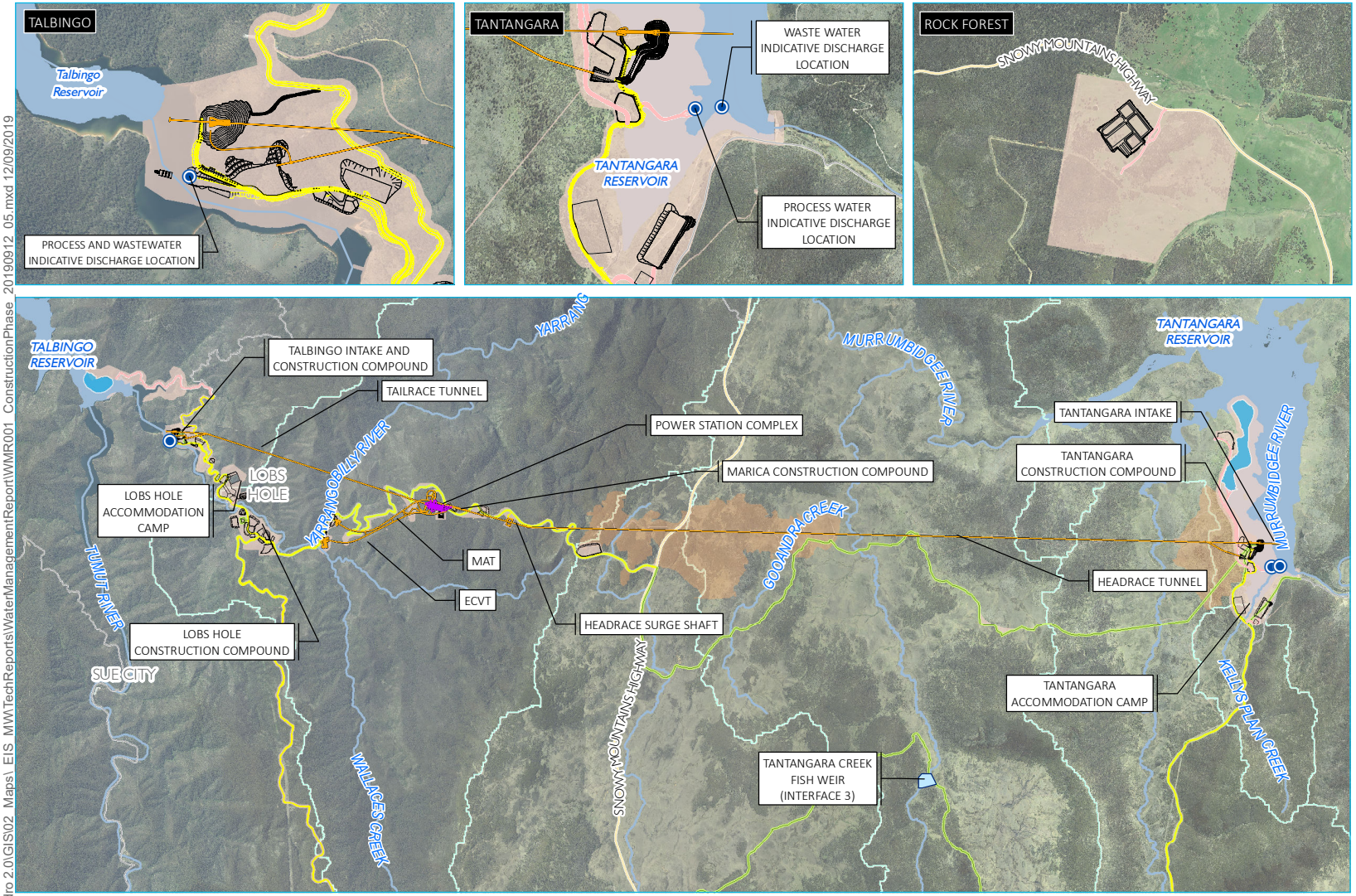
- following the initial 1.5 years of construction when disturbance due to construction of surface infrastructure is complete;
- in watercourses that have large catchment areas relative to disturbance within the catchment;
- in winter and spring when streamflow is seasonally high; and
- in summer and autumn during significant rainfall events that result in high streamflow.

### b Impacts to reservoir water quality during construction (excluding excavated rock emplacement)

The following impact mechanisms (not related to excavated rock emplacement) have potential to change reservoir water quality during construction:

- stormwater discharges into watercourses that flow into reservoirs;
- controlled discharges of treated wastewater and process water directly to reservoirs; and
- underwater removal of the intake rock plug and channel excavation resulting in the formation of turbid plumes in the reservoir.

The predicted impacts of these activities and mechanisms are described in the following sections.




## KEY

Water cycle interfaces

- Approximate groundwater drawdown extent (interface 1)
- Project disturbance area (including interfaces 2 & 3)
- Excavated rock emplacement (interface 4)
- Reservoir discharge locations (interface 6)

Existing environment

- Main road
- Local road
- Watercourse
- Regional catchment divide
- Reservoir

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements

- Temporary construction compounds and surface works
- Temporary access road

Water cycle interfaces (construction)

1 - Impacts to groundwater and connected surface water systems due to subsurface excavations
2 - Stormwater discharges
3 - Instream works and disturbance of waterfront land
4 - Excavated rock emplacement
5 - Water take to supply construction activities
6 - Controlled discharges to reservoirs

*Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)*

0 2.5 5 km

GDA 1994 MGA Zone 55

N

# Water cycle interfaces - construction phase

Snowy 2.0
Environmental Impact statement
Main Works
Figure 6.10

snowy 2.0

EMM creating opportunities

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### Stormwater discharges and controlled process and wastewater discharges

There is potential for measurable changes in reservoir water quality to occur during construction. The greatest increase in nutrient loads entering the reservoirs is expected to occur during the initial construction period due to stormwater discharges from areas disturbance by construction activities.

Changes to salinity levels may occur due to the discharges of treated process water and wastewater that have salinity levels that are higher than ambient levels in the reservoirs. Changes to water quality are most likely to occur near discharge locations.

### Intake structure - rock plug removal and channel excavation

The methodology for the construction of the intake structures for both reservoirs is outlined in section 2.3. While the primary construction method will be drill and blast from shore-based plant and equipment in dry conditions, the key activity with the potential to impact on reservoir water quality will be the removal of the connection between the intake and reservoir (rock plug). This plug will be removed via water-based equipment, with some underwater blasting and/or dredging.

The impacts of rock plug removal and channel excavation in Talbingo Reservoir will be dependent on the methods used and the duration of these activities. The water quality impacts from the removal of the plugs have not been quantified for either reservoir, however in Talbingo, given that the volume of plug material to be removed will be small (approximately 2-3%) compared to the volume of excavated material placed in the Ravine Bay, with the implementation of appropriate management measures, the impacts of rock plug removal and channel excavation on water quality are expected to be small in comparison.

## c Impacts to reservoir water quality during commissioning and operation (excluding excavated rock emplacement)

The following impact mechanisms (not related to excavated rock emplacement) have the potential to change reservoir water quality during commissioning and operation:

- bed sediment disturbance; and
- mixing of water between the reservoirs.

The predicted impacts of these mechanisms are described below.

### Bed sediment disturbance during commissioning and operation

In Talbingo Reservoir, both the fine settled material from the construction phase and the existing reservoir sediments in Middle Bay, downstream of the intake works, and over large areas of Ravine Bay, would be expected to be disturbed by generation and pumping flows. Rock sized greater than 200 mm will be placed on the upper slope of the Ravine Bay emplacement as armouring and will not be disturbed by these flows and, if the drill and blast material on the lower part of the slope is greater than 8 mm, it is also predicted not to be disturbed.

In Tantangara Reservoir, the existing reservoir sediments within the intake channel and areas directly offshore and adjacent (mostly to the north) would be expected to be disturbed by generation and pumping flows. The Tantangara Reservoir excavated rock emplacement will be well to the north of the intake structure and will not be intersected by generation and pumping flows to any material extent.

### Mixing of water between the reservoirs during operation

The construction and commissioning impacts described above will cease at the end of these phases or gradually decrease over time. Over the long-term (years to decades), the primary impact on water quality in the reservoirs will be changes due to the mixing of the water between the reservoirs.

These changes may not be deleterious but will result in a new dynamic equilibrium being established in both reservoirs and most likely with a larger change in the water quality of Tantangara Reservoir than in Talbingo Reservoir. This is because Tantangara Reservoir does not currently receive water from Talbingo Reservoir, and as its total volume is smaller and so transferred water will make up a larger portion of the total volume.

While it is desirable to accurately predict what these changes will be, only broad conclusions can be drawn as the water quality in each of the reservoirs will depend on the transfer regime and the transfer regime will vary widely depending on Snowy Hydro operational decisions and planning within the highly competitive NEM. All of these many factors will continuously vary, such that it is not possible to predict the transfer of water between the reservoirs or the resulting change in water quality in the reservoirs during the operation of Snowy 2.0. Further, there are such a large range of independent factors that the scenarios that combine various states for each factor are effectively limitless.

However, some general predictions may be made regarding potential changes to water quality from the mixing of water between the reservoirs during operation:

- water levels have varied widely in the reservoirs will continue to vary widely;
- as the Tantangara Reservoir active storage is approximately 93.9% of the gross storage (ie the maximum volume of water that may be transferred between the reservoirs), the potential for water temperature change is higher in Tantangara Reservoir than in Talbingo Reservoir where active storage is approximately 17.3% of the gross storage but that these changes cannot be predicted in the absence of an accurately forecast of water transfers; and
- based on 2018–2019 water quality monitoring and default guideline values, mixing of the reservoir waters during operations is unlikely to significantly impact pH, electrical conductivity, turbidity, dissolved oxygen concentration (except as a result of temperature changes); nutrients and metals (with the exception of aluminium and copper where a few measured concentrations indicated that the concentrations may be different between the reservoirs and which requires further monitoring).

### iv Impacts to reservoir water quality from excavated rock emplacement

The key mechanisms with the potential to impact reservoir water quality from excavated rock emplacement are:

- release of suspended solids during construction of the Ravine Bay excavated rock emplacement in Talbingo Reservoir and changes to the reservoir water quality due to interactions between the water and suspended sediment (excavated rock particles) during construction;
- runoff from the parts of the excavated rock emplacements that are above water during intense rainfall resulting in erosion and sedimentation during construction and operations;
- wave erosion of the emplacement outer surfaces during construction and operations; and
- water infiltration into the excavated rock emplacements from: upslope runoff (Tantangara Reservoir only), rainfall, and water movement into submerged parts of the emplacements leading to seepage from the emplacement or directly into reservoir water during construction and operations.

The predicted impacts of these mechanisms are described below.

### a Release of suspended solids during construction of the Ravine Bay excavated rock emplacement

The Ravine Bay excavated rock emplacement will expand from the shore as excavated rock is placed over the advancing face into the reservoir. The excavated rock will travel down the submerged slope of the emplacement until it reaches the bottom or comes to rest on the slope. As the material travels down the slope, fine sediments will be released into the water column. These suspended sediments will form a turbid plume that will then disperse.

As the turbid water moves away from the area where it was generated, the turbidity in the reservoir surface water will be minimised by a silt curtain surrounding the emplacement area. The silt curtain will not extend to the bed of the reservoir, so currents will carry some of the suspended sediment beyond the silt curtain into the body of the reservoir.

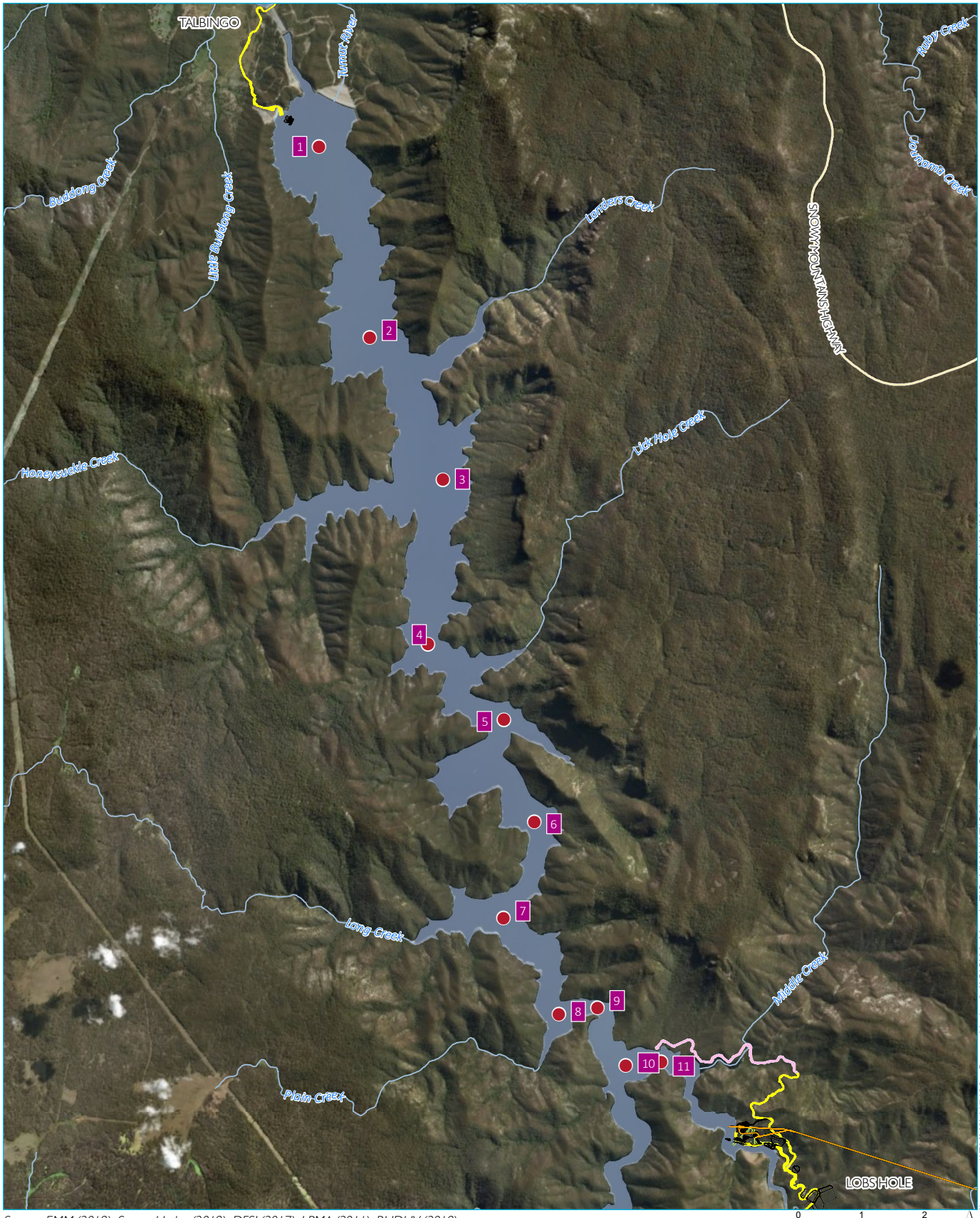
Suspended sediment will interact with the reservoir water with the key stressors of potential concern (SOPC) and contaminants of potential concern (COPC) being TSS/turbidity; pH; electrical conductivity; and aluminium. The primary stressor of concern, TSS/turbidity, is discussed below, as is aluminium, as a mixing zone is proposed.

#### TSS/turbidity

The Ravine Bay emplacement will take about 2 years to construct. The maximum predicted TSS concentrations across the reservoir were modelled over the placement period and the following year (ie for 3 years in total). The locations of the modelling results in Talbingo Reservoir are shown in Figure 6.11.

The maximum TSS concentration within the silt curtains surrounding the placement area is predicted to be high, up to 2,700 mg/L. The TSS concentrations at the surface at locations 1, 4, 9 and 11 are compared to baseline TSS concentrations, baseline turbidity and ANZECC/ARMCANZ (2000) default guideline values in Table 6.1.

It is predicted that TSS concentrations will be highest close to the Ravine Bay placement area and will decrease moving north along the reservoir, with the annual median surface TSS concentration decreasing from 18 mg/L in the Yarrangobilly Arm to 6 mg/L adjacent to the dam wall.

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*Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011); RHDHV (2019)*

KEY

- Time series output location

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements

- Temporary construction compounds and surface works
- Temporary access road

Existing environment

- Main road
- Perennial watercourse
- Scheme storage

Time series output locations

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.11

snowy2.0

EMM
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**Table 6.1 Predicted TSS concentrations and turbidity during placement at representative reservoir locations**

| Location | | | Predicted TSS concentration (mg/L) | | | Predicted turbidity (NTU)[4] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Annual | Warming[1] | Cooling[1] | Annual | Warming | Cooling |
| Talbingo Reservoir background level (2018–2019) | | | | <1–6 mg/L[2] | | | 1–5 NTU[5] | |
| Default guideline value | | | | -[3] | | | 1–20 NTU[6] | |
| 11 | Yarrangobilly Arm, approximately 500 m of placement area | Median | 18 | 43 | 9 | 39 | 61 | 28 |
| | | Maximum | 80 | 80 | 70 | 83 | 83 | 78 |
| 9 | Approximately 1 km north of placement area | Median | 7 | 18 | 7 | 24 | 39 | 24 |
| | | Maximum | 31 | 31 | 25 | 52 | 52 | 46 |
| 4 | Adjacent Lick Hole Creek, approx. half-way along the reservoir | Median | 8 | 15 | 5 | 26 | 36 | 20 |
| | | Maximum | 26 | 26 | 22 | 47 | 47 | 43 |
| 1 | Adjacent the dam wall | Median | 6 | 10 | 3 | 22 | 29 | <20 |
| | | Maximum | 16 | 16 | 14 | 37 | 37 | 34 |

Notes:
1. Warming period: 13 November to 4 May (summer), Cooling period: 5 May to 12 November. Assumes placement starts on 5 May and continues for 2 years.
2. Based on discrete water quality samples collected from Talbingo Reservoir (2018¬2019). Increases to background TSS concentrations are presented.
3. There is no default ANZECC/ARMCANZ (2000) TSS guideline value.
4. Assuming turbidity = 9.0649 x $TSS^{0.506}$ for Ravine Beds (EIS Appendix L, The excavated rock placement assessment summary (RHDHV 2019)).
5. Time-series results from moorings in Talbingo Reservoir (2018¬2019), 1st-percentile to 99th-percentile.
6. Default turbidity guideline value for freshwater lakes and reservoirs in South-Eastern Australia (ANZECC/ARMCANZ 2000).

The reservoir water column becomes stratified (warmer surface waters overlying cooler deep water) as the reservoir warms from early November to early May. This stratification can trap suspended sediments in the surface layer, increasing surface TSS concentrations. Whereas in the longer cooling period from early May to early November, suspended sediments are generally mixed through the water column. For example, the median surface TSS in the Yarrangobilly Arm is predicted to be 43 mg/L for the five warming months and 9 mg/L for the seven cooling months and the median surface TSS adjacent to the dam wall is predicted to be 10 mg/L for the warming months and 3 mg/L for the cooling months.

The maximum surface TSS concentrations are predicted to peak in the second half of the warming period and rapidly decrease as the reservoir cools but will remain above the very low background TSS concentrations in the reservoir.

The TSS concentrations have been modelled. However, there is no default ANZECC/ARMCANZ (2000) TSS guideline value. Instead TSS concentrations have been converted to turbidity values to allow comparison to the default ANZECC/ARMCANZ (2000) turbidity guideline values for freshwater lakes and reservoirs in South-Eastern Australia (1–20 NTU). The relationship between TSS concentration and turbidity for excavated rock particles suspended in reservoir water has been determined as part of the settling tests in reservoir water (EIS Appendix L, The excavated rock placement assessment summary (RHDHV 2019)).

The TSS concentration (in mg/L) and turbidity (in NTU) are similar when the TSS concentration is greater than 50 mg/L. For example, Ravine Bed sediment remaining suspended in reservoir water at 50 mg/L has a turbidity of 66 NTU. However, low TSS concentrations result in comparatively high turbidity values due to the very fine suspended clay-sized particles. For example, Ravine Bed sediment suspended in reservoir water at 10 mg/L would have a turbidity of about 29 NTU. This relationship is not well characterised below about 5 mg/L/20 NTU (ie the upper default guideline value). Based on the derived relationship for Ravine Bed sediment, it is predicted that the turbidity will exceed the default guideline throughout the reservoir.

Surface TSS concentrations and turbidity will return to close to background levels within approximately 8 months of the completion of the Ravine Bay excavated rock emplacement.

### Sediment deposition

The vast majority of excavated rock discharged in the Talbingo placement area will travel down the slope of the emplacement and deposit within the emplacement footprint. However, some of the suspended sediment dispersed in the reservoir will settle to the bed of the reservoir.

Current sediment deposition rates have been estimated based on the examination of sediment cores collected from Talbingo Reservoir. Current annual sediment deposition rates in parts of the Yarrangobilly Arm have been estimated to be 5–15 mm/year, while it is estimated that very little sediment deposition (<1 mm/year) currently occurs in the rest of the reservoir.

During construction, it is predicted that sediment deposition rates will be:

- highest (above 150 mm/year) closest to the placement location;
- 7–45 mm/year in the southern half of the reservoir; and
- 2–15 mm/year in the northern half of the reservoir; and
- higher in shallow parts of the reservoir (ie reservoir edges) than in the deeper parts.

### Sediment discharged from the reservoir

The predicted TSS concentration at Location 1 is representative of the TSS concentration that will be discharged from the reservoir via the T3 Power Station. This indicates that water with an annual median TSS concentration of 6 mg/L, with a maximum up to 16 mg/L, will be discharged at times via the T3 Power Station during the 2-year construction period. It is predicted that a total of 16,021 tonnes of suspended sediment will be discharged from Talbingo Reservoir in total, representing about 0.21% of placed material.

### Aluminium

Mixing excavated rock particles in reservoir water is predicted to result in aluminium concentrations that exceed baseline and default guideline values close to the emplacement area.

Analysis of aluminium concentrations predicted from excavated rock placement in Talbingo Reservoir found that the default trigger value for slightly to moderately disturbed ecosystems (55 µg/L) may not be met immediately outside of the silt curtain around the placement area, but is estimated to be met 500 m from the silt curtain. Therefore, a mixing zone 500 m from the silt curtain would be required to meet the default guideline value for aluminium.

### b Runoff from the parts of the excavated rock emplacements that are above water

There is expected to be runoff from parts of the excavated rock emplacement areas that are above the reservoir water levels, both at Tantangara Reservoir and to a lesser extent Talbingo Reservoir, where the majority of the excavated rock will be placed.

The armouring of the excavated rock emplacement at both Talbingo and Tantangara reservoirs will minimise surface erosion during intense rainfall for areas above the reservoir water level and will also minimise the potential for waves to scour the excavated rock, so that the emplacements will behave similarly to the existing parts of the reservoir shores that are covered by rocks.

### v Impacts to flooding regimes

The key flood impact mechanisms that were considered are associated with:

- locating temporary and/or permanent surface infrastructure on flood prone land (ie land susceptible to flooding by the PMF), including instream works and works on the adjacent floodplain;
- placement of excavated material in Talbingo and Tantangara reservoirs, which may reduce the volume of reservoir storage available during flood events; and
- operation of permanent infrastructure for power generation and pumped storage, which may also reduce the volume of reservoir storage available during flood events.

The key outcomes of the flood risk assessment were as follows.

### a Ravine

Temporary and permanent surface infrastructure will unavoidably need to be constructed on flood prone land in the ravine area, particularly around Lobs Hole. This includes temporary infrastructure and construction support sites (eg associated with construction phase works, such as the accommodation camp and main yard) and permanent infrastructure (eg infrastructure associated with ongoing operation, such as roads, bridges and tunnel portal sites and buildings).

Flood modelling was undertaken to predict changes to existing flooding characteristics along the Yarrangobilly River in Lobs Hole as a result of proposed construction phase works. Whilst the spatial extent and magnitude of impacts is extensive throughout Lobs Hole, in particular for floods of 1% AEP and above, these impacts are not anticipated to impact on existing infrastructure or other areas of significance, and the design of temporary works can accommodate the changed flooding characteristics.

Several sites, including the accommodation camp, will be established predominantly above PMF levels so they can function as flood refuges for the construction workforce.

Flooding impacts in Lobs Hole are anticipated to be reduced during the operational phase, relative to the construction phase, as a result of rehabilitation works and associated permanent landform changes.

No significant change to flooding characteristics for Talbingo Reservoir is anticipated as the volume of excavated material to be placed within the reservoir is very small in comparison to the existing storage volume.

#### b Plateau

Proposed temporary surface infrastructure in the vicinity of Kellys Plain Creek (eg accommodation camp and stockpile area), largely avoids flood prone land and therefore will not impact on existing flooding characteristics. Minor increases to peak flood levels along Kellys Plain Creek are expected to occur from the proposed upgraded road crossing of this watercourse, however these impacts would be localised are not anticipated to impact on infrastructure or other areas of significance.

No significant change to flooding characteristics for Tantangara Reservoir is anticipated as the volume of excavated material to be placed within the reservoir is small in comparison to the existing storage volume.

#### c Rock Forest

This site will be used only during construction of the project and proposed temporary surface infrastructure largely avoids flood prone land and therefore will not impact on existing flooding characteristics.

### 6.2.5 Mitigation measures

Proposed mitigation measures to reduce or mitigate impacts of the construction and operational activities of Snowy 2.0 Main Works on water resources and receivers are provided in Table 6.2.

**Table 6.2 Mitigation measures for water impacts**

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| General | WM01 | A Water Management Plan will be developed for Snowy 2.0 Main Works that includes:<br>• proposed mitigation and management measures for all construction water management categories;<br>• spill management and response;<br>• a surface and groundwater monitoring program;<br>• water quality trigger levels;<br>• reporting requirements;<br>• corrective actions;<br>• contingencies; and<br>• responsibilities for all management measures.<br>The WMP will be prepared in consultation with DPIE, EPA, WaterNSW and key local stakeholders, and would consider concerns raised during the exhibition and approvals process for the project. | Construction | Contractor |
| General | WM02 | A water monitoring program will be developed as part of the water management plan to monitor quality and quantity impacts to surface water, groundwater and reservoirs.<br>The water monitoring program will incorporate and update the existing monitoring network and detail monitoring frequencies and water quality constituents. | Construction and operation | Contractor |
| Water quality impacts from stormwater runoff | WM03 | Where practical, clean water will be diverted around or through construction areas. Runoff from clean water areas that cannot be diverted will be accounted for in the design of water management systems. | Construction | Contractor |

## Table 6.2 Mitigation measures for water impacts

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| Water quality impacts from stormwater runoff | WM04 | An Erosion and Sediment Control Plan (ESCP) will be prepared for each construction area that will include relevant information presented in the water management report (Annexure D to water assessment) | Construction | Contractor |
| Water quality impacts from stormwater runoff | WM05 | A suitably qualified erosion and sediment control professional(s) will be engaged to:<br>• oversee the development of ESCPs;<br>• inspect and audit controls;<br>• train relevant staff; and<br>• progressively improve methods and standards as required. | Construction | Contractor |
| Groundwater modelling | WM06 | The groundwater model developed for Snowy 2.0 Main Works will be validated and, if necessary, recalibrated to new groundwater monitoring data as the monitoring record increases throughout construction.<br>It is recommended that assessment of the monitoring record and groundwater affecting activities, along with model updates, be undertaken at least annually throughout construction and into operation until it is evident that the update frequency can be reduced. | Construction and operation | Contractor<br>Snowy Hydro |
| Groundwater inflow / drawdown | WM07 | Where discrete high flow features are intercepted, pre-grouting and secondary grouting from the TBM may be undertaken to enable tunnel construction. | Construction | Contractor |
| Water supply | WM08 | A water supply system will be established to supply water for potable water use and construction activities.<br>The system will most likely source water from regional groundwater resources, but may also source water from either Tantangara or Talbingo Reservoirs provided licences are available.<br>Extraction from watercourses will be avoided. The most suitable extraction locations and water sources will be established during detailed design | Construction | Contractor<br>Snowy Hydro |
| Reservoir water quality (wastewater management) | WM09 | A wastewater management system will be established to manage effluent from construction compounds and accommodation camps.<br>All wastewater will be treated to meet the water quality specifications provided in the water management report (Annexure D to water assessment) and will be discharged to reservoirs.<br>Wastewater discharges to watercourses will be avoided. | Construction | Contractor |
| Reservoir water quality (process water management) | WM10 | A process water management system will be established to manage water from subsurface excavations and large surface excavations during construction; and to supply water to construction activities.<br>All surplus process water will be treated to meet the water quality specifications provided in the water management report (Annexure D to water assessment) and will be discharged to reservoirs.<br>Process water discharges to watercourses will be avoided. | Construction | Contractor |

**Table 6.2 Mitigation measures for water impacts**

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| Changes to reservoir water quality due to plug removal within the reservoirs | WM11 | The specifications and locations of the proposed environmental measures will be determined as part of detailed design, including the installation of silt curtains.<br>They will be designed such that water quality criteria is agreed with the regulators, with the application of a mixing zone if required. | Construction | Contractor |
| Reservoir bed sediments are disturbed by commissioning water flows | WM12 | Investigations to minimise the disturbance of bed sediments due to water flows during commissioning will be undertaken as part of detailed design. Potential measures to minimise the disturbance of bed sediments include:<br>• investigate mitigated design measures;<br>• dredging sediments from the potential disturbance zones and placing them in another part of the reservoir; and/or<br>• armouring the sediments in the potential disturbance zones.<br>These options are currently being assessed. | Construction | Contractor<br>Snowy Hydro |
| Flooding | WM13 | Further consideration of flooding conditions and impacts, including flood modelling where necessary, will be undertaken to support future detailed design of both temporary and permanent works. | Construction<br>Operation | Contractor<br>Snowy Hydro |
| Flooding | WM14 | Flood emergency response plans will be developed for both construction and operational phases | Construction<br>Operation | Contractor<br>Snowy Hydro |

### 6.2.6 Summary and conclusion

Construction and operational activities associated with Snowy 2.0 Main Works have potential to impact on surface and groundwater levels and quantities, surface water quality (including watercourses and reservoirs) and to flooding regimes.

There is potential for measurable changes to surface water quality to occur in watercourses during the construction phase of the project, generally during the initial 18 months when the greatest area of disturbance and poorest water quality will occur due to surface construction activities. Measures will be implemented by the contractor to minimise impacts.

The water quality in Talbingo Reservoir will be also be impacted during the construction of the Ravine Bay excavated rock emplacement over two years, primarily as a result of increased turbidity, but is predicted to return to baseline levels over the following 8 months.

Mitigation measures will be implemented in the form of grouting to minimise groundwater inflows to subsurface excavations, which will reduce impacts to groundwater drawdown and in turn reduce baseflow and streamflow impacts to Gooandra Creek and Eucumbene River. No High Priority GDEs (including the Yarrangobilly Caves) will be impacted as a result of Snowy 2.0 Main Works.

While local effects will likely occur as a result of the project, the regional effects on the catchment surface water flows, catchment water quality and regional groundwater resources are insignificant.

CHAPTER 6.3

# TERRESTRIAL ECOLOGY

## 6.3 Terrestrial ecology

Biodiversity relates to the variety of plants and animals and the environment in which they inhabit. KNP, in which the Snowy 2.0 Main Works are proposed, is recognised for its unique biodiversity values, incorporating Australia's only alpine area, the Australian Alps along with the South-East Highlands. Altitude, temperature and rainfall (snowfall) influence the types of vegetation communities, species and their species habitat present within the Australian Alps bioregion. There are four main physiographic elements to the bioregion, these being alpine, sub-alpine, montane and tableland areas. Due to the high-altitude environment KNP supports a rich and unique assemblage of cold-climate specialist species that have evolved unique physiological characteristics, enabling them to survive in an environment subject to extreme climate variation.

A comprehensive biodiversity assessment has been completed by EMM and provides:

- an assessment of the biodiversity values present, including Commonwealth and State listed threatened species, terrestrial and groundwater-dependent ecosystems, and Commonwealth listed migratory species;
- an assessment and quantification of impacts of the project on identified biodiversity values and recommendations to avoid, minimise and mitigate these impacts; and
- an outline of the strategy proposed to offset the residual impacts of the project on these ecosystems and species, focussing on enhancing the biodiversity values of the KNP in the medium to long term.

The detailed assessment (and supporting methodology) is documented in the Biodiversity Development Assessment Report (BDAR) prepared in accordance with the *Biodiversity Assessment Method* (BAM) (OEH 2017a) and provided at Appendix M.1. The BDAR is also supported by an Offset Strategy which has been prepared to enhance the values of the KNP (Appendix M.3). This Offset Strategy contains, in part, a strategy to offset biodiversity in line with the NSW Biodiversity Offsets Scheme (BOS). As the project has been declared a controlled action under the EPBC Act, the BDAR also addresses the relevant MNES and is summarised in this chapter.

### 6.3.1 Existing environment

KNP is largely vegetated across its extent and covers a variety of climatic regions which support several distinct ecosystems. The extent of vegetation across KNP provides a high degree of connectivity. Biodiversity values of KNP are linked to its unique landscapes, native vegetation and ecological communities, and flora and fauna.

#### i Landscapes

Landscape and topography changes across the project area, with the steeper terrain of the Lobs Hole area evident compared to the high plains of the Plateau and Tantangara.

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

Geodiversity features are located within the project area and contribute to landscape values, namely the block streams and Devonian outcrops along Lobs Hole Ravine Road. These geodiversity features have been identified and assessed in separate geodiversity assessments provided with the EIS (refer to Appendix O.1 and O.2).

### ii Native vegetation and threatened ecological communities

Field surveys have confirmed the presence of 22 plant community types (PCTs) within the disturbance footprint which are described in Table 5.2 of the BDAR (Appendix M.1) and illustrated in Figure 6.12. The area was found to support a high diversity of communities and a total of 1,053 ha of native vegetation communities were confirmed in the disturbance footprint, with the three dominant communities consisting of:

- PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion (348.14 ha);
- PCT 1224 – Sub-alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion (133.84 ha); and
- PCT 644 – Alpine Snow Gum - Snow Gum shrubby woodland at intermediate altitudes in northern Kosciuszko NP, South Eastern Highlands Bioregion and Australian Alps Bioregion (116.22 ha).

One threatened ecological community (TEC) listed under the BC Act and EPBC Act has been confirmed in the project area, primarily across the Plateau and Tantangara areas as shown in Figure 6.12. The Alpine Sphagnum Bogs and Associated Fens ecological community is listed as endangered under the EPBC Act while the Montane peatlands and swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions is listed as endangered under the BC Act. This community occurs across alpine, sub-alpine and montane landscapes and is generally found in permanently wet areas and situated on slopes and valley floors where soils are waterlogged.

### iii Fauna Habitats

Fauna habitat features relevant to the project include:

- habitat trees including large hollow-bearing trees;
- flowering shrubs and feed tree species;
- waterways; and
- ground litter and logs.

The habitat assessment identified that areas where disturbance has been limited such as upper section of Lobs Hole Ravine Road and Marica, fauna habitat features are abundant. In areas subject to disturbance, such as clearing and human activity, fauna habitat features are limited such as the disturbed areas of Lobs Hole and in Talbingo Reservoir.

### iv Threatened species

Results of targeted surveys have confirmed the presence of six threatened flora species listed under the BC Act, with two also listed under the EPBC Act within the disturbance footprint (Table 6.3, Figure 6.13).

### Table 6.3 Flora species recorded within and adjacent to the disturbance footprint

| Species name | Common name | EPBC Act[1] | BC Act[2] | Talbingo | Lobs Hole | Marica | Plateau | Tantangara | Rock Forest |
|---|---|---|---|---|---|---|---|---|---|
| *Calotis glandulosa* | Mauve Burr-daisy | VU | V | | | | ✓ | ✓ | |
| *Carex raleighii* | Raleigh Sedge | | E1 | | | | ✓ | ✓ | |
| *Discaria nitida* | Leafy Anchor Plant | | V | | | ✓ | ✓ | ✓ | |
| *Glycine latrobeana* | Clover Glycine | VU | E4A | | | | ✓ | ✓ | |
| *Prasophyllum retroflexum* | Kiandra Leek Orchid | | V | | | | ✓ | ✓ | |
| *Pterostylis foliata* | Slender Greenhood | | V | | | ✓ | | | |

1. EPBC Act categories: VU- Vulnerable; EN- Endangered
2. BC Act categories: V- Vulnerable; E1- Endangered; E4A- Critically endangered

There were no threatened flora species recorded in the Lobs Hole, Talbingo Reservoir areas or at Rock Forest.

Twenty-one threatened fauna species listed under the BC Act have been recorded within and adjacent to the disturbance footprint, with six of these species also listed under the EPBC Act (**Error! Reference source not found.** and Figure 6.14).

### Table 6.4 Fauna species recorded within and adjacent to the disturbance footprint

| Species name | Common name | EPBC Act[1] | BC Act[2] | Talbingo | Lobs Hole | Marica | Plateau | Tantangara | Rock Forest |
|---|---|---|---|---|---|---|---|---|---|
| **Ecosystem credit species** | | | | | | | | | |
| *Artamus cyanopterus* | Dusky Woodswallow | | V | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Climacteris picumnus victoriae* | Brown Treecreeper | | V | | ✓ | | | | |
| *Daphoenositta chrysoptera* | Varied Sittella | | V | | ✓ | ✓ | | ✓ | |
| *Dasyurus maculatus* | Spotted-tailed Quoll | EN | V | | | ✓ | | | |
| *Falsistrellus tasmaniensis* | Eastern False Pipistrelle | | V | | ✓ | ✓ | ✓ | ✓ | |
| *Haliaeetus leucogaster* | White-bellied Sea-Eagle | | V | ✓ | ✓ | | | ✓ | |
| *Lophoictinia isura* | Square-tailed Kite | | V | | | | ✓ | | |
| *Miniopterus schreibersii oceanensis* | Eastern Bentwing-bat | | V | ✓ | ✓ | ✓ | ✓ | ✓ | |
| *Pachycephala olivacea* | Olive Whistler | | V | | ✓ | | | | |
| *Petroica boodang* | Scarlet Robin | | V | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Petroica phoenicea* | Flame Robin | | V | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Stagonopleura guttata* | Diamond Firetail | | V | | ✓ | | | | |
| **Species credit species** | | | | | | | | | |

| Species name | Common name | EPBC Act[1] | BC Act[2] | Talbingo | Lobs Hole | Marica | Plateau | Tantangara | Rock Forest |
|---|---|---|---|---|---|---|---|---|---|
| *Callocephalon fimbriatum* | Gang-gang Cockatoo | | V | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

**Table 6.5 Fauna species recorded within and adjacent to the disturbance footprint**

| Species name | Common name | EPBC Act[1] | BC Act[2] | Talbingo | Lobs Hole | Marica | Plateau | Tantangara | Rock Forest |
|---|---|---|---|---|---|---|---|---|---|
| *Cercartetus nanus* | Eastern Pygmy-possum | | V | | ✓ | ✓ | | | |
| *Cyclodomorphus praealtus* | Alpine She-oak Skink | EN | E1 | | | ✓ | ✓ | ✓ | |
| *Hieraaetus morphnoides* | Little Eagle | | V | | | | ✓ | | |
| *Litoria booroolongensis* | Booroolong Frog | EN | E1 | | ✓ | ✓ | | | |
| *Litoria verreauxii alpina* | Alpine Tree Frog | VU | E1 | | | | ✓ | ✓ | |
| *Mastacomys fuscus* | Broad-toothed Rat | VU | V | | | ✓ | ✓ | ✓ | |
| *Pseudomys fumeus* | Smoky Mouse | EN | E4A | | ✓ | ✓ | | | |
| *Tyto novahollandiae* | Masked Owl | | V | | ✓ | | | | |

1. EPBC Act categories: VU- Vulnerable; EN- Endangered
2. BC Act categories: V- Vulnerable; E1- Endangered; E4A- Critically endangered

The ravine (Talbingo Reservoir, Lobs Hole and Marica areas) contain very limited threatened flora and instead have a number of threatened bird and mammal species, including the Eastern Pygmy-possum and Smoky Mouse (Photograph 6.1) which were recorded within habitat zones along Lobs Hole Ravine Road and at Marica. The Booroolong Frog (Photograph 6.2) was also recorded within habitat along the Yarrangobilly River at Lobs Hole.

**Photograph 6.1 Smoky Mouse recorded in Marica during field survey**

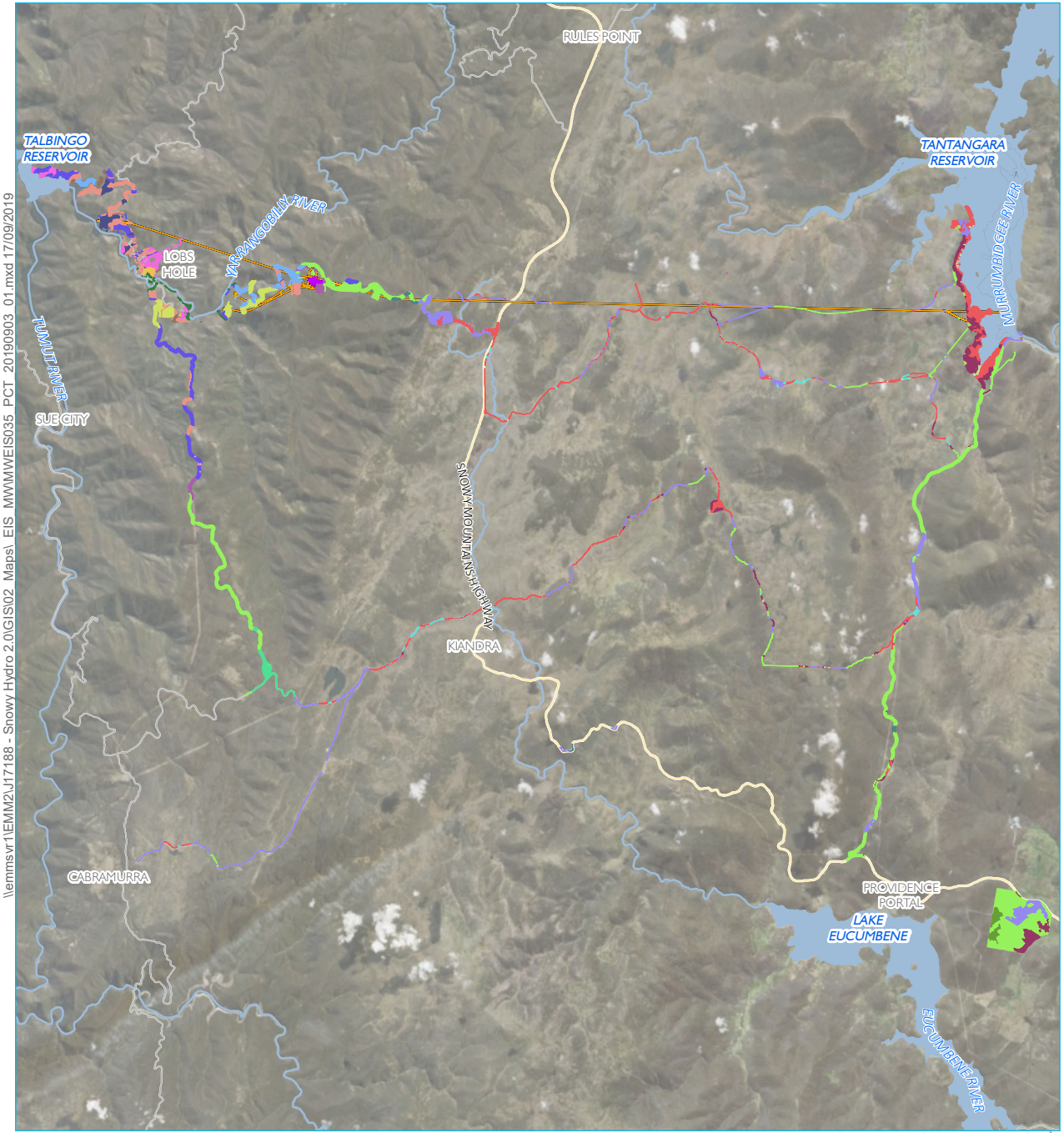
**Photograph 6.2 Booroolong Frog recorded along Yarrangobilly River during field survey**

The plateau (Plateau and Tantangara Reservoir) contain abundant records of threatened flora and include threatened herpetofauna species along watercourses and across the plateau including Alpine Tree Frog and Alpine She-oak Skink (Photograph 6.3).

**Photograph 6.3 Alpine She-oak Skink recorded on the Plateau during field survey**

New records of Clover glycine (Photograph 6.4) were recorded near Tantangara, which previously only had a very limited extent within KNP.

**Photograph 6.4 Clover Glycine recorded near Tantangara during field survey**

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

0 2.5 5 km

GDA 1994 MGA Zone 55

N

## KEY

Plant community type

- PCT 1191 - Snow Gum - Candle Bark woodland on broad valley flats of the tablelands and slopes, South Eastern Highlands Bioregion
- PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 1224 - Sub-alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 1225 - Sub-alpine grasslands of valley floors, southern South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 285 - Broad-leaved Sally grass - sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion
- PCT 296 - Brittle Gum - peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion
- PCT 299 - Riparian Ribbon Gum - Robertsons Peppermint - Apple Box riverine very tall open forest of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion
- PCT 300 - Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment
- PCT 302 - Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion
- PCT 303 - Black Sally grassy low woodland in valleys in the upper slopes sub-region of the NSW South Western Slopes Bioregion and western South Eastern Highlands Bioregion
- PCT 311 - Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion
- PCT 637* - Alpine and sub-alpine peatlands, damp herbfields and fens, South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 638 - Alpine Ash - Mountain Gum moist shrubby tall open forest of montane areas, southern South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 639 - Alpine Ash - Snow Gum shrubby tall open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 643 - Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion
- PCT 644 - Alpine Snow Gum - Snow Gum shrubby woodland at intermediate altitudes in northern Kosciuszko NP, South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 679 - Black Sallee - Snow Gum low woodland of montane valleys, South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion
- PCT 765 - Carex - Juncus sedgeland/wet grassland of the South Eastern Highlands Bioregion
- PCT 952 - Mountain Gum - Narrow-leaved Peppermint - Snow Gum dry shrubby open forest on undulating tablelands, southern South Eastern Highlands Bioregion
- PCT 953 - Mountain Gum - Snow Gum - Broad-leaved Peppermint shrubby open forest of montane ranges, South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 999 - Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies

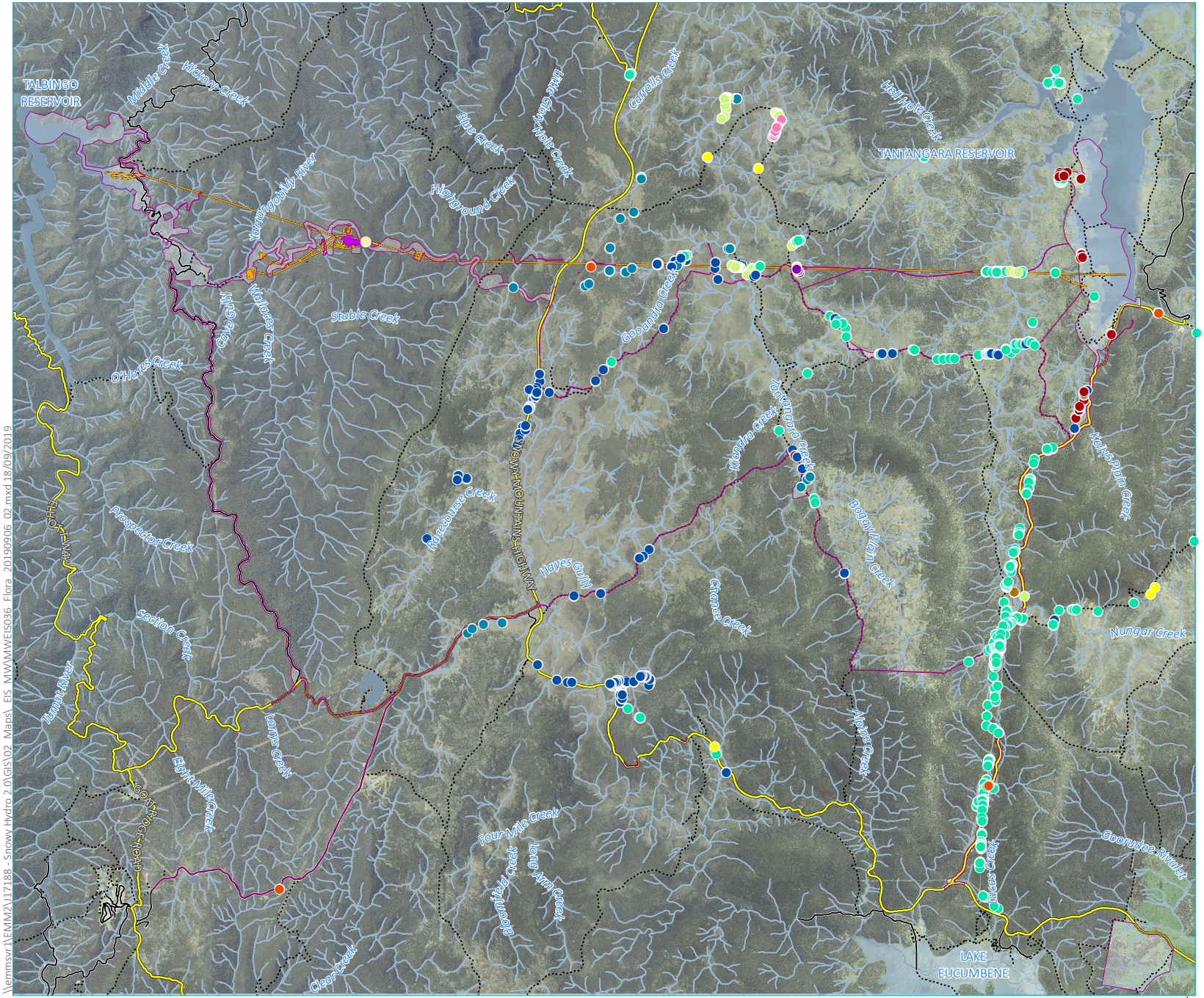
* PCT 637 - Alpine bogs and fens (TEC)

PCTs within the disturbance footprint

snowy 2.0

EMM creating opportunities

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.12

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

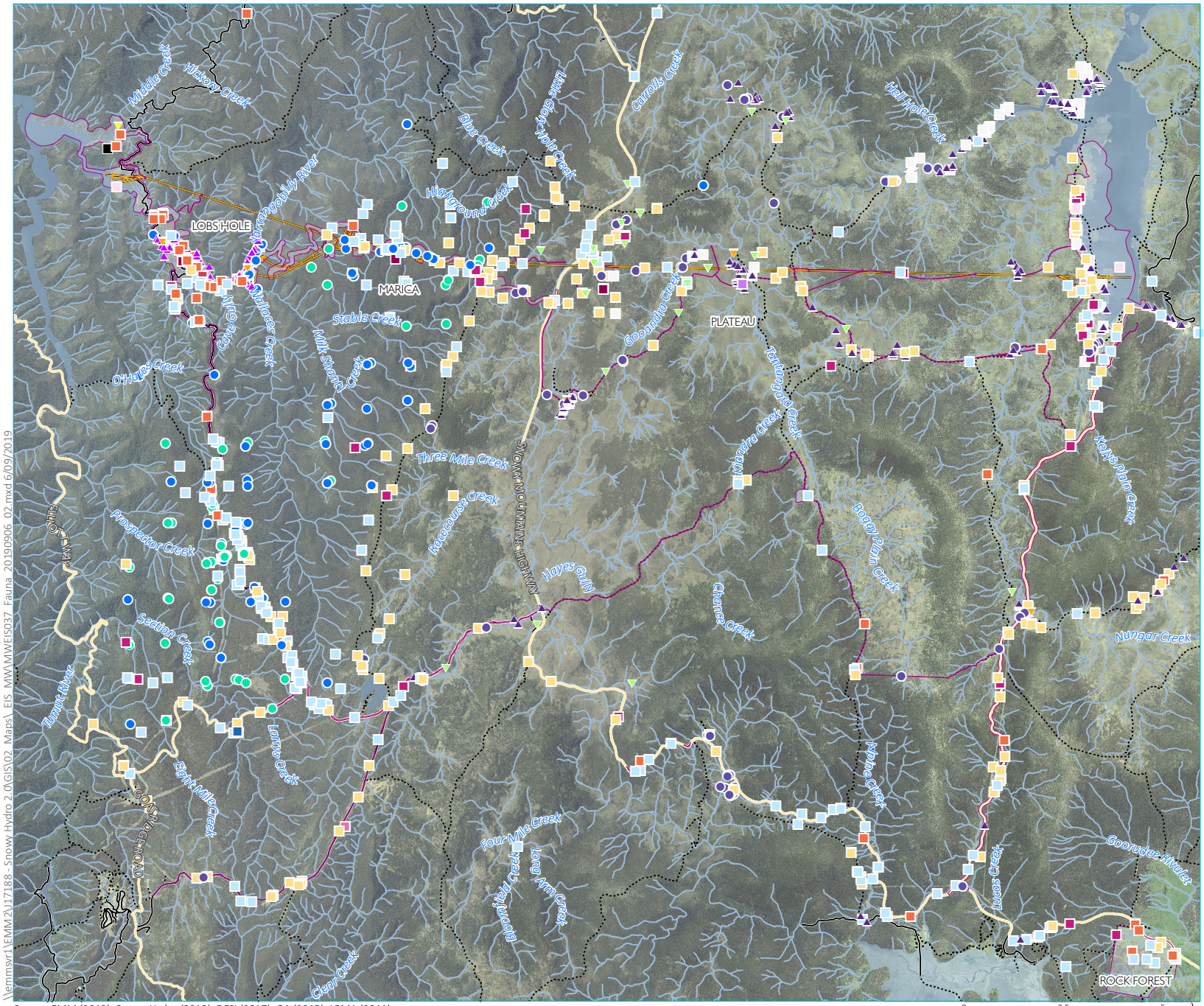
Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

## Threatened flora results

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.13

snowy 2.0

EMM
creating opportunities




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

0 2.5 5 km

GDA 1994 MGA Zone 55

N

## KEY

- Disturbance area*

Birds
- Rainbow Bee-eater
- Flame Robin
- Gang-gang Cockatoo
- Olive Whistler
- Glossy Black-Cockatoo
- Pink Robin
- Masked Owl
- Diamond Firetail
- Latham's Snipe
- Scarlet Robin
- Dusky Woodswallow
- Square-tailed Kite
- Varied Sittella
- Little Eagle
- Brown Treecreeper
- Satin Flycatcher^
- White-bellied Sea-Eagle

Mammals
- Eastern Bentwing-bat
- Smoky Mouse
- Eastern False Pipistrelle
- Eastern Pygmy-possum
- Spotted-tailed Quoll
- Broad-toothed Rat

Reptiles and amphibians
- Alpine She-oak Skink
- Alpine Tree Frog
- Booroolong Frog

Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
- Power station

Existing environment
- Main road
- Local road
- Vehicular track
- Watercourse / drainage line
- Waterbody

^ - migratory species

Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

## Threatened fauna results

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.14

snowy 2.0

EMM creating opportunities

\\emmsvr1\EMM2\J17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MW\MWEIS037 Fauna 20190906 02.mxd 6/09/2019

### v Groundwater dependent ecosystems

As terrestrial vegetation communities are composed of a range of vegetation types, with a range of rooting depths and strategies, there is a relationship between groundwater depth and the types and composition of the vegetation that can access it (Serov 2013). Analysis of the distribution of PCTs in relation to the simulated regional groundwater levels carried out for the project indicated several PCTs are strongly associated with shallow groundwater.

Ground dependent ecosystems (GDEs) were classified into three categories according to their increasing dependence on groundwater:

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

The plant communities identified as having varying degrees of groundwater dependence within the project area are listed in Table 6.6 and shown on Figure 6.15. All other communities were considered non-dependent on groundwater. As can be seen, the majority of entirely/obligate dependent ecosystems occur across the high plains of the Plateau and Tantangara.

**Table 6.6 Groundwater dependent ecosystems**

| Groundwater dependence | Mapped plant community type (PCT) |
|---|---|
| Entirely/obligate dependence on groundwater | • PCT 637 - Alpine and sub-alpine peatlands, damp herbfields and fens, South Eastern Highlands Bioregion and Australian Alps Bioregion;<br>• PCT 765 - Carex - Juncus sedgeland/wet grassland of the South Eastern Highlands Bioregion; and<br>• PCT 1225 - Sub-alpine grasslands of valley floors, southern South Eastern Highlands Bioregion and Australian Alps Bioregion. |
| Facultative proportional dependence on groundwater | • PCT 285 - Broad-leaved Sally grass - sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion;<br>• PCT 299 - Riparian Ribbon Gum - Robertsons Peppermint - Apple Box riverine very tall open forest of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion; and<br>• PCT 302 - Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion. |
| Facultative – opportunistic dependence on groundwater | • PCT 300 - Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment;<br>• PCT 303 - Black Sally grassy low woodland in valleys in the upper slopes sub-region of the NSW South Western Slopes Bioregion and western South Eastern Highlands Bioregion; and<br>• PCT 679 - Black Sallee - Snow Gum low woodland of montane valleys, South Eastern Highlands Bioregion and Australian Alps Bioregion. |

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

### 6.3.2 Community and stakeholder views

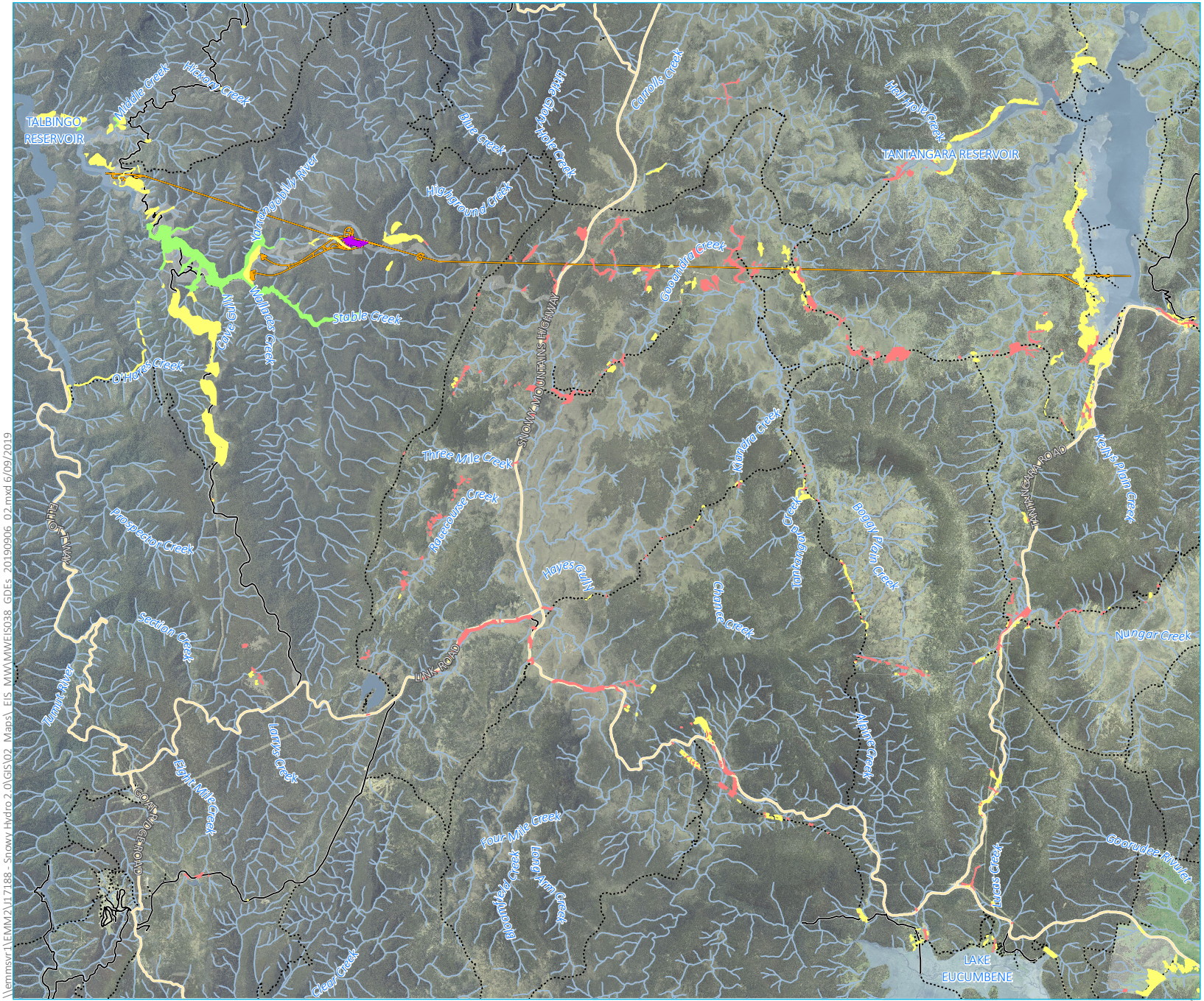
The community generally support the project and recognise that there will be impacts to biodiversity within KNP. Notwithstanding this, the community also recognised that there is a need to avoid and minimise these impacts, in particular to threatened flora and fauna species. Stakeholder engagement with key government stakeholders, including DPIE and DEE, and species experts and accountable officers within these departments, was undertaken to:

- inform the identification of biodiversity values and biodiversity survey methods; and
- seek input and discuss measures proposed to avoid, minimise and mitigate impacts.

### 6.3.3 Avoidance and minimisation through design

A key focus of project design has been to avoid and minimise impacts to biodiversity values, identified during the field surveys, as a result of surface infrastructure. In recognition of the location of the Snowy 2.0 project in the KNP, and associated biodiversity and other values of the park, the project has undergone significant steps to avoid, minimise and mitigate impacts through the DIAA process. Examples of measures undertaken to avoid, minimise and mitigate impacts that have arisen during the process are outlined below, with more detail provided in the BDAR (Appendix M.1) and Options Report (Appendix C):

- Placement of excavated rock – many of the options considered required much larger disturbance to identified biodiversity values. The current proposed option for disposal of excavated rock has resulted in a significant reduction in predicted impacts;
- Access roads – the design of these access roads has attempted to limit disturbance as far as practicable, largely through the use of the existing road network, resulting in upgrades to existing roads rather than construction of new roads and reducing the overall extent of disturbance required;
- Surface infrastructure – early designs for the project included a number of ancillary facilities to be located over the sensitive plateau area. Due to identified biodiversity constraints the project was refined, with only the communication cables to be located in this area. All other project elements have been removed and associated impacts will be avoided as much as possible; and
- Significant measures were put in place to avoid impacts to Clover Glycine when a large population was recorded along a proposed Tantangara East Road to access private property along the eastern edge of KNP. Surveys of this option identified significant biodiversity values along this proposed route, including a population of over 600 Clover Glycine, representing approximately 65% of the known population of the species in NSW. The removal of this option has resulted in a substantial and significant reduction in impacts to Clover Glycine.




KEY

Groundwater dependent ecosystems
- Entirely/obligate dependence
- Facultative - proportional
- Facultative - opportunistic

Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
- Power station

Existing environment
- Main road
- Local road
- Vehicular track
- Watercourse / drainage line
- Waterbody

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

0 2.5 5 km

GDA 1994 MGA Zone 55

N

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## Groundwater dependent ecosystems

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.15

snowy 2.0

EMM creating opportunities

Since the initial identification of the Smoky Mouse along Lobs Hole Ravine Road (as well as a number of other threatened species), a number of options for the widening of Lobs Hole Ravine Road have been considered by the design team to avoid and minimise clearing in this area. Large-scale regional surveys undertaken for the Smoky Mouse recorded a significant regional population of the Smoky Mouse extending from Coppermine Firetrail in the north to Link Road in the south, and from Wallaces Creek Firetrail in the east to near Goat Ridge Road in the west. These regional surveys placed the original finding of Smoky Mouse on Lobs Hole Ravine Road in a broader regional context. This has negated much of the benefit of alternative options to widening of Lobs Hole Ravine Road. Consideration was given to fencing off Lobs Hole Ravine Road in order to minimise impacts to fauna species such as Smoky Mouse and the Eastern Pygmy-possum, with provision of under-road crossing points via culvert. Concerns were raised that this measure may result in significant fragmentation and loss of connectivity, and thus alternative measures have been proposed (see Section 6.3.5).

### 6.3.4 Predicted impacts

The current design for many elements of Snowy 2.0 Main Works has included a disturbance area that is much larger than is required to construct the project. Therefore, the current disturbance footprint is likely to significantly overestimate the impacts arising from the project, and currently represents the maximum extent where construction works will be carried out.

The detailed design for the project is ongoing. In recognition of the biodiversity values of KNP, and the unique native species and communities that it supports, the disturbance area will be minimised as much as possible during detailed design as part of the continuing DIAA process.

The main direct impacts of the project will be associated with impacts arising from the clearing works for construction of the project. Potential direct impacts that could arise include:

- clearing of areas of significant native vegetation;
- clearing of high-quality threatened species habitat;
- clearing of TECs; and
- disturbance of river/creek beds and banks.

Indirect impacts that could occur include:

- drawdown of groundwater, resulting in impacts to GDEs;
- increased noise, vibration and dust levels resulting in disturbance of fauna species, and consequent abandonment of habitat, or changes in behaviour (including breeding behaviour);
- lighting for night works, resulting in disturbance to fauna species and changes in occupancy or behaviour;
- increase in weeds and pathogens, resulting in degradation of retained native vegetation and habitat; and
- increase in predatory and pest animal species, resulting in increased predation and competition and a consequent reduction in populations.

Based on the biodiversity assessments that have been completed to identify the presence of Commonwealth and State listed communities and species, and after avoidance and mitigation measures are implemented, the residual impacts to biodiversity will be primarily associated with the loss of native vegetation communities and fauna species habitats. Alpine Bogs and Fens are a TEC and GDE located across the Plateau and predicted impacts have also been estimated based on current groundwater modelling for the project.

### i Native vegetation and threatened ecological communities

The disturbance footprint covers an area of 1,680 ha. As a worst-case prediction, it is anticipated there will be a total loss of 1,053 ha of native vegetation including 4.09 ha of TECs and 992 ha of habitat for fourteen threatened species. A detailed breakdown of specific PCTs to be cleared is provided in the BDAR (Appendix M.1).

As a result of the measures to avoid and minimise impacts, particularly removal of large sections of the project area across the Plateau, there has a been a significant reduction in impacts to Alpine Sphagnum Bogs and Associated Fens (the only TEC occurring within the disturbance footprint). Snowy 2.0 Main Works will result in a residual impact to 4.09 ha of the community, representing 0.04% of the national extent of the community. A further 17.51 ha is mapped within the groundwater drawdown area and may be subject to impacts arising from changes in hydrology. The scale and extent of these impacts are unknown and will be subject to ongoing monitoring.

### ii Threatened species and their habitat

Removal of native vegetation and threatened species habitat has the potential to result in fragmentation of fauna habitat, with resultant effects on fauna species movement, reproduction and gene flow. Habitat loss is expected for several threatened species, summarised as follows:

- 2.01 ha of habitat for Clover Glycine;
- 1.67 ha of habitat for the Kiandra Leek Orchid;
- 17 individuals of the Leafy Anchor Plant;
- 16.55 ha of habitat for the Mauve Burr-daisy;
- 0.38 ha of habitat for the Raleigh Sedge;
- 0.18 ha of habitat for the Slender Greenhood;
- 0.04 ha of habitat for *Thelymitra alpicola*;
- 5.42 ha of breeding habitat for the Gang-gang Cockatoo;
- 30.23 ha of habitat for the Broad-toothed rat;
- 552.94 ha of habitat for the Eastern Pygmy-possum;
- 174.39 ha of habitat for the Smoky Mouse;
- 9.85 ha of habitat for the Booroolong Frog;
- 48.87 ha of habitat for the Alpine Tree Frog; and
- 133.83 ha of habitat for the Alpine She-oak Skink.

Further discussion on key species subject to greatest impact include:

- Clover Glycine - Twenty-six individuals will be impacted by the project, in the Tantangara area. This represents 2.9% of the location population of the species recorded during surveys undertaken for Snowy 2.0, and approximately 0.4% of the estimated national population (Carter and Sutter 2010), including records from Snowy 2.0 surveys;

- Kiandra Leek Orchid - direct impacts on 1.67 habitat for the Kiandra Leek Orchid;

- Mauve Burr-daisy - the Mauve Burr-daisy was found to be ubiquitous throughout KNP, often growing on the margins of disturbed areas such as management tracks and firetrails. This has meant that measures to avoid and minimise impacts are challenging. The Snowy 2.0 Main Works project is expected to impact 3,686 individuals. This represents less than 17% of the national population of the species;

- Raleigh Sedge - direct impacts on 0.38 ha of habitat for the Raleigh Sedge; and

- Smoky Mouse - Regional surveys have contributed a significant amount of knowledge on the distribution of this species in northern KNP. These surveys recorded the species over a large area of suitable habitat. It is estimated that Snowy 2.0 Main Works will result in impacts to 174.39 ha of habitat for the species, representing less than 3% of the estimated available habitat in the region. There is also potential for indirect impacts from fragmentation, fauna vehicle collisions, weeds and pathogens and increased predation to further impact this species if unmitigated.

Two migratory species listed under the EPBC Act (Satin Flycatcher and Latham's Snipe) were recorded within or adjacent to the disturbance footprint and will have habitat impacted as a result of the project.

#### iii Groundwater dependent ecosystems

Groundwater-dependent riparian vegetation is predicted to be at moderate risk of predicted impact, as the GDE will experience some drawdown, but some level of baseflow is expected to be maintained to large areas and the community will only experience minor changes in species composition.

PCTs 1225 and 637 are considered to be at high risk of predicted impact given the level of drawdown, the entirely/obligate dependence of these communities on groundwater and possible changes in species composition. However, these impacts will occur to a small portion of these communities at a local, NSW and national scale.

It is worth noting that these predicted impacts are considered an unrealistic, worst-case scenario given the groundwater model was not able to consider the effectiveness of pre-grouting the tunnel, which will be implemented during construction. This is likely to considerably reduce the drawdown arising from the project; however, the degree of reduction is unknown.

### 6.3.5 Mitigation measures

Direct impacts will need to be offset in accordance with the BC Act and the total credits and strategy to be implemented is discussed in Appendix M.3. Mitigation measures recommended to manage indirect impacts of the project to biodiversity are provided in Table 6.7.

### Table 6.7 Mitigation measures for terrestrial ecology impacts

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| Fauna strike to Smoky Mouse and Eastern Pygmy possum | ECO1 | Management measures to mitigate the potential impacts of fauna strike are currently being considered. These measures include:<br>• reduced speed limit along Lobs Hole Ravine Road and Marica Trail at night, when fauna species are likely to be most active;<br>• fencing of these roads to prevent access to the road surface; and<br>• construction of fauna underpasses.<br>The adopted measures will be agreed in consultation with DPIE. | Construction | Contractor |
| Spread of weeds | ECO2 | A weed and pathogen monitoring program will be implemented, with a weed control program to be implemented if weeds are identified along road verges. This will include wash-down stations will be constructed at a suitable location, with wash down for weeds as well as *P.cimmamomi*. | Construction | Contractor |
| Impacts to GDEs | ECO3 | A GDE monitoring program will be implemented to ensure actual impacts are within prediction. If actual impacts are greater than predicted, adaptive management will be implemented. | Construction | Contractor |
| Removal of native vegetation and threatened species habitat | ECO4 | A Biodiversity Management Plan will be prepared and implemented during construction. It will include the following measures:<br>• establishment of exclusion zones around retained vegetation, including fencing and signage;<br>• pre-clearing surveys conducted prior to clearing, including translocation of fauna into areas of retained vegetation;<br>• vegetation clearing undertaken in accordance with the two-stage process;<br>• mulching and stockpiling of cleared native vegetation for use during rehabilitation;<br>• retention of hollows logs and limbs for placement within retained vegetation and reuse during rehabilitation;<br>• regional surveys for the Smoky Mouse to demonstrate presence of a significant regional population;<br>• collection of native seeds and alpine sod for propagation; and<br>• establishment of native plant nursery and propagation of endemic native species for use in rehabilitation works. | Construction | Contractor |
| | ECO5 | A threatened species monitoring program will be designed and implemented to ensure impacts arising from clearing are within prediction. | Construction | Contractor |
| Increase in predatory and pest species | ECO6 | A pest and predator monitoring program will be designed and implemented to ensure Main Works does not result in a significant increase in numbers of pest and predatory species and impacts to threatened species remain within prediction. | Construction | Contractor |

## 6.3.6 Summary and conclusion

A key focus of project design has been to avoid and minimise impacts to biodiversity values identified during the field surveys as a result of surface infrastructure. In recognition of the location of the Snowy 2.0 project in the KNP, and associated biodiversity and other values of the park, the project has undergone significant steps to avoid, minimise and mitigate impacts through the DIAA process.

The disturbance footprint for Snowy 2.0 Main Works covers an area of 1,680 ha. As a worst-case prediction, it is anticipated there will be a total loss of 1,053 ha of native vegetation including 4.09 ha of TECs and 992 ha of habitat for fourteen threatened species. Removal of native vegetation and threatened species habitat has the potential to result in fragmentation of fauna habitat, with resultant effects on fauna species movement, reproduction and gene flow. Habitat loss is expected for several threatened species.

Residual impacts will be offset. Further detail regarding offset credits and approach to delivering the biodiversity offsets for the project are summarised in Section 8.4 of the BDAR (Appendix M.1) and Offset Strategy (Appendix M.3).

CHAPTER 6.4

# AQUATIC ECOLOGY

## 6.4 Aquatic ecology

Construction and operational aspects of Snowy 2.0 have potential to impact aquatic ecology in local catchments upstream and downstream of Talbingo and Tantangara reservoirs, and within the reservoirs.

A comprehensive aquatic ecology assessment has been completed by Cardno (2019b – Appendix M.2) and provides:

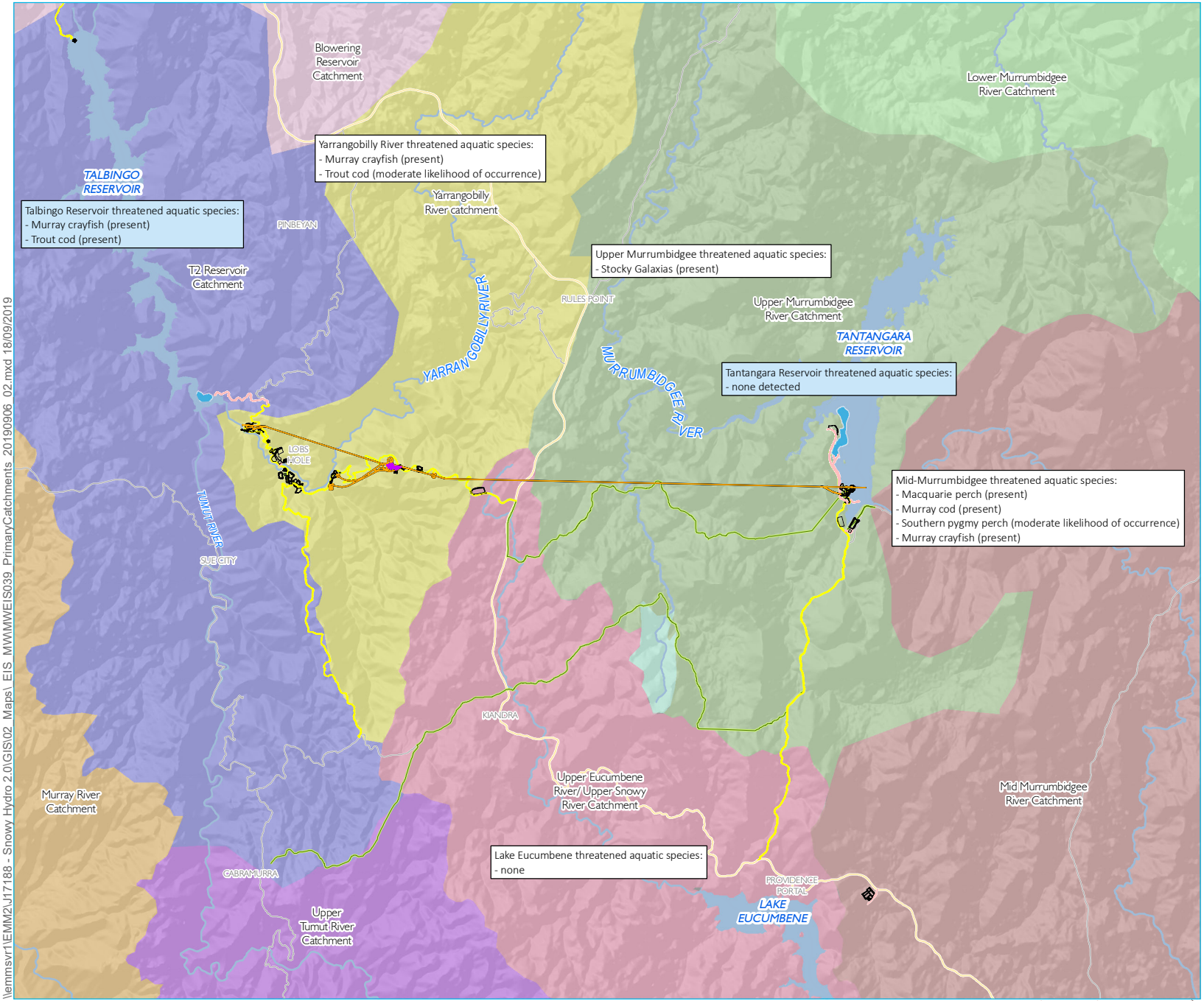
- an assessment of the biodiversity values present including Commonwealth and State listed threatened aquatic species;
- an assessment and quantification of impacts of the project on identified aquatic ecology values; and
- outlines the strategy proposed to offset the residual impacts of the project on these aquatic ecosystems and species.

The assessment incorporates findings from various technical studies undertaken to characterise the aquatic ecology associated with Tantangara and Talbingo reservoirs and associated catchments. A number of scientific investigations and technical studies have been carried out to inform this assessment of impacts to aquatic ecology.

### 6.4.1 Existing environment

Snowy 2.0 is within the Snowy-Tumut Development which provides for the diversion off the Eucumbene, the Upper Murrumbidgee and the Tooma rivers at Blowering Reservoir. This development currently provides an existing one-way transfer of water Tantangara Reservoir to Talbingo Reservoir via Lake Eucumbene and a series of tunnels and power stations through the Upper Tumut catchment into Talbingo Reservoir and the lower Tumut River. The Snowy-Murray Development involves the diversion of the Snowy River by a tunnel system to the Geehi River and then to the Swampy Plain River via a series of tunnels and power stations.

Key catchments relevant to potential impacts are Talbingo Reservoir, Yarrangobilly River, Lake Eucumbene and Mid-Murrumbidgee River which are shown in Figure 6.16. Table 6.8 and Table 6.9 provide an overview of aquatic information for the key catchments and two reservoirs, respectively.

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*Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)*

## KEY

Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements
- Temporary construction compounds and surface works
- Temporary access road
- Indicative rock emplacement area

Primary catchments
- Blowering Reservoir catchment
- Lower Murrumbidgee River catchment
- Mid Murrumbidgee River catchment
- Murray River catchment
- Yarrangobilly River catchment
- T2 Reservoir catchment
- Upper Eucumbene River/ Upper Snowy River catchment
- Upper Murrumbidgee River catchment
- Upper Tantangara Creek catchment
- Upper Tumut River catchment

Existing environment
- Main road
- Local road
- Watercourse
- Waterbodies

# Primary catchments and threatened aquatic species

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.16

snowy 2.0

EMM creating opportunities

## Table 6.8 Key catchment features

| Feature | Yarrangobilly River | Lake Eucumbene | Upper Murrumbidgee River | Mid-Murrumbidgee |
|---|---|---|---|---|
| General description and watercourses | Headwaters of the Yarrangobilly River lie approximately 22 km east of Talbingo. The river flows predominantly southwest and south, passing beneath the Snowy Mountains Highway before combining with Wallaces Creek and turning north-west into the Tumut River and into Talbingo Reservoir. | Encompasses the whole of Lake Eucumbene, the Eucumbene River and several small tributaries (including Bullocks Head Creek, Chance Creek, Racecourse Creek, Three Mile Creek and Gang Gang Creek) and is bound by the Lake Eucumbene dam wall in the south western section of Lake Eucumbene.<br>The primary watercourse is the upstream section of the Eucumbene River which runs for approximately 37 km south from its source in the plateau region of the study area before reaching Lake Eucumbene. | Extends from the upper alpine areas of KNP with the Murrumbidgee River flowing into the northern end of Tantangara Reservoir and exiting at the southeast corner via the Tantangara Reservoir dam wall. Major tributaries include Nungar Creek, Tantangara Creek, Gooandra Creek and Mufflers Creek west of the reservoir, Mosquito Creek in the north and Kellys Plain Creek in the south.<br>Major watercourses in the west of the catchment are generally perennial and flow through alpine environments with a mixture of native and non-native sedges, grasses and shrubs. Tantangara Creek and Gooandra Creek are narrower and shallower than the Murrumbidgee River and flow over a mixture of cobble, pebble and gravel substratum with some boulders, bedrock and deeper pool sections. Nungar Creek has a similar morphology to Tantangara Creek and with a greater proportion of gravel and sand substratum. | Extends from below Tantangara Reservoir dam wall to the ACT/NSW border. The primary watercourses in this catchment include the Murrumbidgee River and the Numeralla River. The Murrumbidgee River is approximately 190 km to the ACT border and the Numerella River is approximately 110 km. Below the Tantangara Reservoir dam wall, the catchment to Yaouk (13 km south-east) is undisturbed grassland and grassy woodland.<br>Downstream from Yaouk the catchment is heavily cleared until the Binjura Nature Reserve in the southern part of the catchment where the channel becomes deeply incised and surrounded by undisturbed native sclerophyll forest. |
| Aquatic values | The Yarrangobilly River is relatively undisturbed, is considered of high ecological value (EMM 2018) and has no natural or artificial barriers to fish passage in the sections of Yarrangobilly River and Wallaces Creek surveyed by Cardno (2019b). | The upper reaches of the Eucumbene River meander through the KNP with pools, riffles and cobbles and boulder habitat. The surrounds generally comprise open and closed woodland or alpine tundra. | Areas of shallow riffles and deeper pools with widths of up to 10 m. Native aquatic vegetation (*Potamogeton tricarinatus* and *Myriophylum* sp.) is present in isolated patches in Tantangara and Gooandra Creeks, the Murrumbidgee River and most of the smaller tributaries. Large rocks and gravel beds are also present. | Areas of riffles and deep pools with large rocks, wood debris and native aquatic plants support a diverse fish community. |

## Table 6.7 Key catchment features

| Feature | Yarrangobilly River | Lake Eucumbene | Upper Murrumbidgee River | Mid-Murrumbidgee |
|---|---|---|---|---|
| Key fish habitat (KFH) | Yarrangobilly River and Wallaces Creek support type 1 – Highly Sensitive KFH due to the presence of large rocks, large wood debris (in Yarrangobilly River) and the provision of habitat for a threatened species (Murray crayfish) in both watercourses.<br>Lick Hole Creek and Sheep Station Creek are ephemeral tributaries of Wallaces Creek with limited instream habitat (type 3 – minimally sensitive KFH). | Eucumbene River and its main tributaries provide type 1 KFH, due the presence of native aquatic plants and / or their association with the EEC listing for the Snowy River, which includes these watercourses and provides endangered status to all associated species. | The Murrumbidgee River, Tantangara Creek (and tributary TCA1/2), Gooandra Creek, Nungar Creek, Bally Creek and Ghost Gullyprovide type 1 – highly sensitive KFH, due to the presence of native aquatic plants and large rocks; they are also Class 1 waterways due to their perennial flow.<br>The remaining watercourses including Mufflers Creek and Kellys Plain Creek provide type 2 – moderately sensitive KFH, and the pools associated with Gooandra Creek, Tantangara Creek and Nungar Creek are type 3 KFH. | The Murrumbidgee River downstream of Tantangara dam wall provides type 1 – highly sensitive KFH due to the presence of large rocks, wood debris, native aquatic plants and the threatened Macquarie perch (*Macquaria australasica*), at least as far downstream as Yaouk Bridge. |
| Species – threatened | Murray crayfish (present) and trout cod (moderate likelihood of occurrence). | Snowy River endangered ecological community. | Stocky galaxias (present) – upper Tantangara Creek only. | Macquarie perch (present), trout cod (present), Murray cod (present), southern pygmy perch (moderate likelihood of occurrence) and Murray crayfish (present). |
| Species – native | Two-spined blackfish (present), mountain galaxias (present), climbing galaxias (present), flathead gudgeon (moderate likelihood of occurrence), common yabby (moderate likelihood of occurrence) and unidentified spiny crayfish (present). | Climbing galaxias (present), flathead gudgeon (present), common yabby (present) and Reiks crayfish (present). | Mountain galaxias (present), common yabby (present) and Reiks crayfish (present). | Golden perch (present), two-spined blackfish (present), Australian smelt (present), flathead gudgeon (present), carp gudgeon (present), common yabby (present), Reiks crayfish (present), freshwater prawn (present) and freshwater glass shrimp (present). |
| Species – non-native | Redfin perch (present), rainbow trout (present) and brown trout (present). | Eastern gambusia (present), wild goldfish (present), oriental weatherloach (present), rainbow trout (present), brown trout (present) and brook trout (present). | Cypriniforme OTU2 (moderate likelihood of occurrence), rainbow trout (present) and brown trout (present). | Eastern gambusia (present), wild goldfish (present), carp (present), oriental weatherloach (present), rainbow trout (present) and brown trout (present). |

## Table 6.9 Key reservoir features

| Feature | Talbingo | Tantangara |
|---|---|---|
| Water flow | Receives water from natural catchment inflows, with the Tumut River, Yarrangobilly River and several smaller creeks contributing to the catchment inflow. Water discharged from T3 can also be pumped back into the reservoir from Jounama Pondage immediately downstream of Talbingo Reservoir. Once water is released from Jounama Pondage, it enters Blowering Reservoir where it is released by WaterNSW. | The Reservoir impounds the headwaters of the Murrumbidgee River for diversion through the Murrumbidgee-Eucumbene Tunnel into Lake Eucumbene for storage. Water from the Goodradigbee River, a downstream tributary of the Murrumbidgee River, is also collected within the reservoir via the Goodradigbee River Aqueduct. |
| Sediments | Soft and muddy, fine textured predominantly consisting of coarse silts (RHDHV 2018). Sediment metal concentrations are below the interim sediment quality guidelines (ISQG) low values (ANZECC/ARMCANZ 2000) except for copper and nickel which are naturally high and unlikely to be bioavailable (RHDHV 2018).<br>Sedimentation rates are approximately 2 mm per year except at Middle Bay (15 mm per year) where sediment loads from the Yarrangobilly River deposit. | Soft and muddy, fine textured predominately consisting of coarse silt with small varying fractions of clay (Cardno 2019b). Heavy metal concentrations were within ISQG guideline values at all sites sampled.<br>Sedimentation rates are up to 3 mm per year. |
| Aquatic habitat | Soft sediment habitats predominate throughout the reservoir, and submerged timber is abundant. Beds of aquatic macrophytes occur in the shallower margins of the reservoir, particularly within the lower Yarrangobilly River and Middle Creek areas where large dense beds of the introduced water weed *Elodea canadensis* form thick mats to around 5 m water depth (Cardno 2019b). Macrophytes are seasonal, generally being present during the warmer months of the year.<br>Types of habitat include unvegetated soft sediment, aquatic macrophytes (*Elodea*), submerged timber, rocky rubble and open water. | Soft sediment predominates and drowned grasses and tussocks are present at the confluence of Nungar Creek and the Murrumbidgee River within the reservoir. Areas of large boulders and emergent bedrock are present throughout the reservoir, which likely provide habitat for invertebrates and fish (Cardno 2019b). One small patch of *Elodea* was reported in shallow water on the eastern shore.<br>Types of habitat include unvegetated soft sediment, drowned grass tussocks and shrubs, rocky rubble, rock boulders and emergent bedrock and open water. |
| Benthic invertebrates | Oligochaete worms were numerically abundant in benthic samples, accounting for 81% and 79% of all individuals collected from the reservoir in March 2018 and January 2019, respectively. Other prominent benthic taxa included chironomids (insects) and nematode worms (Cardno 2019b). | Oligochaete worms, chironomids (non-biting midges) and nematode worms accounted for over 95 % of the benthic invertebrates sampled. Number of taxa sampled generally low within Tantangara Reservoir for both surveys, with fewer than four taxa recorded at most locations sampled. No clear pattern of spatial variability. |
| Phytoplankton | Phytoplankton assemblages within Talbingo Reservoir comprise chlorophytes (45%), cyanophytes (38%) and bacillariophytes (15%) and less than 2% of other taxa (Cardno 2019b). Seasonal variation in phytoplankton assemblages is apparent, although there is very little spatial difference throughout the reservoir. | Chlorophytes (44%), cyanophytes (19%) and bacillariophytes (30%) and less than 8% of other taxa (Cardno 2019b).<br>No strong seasonal variation in phytoplankton. |
| Key fish habitat | Type 1 KFH due to the known presence of Murray crayfish. | Type 2 KFH (moderately sensitive fish habitat). No threatened or protected species have been reported. |
| Species – threatened | Murray crayfish (present) and trout cod (present). | None detected. |

## Table 6.8 Key reservoir features

| Feature | Talbingo | Tantangara |
|---|---|---|
| Species – native | Two-spined blackfish (present), mountain galaxias (present), climbing galaxias (moderate likelihood of occurrence), flathead gudgeons (present), common yabby (present). | Mountain galaxias (present), common yabby (present), Reiks crayfish (present). |
| Species – non-native | Redfin perch (present), eastern gambusia (present), rainbow trout (present), brown trout (present), wild goldfish (present). | Rainbow trout (present) and brown trout (present). |
| Macrophytes | The introduced weed *Elodea* is widespread. | Elodea is present in low abundance |
| Pathogens | EHNV is known to occur in the wider Murrumbidgee catchment but has not been recorded in the Reservoir or upstream catchment | EHNV is known to occur in the wider Murrumbidgee catchment but has not been recorded in the Reservoir or upstream catchment |

### 6.4.2 Community and stakeholder views

Community and stakeholder views were considered through the development of the project, with these views obtained through community consultation and government agency meetings including DPI-Fisheries.

Key matters raised through the period of engagement with DPI Fisheries were potential impacts on:

- native aquatic species and recreation as a result of potential pest fish (Redfin perch) transfer between Tantangara and Talbingo reservoirs, and further impacts from distribution upstream and downstream, if not contained;
- recreational fish (trout) as a result of potential Redfin perch transfer into Tantangara reservoir;
- transfer of pathogens, especially the EHNV through the power waterway;
- threatened species (Murray crayfish) as a result of excavated rock material placement in Talbingo Reservoir.

Targeted community consultation was carried out for the purpose of the social and recreational user assessments for the EIS (Appendix X.2), to determine the current level of understanding of the project and its potential impacts, and possible measures or opportunities that would be considered suitable by the community to mitigate or offset those impacts. The aquatic values identified by recreational users generally included fishing at Lobs Hole and Tantangara Reservoir.

### 6.4.3 Avoidance and minimisation through design

In response to key matters raised by stakeholders regarding the potential transfer/movement of fish between the reservoirs, Snowy Hydro carried out detailed design investigations for fish barrier controls.

The approach included investigations of the feasibility and effectiveness of controls that could be incorporated at the intake structures in Tantangara and Talbingo reservoirs (primary controls) to prevent live fish transfer to Tantangara Reservoir. However, due to the complex nature of the proposed structures and their operation, no feasible primary control measures were identified to prevent the transfer of fish, larvae and/or eggs between the reservoirs. Consequently, the objective of the barrier control measures is to contain any fish potentially transferred and restrict them to within Tantangara Reservoir and out of any catchments known to contain threatened species.

These investigations identified secondary design controls which form part of Snowy 2.0 Main Works. These are:

- In Tantangara Creek just upstream of the waterfall upstream of Alpine Creek Trail. This barrier is designed to prevent movement of Climbing galaxias into the 4 km upstream section of Tantangara Creek where stocky galaxias are found;
- At Tantangara Reservoir dam wall. This barrier is designed to prevent transfer via the existing environmental release from Tantangara Reservoir to the Mid and Lower Murrumbidgee River catchments; and
- At the entrance to the Murrumbidgee-Eucumbene tunnel that transfers water from Tantangara Reservoir to Lake Eucumbene. This barrier has been designed to prevent fish transfer from Tantangara Reservoir to the Snowy River, Upper Tumut River and Murray River catchments.

These barriers are a result of considerable volumes of research and design development initiated by Snowy Hydro aimed to eliminate the potential risk to pre-existing fish populations and other components of aquatic ecology at risk from fish transfer.

### 6.4.4 Predicted impacts

Potential direct and indirect impacts to habitat, water resources and biota would be broadly managed via the CEMP and specific sub-plans. Any disturbed habitat would be appropriately rehabilitated and/or offset as required. Impacts of surface works would primarily be controlled via the methodologies outlined in the Erosion and Sediment Control Plan (ESCP) but will be supported by other sub-plans including:

- Biodiversity Management Plan;
- Aquatic Habitat Management Plan;
- Water Management Plan; and
- Rehabilitation Plan.

The subsequent sections of this section describe the key matters associated with the interactions between the construction and operation of Snowy 2.0 Main Works and aquatic ecology. Detailed information is provided within the aquatic ecology study provided in Appendix M.2.

#### i Removal/modification of aquatic habitat and associated biota

Altering the aquatic environment through removal and/or modification of habitat can affect the number and type of aquatic species living in an area. Each species has an environmental preference with respect to water quality, water flows, substrate type and the presence of predators, competitors and food. Snowy 2.0 Main Works activities have potential to alter aquatic habitats with a summary of these impacts provided in Table 6.10.

## Table 6.10 Removal/modification of aquatic habitat and associated biota

| Activity | Impact assessment | Residual risk[1] |
|---|---|---|
| Construction of surface infrastructure and utilities | Where possible, an exclusion buffer will be applied for road construction either side of a river except where bridges or other crossing structures are required. Habitat loss / modification would be minor due to the small footprint of waterway crossing sites compared with extensive similar riparian and instream habitat along the Eucumbene River, Nungar Creek, Kellys Plain Creek and Talbingo Reservoir.<br>Temporarily disturbed riparian vegetation will be rehabilitated in accordance with the rehabilitation strategy. Cables will be underbored where they cross third order perennial waterways with Type 1 KFH with appropriate erosion and sediment controls, keeping disturbance at all locations short term and highly localised.<br>Wastewater outlets entering creeks and reservoirs would be designed and positioned to minimise the footprint of hard bank engineering and prevent bank scouring and erosion. Quality of discharge will be maintained within licence conditions. | Low |
| Subaqueous placement of excavated rock in Talbingo Reservoir | Bare soft sediment habitat makes up the largest area of benthic aquatic habitat within the proposed excavated rock placement area of Talbingo Reservoir, and within the entire reservoir. The relatively small area directly impacted is not expected to significantly affect the functioning of soft sediment habitats in the reservoir. Similarly, small areas of fringing rocky habitat within the excavated rock placement area will be lost; although the addition of coarse excavated material should adequately compensate for any losses.<br>Aquatic vegetation in Talbingo Reservoir in the areas of the excavated rock placement is mostly non-native *Elodea*, and loss of this nuisance species is not considered to be a negative impact. A few individuals of native aquatic species may be lost but would not affect the overall population in the reservoir.<br>Submerged timber is extensive throughout Talbingo Reservoir, including within the vicinity of the proposed excavated rock emplacement area. On a reservoir scale, the loss of submerged timber within the proposed excavated rock placement area is unlikely to cause any long-term impacts on habitat availability. | Low |
| Dry placement of excavated rock below FSL in Tantangara Reservoir | Bare soft sediment habitat makes up the largest area of benthic aquatic habitat within the proposed placement area of Tantangara Reservoir. Due to the variability of water level that occurs within Tantangara Reservoir, the soft sediment habitat and benthic communities between MOL and FSL experience constant disturbance and the ecological value of benthic environment is diminished compared to areas that are permanently inundated below MOL (Cardno 2019b).<br>No aquatic vegetation was observed. Very few areas of rocky shoreline habitat are present within Tantangara Reservoir, and where present, consist of scattered boulders and smaller rocks amongst the soft sediment (Cardno 2019b). The loss of a small proportion of these habitat types within the reservoir is not considered a significant impact. | Low |

## Table 6.9 Removal/modification of aquatic habitat and associated biota

| Activity | Impact assessment | Residual risk[1] |
|---|---|---|
| Construction of intakes and dredging works | The soft sediment habitat in and around the proposed intake is not considered to be unique and once dredging and construction of the intakes are complete, areas within the approach channel will be stabilised with rock capping. There will be a complete loss of soft sediment habitat within the intake footprints and any uncapped areas would be recolonised over time. The loss of a small percentage of total soft sediment habitat within the reservoirs is negligible and is unlikely to have a long-term impact on nutrient cycling or trophic interactions beyond the immediate vicinity of the excavated intake areas.<br>Similarly, a small area of natural rocky habitat along the shore will be lost during construction of the intakes. Although, the total overall area of hard substrate will be increased through stabilisation of the approach channel, which will compensate for any habitat loss.<br>Aquatic vegetation in Talbingo Reservoir in the areas of the intake is mostly non-native *Elodea*, and removal of this nuisance species is not considered to be a negative impact. Scattered individuals of native aquatic species may be lost but would not affect the overall population in the reservoir. Macrophytes are largely absent from Tantangara Reservoir.<br>Wood debris along the shore of Talbingo Reservoir in the vicinity of the intakes is likely to provide habitat for fish and crayfish species. Following disturbance, associated fish species would move to available habitat nearby. Pre-disturbance surveys of Murray crayfish would be undertaken prior to any habitat removal.<br>Wood debris is largely absent from Tantangara Reservoir; instead there are areas of submerged grass tussocks. | Low |
| Transfer of water between reservoirs during operations | Available data indicates phytoplankton is more abundant in Tantangara Reservoir than Talbingo Reservoir. Some phytoplankton may die when transferred between reservoirs (due to pressure changes that rupture cells) while others could be expected to survive, resulting in the transfer of viable phytoplankton, including one species implicated in harmful algal blooms that are currently in Tantangara Reservoir that could be transferred to Talbingo Reservoir. Transfer of phytoplankton between Tantangara Reservoir and Talbingo Reservoir would likely result in changes to the phytoplankton assemblages in both reservoirs so that they become more alike. Changes to the phytoplankton assemblage in Talbingo Reservoir have the potential to alter the composition of other components of aquatic life in the reservoir, such as zooplankton communities, although this would not necessarily result in a negative impact.<br>A one-way water linkage currently exists between Tantangara and Talbingo reservoirs via Lake Eucumbene and the upper Tumut River, and therefore plankton exchange between the two reservoirs is already possible. Despite the certainty of new water exchange pathways associated with Snowy 2.0, the consequence of mixing plankton assemblages is deemed to be minor. There are no direct practical methods for mitigating the transfer of phytoplankton between reservoirs or reducing the likelihood of occurrence and residual risk ranking is moderate.<br>Given the abundance of Elodea in Talbingo, transfer of fragments during operation is likely. Elodea is already present in Tantangara and it is not known if this would lead to an increase in abundance of this species. | Low - Moderate |

Notes: 1. Residual risk following implementation of management measures.

### ii Impacts to aquatic species and their distribution

The natural distribution of aquatic species is determined by environmental conditions and the ability of individuals (or eggs, larvae) to move between areas. Project activities can directly impact species (eg by smothering), can force individuals to flee from distasteful conditions (eg noise) or can restrict the natural movement of individuals between different areas (eg for spawning). New species introduced into areas can also compete with or consume local species. Several activities associated with the construction and operation of Snowy 2.0 could affect the natural distribution and/or movement of aquatic species in the project area. These are summarised in Table 6.11 below.

**Table 6.11 Impacts to aquatic species and their distribution**

| Activity | Impact assessment | Residual risk[1] |
|---|---|---|
| Construction of surface infrastructure and utilities | Fish passage<br>Construction of permanent crossings has potential to temporarily obstruct the passage of fish and mobile macroinvertebrates. This is important for species where migration is required to complete reproductive life cycles and their ability to breed and spawn is restricted.<br>The crossing site at Talbingo Reservoir has potential to provide habitat for several non-threatened native species and threatened Murray crayfish and trout cod. Temporary construction works at this site would therefore require site specific management. Temporary waterway obstructions would be minimised during the upgrade or construction of bridges and culverts. Where practical, waterways will be partially closed using a coffer dam, with works staged to minimise the total disturbance and maintain fish passage. Any flow diversion barriers and instream sediment control barriers would be removed as soon as practicable and rehabilitated.<br>As stated above, cables will be underbored where they cross third perennial order waterways with Type 1 KFH with appropriate erosion and sediment controls, which will keep disturbance at these locations short term and highly localised. | Low |
| | Spread of aquatic weeds and pests<br>Heavy plant, vehicles and barges operating in and around waterways during construction of roads, utilities and infrastructure have potential to act as vectors for a range of aquatic weeds and pest fish if not properly managed. The noxious weed *Elodea* is widespread in Talbingo Reservoir and plant fragments could inadvertently be transferred to other waterways. Similarly, eggs of non-native pest species, such as redfin perch, eastern gambusia and wild goldfish could be transferred between waterways.<br>The risk of Redfin perch spreading from Talbingo Reservoir and its tributaries to Tantangara Reservoir and tributaries where it does not currently occur is of concern. Eastern gambusia and Wild goldfish are also not currently found in Tantangara Reservoir, the Upper Tantangara or Upper Murrumbidgee catchments. The introduction of pests to these catchments could impact on native species.<br>A Weed, Pest and Pathogen Management Plan will be prepared and implemented to minimise and manage the spread of weeds, pest fish and pathogens which will include a description of measures that would be implemented to minimise the spread of weeds and pest via vehicle and plant movements. | Moderate |

## Table 6.10 Impacts to aquatic species and their distribution

| Activity | Impact assessment | Residual risk[1] |
|---|---|---|
| Subaqueous placement of excavated rock in Talbingo Reservoir | Given the excavated rock emplacement area amounts to a small proportion of Talbingo Reservoir and recovery of benthic communities is expected to occur following the cessation of placement activities, the loss of soft sediment and rocky habitat biota would be temporary and amount to only a minor localised impact.<br>Submerged wood habitat is widespread throughout the reservoir and any direct loss of this habitat within the excavated rock emplacement area likely represents only a small area compared to the broader reservoir. Therefore, any impacts to submerged timber in the excavated rock emplacement area would have a negligible effect on aquatic biota. | Low |
| Dry placement of excavated rock below FSL in Tantangara Reservoir | Excavated rock placement within Tantangara Reservoir would cause mortality to benthic infauna assemblages residing within sediments directly within the placement area. Given the excavated rock emplacement area amounts to a small proportion of Tantangara Reservoir and recovery of benthic communities is expected to occur following the cessation of placement activities, the loss of soft sediment and rocky habitat biota would be temporary and amount to only a minor localised impact. | Low |
| Construction of intakes and dredging works | Noise and vibration from blasting<br>Receptors in the water column of the reservoirs that have potential to be directly affected by underwater noise and vibration associated with blasting include zooplankton, macroinvertebrates (including crustaceans such as crayfish, adult fish (native and non-native), larvae and eggs. Most fish species in Talbingo Reservoir are non-native brown / rainbow trout or pest species (redfin perch) and impacts to these species are not considered as having a direct negative impact.<br>Designated blast limits and other management measures to minimise impacts to aquatic ecology will be outlined in the Blast Management Plan. Pre-disturbance clearance surveys would be undertaken to remove Murray crayfish from outside the affected zone and relocate them. | Low to moderate |
| | Hydraulic entrainment within dredge areas<br>Direct entrainment of fish (individuals, larvae and/or eggs) into the dredge head is possible if a suction type dredge is used. Mobile species may be able to actively avoid the suction head. Non-native species are most likely to be entrained given their relative abundance in both reservoirs. Entrainment risk of crayfish is unknown. Pre-disturbance clearance surveys would be undertaken to remove Murray crayfish from outside the effect zone and relocate them. | Low |
| Tunnel excavation and dewatering | Modelled impacts to groundwater drawdown are presented in the Section 6.2 above. Predicted impacts are mainly restricted to discrete sections of the Gooandra Creek and the upper Eucumbene River. Increased periods of no flow would cause a decrease in available aquatic habitat, and population sizes of aquatic biota could decrease. Trout but no native fish species and only Reik's crayfish were found in Gooandra Creek during recent surveys. Likewise, for the upper Eucumbene catchment. Drawdown in the Yarrangobilly River catchment is predicted to be localised, with minimal changes overall for Yarrangobilly River and Wallaces Creek.<br>The extent of associated impacts to aquatic habitat and biota from drawdown would be relatively minor within the context of each catchment. | Low |

## Table 6.10 Impacts to aquatic species and their distribution

| Activity | Impact assessment | Residual risk[1] |
|---|---|---|
| Transfer of water between reservoirs during operations | Entrainment and transfer of biological material<br>During operation, the flow of intake water at the reservoirs could entrain aquatic flora and fauna into the intake. Species drawn into the intake could be transferred alive through the tunnel (and underground power station) or be critically injured or killed during passage through the system.<br>Plankton are not strong swimmers and would offer no resistance to being entrained in water being transferred between reservoirs. Daily abstractions by the intakes would be a small fraction of the total volume of reservoir water.<br>Fish occurring in Talbingo Reservoir include a mixture of native and introduced species although introduced species make up a large proportion of the fish community (Cardno 2019b). Eggs of most of these species are at low risk of entrainment given they are adhesive and laid on submerged objects such as vegetation, logs and rocks or higher up tributaries. Eggs of freshwater crayfish in the reservoir, including the threatened Murray crayfish, are carried by females until they hatch in summer, and are unlikely to be entrained. Some benthic invertebrates release planktonic eggs and larvae which could be entrained into the inter-reservoir water exchange. Given the large volume of Talbingo Reservoir, the amounts of fish and invertebrate eggs entrapped daily by the intakes would likely constitute a negligible fraction of the total number of eggs at any one time in the reservoir.<br>Fish larvae in the vicinity of the intake, would be susceptible to entrainment when the station was operating. Depending upon the species and size of individual, juvenile and adult fish species (including redfin perch and eastern gambusia) could also be entrained. | Low |

## Table 6.10 Impacts to aquatic species and their distribution

| Activity | Impact assessment | Residual risk[1] |
|---|---|---|
| | Transfer of fish between reservoirs<br>Ning *et al*. (2019) were commissioned by Snowy Hydro to investigate the potential survival of various life-history stages of redfin perch and of adult eastern gambusia through the proposed pumped hydro system. This was undertaken via a series of laboratory based experiments and modelling that simulated various aspects and scenarios of pumping from Talbingo to Tantangara reservoirs. This included simulated blade strike, shear stress and pressure changes. In additional to surviving passage through the pipeline and station, the likelihood of redfin perch or gambusia reaching Tantangara is also dependant on them becoming entrained at the intake. This would depend on conditions at the intake, factors related to fish behaviour and swimming speeds and presence of different life-history stages near the intake. Overall, they concluded that based on the results of their experiments and modelling, if entrained into the intake at Talbingo Reservoir, a proportion of redfin perch or eastern gambusia could survive the shear, blade strike and pressure impacts expected to occur within the pumped hydro system (Ning *et al*. 2019). Whether redfin and gambusia will be entrained into the intake and survive transfer through the completed development in 'real life' cannot be known with certainty until Snowy 2.0 becomes operational. In absence of this, the assessment is based on the experimental results.<br>No data were obtained on survival of other fish species known to be present in Talbingo Reservoir and no studies were undertaken on the likelihood of survival of fish during the transfer of water from Tantangara Reservoir to Talbingo Reservoir in generation mode. Thus, as a precautionary approach Cardno's (2019b) assessment assumed the potential for any species currently present in either reservoir to survive transport through the pumped hydro system.<br>The key ecological concern relating to water transfer is the potential transfer of undesirable species (redfin perch, gambusia, goldfish and climbing galaxias) from Talbingo to Tantangara which is considered likely for redfin perch and possible to unlikely for other species. Research into available options for preventing transfer has determined that no reasonable and feasible options exist for the Snowy 2.0 waterway; however, fish barriers are proposed at the outflows from Tantangara and near the waterfall on Tantangara Creek. These secondary controls form part of Snowy 2.0 Main Works. While the transfer of these species could lead to populations establishing in Tantangara reservoir and some distance upstream with consequent impacts on native fish and salmonids, the installation of barriers will limit the potential range expansion and prevent these fish from entering Lake Eucumbene or the known habitats of any threatened species. | Moderate to high |
| | Transfer of fish diseases between reservoirs<br>The potential of Snowy 2.0 Main Works to increase the range of EHNV was assessed by the University of Sydney (Hick *et al.* 2018). EHNV is a viral pathogen of fish that is of international concern and in Australia has been restricted to the south-east mainland where it has caused sporadic outbreaks of high mortality disease in redfin perch since the 1980s, and low mortality disease in farmed rainbow trout. EHNV is not known to occur in Tantangara or Talbingo reservoirs and was not detected in limited testing undertaken for this project. As redfin perch is considered the host for this disease, there is potential for it already occur or to establish in Talbingo in the future (unrelated to Snowy 2.0).<br>A direct water connection between Talbingo and Tantangara reservoirs increases the risk for expanding the range of EHNV, if EHNV occurs in Talbingo Reservoir or occurs at some point in the future. Without any disease mitigation, there is a high risk of EHNV accessing new locations and impacting susceptible fish populations including native species. The implementation of the fish barriers described in the section above will reduce, but not eliminate the potential for spread of the virus to other locations, should it occur in either of the reservoirs in the future. A monitoring program for EHNV is proposed as part of the project. | Moderate |

Notes: 1. Residual risk following implementation of management measures.

### iii Changes to water quality

Water quality naturally varies between different water bodies while often fluctuating with season. Water quality is critical for the health of aquatic species and determines which aquatic species can live successfully in each aquatic habitat. Snowy 2.0 Main Works activities that alter the quality (or quantity) of surface water can impact on the health and distribution of aquatic species. These are summarised in Table 6.12.

**Table 6.12 Changes to water quality and quantity**

| Activity | Impact assessment | Residual risk[1] |
|---|---|---|
| Surface infrastructure and utilities | Temporary and permanent wastewater discharge outlets would be constructed with appropriate water quality maintained.<br>Except for uncontrolled stormwater discharge, wastewater treatment would comply with the surface water quality guidelines and discharge limits as set out in the relevant management plans. Where possible, process water will be reused for TBM operations, dust suppression and greywater to reduce the flow discharged into reservoirs.<br>Construction of new roads, accommodation camps and construction staging sites may lead to increased diffuse surface run-off. Contaminants such as hydrocarbons and metals may accumulate on road and hardstand surfaces used by heavy plant and equipment and could enter waterways during rainfall events. The increase in area of impervious surfaces is small compared to the entire project area and unlikely to cause widespread changes in surface water quality. Localised effects may be apparent and would be managed using standard stormwater practices. This may vary depending upon location within the project area. | Low |
| Subaqueous placement of excavated rock in Talbingo Reservoir | Emplacement of excavated rock material within Talbingo Reservoir has the potential to change water quality throughout the reservoir and impact aquatic ecology. Fine materials could stay suspended within the water column before settling out and depositing in areas within and outside of the placement area. Two main impact pathways on water quality exist as a result of the placement of excavated rock materials within Talbingo Reservoir: increased turbidity and sedimentation and increased levels of contaminants entering the water column.<br>Increased turbidity (TSS) and sedimentation will occur in Talbingo Reservoir during placement of excavated rock (Royal Haskoning DHV 2018). Elevated TSS and sedimentation will be greatest at the placement area and will decrease with increasing distance. Silt curtains will be used to help contain suspended sediment to the immediate area around the placement site. Elevated TSS and sedimentation can impact the health of aquatic species.<br>Contamination from excavated rock is not expected since most of the rock will come from underground areas associated with the tunnels and underground power station. Some excavated rock will be PAF so excavated rock will be stockpiled and screened for PAF before being allocated for reuse or placement in the reservoir. | Low to moderate (TSS) |
| Dry placement of excavated rock below FSL in Tantangara Reservoir | The Tantangara Reservoir excavated rock emplacement will be constructed immediately below FSL – allowing it to be constructed above the reservoir water level using standard ‘dry’ earthmoving equipment and techniques. As such, impacts to water quality are expected to be low. The final excavated rock placement will be at least 1m above FSL to allow for rehabilitation.<br>Contamination from excavated rock is not expected since most of the rock will come from underground areas associated with the tunnels and underground power station. | Low |

## Table 6.11 Changes to water quality and quantity

| Activity | Impact assessment | Residual risk[1] |
|---|---|---|
| Construction of intakes and dredging and blasting works | Dredging and blasting will cause an unavoidable and localised increase in suspended sediments. Aquatic species in the vicinity of the dredge will be exposed to turbid water and mobile species will move away to clearer water. Receptors likely to occur within the water column include plankton, fish larvae and adult fish. Based on fish populations known to occur within both reservoirs, mostly non-native species including stocked rainbow trout and brown trout and pest redfin perch (in Talbingo Reservoir) would be affected.<br>Silt curtains deployed around the disturbance area will seek to contain turbid water within close proximity to the dredge. Silt curtains would also help to keep fish away from the high impact areas. Pre-clearance surveys prior to disturbance will be undertaken to minimise the risk of harm to Murray crayfish. Results of testing indicated that sediments, if mobilised would be unlikely to present any risk to the aquatic environment via the release of contaminants such as lead, nickel and zinc (Royal Haskoning DHV 2018). | Low |
| Tunnel excavation and dewatering | Impaired water quality could occur in watercourses associated with reduced flow from drawdown. Water quality in disconnected pool habitat could be compromised due to potential for elevated temperatures and reduced concentrations of dissolved oxygen particularly during summer. Affected areas would be relatively minor within the context of each catchment. | Low |
| Transfer of water between reservoirs during operations | The primary impact on water quality in the reservoirs will be changes due to the mixing of the water between the reservoirs. These changes may not be deleterious but will result in a new dynamic equilibrium being established in both reservoirs but most likely with a larger change in the water quality of Tantangara Reservoir as it does not currently receive water from Talbingo Reservoir and its total volume is smaller than Talbingo Reservoir.<br>Only broad conclusions can be drawn because the water quality in each of the reservoirs will depend on the transfer regime and the transfer regime will vary depending on SHL operational decisions. Mixing of the reservoir waters during operations is unlikely to significantly impact pH, electrical conductivity, turbidity, dissolved oxygen concentration (except as a result of temperature changes); nutrients and metals (except for aluminium and copper). The greatest change to reservoir water quality is likely to be in water temperature, particularly in Tantangara Reservoir. | Low |

Notes: 1. Residual risk following implementation of management measures.

### 6.4.5 Mitigation measures

Proposed mitigation measures to reduce or mitigate impacts of the construction and operational activities of Snowy 2.0 Main Works on aquatic ecology are provided in Table 6.13.

**Table 6.13 Mitigation measures for aquatic ecology impacts**

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| Impacts to aquatic habitats | AE01 | An Aquatic Habitat Management Plan will be prepared and implemented to guide management of impacts to aquatic habitat. The plan will:<br>• be prepared in consultation with NPWS and DPI-Fisheries;<br>• include a description of measures that would be implemented to:<br>– protect aquatic habitat outside the approved disturbance areas;<br>– minimise the loss of key aquatic habitat;<br>– minimise the impacts of the development on threatened fauna species;<br>– minimise the impact of the development on fish habitat;<br>– relocate Murray crayfish from the shallower parts of the approved disturbance area in Talbingo Reservoir prior to disturbing these areas<br>– notify DPI-Fisheries of any fish kills;<br>• include a trigger action and response plan for the Murray crayfish, which would be implemented if monitoring shows the development is adversely affecting the species;<br>• include a program to restore and enhance the aquatic habitat of the approved disturbance area expect for the intake and their approach areas as soon as practicable following the completion of development in these areas;<br>• include a program to monitor and report on the effectiveness of these measures. | Construction | Contractor |
| | AE02 | Bridges or culverts would be designed and constructed in accordance with NSW DPI fish passage requirements for waterway crossings (Fairfull & Witheridge 2003). | Construction | Contractor |
| | AE03 | Construction works within the channel of a permanent waterway with type 1 or 2 key fish habitat would allow some flow to maintain fish passage at all times and be staged to minimise the total disturbance at any given time. | Construction | Contractor |
| Spread of weeds pest fish and pathogens | AE04 | A Weed, Pest and Pathogen Management Plan will be prepared and implemented to minimise and manage the spread of weeds, pest fish and pathogens. The plan will:<br>• be prepared in consultation with NPWS and DPI-Fisheries;<br>• include a description of measures that would be implemented to:<br>– minimise the spread of weeds and pest via vehicle and plant movements;<br>– remove aquatic macrophytes appropriately where required to do so to enable construction activities;<br>• include a program to monitor and report distribution of pest fish within the project area;<br>• include a surveillance plan for EHNV in key locations within the project area. | Construction | Contractor |

**Table 6.12 Mitigation measures for aquatic ecology impacts**

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| Underwater blasting impacts | AE05 | Designated blast limits and other management measures to minimise impacts to aquatic ecology will be outlined in the Blast Management Plan. | Detailed design | Contractor |
| Controls | AE06 | Install the following:<br>• fish barrier on Tantangara Creek designed to prevent upstream migration of Climbing galaxias; and<br>• fine mesh screens to prevent transfer of key species through releases from the Tantangara Dam River Outlet Works and the Murrumbidgee – Eucumbene tunnel. | Construction | Contractor |

### 6.4.6 Summary and conclusion

Construction and operational activities associated with Snowy 2.0 Main Works have potential to impact on aquatic ecology in some waterbodies in the project area. After adoption of mitigation measures to reduce impacts where possible, the residual risk for most activities is classified as low. The exceptions are associated with potentially moderate risks associated with the potential transfer of noxious species (fish and/or fish disease) between Talbingo and Tantangara reservoirs, and into associated catchments. Elevated TSS associated with emplacement of excavated rock in Talbingo Reservoir is also classified as moderate.

The management of risks to aquatic ecology will occur via the mitigation measures listed above and through the development of a range of management plans which will contain measures to construct the proposed development in a way that seeks to minimise negative impacts on the aquatic environment.

In response to the risk of fish transfers, Snowy Hydro has incorporated additional secondary controls into the Snowy 2.0 Main Works to prevent fish passage at the outflows of Tantangara Reservoir at the Tantangara Dam wall and Murrumbidgee-Eucumbene Tunnel and above the waterfall on Tantangara Creek. These measures will limit the potential range expansion of any fish that may be transferred as a result of the project and will prevent these fish from entering the known habitats of any threatened species including the Murrumbidgee River below Tantangara Reservoir and Lake Eucumbene. These controls are a result of considerable volumes of research and design development initiated by Snowy Hydro aimed to eliminate the potential risk to pre-existing fish populations and other components of aquatic ecology at risk from fish transfer.

CHAPTER 6.5

# LAND

## 6.5 Land

### 6.5.1 Context

Potential impacts of Snowy 2.0 Main Works on soils and land capability, topography, geotechnical stability and geodiversity values have been assessed. The assessment relies on technical and specialists' reports prepared for the project and should be referred to for detailed information, including:

- a Preliminary Site Investigation (PSI) and Soils and Land Assessment (SLA) prepared by EMM and provided at Appendix N.1 and N.2 respectively;
- two specialist reports addressing Cenozoic and Paleozoic geodiversity values of the project area prepared by Dr Alexa Troedson and Dr Ian Percival and provided in Appendix O.1 and O.2; and
- a rehabilitation strategy for the project prepared by SLR and provided in Appendix F.

These technical reports collectively address potential impacts to land from Snowy 2.0 Main Works and are summarised in this section.

An overview of the existing environment as it relates to land is provided in Table 6.14, along with relevant community and stakeholder views and project design considerations relevant to the assessment.

**Table 6.14 Context of land for Snowy 2.0 Main Works**

| | |
|---|---|
| **Existing environment** | The project area is within the south-eastern portion of the Lachlan Fold Belt of NSW. The geology between Talbingo and Tantangara reservoirs is structurally deformed with numerous folds and several major faults associated with the north-south trending LPF Zone. The project intercepts two major structural blocks. These two structural blocks form distinct geological terrains; the dominantly Silurian Tumut Block in the west (the incised ravine, and the dominantly Ordovician Tantangara Block in the east (the Plateau). The terrains are separated by an escarpment caused by movement on the LPF.<br>The soils of the project area reflect the extreme climatic gradient across the ravine and Plateau, and complex geology on which the soils have formed. Climatic conditions have a more dominant role in soil formation across the alpine and subalpine areas of the Plateau compared to the low-lying areas of the ravine.<br>The range of geologies present has led to a wide variety of soils forming across the project area including Kandosols, Tenosols, Rudosols, Dermosols, Chromosols, Vertosols, Ferrosols and Organosols.<br>The Talbingo Reservoir, Lobs Hole and Marica project areas consist of steep valleys and ravines of the Yarrangobilly River and tributaries. The subalpine Plateau that includes the Tantangara Reservoir project area has had a complex geomorphic history resulting in a landscape of disrupted drainage patterns and swampy basin. The Rock Forest site, situated outside the boundary of KNP, is on relatively gentle slopes.<br>There are several recognised geodiversity features within the project area including and most notably periglacial block streams, Devonian fossiliferous rocks and tufa near Lobs Hole. The Yarrangobilly karst area is recognised for exceptional geodiversity values (KNP PoM) and while it is within the project area, it is some 5 km north of the tunnel alignment.<br>Lobs Hole is the main area of potential contamination concern, due to its previous use as a copper mine and existing areas of identified metal contamination primarily associated with historical stockpiles. Some areas in the project area have also been identified as potentially containing NOA. |

**Table 6.13 Context of land for Snowy 2.0 Main Works**

| | |
|---|---|
| **Community and stakeholder views** | Community and stakeholder views obtained through the preparation of the EIS highlight the need to address:<br>• long term stability of soils and land resources;<br>• progressive rehabilitation of land as well as the agreed state of final rehabilitation;<br>• avoidance and minimisation of impacts to geodiversity in KNP, particularly fossil beds and blocks streams; and<br>• NPWS stated a preference for removing all excavated material placed on land from the KNP post-construction.<br>These views have been considered through the development of the Rehabilitation Strategy (Appendix F) and ongoing design development. |
| **Avoidance and minimisation through design** | A specifically designed hybrid TBM will be used for tunnelling where there is potential for NOA to be encountered, and management measures for handling of this material at the surface.<br>A geotechnical investigation program was undertaken across the project alignment to optimise the design of underground project elements including tunnels, chambers and shafts. Additional geotechnical investigations will be undertaken as part of the Exploratory Works to further refine the underground design.<br>Geological and geotechnical risks have been considered as part of the geotechnical investigation program and project design and included consideration of potential for ground and sub-surface movement. The design of the proposed underground works has incorporated suitable excavation and primary support schemes and construction techniques.<br>The construction method has been developed based on the known geological in-situ stress and strength conditions. |

### 6.5.2 Predicted impacts

Key impacts of Snowy 2.0 Main Works relating to land include the presence of PAF material, NOA, and other contaminating materials in some limited areas that could be disturbed by tunnelling, excavation and other construction activities. Appropriate management measures and protocols are proposed to minimise contamination risks. These activities are also planned to occur through, or in proximity to, identified geodiversity features.

A key impact of the project is the creation of new landforms. These landforms are directly linked to the excavated material management strategy for Snowy 2.0 Main Works and the Rehabilitation Strategy prepared for the project, which have been previously described in Chapter 2. The Rehabilitation Strategy has been developed to provide guidance on the rehabilitation of disturbed areas, as well as final land use consistent with the KNP PoM. The strategy identifies measures to enhance landforms to remain permanently within KNP at completion of construction, and outlines rehabilitation objectives are met.

#### i Talbingo Reservoir

The risk of contamination from construction activities at Talbingo Reservoir are considered to be low. There are no known geodiversity sites near the proposed works in this area.

### ii Lobs Hole

The existing use of Lobs Hole as a remote campground within KNP presents opportunities for the project to enhance recreational values within the KNP. Through the Main Works design process, opportunities to enhance recreational opportunities at Lobs Hole have been identified. Key enhancements to recreation values at Lobs Hole include improving access roads as well as enhancing the geotourism potential of several geodiversity sites.

A conceptual site model for potential contamination impacts at Lobs Hole is provided in Figure 6.17. The main contamination risk at Lobs Hole is associated with disturbance to the existing excavated rock stockpiles associated with the historic Lobs Hole copper mine. There is also risk of contamination impacts from construction of access roads, construction yard and utilities infrastructure with potential to intercept PAF rock at Lobs Hole. Risks of encountering contaminated land during construction in this area will be managed through construction methods and suitable controls.

Geodiversity sites likely to be impacted by Snowy 2.0 Main Works are provided in Figure 6.18. The road upgrades on Lobs Hole Ravine Road will impact on three known geodiversity features; the Ravine block streams, the Ravine tufa and the Devonian fossil beds. The proposed road widening is expected to have some impacts on theses geodiversity features with a disturbance footprint of up to 80 m wide.

The proposed road widening works will be refined through the detailed design process to minimise impacts to the Ravine block streams and Devonian fossil beds. Key considerations in finalising the design will be to minimise the removal or permanent covering of these features. Where permanent covering is required for geotechnical stability and road safety construction methods with low visual impacts will be selected where practical.

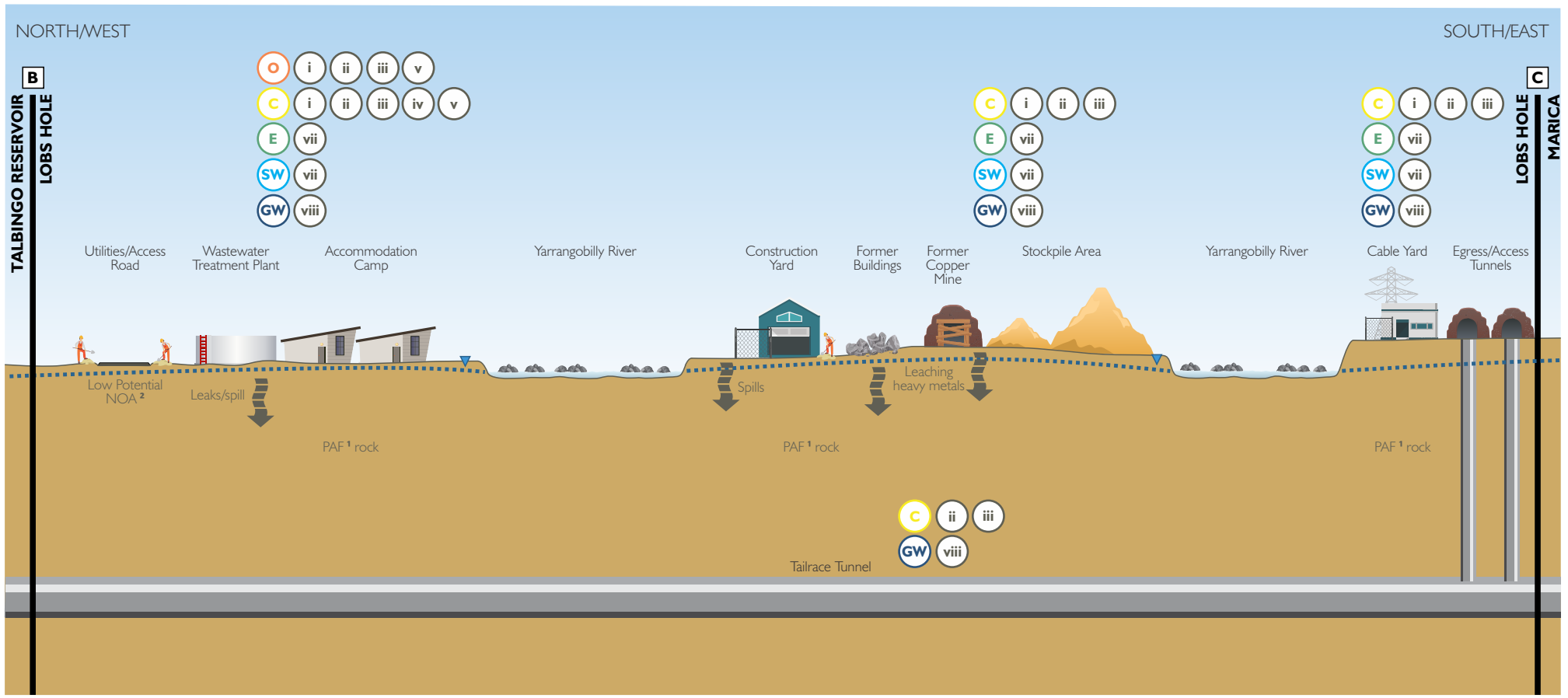
While the proposed works will impact the visible geodiversity features, they will remain largely intact.

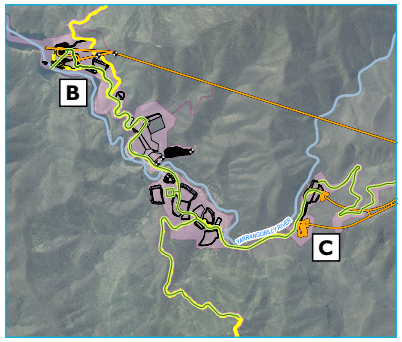
Post construction, the access road works adjacent to the block streams and Devonian fossil beds provide an opportunity to enhance the geotourism potential of these features through the establishment of educational signage.

The road upgrades will not impact any of the high value cliff edge tufa within Cave Gully or Lick Hole Gully. Similarly, vibration impacts to tufa deposits outside the existing roadway are expected to be negligible. Three small tufa outcrops within the existing Lobs Hole Ravine Road corridor will be directly impacted by the proposed road upgrades. These impacts are considered to be minor relative to the remaining areas of high value tufa in the vicinity.

Approximately 1,000,000 $m^3$ of excavated material used for temporary construction pads will remain in Lobs Hole following construction. Temporary construction pad areas will be rehabilitated with some areas in Lobs Hole shaped and landformed. Snowy Hydro will continue to engage with NPWS regarding the longer term use and design of Lobs Hole. Detailed design will follow the principles and concepts in the Rehabilitation Strategy provided in Appendix F to achieve stable non-polluting landforms and recreational areas.

Overall, with careful design the proposed works have potential to avoid significant impacts and enhance the geotourism potential of geodiversity sites on Lobs Hole Ravine Road and recreational opportunities within Lobs Hole.




## Key

Groundwater level

## Receptors

- C Construction workers
- E Terrestrial ecosystem
- SW Surface water and sediment ecology
- GW Groundwater ecosystem
- O Open space/recreational users

## Pathways

- i Dermal contact and incidental ingestion of soil
- ii Inhalation of dust from soil
- iii Dermal contact and incidental ingestion of surface water/groundwater/leachate
- iv Inhalation of soil/groundwater vapours in indoor air
- v Inhalation of soil/groundwater vapours in outdoor air
- vi Inhalation of soil/groundwater vapours within a trench
- vii Plant uptake and/or ingestion by animals
- viii Uptake of CoPC from groundwater (stygofauna and microorganisms)

¹ PAF – Potentially Acid Forming

² NOA – Naturally Occurring Asbestos

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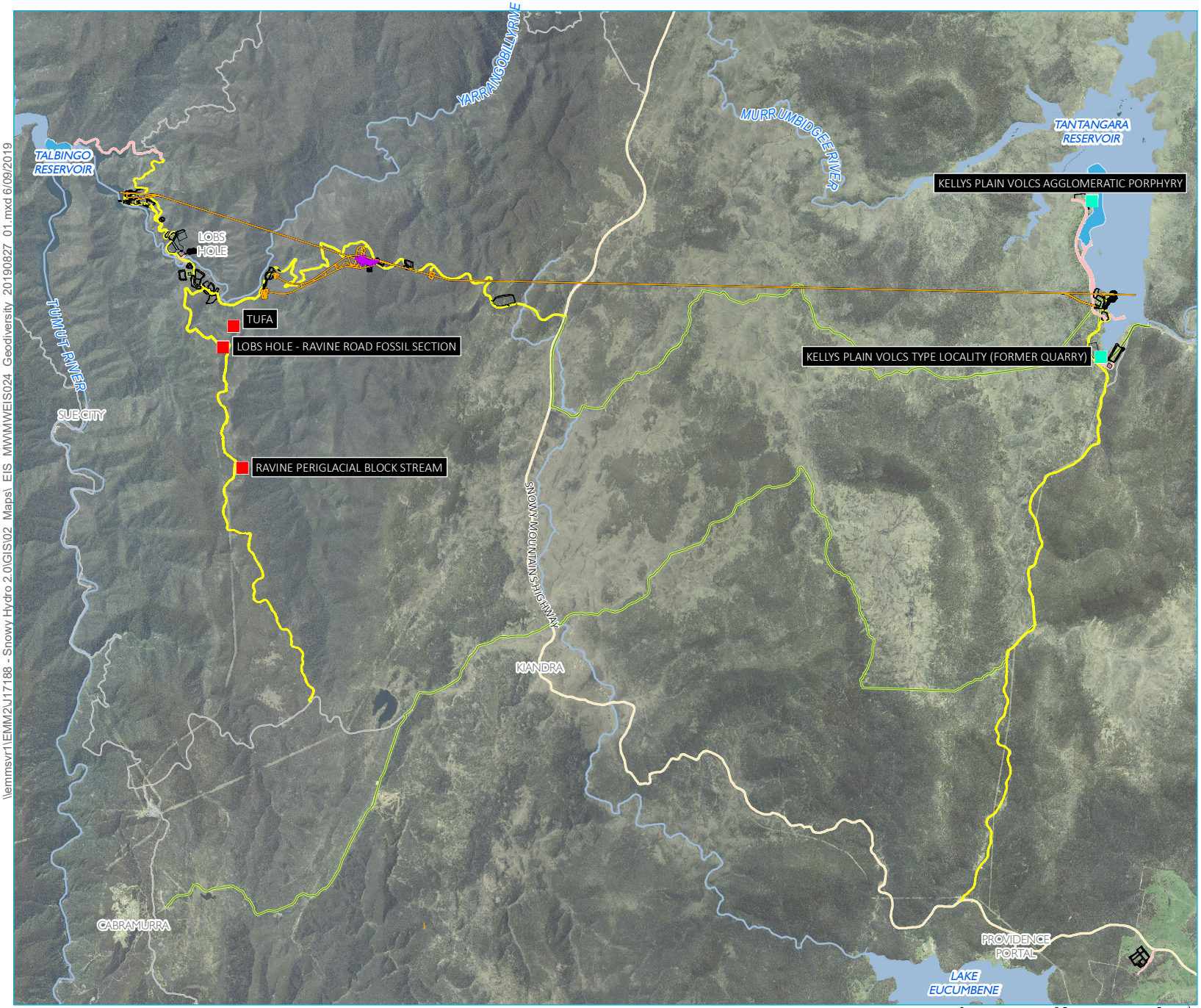
EMM creating opportunities

snowy2.0

Contamination Assessment Conceptual Site Model – Lobs Hole
Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.17

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KEY

Geodiversity sites
- Known site likely to be impacted
- New sites likely to be impacted

Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements
- Temporary construction compounds and surface works
- Temporary access road
- Indicative rock emplacement area

Existing environment
- Main road
- Local road
- Watercourse
- Waterbodies

*Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)*

0 2.5 5 km

GDA 1994 MGA Zone 55

N

Geodiversity sites likely to be impacted

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.18

snowy 2.0

EMM creating opportunities

#### iii Marica

The risk of contamination from construction activities at Marica are considered to be low.

There are no known geodiversity sites near the proposed works in this area. The Yarrangobilly karst area is north of Marica. There is no potential for direct impacts to the Yarrangobilly caves or other geodiversity features of the Yarrangobilly karst area. Indirect impacts to the Yarrangobilly karst area were assessed in the water assessment (Appendix J) and the noise and vibration impact assessment (Appendix R) and no impacts are expected. Permanent infrastructure to remain at Marica includes the Marica Road from the Snowy Mountains Highway (which accesses the MAT and ECVT portals), ventilation shaft and surge shaft yard.

#### iv Plateau

There is risk of encountering NOA through tunnelling across the Plateau. No known geodiversity sites will be impacted in this area. The communications cable, predominantly buried within the Gooandra Track, will be the only permanent infrastructure proposed in this location. The route will intersect some Alpine humus soils and peat bogs/fens, however these impacts are considered to be minor due to the nature of the trenching and underboring activities and subsequent rehabilitation.

#### v Tantangara Reservoir

There is medium risk of contamination impacts from construction activities at the Tantangara accommodation camp and utilities near a former quarry site, Traces Knob. Permanent infrastructure to remain in this area includes the Tantangara intake, upgraded Tantangara Road and utilities. The Tantangara camp will be decommissioned and the landform retained for inclusion in a masterplan for recreational use (eg camping) in consultation with NPWS.

Two sites with geodiversity potential may be impacted in this area. These sites are not listed in the KNP PoM or Kosciuszko National Park Geodiversity Action Plan (KGAP) but were identified as having some geological values from a comprehensive review of existing literature and mapping. These sites are part of the Kellys Plains Volcanics formation and are the former quarry site at Traces Knob and an outcrop of agglomeratic porphyry. The agglomeratic porphyry is within the Tantangara Reservoir FSL and has potential to be impacted by excavated rock emplacement. As the feature is within the existing reservoir the site has already been impacted and is frequently unobservable. The further impacts of covering by the excavated rock emplacement are not practical and therefore, considered unavoidable.

The former Traces Knob quarry may be impacted by construction activities for the Tantangara camp and associated utilities. Impacts to the quarry are considered to be reasonable and are consistent with the principles of avoiding and minimising impacts through the use of previously disturbed areas where practical.

#### vi Rock Forest

The risk of contamination from construction activities at Rock Forest are considered to be low. Also, there are no known geodiversity sites near the proposed works in this area.

### 6.5.3 Mitigation measures

The mitigation measures to be implemented for impacts to land are provided in Table 6.15.

## Table 6.15 Mitigation measures for land impacts

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| Rehabilitation | REHAB01 | A Rehabilitation Management Plan will be prepared for the new landforms at Tantangara Reservoir, Lobs Hole and Talbingo Reservoir. The plan will:<br>• include a detailed plan for rehabilitation of the site;<br>• include detailed performance and completion criteria for evaluating the performance of the rehabilitation of the sites, and triggering any remedial action (if necessary);<br>• describe the measures that would be implemented to:<br>– comply with the rehabilitation objectives and associated performance and completion criteria;<br>– progressively rehabilitate the site;<br>• include a program to monitor and report the effectiveness of these measures. | Construction | Contractor |
| Creation of new landforms | REHAB02 | New landforms will:<br>• be safe, stable and non-polluting;<br>• maximise surface drainage to the natural environment | Construction | Contractor |
| Assessment of surface disturbance and excavation areas | CONTAM01 | Targeted investigations will be undertaken prior to construction along the surface disturbance areas using a risk-based approach. The results of these targeted investigations will determine the level of management to be implemented. | Pre-construction | Contractor |
| Assessment of imported Virgin Excavated Natural Material (VENM) | CONTAM02 | Prior to the importation of any VENM during construction, the VENM source(s) will be identified and assessed against the definition of VENM in the *Waste Classification Guidelines* (NSW EPA 2014) and POEO Act. The VENM source(s) will be assessed by an appropriately qualified contaminated land consultant. | Construction | Contractor |
| Contaminated soil management during construction | CONTAM03 | Protocols for the management of contaminated soil during construction will be included in the CEMP. | Construction | Contractor |
| Excavated rock waste management and transport | CONTAM04 | Material which has been assessed as not suitable for reuse on land or for subaqueous disposal or cannot be reused will be classified in accordance with the *Waste Classification Guidelines* (NSW EPA 2014). The excavated rock would be transported to an appropriate excavated rock disposal area. Approval would be obtained prior to transport and would require an estimate of the likely volume of excavated rock to be disposed. | Construction | Contractor |
| Asbestos management | CONTAM05 | An Asbestos Management Plan (AMP) will be developed for areas and items identified during pre-construction investigations as containing Asbestos Containing Materials ACM (ACM), areas suspected of containing ACM (such as historical buildings) and to address unexpected finds of ACM during construction. Specifically, protocols will be stipulated for separation, monitoring, validation and clearance of asbestos. | Pre-construction | Contractor |
| Asbestos management | CONTAM06 | An Occupational Hygienist (Hygienist) will be on-site for the duration of the excavation works where ACM has been identified from pre-construction or where unexpected finds of ACM are encountered. | Construction | Contractor |

## Table 6.14 Mitigation measures for land impacts

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| PAF rock | CONTAM07 | An Excavated Rock Management Plan would be developed which would include measures identified in the Preliminary Site Investigation – Contamination (Appendix N.1). | Pre-construction | Contractor |
| Unexpected finds | CONTAM08 | An unexpected finds procedure will be included in the CEMP. Workers will be trained to identify potential contamination that may be encountered during construction. | Pre-construction | Contractor |
| Alpine humus soils and peat bogs/fens | SOIL01 | Mitigations will be included in the Rehabilitation Management Plan to minimise impacts to Alpine humus soils and peat bogs/fens. | Construction | Contractor |
| Loss of soil resource | SOIL02 | Preservation of the soil resource including quantity and quality to be managed through the implementation of soil management measures incorporated within the rehabilitation management plan which includes:<br>• an inventory of soils to be stripped, including depths and volumes;<br>• a topsoil stripping and stockpiling procedure;<br>• subsoil management measures; and<br>• a soil reinstatement methodology which includes a topsoil application procedure. | Construction and operation | Contractor |
| Soil erosion and sedimentation | SOIL03 | Site-based Erosion and Sediment Control Plans (ESCPs) will be prepared by a Certified Professional in Erosion and Sediment Control (CPESC) for the construction works with controls addressing the sensitivity and the proximity of the receiving environment and attention will be given to areas where there is an increased risk of erosion, such as, dispersive soils and steep slopes and subalpine landscapes. | Construction | Contractor |
| Soil capability | SOIL04 | The Rehabilitation Management Plan (refer to REHAB01) will be implemented and will include measures to minimise:<br>• loss of soil;<br>• loss of organic matter and nutrient decline;<br>• soil structural decline; and<br>• compaction.<br>The plan will include measures for subsoil management. | Construction and operation | Contractor |
| Geodiversity – Ravine block streams | GEO1 | Design principles identified in the Cenozoic Geodiversity Report will be implemented to minimise impacts to the Ravine block streams during detailed design. | Design and construction | Contractor |
| Geodiversity – Ravine tufa | GEO2 | Design principles identified in the Cenozoic Geodiversity Report will be implemented to minimise impacts to the Ravine tufa during detailed design. | Design and construction | Contractor |
| Geodiversity – Lick Hole Formation fossil locality | GEO3 | Final road design will consider incorporating interpretive signage and safe stopping space within the proposed road and disturbance footprint where practical. | Construction | Contractor |
| Geodiversity – Kellys Plain Volcanics Type Locality | GEO4 | During construction, ensure that the former Traces Knob quarry is not in-filled. | Construction and operation | Contractor and Snowy Hydro |

**Table 6.14 Mitigation measures for land impacts**

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| Geodiversity – Kellys Plain Volcanics agglomeratic porphyry | GEO5 | Identify outcrops of agglomeratic porphyry prior to construction at Tantangara portal. Excavated rock placement should leave some of the best examples of the agglomeratic porphyry uncovered. | Pre-construction, construction and operation | Contractor and Snowy Hydro |
| Geodiversity | GEO6 | A management plan will be prepared that includes measures that minimise impacts to known geodiversity sites and potential undocumented geodiversity sites identified in accordance with the recommendation in the Cenozoic and Paleozoic Geodiversity reports. | Construction | Contractor |
| Geodiversity | GEO7 | Consult with NPWS regarding opportunities to enhance the geotourism potential of impacted geodiversity sites through the development of the masterplan for recreational use. | Operation | Snowy Hydro |

### 6.5.4 Summary and conclusion

Key contamination matters relevant to land identified include contamination risks associated with PAF material at Lobs Hole and NOA materials at the Plateau that may be encountered during excavation works. Appropriate management measures and protocols are proposed to minimise contamination risks.

A Rehabilitation Strategy has been prepared to provide a final and end land use consistent with the KNP PoM. Work methods will implemented management measures to minimise impacts to soils and land capability. The proposed construction works have potential to impact on three known geodiversity sites and two potential newly identified geodiversity sites. Measures will be implemented to minimise impacts, manage and enhance the geodiversity sites identified and it is expected that the geodiversity values of the impacted sites will be maintained.

Impacts to land have been considered through the design of the Snowy 2.0 Main Works and risks and sensitivities for contamination, soils and land capability, rehabilitation and geodiversity were assessed and suitable management measures identified. With the implementation of the proposed management measures it is expected that the project will minimise impacts to land and achieve an end land use consistent with the KNP PoM.

CHAPTER 6.6

# NATIONAL HERITAGE VALUES

## 6.6 National heritage values

Snowy 2.0 Main Works is within the listed boundaries of two National Heritage places:

- Australian Alps National Parks and Reserves (AANP) – Place ID 05891; and
- the Snowy Mountains Scheme – Place ID 105919.

National Heritage places are protected under the EPBC Act and are deemed MNES under the EPBC Act. An assessment of cultural and heritage impacts of the project including the listed values of the AANP and Snowy Mountains Scheme and the cultural values of KNP is detailed in the heritage assessment and statement of heritage impact (HA&SoHI) (Appendix P.2) and the Aboriginal cultural heritage assessment report (ACHAR). The KNP is not listed as a National Heritage place individually but is one of the 11 National Parks and Reserves that comprise the AANP.

The AANP features both natural and cultural listed values. Impacts to the natural heritage values of the AANP have been assessed based on the results of several specialist studies related to geological, landscape, recreational and ecological values, which have been prepared to support this EIS.

### 6.6.1 Context

An overview of the heritage values of the AANP, Snowy Mountains Scheme and KNP are provided in Table 6.16, along with relevant community and stakeholder views for each item and project design considerations. The boundaries of these items are shown on Figure 6.19.

**Table 6.16 Existing environment relevant to National heritage places**

| Existing environment | Community and stakeholder views | Avoidance and minimisation through design |
|---|---|---|
| Australian Alps National Parks and Reserves | | |
| The AANP is the mountainous bioregion that extends over NSW, ACT and Victoria. Snowy 2.0 Main Works is wholly within the boundaries of the listed place, except for Rock Forest which directly borders part of the place's eastern boundary (refer Figure 6.19). The AANP has outstanding heritage value to the national because of the place's importance in the course, or pattern, of Australia's nature and cultural history. The AANP is part of a unique Australian mountainous region. Human interaction with the region has been distinctive in its response to the challenges and opportunities present by the unique environment (Commonwealth of Australia Gazette 7 Nov.2008). The AANP listed National Heritage values are presented according to which significance criteria they fulfil. The AANP fulfils the threshold of six criteria which are provided in Table 6.17 | SEARs issued by DPIE require the impacts to National Heritage place's official values to be addressed in the EIS. Consideration and assessment of impacts to the KNP geology, ecology, cultural heritage, recreation and landscape that contribute to some of the official values have been addressed in relevant specialist studies. Relevant impacts and issues are summarised in Table 6.17. | The design measures employed to avoid and minimise impacts to geological, ecological cultural heritage, recreational and landscape values have been assessed.<br>Key design considerations to minimise impacts have been through a primarily underground design (minimised surface disturbance footprint) and developing opportunities for the public to explore and appreciate the KNP's significant values. |

**Table 6.15 Existing environment relevant to National heritage places**

| Existing environment | Community and stakeholder views | Avoidance and minimisation through design |
|---|---|---|
| **Snowy Mountains Scheme** | | |
| The Snowy Mountains Scheme was constructed between 1949 and 1974. It is the largest public works engineering scheme ever undertaken in Australia. It is nationally significant for its engineering success and as a symbol of Australian achievement (Commonwealth of Australia Gazette 14 October 2016).<br>Snowy 2.0 Main Works is wholly within the boundaries of the listed place, except for Rock Forest which directly borders part of the place's eastern boundary. The Snowy Mountains Scheme listed National Heritage values are presented according to which significance criteria they fulfil. The Snowy Mountains Scheme fulfils the threshold of six criteria which are provided in Table 6.6. | No specific concerns related to the place's official heritage values were raised by community or stakeholders.<br>Snowy Hydro, who manage the legacy of the Snowy Mountains Scheme, is supportive of the project and view it as a means to facilitate the expansion of the original engineering achievement into the current generation. | Not applicable. |
| **Kosciuszko National Park** | | |
| The cultural heritage of KNP encompasses many places and themes. It contains a great number of heritage sites, structures and artefacts and innumerable intangible values, some of which are recognised and celebrated nationally, while others are significant to particular groups, communities, families or individuals. The KNP features cultural values related to Aboriginal heritage, pastoralism, huts, mining, water harvesting, scientific research, conservation and recreation.<br>Snowy 2.0 Main Works is wholly within the boundaries of KNP except for Rock Forest.<br>The Aboriginal and historical heritage cultural values affected by the project area primarily addressed in the relevant technical assessments in Appendices P.1 and P.2. respectively. | The historical and Aboriginal cultural heritage assessments included community consultation to gather cultural and historical information about the project area. These are documented in Appendices P.1 and P.2.<br>No specific concerns related to the KNP's conservation or scientific values were identified.<br>Community and stakeholder views relating to recreational values are addressed in Appendix Y. | Measures to avoid historical and Aboriginal cultural heritage items are documented in Appendices P.1 and P.2. These studies detail extensive archaeological survey, and test excavation where relevant, which has resulted in the identification and avoidance of historical and Aboriginal sites where feasible. This includes avoidance of historical items Ravine Cemetery and Washington Hotel at Lobs Hole and an Aboriginal rock shelter at Tantangara Reservoir. |

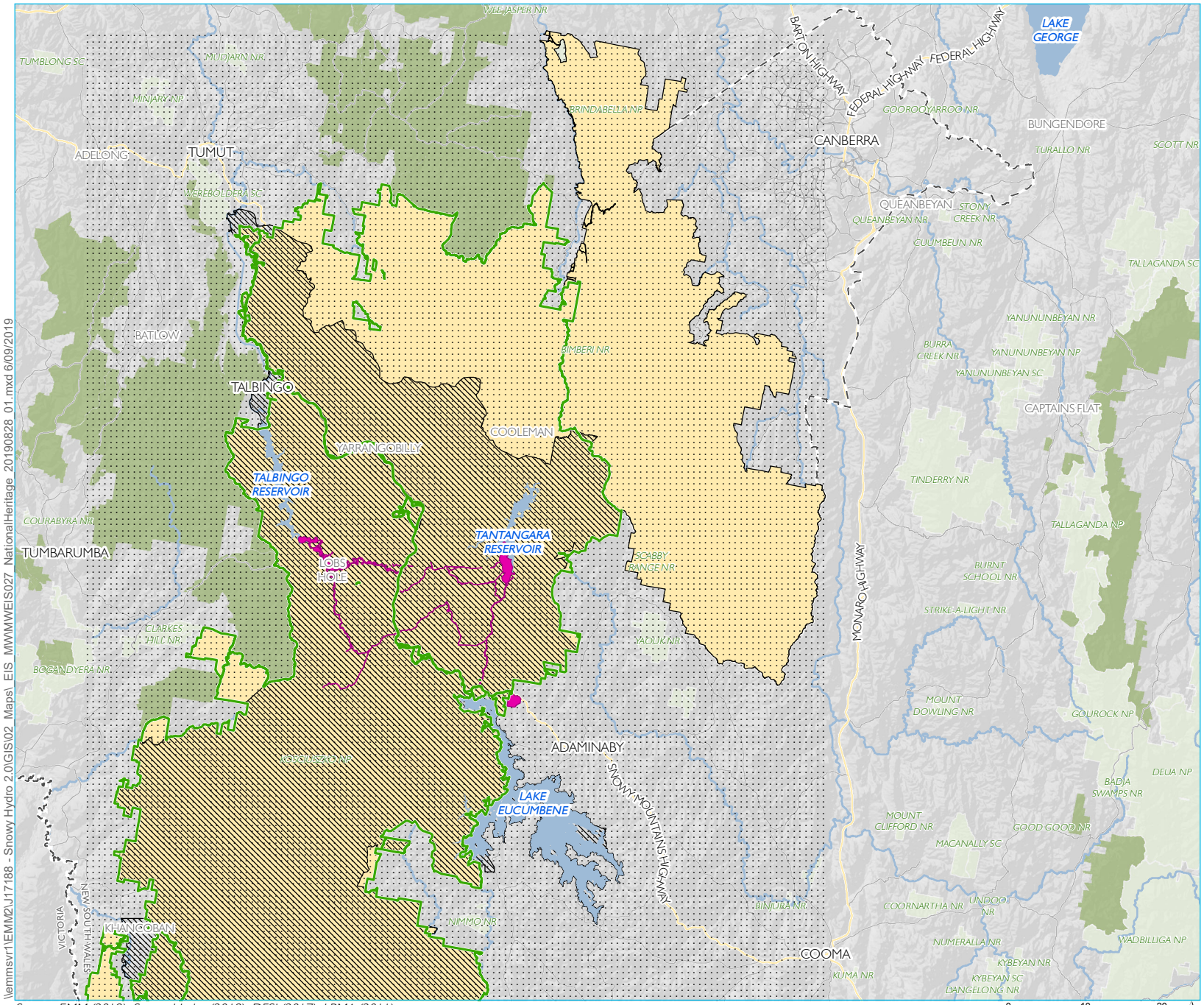
### 6.6.2 Predicted impacts and mitigation measures

A referral under the EPBC Act for Snowy 2.0 Main Works was submitted to DEE on 21 October 2018. The referral nominated that Snowy 2.0 Main Works had the potential to have a significant impact on the nominated National Heritage places, although the level of impact was not determined at the time of lodgement. Accordingly, DEE determined that the project is a controlled action with a controlling provision including National Heritage places.

The project has several elements that will result in direct impacts within the AANP and Snowy Mountains Scheme National Heritage place boundaries and the non-listed KNP boundaries. A summary of the impact assessment and mitigation measures for the AANP, Snowy Mountains Scheme is provided in Table 6.17 and Table 6.18. A summary of the impact assessment and mitigation measures the non-National Heritage listed cultural values related to the KNP is provided in sections 6.7 and 6.8and detailed in the ACHAR and HA&SoHI (Appendices P.1 and P.2).

Consideration of cumulative impacts from the approved Exploratory Works and the proposed Snowy 2.0 Transmission Connection project (a separate application by TransGrid, SSI-9717) was made for the AANP, Snowy Mountains Scheme and KNP. Exploratory Works was not determined to have a significant impact on MNES and was therefore not a controlled action. Accordingly, Exploratory Works will be a minor cumulative addition to the impacts of the current project.

The Snowy 2.0 Transmission Connection project is a controlled action with the relevant controlling provisions of National Heritage places, listed threatened species and communities and listed migratory species. However, the Snowy 2.0 Transmission Connection project is considered to represent a minor cumulative addition to the impacts of the current project considering it is relatively lesser in scope of disturbance and geographic extent. Impacts of the Snowy 2.0 Transmission Connection project will be addressed in a separate application and EIS.

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*Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)*

## KEY

- Kosciuszko National Park boundary
- Disturbance area*

EPBC Act matters of national environmental significance: National Heritage List

- Place ID: 105891 - Australian Alps National Parks and Reserves
- Place ID: 105919 - Snowy Mountains Scheme

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- NPWS reserve
- State forest
- State boundary

Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

# National heritage listing boundaries (AANP and Snowy Mountains Scheme) and KNP boundary

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.19

snowy 2.0

EMM creating opportunities

## Table 6.17 Australian Alps National Park impact assessment and mitigation

| Official values | Impact assessment and proposed management and mitigation |
|---|---|
| **Criterion A Events and processes** | |
| **Glacial and periglacial features** | |
| The assemblage of glacial deposits and features in the AANP includes five alpine lakes, thirteen cirques and associated moraines, ice-grooved and polished pavements and erratic boulders. Periglacial features, both fossil and modern, include block streams, permafrost and solifluction deposits. These features are the material expression of the cold-climate, high-altitude history of the AANP, unique in the low-latitude, low-altitude Australian continent. The glacial and periglacial features contribute uniquely to our understanding of the nature of landscape response to climate during the ice ages of the late Quaternary and into the present and therefore has outstanding heritage value to the nation for its importance in the pattern of Australia's natural history (Percival 1985; Galloway 1989; Yeates 2001a; ISC 2004; AALC 2006). | Snowy 2.0 Main Works will impact on five periglacial block streams through roadworks on Lobs Hole Ravine Road in the Ravine area of KNP. Block streams are linear deposits of boulders and cobbles, formed where periglacial conditions have promoted the frost-induced fracture of bedrock outcrops and subsequent en masse down-slope movement of the coarse rock debris under the influence of interstitial ice (Wilson 2007).<br><br>The Cenozoic geodiversity assessment detailed the significance and potential for impacts to these features (Appendix O.2). This report found that the Ravine block streams have significance for their cultural value due to their potential use in geo-tourism and earth science education. They are part of the story of the ice age heritage of the park, a spectacular example of the effects of periglacial processes, and a prominent testament to late Quaternary climate change. Of additional interest are the visible ridges on the surface of Block Stream B which can be inferred to relate to ice age depositional processes. Intermittent views of the block streams can be obtained at various points on Lobs Hole Ravine Road.<br><br>These block streams are bisected by the existing Lobs Hole Ravine Road and would be impacted further by project road upgrades. A proposed 80 m wide road corridor has been identified as the maximum extent of impact to the Ravine boulder streams. Snowy 2.0 Main Works are expected to negatively impact the boulder streams through the permanent removal and covering of boulders by the proposed roadworks. The extent of periglacial block streams in this area was mapped as part of the Cenozoic geodiversity assessment which demonstrated that even with the maximum impact occurring a significant extent of boulder streams would remain present in the Ravine area. The Cenozoic geodiversity assessment also identified several additional sites where undocumented periglacial features are likely to occur in the northern section of KNP.<br><br>To manage the potential impacts to the Ravine block streams several management measures are proposed and are detailed in Section 4.3 of the Cenozoic geodiversity assessment. Measures to be implemented to minimise impacts to the Ravine block streams include selection of construction methods that minimise the road footprint and the visual impacts of the works during detailed design as well as additional field mapping and regular monitoring of block streams during construction. In addition, measures have been identified to enhance the geo-tourism potential of the block streams by providing educational signage and safe stopping space within the proposed road and disturbance footprint where practical. |

## Table 6.16 Australian Alps National Park impact assessment and mitigation

| Official values | Impact assessment and proposed management and mitigation |
|---|---|
| | It is expected that the Ravine block streams will be directly impacted by project road works, but that they will maintain their potential to contribute to our understanding of the nature of landscape response to climate during the ice ages of the late Quaternary. The design of the project road works, and implementation of proposed mitigation measures will ensure that the Ravine block streams maintain and enhance their values as spectacular landscape features that demonstrate glacial and periglacial processes and patterns in Australia's natural history. Therefore, Snowy 2.0 Main Works will not diminish the geoheritage values of the Ravine block streams and with the implementation of the proposed mitigation measures will enhance their geodiversity and geo-tourism potential. |
| **Fossils** | |
| The Mt Howitt fish fossil site demonstrates remarkable fossil species diversity and preserves fish fossils across a wide range of life stages from larvae to mature fish, over tens of millions of years. The site contributes an important narrative about the evolution of fish across a number of different marine and freshwater environments, and the development of features that enabled vertebrates to leave the water to exploit terrestrial environments for the first time. Fossils revealed at the site have outstanding heritage value to the nation for their place in vertebrate evolution during the so-called 'Age of Fish' (Vickers-Rich and Rich 1993; Cook ed. 2007). | Not applicable. This value relates to Mt. Howitt fish fossil site which is not within the project area and will not be affected by Snowy 2.0 Main Works. |
| **Karst** | |
| The Yarrangobilly karst area contains an outstanding collection of surface karst features including gorges, arches, blind valleys, springs and pinnacle fields. It also contains several hundred caves including six show caves with many intricate cave decorations, open for public viewing (ISC 2004). Yarrangobilly has yielded valuable information on the long-term dynamics of landscape formation. The thick flowstone sequences in Jersey Cave span half a million years and provide the longest continuous fire history record from a single site in Australia (DEH 2006b). Yarrangobilly has outstanding value to the nation for its features and karst processes evident in the limestone karst landscape. | The potential for impacts to karst features in the Snowy 2.0 Main Works project area were addressed in the Paleozoic geodiversity report (Appendix O.1). The report found that no features of the Yarrangobilly karst area will be impacted by the project. No direct construction impacts will occur as all construction works are remote from the Yarrangobilly karst area.<br>The Paleozoic geodiversity report also identified that of particular importance to karst sites is the preservation of the existing hydrology regime. As documented in the Snowy 2.0 Main Works water assessment (Appendix J) it is considered highly unlikely that the proposed tunnelling and excavation works would result in any hydrology impacts in the Yarrangobilly karst area.<br>Therefore, the project is not expected to impact on karst features of the Yarrangobilly karst area or their value to the nation for its features and karst processes evident in the limestone karst landscape. |

## Table 6.16 Australian Alps National Park impact assessment and mitigation

| Official values | Impact assessment and proposed management and mitigation |
|---|---|
| **Biological heritage** | |
| The Alps are one of eleven sites recognised in Australia by the IUCN as a major world centre of plant diversity. During the late Quaternary and into the present, the high-altitude, cold-climate environment has provided refuge for species in an increasingly arid climate. Containing most of the contiguous montane to alpine environments in Australia, the AANP supports a rich and unique assemblage of cold-climate specialist species that have evolved unique physiological characteristics, enabling them to survive in an environment subject to extreme climate variation. Outstandingly rich flora taxa in the AANP include the daisies (Asteraceae), willow-herbs (Onagraceae), starworts and cushion-plants (Caryophyllaceae), southern heaths (Epacris), bottlebrushes (Callistemon), orchids (Pterostylis, Prasophyllum and Dipodium) and pimeleas (Thymaelaeaceae). Cold-climate adapted and endemic fauna species include the mountain pygmy-possum (Burramys parvus), the alpine she-oak skink (Cyclodomorphus praealtus), Snowy Mountains rock skink (Egernia guthega), Baw Baw frog (Philoria frosti), southern corroboree frog (Pseudophryne corroboree), and the northern corroboree frog (P. pengilleyi). Species of a great many invertebrate taxa are endemic to the Alps. These include stoneflies, caddisflies, mayflies, grasshoppers, and earthworms. Many display cold-climate adaptations, such as the mountain grasshopper (Acripeza reticulata), mountain spotted grasshopper (Monistria concinna) and alpine thermocolour grasshopper (Kosciuscola tristis). The Bogong moth undertakes regular migration in Australia and an essential part of its lifecycle occurs within the AANP. The AANP is a vital refuge for alpine and sub-alpine flora and fauna species, with a high level of richness and endemism across a wide range of taxa, and therefore has outstanding value to the nation for encompassing a significant and unique component of Australia's biological heritage (Nankin 1983; Costin 1989; Strahan 1995; Good 1995; Boden and Given 1995; WWF and IUCN 1995; Cogger 1996; Crabb 2003 Good 2003; ISC 2004; DSE 2005; AALC 2005; DEC 2006; McDougall & Walsh 2007, ANHAT 2007). | The relevant species listed under the biological heritage values which were recorded within and adjacent to project area include Alpine She-oak Sink, Mauve Burr-daisy (*Calotis glandulosa*), Max Mueller's Burr-daisy (*Calotis pubescens*), *Prasophyllum innubum*, Kiandra Leek Orchid (*Prasophyllum retroflexum*), *Pterostylis alpina* and Slender Greenhood (*Pterostylis foliata*).<br><br>Additionally, extensive surveys have resulted in an increased knowledge of the critically endangered Smokey Mouse. The species was only previously recorded three times within KNP. Following remote surveys, the species is now known from 70 locations within KNP. These surveys have significantly expanded the species known distribution within KNP. Providing further information around associated vegetation communities and altitudinal preference.<br><br>For further detailed assessment on threatened flora and fauna within the KNP, please refer to the biodiversity assessment development report (Appendix M.1).<br><br>Mitigations for project-related impacts include credit species offsets which will apply to affected species, weed protocols to ensure no introduced species will result from the project, and the prevention of the spread of existing exotic species. |

## Table 6.16 Australian Alps National Park impact assessment and mitigation

| Official values | Impact assessment and proposed management and mitigation |
|---|---|
| **Moth feasting** | |
| The use of an adult insect – the Bogong moth – as the basis for past large-scale annual gatherings of different Aboriginal groups for ceremonies sets the gatherings in the AANP apart from other Aboriginal ceremonial gatherings and has captured the Australian imagination, making it exceptional in Australia (White 2006). Therefore the AANP has outstanding heritage value to the nation because of the importance of Aboriginal social gatherings based on moth feasting in the course, or pattern, of Australia's cultural history | The areas associated with moth feasting are relatively place specific and refer to travel routes, ceremonial places and rock tors that host bogong moths. The Kiandra Plateau would have been traversed by people making their way between important localities such as the Bogong Mountains to the north and Jagungal in the south that were associated with moth feasting and ceremonies (Knight 2009). Moth feasting localities such as rocky tors are, however, generally absent from the project area. The exception is a large rock shelter site at Tantangara which is near to but nevertheless outside the project disturbance footprint.<br>Impacts to the Kiandra Plateau in which travel would have occurred will include road access (most of which currently exists) and the installation of communication cabling within existing road corridors. Such impacts to the landscape can be considered minor and certainly visually insignificant. Impacts would not occur to known moth feasting locales or areas associated with moth feasting ritual activity. Therefore, no moth feasting places, or areas associated with moth feasting will be impacted as a result of the proposed action. The project will not cause a significant impact to the National Heritage values of moth feasting in the AANP. No mitigation is required. |
| **Transhumant grazing** | |
| The AANP has outstanding heritage value for its association with historic transhumant grazing that commenced in the 1830s. The practice of using alpine high plains to graze stock during the summer months was a significant pastoral activity of the nineteenth and twentieth centuries and was continuously practised for a period of over 150 years; making a considerable contribution to the early pastoral industry of south-east Australia. Transhumant grazing created and sustained a distinctive way of life that is valued as an important part of Australia's pioneering history and culture. Evidence of transhumant grazing includes huts, the former grazing landscapes, stock yards, and stock routes. | All areas in which impacts would occur, including Talbingo, Lobs Hole, Marica, the Plateau and Tantangara were used in the past for transhumant grazing. The evidence of transhumant grazing including huts, stock yards and stock routes occur within the general area of the disturbance area, however, the primary evidence is old stock fences lines, many of which occur within the project disturbance footprint. No huts or stock years occur within the project disturbance footprint.<br>The impact assessment as presented in the HA&SoHI (Appendix P.2) has determined that impacts to stock fences range from negligible or little in most instances, to moderate in a few.<br>In order to minimize impacts to the official value of transhumant grazing, management and mitigation measures have been proposed as set out in the HA&SoHI (Appendix P.2). These include measures such minimizing impacts as much as possible, the establishment of no-go zones, archival research and archival recording.<br>Snowy 2.0 Main Works will not cause a significant impact to the National Heritage values of transhumant grazing in the AANP. |
| **Scientific research** | |
| The AANP has outstanding heritage value for the scientific research that has taken place since the 1830s, demonstrated by the density and continuity of scientific endeavour. Research sites within the AANP include those relating to botanical surveys, soil conservation exclosures, karst research, fauna research, meteorology, fire ecology plots, arboreta and glacial research sites. Space tracking undertaken in the ACT with Honeysuckle Creek Tracking Station having played a significant role in the Apollo 11 moon landing mission. | The additional scientific research that has been completed for the Snowy 2.0 project (Exploratory Works and Main Works) will constitutes a positive impact which will be built upon subsequent to project approval. This includes significant ecological findings (eg endangered Smoky Mouse and bogs and fens), additional investigation into geodiversity and its public accessibility and interpretation, and increased evidence of Aboriginal and historical occupation of the KNP. |

## Table 6.16 Australian Alps National Park impact assessment and mitigation

| Official values | Impact assessment and proposed management and mitigation |
|---|---|
| **Water harvesting** | |
| Water harvesting in the AANP has outstanding heritage value to the nation for its contribution to the social and economic development of Australia. Water harvested from headwaters in the AANP contributes to the water needs of Canberra and Melbourne. The Snowy Scheme and the Kiewa Valley Hydro-electric Scheme also contributes to the electricity needs of south-eastern Australia. Both schemes were major post-war reconstruction projects, encouraging migration to Australia and employing over 60,000 displaced persons from post war Europe. Evidence of water harvesting in the AANP for power and irrigation includes the major pondages along with the numerous tunnels, aqueducts, power stations, huts, roads and former settlements, town and work camp sites. | Snowy 2.0 Main Works is based on a water recycling system and accordingly, any potential net loss in the water harvesting scheme is considered negligible. The proposed impacts would have a neutral impact on the water harvesting values of the AANP.<br>In regard to the use of water for the production of electricity, the project rationale is to significantly increase the electricity generating capacity of the Snowy Mountains Scheme.<br>The project will not cause a significant impact to the National Heritage values of water harvesting in the AANP. |
| **Recreation** | |
| The AANP has outstanding heritage value for the longevity and diversity of its recreational use. Snow sports commenced in Kiandra in 1861 with the establishment of the Kiandra Snowshoe Club and expanded from an ad hoc activity by enthusiasts to a multi-million dollar snow sport and tourism industry characterised by the groomed ski slopes, ski lift infrastructure and substantial village resorts. The chalets supported by government were major features of the expanding activity and were established in scenic locations in the early twentieth century when mountain retreats were highly regarded for good health. These include the Mount Buffalo Chalet, the Yarrangobilly Caves House Precinct, the Chalet at Charlottes Pass, and the former Hotel Kosciuszko and Mount Franklin Chalets. | Potential impacts to recreational values of KNP are documented in TRC Tourism (2019, Appendix Y). The listed recreational sites contributing to the heritage values of AANP will not be impacted by Snowy 2.0 Main Works.<br>The nearest snow sport centre is Selwyn Snowfields, a small ski field on the Kings Cross Road, off Link Road. No direct impacts to the use of this area is expected, however there will be indirect impacts associated with an increase of construction vehicles utilising the Snowy Mountains Highway and Link Road. Recreational uses potentially impacted by the project are limited to sites at Lobs Hole (remote camping, 4WD) and Tantangara (remote camping, fishing, 4WD, horse riding). At the end of construction, public access will be reinstated except where there is a risk to public safety (eg within reservoirs near operational intake structures).<br>Snowy 2.0 Main Works will not impact the National Heritage values of recreation in the AANP. |
| **Criterion B Rarity** | |
| **Landscape and topography** | |
| The high altitudes of the plateaus and peaks in the AANP are prominent in a continent with an average elevation of only 330 m above sea level. The AANP includes most of continental Australia's peaks over 1,700 m and all of those over 1,900 m. These high peaks and plateaus contain the vast majority of alpine and sub-alpine environments in Australia. The AANP experiences extensive snow coverage on a seasonal basis, and its glacial lakes are the only wetlands on the Australian mainland covered by ice sheets in winter. The high-altitude landscape of the AANP has outstanding heritage value to the nation for its topographic heights, uncommon alpine and sub-alpine ecosystems and glacial lakes. (AALC 2005; DEC 2006; Geoscience Australia 2007). | The landscape values of KNP have been assessed in Spackman Mossop Michaels (Appendix S) as relevant to Snowy 2.0 Main Works. The sensitivity of the existing landscape character to change is recognised as high due to its scenic quality, landforms and topography, alpine vegetation, and many other unique characteristics. While the assessment concludes that landscape character impacts are higher during construction, rehabilitation of disturbed areas is expected reduce these impacts during operation.<br>Permanent structures to remain within KNP will be new elements in the landscape. However, these are largely within previously disturbed areas or are consistent with the presence of other infrastructure established during the existing Snowy Mountains Scheme and familiar to visitors of KNP (such as the existing reservoirs and buildings). A number of design measures have been recommended to minimise the visual and landscape impacts of Snowy 2.0 Main Works on KNP. |

## Table 6.16 Australian Alps National Park impact assessment and mitigation

| Official values | Impact assessment and proposed management and mitigation |
|---|---|
| **Glacial and periglacial features** | |
| Continental Australia and its southern territorial islands have experienced periods of historic glaciation, with current snow and ice coverage limited to the highest peaks and altitudes. On mainland Australia, the AANP preserves a concentration of glacial and periglacial features without comparison from the ice ages of the late Quaternary Period. The Kosciuszko Plateau is unique in mainland Australia as the only place irrefutably exhibiting landforms shaped by Late Pleistocene glaciers during a series of glacier advances known as the Late Kosciuszko Glaciation. The active and fossil periglacial landforms of the AANP include block streams and solifluction features (solifluction is the gradual movement of waterlogged soil down a slope, especially where percolation is prevented by a frozen substrate). They are the most striking and extensive in mainland Australia and demonstrate the widespread effects of cold climate in the Quaternary, mild climate in the Holocene and the absence of intensive Pleistocene ice modification of the elevated landscape of the Victorian and ACT Alps. Therefore the AANP has outstanding heritage value to the nation for containing uncommon glacial and periglacial features (Percival 1985; Yeates 2001; Barrows et al. 2001). | The potential impacts and management for glacial and periglacial features are addressed under Criterion A in this table. The project will have minimal effect on the rarity of these values because the Cenozoic geodiversity assessment identified that a significant extent of block streams would remain present in the Ravine area, despite there being impacts proposed to five periglacial block streams (Appendix O.2).<br>The affected uncommon periglacial features will be showcased by providing interpretive signage and safe stopping space within the proposed road and disturbance footprint where practical.<br>This has the potential to enhance the geo-tourism value of the periglacial features. |
| **Fossils** | |
| The Mt Howitt fish fossil site is globally rare because it preserves a diverse array of fossil fish in uncommon detail at all stages of their lives. It is unique nationally in providing a snapshot of a complete freshwater vertebrate community from the past, and for yielding fossils from all stages of growth of a species, from tiny fish larvae to adult fish, and therefore has outstanding heritage value to the nation because of its preservation of an uncommon aspect of Australia's natural history (Long 2002; Cook ed. 2007). | Not applicable. This value relates to Mt Howitt fish fossil site which is not within the project area and will not be affected by the project disturbance footprint. |

## Table 6.16 Australian Alps National Park impact assessment and mitigation

| Official values | Impact assessment and proposed management and mitigation |
|---|---|
| **Alpine and sub-alpine ecosystems** | |
| The AANP has outstanding heritage significance to the nation for possessing extremely uncommon aspects of Australia's natural history. Alpine and sub-alpine ecosystems are uncommon in the generally arid and warm climate of Australia. The distribution of cold-climate species on the mainland retreated to the higher altitudes of the Alps in the Late Pleistocene as conditions began to warm up. The AANP contains most of the alpine and sub-alpine ecosystems on mainland Australia, supporting flora and fauna species that have evolved to the harsh conditions of the high altitudes. Many of these species are endemic to the Alps and are found nowhere else in Australia. The bog and fen groundwater communities are supported by organic soils and contain exceptional water retention properties. These communities play an integral role in ecosystem function by regulating the slow release of water from saturated peatbeds to the surrounding alpine humus soils, streams and other alpine communities (Good 1995; AALC 2006b). | The BDAR completed for the project assessed the impacts to Alpine and sub-alpine peatlands, damp herbfields and fens which are referred to as 'Alpine Sphagnum Bogs and Associated Fens' (Appendix M.1). Direct impacts to these ecosystems have been largely avoided during the detailed design process by review and redesign of proposed infrastructure and comms line routes. Small areas where comms routes intersect with the ecosystems will be offset in accordance with the biodiversity offset framework outlined in Appendix M.1.<br>As a result of the measures to avoid and minimise impacts, particularly removal of large sections of the project area across the plateau area, there has a been a significant reduction in impacts to this community. Snowy 2.0 Main Works will result in a residual impact to 3.94 ha of the community, representing 0.04% of the national extent of the community. A further 17.51 ha is mapped within the groundwater drawdown area and may be subject to impacts arising from changes in hydrology. The scale and extent of these impacts are unknown and will be subject to ongoing monitoring.<br>For further detailed assessment on threatened flora and fauna within the KNP, refer to the BDAR (Appendix M.1). |
| **Eucalypt flora community** | |
| The AANP provides an outstanding example of the adaptability of a plant genus, the genus Eucalyptus, along a steep topographical transect. The eucalypts dominate the AANP vegetation from the lowlands to as high as the alpine region, where the snow gum (E. pauciflora) defines the treeline. Much of the highest land in Australia occurs within the AANP, which also demonstrates very large topographical variations, which in turn is reflected in the high diversity of eucalypt species replacing each other along the altitudinal and climatic gradient (Costin 1988; Kirkpatrick 1994; ISC 2004; ANHAT 2007). | A key focus of design for Snowy 2.0 Main Works has been to avoid and minimise impacts to biodiversity values, including Eucalypt flora communities. Eucalyptus species provided important habitat and food supply for a variety of threatened fauna species. Where viable, high condition vegetation has been avoided, utilising existing tracks and low condition vegetation where Eucalypts are not present. Areas where Eucalyptus communities were unable to be avoided will be offset in accordance with the biodiversity offset framework as discussed in the BDAR (Appendix M.1).<br>For further detailed assessment on threatened flora and fauna within the KNP, please refer to the BDAR (Appendix M.1). |

## Table 6.16 Australian Alps National Park impact assessment and mitigation

| Official values | Impact assessment and proposed management and mitigation |
|---|---|
| **Criterion D Principal characteristics of a class of places** | |
| **North-East Kosciuszko Pastoral Landscape** | |
| The landscape is outstanding for demonstrating the use of mountain resources, namely the summer grasses and herbfields. As a relict landscape of past grazing leases it conveys the principal characteristics of transhumance and permanent pastoralism in a remote environment, these being large areas of open grassy landscapes between timbered ridges and hills, stockman's huts, homestead complexes, stockyards and stock routes. The grasslands with swathes of pioneer shrubs include the Kiandra landscape, Boggy Plain, Nungar Plain, Gulf Plain, Wild Horse Plain, Tantangara Plain, Dairymans Plain, Currango Plain, Long Plain, Cooleman Plain, Kellys Plain, Blanket Plain, Peppercorn and Pockets Saddle (KHA 2008). Homestead buildings include Cooinbil and Old Currango and the modest homestead complexes of Currango and Coolamine with additional features including exotic plantings, sheds, barns, and workers' accommodation. Former stock routes, now fire trails, include the Port Philip Fire and Murrays Gap Fire Trails. in the former grazing leases are stockman's huts, Bill Jones Hut, Circuits Hut, Gavels Hut, Hains Hut, Hainsworth Hut, Millers Hut, Oldfields Hut, Pedens Hut, Pockets Hut, Townsends Lodge, Gavels Hut, Long Plain Hut, Gooandra Hut, Schofields Hut, and Witzes Hut (KHA 2008), which in their use and re-use of available materials typify a lifestyle and vernacular bush building technology using hand tools. The array of characteristics relate to over a century of alpine grazing. | The project Plateau and Tantangara Reservoir areas are within the North-East Kosciuszko Pastoral Landscape. Specifically, minor impacts would occur within the Kiandra landscape, Boggy Plain, Nungar Plain, Tantangara Plain and Kellys Plain. The relic landscape is comprised of open grassy landscapes between the timbered ridges and hills and includes huts, homestead complexes stock yards and stock routes occur within the general area of the proposed disturbance footprint, however, the primary evidence is old stock fences lines, many of which occur within the project disturbance footprint. No huts, homesteads or stock yards occur within the project disturbance footprint. Largely, the impacts proposed across pastoral landscapes will be linear; such as road access (existing roads/fire trails) or underground cabling within road corridors, and can be considered to be minor in nature.<br><br>In order to minimize impacts to the official value of the North-East Kosciuszko Pastoral Landscape, management and mitigation measures have been proposed such as the establishment of no-go zones, archival research and archival recording.<br><br>The project will not cause a significant impact to the National Heritage values of North-East Kosciuszko Pastoral Landscape in the AANP. |

## Table 6.16 Australian Alps National Park impact assessment and mitigation

| Official values | Impact assessment and proposed management and mitigation |
|---|---|
| **Criterion E Aesthetic characteristics** | |
| **Distinctive and valued landscapes** | |
| The AANP is a powerful, spectacular and distinctive landscape highly valued by the Australian community. The mountain vistas, including distinctive range-upon-range panoramas, snow covered crests, slopes and valleys, alpine streams and rivers, natural and artificial lakes, the snow-clad eucalypts and the high plain grasslands, summer alpine wildflowers, forests and natural sounds evoke strong aesthetic responses. Much of the terrain of the AANP is highly valued for its remoteness, and naturalness, including views to and from the region that capture snow clad ranges and mountain silhouettes against clear skies as well as expansive views of natural landscapes from the high points of the Alps.<br>The upper Snowy River and Snowy Gorge, Mount Buffalo, the Kosciuszko Main Range, Lake Tali Karng, Dandongadale Falls the peaks and ridges between and including Mt Cobbler, Mt Howitt and the Bluff, and other high peaks, ridgelines, granite outcrops and escarpments are examples of dramatic awe-inspiring landscapes. Recreational pursuits in these landscapes are enhanced by aesthetic appreciation of their wild and natural quality.<br>Snow-covered eucalypts, huts in mountain settings and mountain landscapes are distinctive Australian images captured by numerous artists and photographers. The mountain landscapes have inspired poets, painters, writers, musicians and film makers. | The project disturbance footprint is not in areas specifically recognized as powerful, spectacular and distinctive landscapes. Many of the notable aesthetic values of the AANP such as mountain vistas, including distinctive range-upon-range panoramas would not be impacted by project. Minor, insignificant or temporary impacts would otherwise occur to aspects of the landscape including snow covered crests, slopes and valleys, alpine streams and rivers, natural and artificial lakes, the snow-clad eucalypts and high plain grasslands and summer alpine wildflowers would. Most of the high plain grasslands and valleys across Plateau will only have minor visual impacts through linear infrastructure.<br>Most of the proposed permanent structures are within previously disturbed areas or are consistent with the presence of other infrastructure established during the existing Snowy Mountains Scheme and familiar to visitors of KNP (such as the existing reservoirs and buildings). Accordingly, such landscapes are not necessarily distinctive as natural and remote landscapes because human modification through damming and infrastructure is clearly visible in key project areas such as Talbingo and Tantangara reservoirs.<br>Lobs Hole represents a cleared and remnant indicator of the previous Ravine Village and Lobs Hole Mining Complex. These historical land uses have resulted in a landscape that is not prized for its natural or remote landscape values. |
| **Criterion G Social value** | |
| The Australian Alps have a special association with the Australian community because of their unique landscapes, the possibility of experiencing remoteness and as the only opportunity for broad-scale snow recreation in Australia. The AANP is widely recognised by Australians as the 'high country' and many community groups have a special association with the AANP for social and cultural reasons. | The social values of KNP have been assessed by TRC Tourism (Appendix Y) through a recreational user assessment, which has included responses to a survey of park users within the areas potentially impacted by Snowy 2.0 Main Works. Lobs Hole and Tantangara are recognised as camping destinations for those that want to experience the remoteness of the area, undertake water-based activities, or have a family connection to the area. While there will be impacts to recreational uses at Lobs Hole and Tantangara, it is proposed to rehabilitate these impacted areas to provide improved recreational facilities. There is opportunity to improve the social values of AANP by proving improved access and facilities at these locations. The rehabilitation and master planning of potential recreational facilities will be determined in consultation with NPWS, to ensure relevant KNP values are maintained. |

## Table 6.16 Australian Alps National Park impact assessment and mitigation

| Official values | Impact assessment and proposed management and mitigation |
|---|---|
| **Criterion H Significant people** | |
| The Australian Alps have a special association with the Australian community because of their unique landscapes, the possibility of experiencing remoteness and as the only opportunity for broad-scale snow recreation in Australia. The AANP is widely recognised by Australians as the 'high country' and many community groups have a special association with the AANP for social and cultural reasons. Mount Kosciuszko is an iconic feature for all Australians and visited by over 100,000 people each year. It was named by the explorer Paul Edmund Strzelecki after the Polish freedom fighter, General Tadeusz Kosciuszko, in appreciation of freedom and a free people, an association that is highly valued by Australia's Polish community. The pioneering history of the high country is valued as an important part of the construction of the Australian identity featuring in myths, legends and literature. The ballad of The Man from Snowy River epitomises horsemanship undertaken historically in the rugged landscape. The stories, legends and myths of the mountains and mountain lifestyles have been romanticised in books, films, songs, and television series and many such as the Elyne Mitchell's Silver Brumby novels are part of Australia's national identity. The mountain huts of the AANP constructed for grazing, mining and recreation are valued by communities as a physical expression of the cultural history of the region. They have special associations with many groups, such as mountain cattlemen, skiers and bushwalkers but particularly with huts associations that have been maintaining mountain huts and associated vernacular building skills for over 30 years. | The project area is not specifically associated with the life, actions or legacy significant people. Importantly, the project will not impact valued huts that were constructed for grazing, mining and recreation. Therefore, groups that have special associations with huts such as mountain cattlemen, skiers and bushwalkers would not experience loss of social related values. |

## Table 6.18 Snowy Mountains Scheme impact assessment and mitigation

| Official values | Impact assessment and proposed management and mitigation |
|---|---|
| **Criterion A Events and processes** | |
| The Snowy Mountains Scheme is an unprecedented civil engineering project stimulated by the will of the post-World War II Commonwealth Government to build a strong Australian economy. The Snowy Mountains Scheme was a major impetus in the development of Australia's engineering expertise and industrial relations environment in the post-war period. The Snowy Mountains Scheme employed people from thirty different countries, including approximately 60,000 European Displaced Persons and migrants. The Scheme was hailed as a model of multicultural co-operation and integration and provided the opportunity for thousands of migrants to start a new life after the impacts of the war. The vast workforce that was required to build the Snowy Mountains Scheme required new management practices and the mechanisms implemented by Sir William Hudson permanently changed the nature of industrial relations and workplace conditions in Australia. | The project will not cause an impact to the National Heritage values associated with the engineering expertise and industrial relations environment of the Snowy Mountains Scheme in the post-war period. It will not diminish the significance of the Snowy Mountains Scheme relating to the multicultural co-operation and integration provided to the thousands of migrants to start a new life after the impacts of the war. |
| **Criterion B Rarity** | |
| The Snowy Mountains Scheme is a rare example of an engineering program of enormous complexity and scale. | In the original Snowy Mountains Scheme design, a tunnel and associated power station between Tantangara and Talbingo was proposed. It was never built, and it is this link between the two existing reservoirs that Snowy Hydro now plan to construct as Snowy 2.0 Main Works. Accordingly, the project will serve to complete the scheme and hence amplify the significance of the Snowy Mountains Scheme.<br>The project will not cause an impact to the rarity of the engineering program of enormous complexity and scale which is embodied in the Snowy Mountains Scheme. |
| **Criterion D Principal characteristics of a class of places** | |
| The Snowy Mountains Scheme is an exemplar as a currently operating, intact hydro-electric scheme that is the largest and most complex example of such schemes in Australia. The Snowy Mountains Scheme retains all the characteristics of a complex hydro-electric and irrigation scheme with a very high degree of integrity. | The project will not cause an impact to the example of the Snowy Mountains Scheme as a currently operating, intact hydro-electric scheme that is the largest and most complex example of such schemes in Australia. It will not cause an impact to any aspect of the nature of the complex hydro-electric and irrigation scheme. As a component of the original design, Snowy 2.0 Main Works would serve to further develop the scale and complexity of the existing electric and irrigation scheme. |
| **Criterion F Creative or technical achievement** | |
| The Snowy Mountains Scheme is widely regarded as one of the engineering wonders of the world. The Scheme is a major engineering feat that is recognised for its technical excellence and innovation. | The project will not cause an impact to the status of the Snowy Mountains Scheme as being one of the engineering wonders of the world. It will not cause an impact to the technical excellence and innovation as embodied in the Snowy Scheme. As a component of the original design, Snowy 2.0 Main Works will serve to further develop the engineering significance and technical excellence and innovation that the scheme is recognised for its. |

**Table 6.17 Snowy Mountains Scheme impact assessment and mitigation**

| Official values | Impact assessment and proposed management and mitigation |
|---|---|
| **Criterion G Social value** | |
| The Snowy Mountains Scheme is strongly symbolic for large parts of the Australian community and is held in special regard, especially by the thousands of former Snowy workers and their families who lived and worked there. | The project will not cause an impact to the symbology embodied in the Snowy Mountains Scheme to large parts of the Australian community, especially the thousands of former Snowy workers and their families who lived and worked there. |
| **Criterion H Significant people** | |
| The Scheme is significant for the association with Sir William Hudson and Olav Olsen. Hudson, the 'Father of the Snowy', was Commissioner of the Snowy Mountains Authority from 1949 to 1967. Olsen was originally on the Hydro-electric Sub-committee of the Commonwealth-States Technical Committee and was subsequently employed as the Chief Investigating Engineer for the Snowy Mountain Authority. | The project will not cause an impact to the significance of the work of Sir William Hudson and Olav Olsen in relation to the Snowy Mountains Scheme. |

### 6.6.3 Summary and conclusion

Overall Snowy 2.0 Main Works will have a minor impact on AANP values through ground disturbance activities within the project disturbance footprint and permanent and temporary changes to natural and cultural heritage landscape characteristics through constructed project elements. Landscape character impacts are higher during construction, but suitable rehabilitation of disturbed areas will reduce these impacts during operation. Snowy 2.0 Main Works will impact values of the AANP relating to geodiversity, ecology, cultural heritage, landscape character and recreation. However, proposed impacts are within a manageable framework that will be minimised and result in only limited impact on official values, which will be confined to the areas within the project disturbance footprint and vantage points overlooking the affected landscapes.

Positive impacts to the values of the ANNP includes the additional scientific research that has been completed for Snowy 2.0 Main Works and will be built upon subsequent to project approval. This includes significant ecological findings (eg critically endangered Smoky Mouse) and increased evidence of Aboriginal and historical occupation of the KNP. Furthermore, there will be enhanced recreational values through improved recreational access and facilities within the KNP, subject to ongoing consultation with NPWS.

The project is assessed to have a direct positive on the National Heritage values of the Snowy Mountains Scheme through further developing the civil engineering project stated in 1949 and is likely to reignite an interest in the scheme and its symbolism relating to a multicultural, independent and resourceful Australian identity. Overall the project represents an expansion of a major engineering achievement which is a key value of the Snowy Mountains Scheme.

CHAPTER 6.7

# ABORIGINAL CULTURAL HERITAGE

## 6.7 Aboriginal cultural heritage

An assessment of the Aboriginal cultural heritage impacts of Snowy 2.0 Main Works has been completed by NSW Archaeology and provided in the Aboriginal Cultural Heritage Assessment Report (ACHAR) at Appendix P.1. The ACHAR has been conducted in line with the DPIE *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH 2011) and *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (NSW DECCW 2010a). A process of Aboriginal community consultation has been undertaken in accordance with the NSW DPIE *Aboriginal cultural heritage consultation requirements for proponents 2010* (NSW DECCW 2010b).

The ACHAR has involved the following components:

- statutory and non-statutory heritage register searches covering the project area and its surrounds, including the NSW DPIE Aboriginal Heritage Information Management System (AHIMS) database;
- review of the project area's environmental, archaeological and ethno-historical context to develop a predictive model of archaeological site type and distribution across the project area and its surrounds;
- regular and ongoing consultation with the Aboriginal community including the five registered Aboriginal parties (RAPs) for the project and five additional groups that expressed interest in the project as it has developed since Exploratory Works;
- an extensive archaeological field survey across the project disturbance footprint and including some previous iterations of the project design footprint (survey area). The survey was divided into 29 survey areas made up of 404 survey units, defined based on landscape features and predicted archaeology sensitivity; and
- an extensive archaeological test excavation program to characterise the archaeological character of the project area, given that the field survey was often met with low ground visibility for the detection of Aboriginal objects. In total 654 test pits measuring 50 cm by 50 cm have been excavated as part of the Exploratory Works and project excavation programs (163 $m^2$) at Lobs Hole, Gooandra Hill (within Plateau) and Tantangara (Tantangara Road and Tantangara Dam).

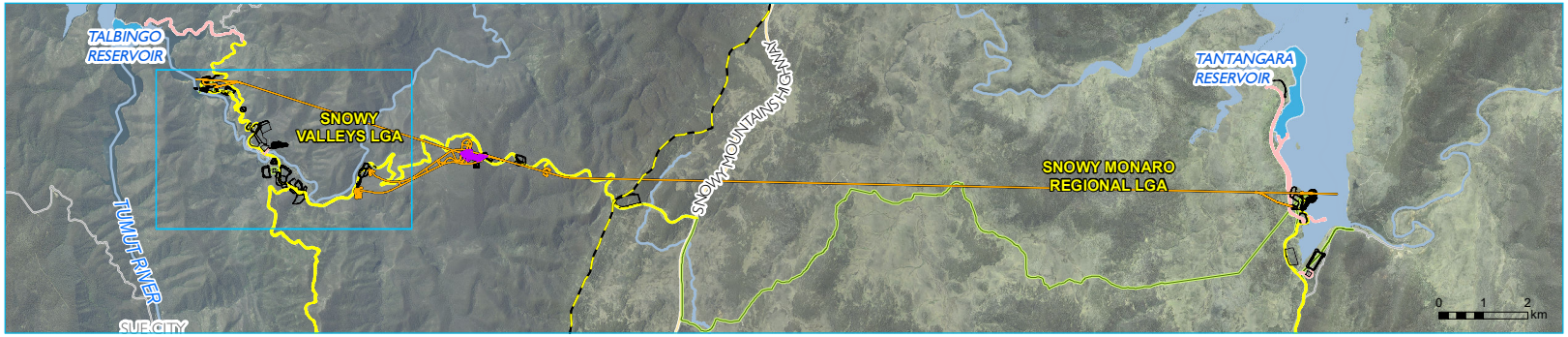
The archaeological field survey and test excavation programs completed for the project were approached as continuation of the programs completed for Exploratory Works, and there was some overlap in project footprints. Due to some recent additions to the project footprint some survey units are yet to be surveyed. Where necessary, un-surveyed areas will be investigated prior to project approval and assigned updated management and mitigation strategies.

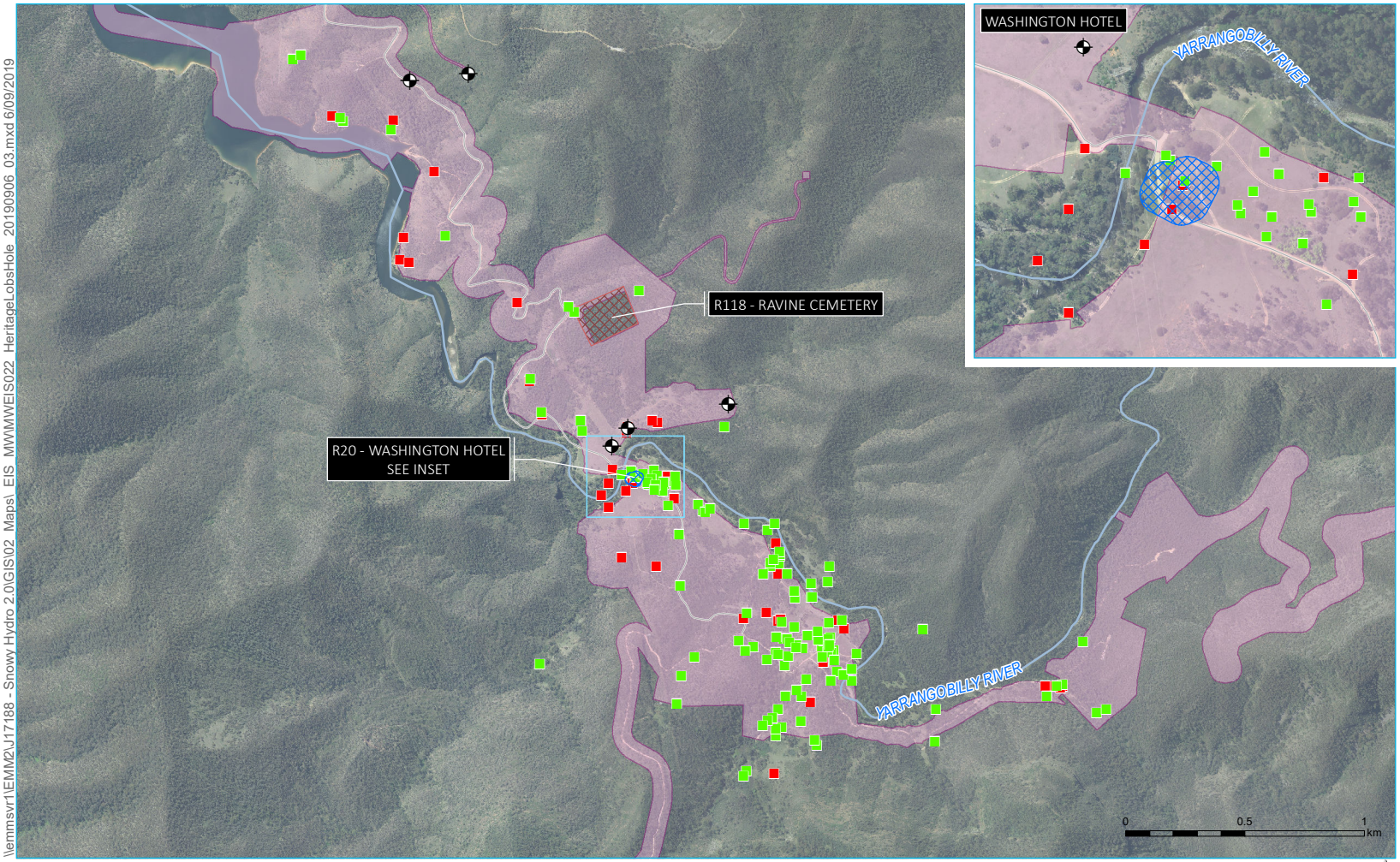
### 6.7.1 Context

The Aboriginal cultural heritage values related to the project are presented in Table 6.19. Community and stakeholder views are also outlined including how the project design has taken these views into account to avoid or minimise impacts to Aboriginal cultural heritage.

## Table 6.19 Existing environment and key issues for Aboriginal heritage

| | |
|---|---|
| **Existing environment** | Recent archaeological research has confirmed an Aboriginal presence in the Snowy Mountains since the early Holocene (from around 9,000 years ago) (Aplin et al. 2010, Theden-Ringl 2016).<br>The project area is within the Country of the Wolgalu people (Tindale 1974, Boot 2000). The Snowy Mountains is country to several groups and many Aboriginal people have cultural and spiritual associations that have long histories embodied in objects which can be seen on the ground and other intangible values related to the past and current concerns and aspirations (NSW DEC 2006).<br>Prior to the NSW Archaeology investigation, 29 AHIMS registered Aboriginal sites were present within the project survey area. A total of 306 sites were recorded during the field survey and 3,394 stone artefacts were retrieved from test excavation. This represents a significant increase in the archaeological knowledge of the area. The field survey and test excavation results were used to characterise the archaeological status of the project area and its surrounds.<br>The investigation identified that the areas where Aboriginal sites were identified are generally disturbed by previous use and/or natural geomorphological process. The primary archaeological features across the survey area are Aboriginal stone artefacts and are mostly present in negligible, very low or low density distributions. However, several survey units or micro topographies within survey units have higher artefact densities. At Lobs Hole higher artefact densities were recovered on favourable landforms such as flats and gentle gradient crests adjacent to the Yarrangobilly River and such areas are likely to have been used regularly and reasonably intensively by Aboriginal people.<br>Excavation results at Tantangara indicates widespread Aboriginal use but with highly variable occupation intensity. Although most areas featured low artefact densities, certain benched areas on hill slopes featured higher artefact densities. These areas were at the interface with woodland that occurs at higher elevations (eg TSU4 and TSU15). Such areas are likely to have provided shelter from prevailing weather, frosts and cold air drainage and provided abundant firewood otherwise absent from open grasslands on valley floors. Conversely, areas closer to the Murrumbidgee River featured lower artefact densities which may have been because they were exposed to cold air drainage and winds that would have been a deterrent for occupation. Additional to the stone artefact sites identified, one rock shelter with stone artefacts and potential archaeological deposit was identified 200 m west of the project disturbance footprint at Tantangara Reservoir (site name TSU11/L16) (Figure 6.20).<br>Other areas investigated including Talbingo Reservoir, Marica, Plateau and Rock Forest all featured results consistent with the predictive model for site types, their distribution and predicted artefact densities. The archaeological significance of these areas is accordingly most often negligible/low and infrequently of low/moderate significance. Overall, the most frequently occurring areas of moderate archaeological significance are distributed across favourable landforms at Tantangara Reservoir and Lobs Hole. |
| **Community and stakeholder views** | RAP consultation did not identify any specific socio-cultural information to the project area but the identified Aboriginal sites have high cultural value to the local Aboriginal community through the tangible link they provide with their ancestral past.<br>RAPs have been involved in the investigation and decision-making process for matters related to cultural heritage impact assessment and management for the project.<br>NPWS representatives and DPIE regional archaeologists have been consulted over the course of the assessment through on-site and off-site meetings and have supported the investigation approach, methods and mitigation measures. In December 2018, DPIE provided SEARs input requesting for archival and oral history recordings for any items or landscapes with significant Aboriginal heritage values likely to be disturbed or harmed by the project. However, through consultation NSW Archaeology did not identify any specific cultural information of relevance to the project area and therefore no significant Aboriginal heritage items or landscapes are likely to be disturbed or harmed by the project. As such, no oral history or archival recording was completed for the ACHAR. |
| **Avoidance and minimisation through design** | The archaeological resource within the project disturbance footprint does not surpass significance thresholds which would act to preclude the proposed impacts. Impact mitigation where warranted is a suitable response to the anticipated project design impacts.<br>Notwithstanding, a 50 m buffer zone from the bank of the Yarrangobilly River was established during the Exploratory Works EIS and has largely continued to be applied to Snowy 2.0 Main Works.<br>The rock shelter site TSU11/L16 is a site of higher significance and research potential. This site was identified early in the investigations phase and the project design was modified to be over 200 m from the project disturbance footprint (Figure 6.21). |




## KEY

Heritage
- Aboriginal heritage site
- Historic heritage site
- Washington Hotel avoidance area
- Ravine cemetery avoidance area

Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements
- Temporary construction compounds and surface works
- Temporary access road
- Geotechnical investigation
- Indicative rock emplacement area
- Disturbance area*

Existing environment
- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

*Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)*

GDA 1994 MGA Zone 55

N

# Key Aboriginal and historical heritage items for avoidance - Lobs Hole

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.20

snowy 2.0

EMM creating opportunities

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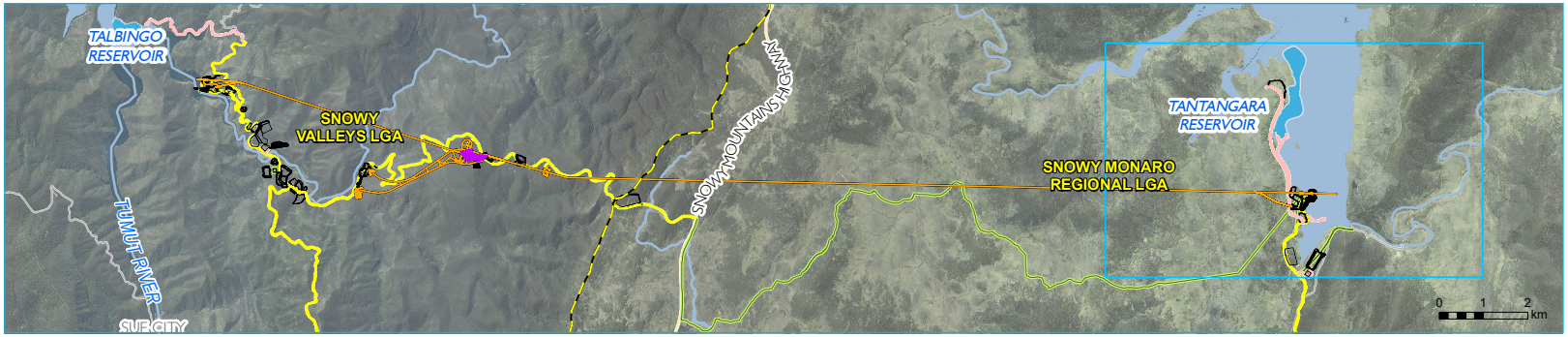


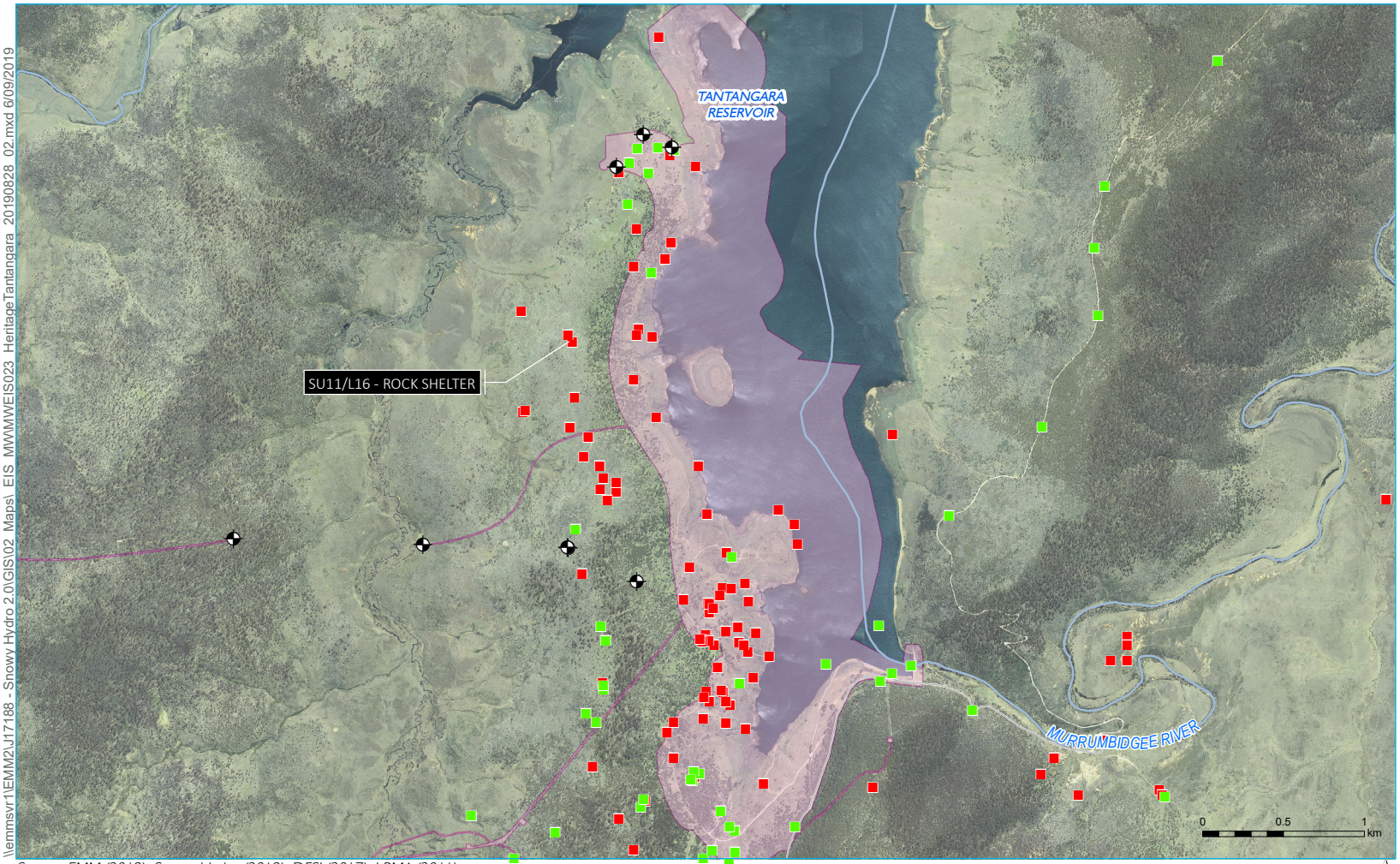


## KEY

Heritage
- Aboriginal heritage site
- Historic heritage site

Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements
- Temporary construction compounds and surface works
- Temporary access road
- Geotechnical investigation
- Indicative rock emplacement area
- Disturbance area*

Existing environment
- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

*Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)*

GDA 1994 MGA Zone 55

N

# Key Aboriginal and historical heritage items for avoidance - Tantangara

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.21

snowy 2.0

EMM creating opportunities

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### 6.7.2 Predicted impacts

The proposed construction activities within project disturbance footprint will impact Aboriginal sites and objects. No statutory or non-statutory places of Aboriginal cultural significance have been identified within the project disturbance footprint or nearby. The ACHAR addresses impacts to a component of the cultural values of the KNP which covers all Aboriginal objects and places within the KNP (Appendix P.1).

The AHCAR considered the principles of ecologically sustainable development (ESD) in assessing harm to Aboriginal cultural heritage, including consideration of cumulative impacts from the approved Exploratory Works and the proposed Snowy 2.0 Transmission Connection project. Although the project disturbance footprint and Snowy 2.0 Transmission Connection project span across an extensive geographical area, the existing Aboriginal cultural heritage values will generally not be impacted to a significant level because the project is largely linear in nature. Therefore, broad-scale impacts to any one area are limited.

At Lobs Hole, where higher stone artefact densities occur and more concentrated development is proposed, the project disturbance footprint has maintained a 50 m buffer from the Yarrangobilly River where possible. Furthermore, the only rock shelter site near the project disturbance footprint will be avoided (Figure 6.21). Overall, the consideration of ESD and cumulative harm has concluded that further avoidance of impacts is not warranted.

The impact assessment was made considering the level of impact to broader survey units, which sometimes feature none or multiple Aboriginal site locales. The project will not impact the entirety of the survey units within the project disturbance footprint and are therefore considered to be partially impacted (rather than totally impacted). A summary of impacts at each of the construction areas is provided in Table 6.20.

**Table 6.20 Predicted impacts to Aboriginal cultural heritage values**

| Area | Summary of impacts |
|---|---|
| Talbingo Reservoir | Impacts to the archaeological resource at Talbingo is anticipated to be minor as the area features only survey units of negligible potential and significance. These will be impacted through construction of access roads and adjacent construction areas. |
| Lobs Hole | Impacts to the archaeological resource at Lobs Hole will not represent a significant addition to the approved impacts for the Exploratory Works project. All survey units of moderate significance will be impacted by Exploratory Works to some extent prior to Snowy 2.0 Main Works impacts. The remaining impacts will be to survey units of negligible to low significance, many of which will be impacted by the Exploratory Works to some extent prior to Snowy 2.0 Main Works impacts. |
| Marica | Impacts to the archaeological resource at Marica area are anticipated to be minor as the area features survey units generally of negligible or low potential and significance, except for four Aboriginal site locales which may be of low/moderate or moderate significance. Their actual significance values will be established through future salvage excavation if impacts are proposed. |
| Plateau | Impacts to the archaeological resource across the Plateau area will be minor, considering that project impacts will be primarily linear from communications and electricity cable alignments and construction buffers. Accordingly, only small portions of archaeologically sensitive landforms within relevant survey units will be harmed.<br>There are minor areas of the project disturbance footprint that have not yet been surveyed but are predicted to have negligible archaeological potential negligible significance. These areas will be investigated and assessed prior to project approval. |

**Table 6.19 Predicted impacts to Aboriginal cultural heritage values**

| Area | Summary of impacts |
|---|---|
| Tantangara Reservoir | Impacts to the archaeological resource at Tantangara Reservoir is generally anticipated to be minor. Most of the survey units that will be impacted are of very low to low potential and significance. There are areas with higher artefact densities considered to be of low/moderate (TSU2, TSU3, and TSU14) and moderate (TSU4 and TSU15) significance that will be partially impacted. A substantial archaeological resource will remain to the west of the project disturbance footprint at Tantangara Reservoir, including the rock shelter site TSU11/L16 (Figure 6.21). The noise and vibration impact assessment completed for the project has predicted that the rock shelter is outside the area of potential vibration impact. Notwithstanding, rock shelter monitoring may be employed if work methods or the project disturbance changes. |
| Rock Forest | Impacts to the archaeological resource at Rock Forest is anticipated to be minor. Most of the survey units that may be impacted are of negligible to low potential and significance.<br>Notably, the actual disturbance footprint at Rock Forest is anticipated to be much smaller than that mapped as it accounts for a broader area from which the proposed logistics yard will placed within.<br>The southern half of the Rock Forest disturbance footprint has not yet been surveyed but is predicted to have similar values to the areas surveyed. This area will be investigated and assessed if disturbance to this area is expected as determined during detailed design. |

### 6.7.3 Mitigation measures

The mitigation measures presented in Table 6.21 consider the following:

- the significance of the archaeological resource identified through the ACHAR investigation; and
- and the type and scale of impacts proposed by Snowy 2.0 Main Works, the Exploratory Works and the Transmission Connection Project.

Management and mitigation of impacts is proposed according to a tiered approach appropriate for each survey unit, the nature of impacts proposed and their assessed level of significance.

**Table 6.21 Summary of mitigation measures for Aboriginal heritage**

| Impacts/risks | Reference# | Measures | Timing | Responsibility |
|---|---|---|---|---|
| Impact to known and unknown heritage sites and items | HER01 | An Aboriginal Heritage Management Plan (AHMP) will be prepared and implemented to guide the process for management and mitigation of impacts to Aboriginal objects. The AHMP will:<br>• be prepared in consultation with RAPs and DPIE;<br>• describe survey units in which impacts are allowable; and<br>• include procedures relating to the conduct of additional archaeological assessment, if required. | Pre-construction | Contractor |

**Table 6.20 Summary of mitigation measures for Aboriginal heritage**

| Impacts/risks | Reference# | Measures | Timing | Responsibility |
|---|---|---|---|---|
| Loss of Aboriginal cultural heritage | HER02 | Specific management and mitigation measures are listed for each individual survey unit and Aboriginal object locale in Appendix P.1 and will be included in the AHMP.<br>Management measures to be included in the AHMP are:<br>• for survey units within the project disturbance footprint which are assessed to be of higher significance values, impact mitigation measures will be implemented. These would comprise salvage in the form of archaeological excavation and archaeological analysis prior to impacts; and<br>• the AHMP is to include measures for the management of any Aboriginal objects that may be found during construction. | Pre-construction | Contractor |

### 6.7.4 Summary and conclusion

The ACHAR for the Exploratory Works and Snowy 2.0 Main Works has contributed significantly to our understanding of the archaeological record of the KNP and is evidence of Aboriginal occupation and adaptations to cold climate environments. Although impacts to Aboriginal sites and objects are unavoidable in all instances, mitigation strategies including salvage excavation will aim to recover a representative sample of the areas subject to impact and contribute further to our understanding of Aboriginal occupation. The Aboriginal community will continue to be consulted about the affected Aboriginal cultural heritage values and their management.

CHAPTER 6.8

# HISTORICAL HERITAGE

## 6.8 Historical heritage

An assessment of the impacts of the project on historical heritage items has been completed by NSW Archaeology and provided the HA&SoHI at Appendix P.2. The HA&SoHI used the principles of the *Australia ICOMOS Burra Charter* (Australia ICOMOS 2013a) and its relevant practice notes (Australia ICOMOS 2013b, 2013c, 2017). It also complies with the *Historical Archaeology Code of Practice* (Heritage Council of NSW 2006) and the *NSW Heritage Manual* (1996) and other guidelines published by the NSW Heritage Office (1996, 2001, 2009).

The HA&SoHI has involved the following components:

- a search of relevant statutory and non-statutory heritage registers;
- historical research using primary and secondary sources (including historical maps);
- consultation with the local community to identify historic values and items; and
- an extensive archaeological field survey across the project disturbance footprint and including some previous iterations of the project design footprint (survey area). The survey for historical items was completed in tandem with Aboriginal archaeological field survey.

### 6.8.1 Context

The historic heritage values related to the project are presented in Table 6.22. Community and stakeholder views are also outlined including how the project design has taken these views into account to avoid or minimise impacts to historic heritage through the DIAA process.

**Table 6.22 Existing environment and key issues for historic heritage**

| | |
|---|---|
| **Existing environment** | The Snowy Mountains has a rich history 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 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.<br>Lobs Hole 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 (from the 1860s to about 1917) and recreation and processing, recreation. The Marica area is part of the Kiandra plateau which has been used since the early 1800s for summer grazing. From the late 1850s, the area underwent extensive gold mining activity. Tantangara has been used for summer grazing, mining and more recently the construction of the dam and its associated infrastructure. Tantangara is now a popular fishing and camping spot.<br>Statutory and non-statutory heritage search results are shown in the table inset below. The table only refers to listed items that intersect with, are within, or may be affected by the project disturbance footprint. Apart from Rock Forest, the project is entirely within the boundaries of the National Heritage Listed Australian Alps National Parks and Reserves, and Snowy Mountains Scheme. As a result of desktop research, register searches and archaeological survey, a total 550 historic items and potential historic items were recorded as part of the assessment.<br>The 550 items were categorised and assessed of significance according to the cultural heritage complexes and historical themes they contribute to. The historical complex relating to the Ravine Township settlement at Lobs Hole, including Struggle Street, was assessed to be of local heritage significance. Other areas such as Marica and Plateau feature items have local contributory significance to historical themes of mining, pastoralism, transport and Snowy Mountain Authority presence. Historical items at Tantangara include items of local and local contributory significance to pastoralism, mining and the Snowy Mountains Scheme, including survey camps, infrastructure, quarries, the Tantangara Works Centre and Gang Gang Creek Camp. Historical items at Rock Forest include those relating to mining, agriculture and pastoralism and have limited local and local contributory significance. |

**Table 6.21 Existing environment and key issues for historic heritage**

| | Register | Listing type | Register listing |
|---|---|---|---|
| | World Heritage List (WHL) | Statutory | Nil |
| | National Heritage List (NHL) | Statutory | Australian Alps National Parks and Reserves – Place ID 05891 |
| | | | Snowy Mountains Scheme – Place ID 105919 |
| | Commonwealth Heritage List (CHL) | Statutory | Nil |
| | State Heritage Register (SHR) | Statutory | Nil |
| | Section 170 Registers | Statutory | Nil |
| | *Tumut Local Environmental Plan 2012* (Schedule 5) | Statutory | Nil |
| | *Cooma-Monaro Local Environmental Plan 2013* (Schedule 5) | Statutory | Nil |
| | National Trust | Non-statutory | Nil |
| | Register of National Estate (non-statutory) | Non-statutory | Kosciuszko National Park (1981 boundary) |
| | | | Snowy Scheme |
| | | | Lobs Hole Copper Mine |
| | | | Washington Hotel Ruin (Lobs Hole) |
| | | | Kiandra Mining Area |
| | Kosciuszko Huts Association (KHA) | Non-statutory | A number of pastoral routes and other pastoral items intersect with the project disturbance footprint. However, there are no huts within the project disturbance footprint. |

| | |
|---|---|
| **Community and stakeholder views** | Local community members were consulted to gather historical information about the project area with aided this historical site investigation.<br>The NSW Heritage Division did not raise any concerns as the project was not identified to be within the vicinity of any previously known heritage items or archaeological sites.<br>NPWS requested that a comprehensive archival history of Lobs Hole be completed as part of the Exploratory Works which has been completed and will continue to be incorporated into the Snowy 2.0 Main Works Project. |
| **Avoidance and minimisation through design** | As a result of refinements and changes to the project disturbance footprint, many of the heritage items of local heritage significance identified during the assessment are now outside impact areas as a result of refinements and changes to the project disturbance footprint.<br>During the initial stages of project design, it was resolved to avoid the two most significance historic heritage items at Lobs Hole/Ravine. This comprises the Washington Hotel pise' ruin structure (site R20) and the cadastral boundary of the Ravine Cemetery (site R118) (Figure 6.20). Furthermore, a previous project design iteration of communication routes and former substation on Plateau was modified to avoid impacts to the State heritage listed Kiandra Courthouse and Chalet and surrounding items with associated significance. Avoidance measures are further is discussed in Section 6.8.3 |

### 6.8.2 Predicted impacts

The construction activities within the disturbance area will impact historical items, landscapes and historical archaeological deposits. The impact assessment for historical items includes consideration of the significant cultural values and features of the KNP relevant to the project, which includes historical items of the Register of the National Estate (Kiandra Mining Area and Lobs Hole Copper Mine), Kosciuszko homestead complexes, huts, ruins and hut sites, physical items of the pastoral era, mining sites and objects, logging sites, Snowy Mountains Scheme sites and scientific research sites. The project impacts to National Heritage place (AANP and Snowy Mountains Scheme) official values are discussed specifically in Section 6.6.2.

The historic items recorded during the assessment are a part of various historical complexes (eg the Lobs Hole complex and the Kiandra mining complex). On their own, many of the elements do not satisfy archaeological significance criteria. However, these combine to make up the historic landscapes which are place of local or greater significance for their historical, technological, social and research values.

The HA&SoHI considered the cumulative impacts from the approved Exploratory Works and the proposed Snowy 2.0 Transmission Connection project. Although the project disturbance footprint and Transmission Connection project span across an extensive geographical area, the existing historical heritage values will generally not be impacted to a significant level because the project is largely linear in nature. Therefore, broad-scale impacts to any one area is limited. Notwithstanding, the cumulative impacts at Lobs Hole from Exploratory Works and the project will involve broad-scale impacts across the historical features that make up the former Ravine village and mining complexes at Lobs Hole. Where possible, the proposed impacts to these complexes were minimised through design by avoiding the Washington Hotel pise' ruin, Ravine Cemetery and mining related sites within a 50 m buffer from the Yarrangobilly River where possible. Overall, the consideration of ESD and cumulative harm has concluded that further avoidance of impacts is not warranted, given their ascribed significance ratings.

Overall, it is anticipated that the project will have a generally low negative effect on the historical heritage significance of the key themes of mining, pastoralism, infrastructure, and the Snowy Mountains Scheme. However, within the project disturbance footprint itself a moderately negative effect would occur both to some individual historic items and, at Lobs Hole and Tantangara Reservoir historic landscape itself. A summary of impacts across the survey areas are shown in Table 6.23. Only items that meet local significance criteria will be impacted by the project. No local or State listed heritage items (LEP or SHR) will be impacted.

**Table 6.23 Predicted impacts to historic heritage values**

| Area | Summary of impacts |
|---|---|
| Talbingo Reservoir | Impacts to historical heritage items at Talbingo is anticipated to be minor as the area features only some areas of former vehicle track cuttings which have little contributory significance to the landscape. |
| Lobs Hole | Project impacts to historical heritage complexes of Ravine Township, Greater Ravine Township and Struggle Street at Lobs Hole (local significance). These impacts will result in the loss of features that contribute to the local significance of the complexes. The primary impact additional to Exploratory Works will be of the Struggle Street historic complex.<br>Overall, the impacts to the broader Lobs Hole Ravine will not represent a significant addition to the approved impacts for the Exploratory Works project. There will be additional impacts to the Struggle Street and Lobs Hole mining complex features but none of these items meet the significance threshold to warrant outright conservation. The primary items of significance and archaeological potential will continue to be avoided, being Ravine Cemetery and the Washington Hotel pise' ruin. |
| Marica | Impacts to historical heritage items at Marica area are anticipated to be negligible as only one historical item (a remnant pastoral fence line) is within the project disturbance footprint which has little local contributory significance to the broader pastoral landscape which does not meet local or State significance criteria. |

**Table 6.22 Predicted impacts to historic heritage values**

| Area | Summary of impacts |
|---|---|
| Plateau | Impacts to historical heritage items across the Plateau area will be minor, considering that project impacts will be primarily linear from communications and electricity cable alignments and construction buffers. Ground disturbance will largely be within existing vehicle tracks, and although project elements traverse locally significant complexes and landscapes such as historic mining complexes at Kiandra and Gooandra which are of local and local contributory significance, there will be only minor impacts to historic items related to mining, pastoralism and transport and limited visual impacts on the pastoral and mining character of the landscape. This type of impact is also limited to the project construction phase, as infrastructure will be buried and areas rehabilitated.<br>There are minor areas of the project disturbance footprint that have not yet been surveyed but are predicted to have negligible archaeological potential negligible significance. These areas will be investigated and assessed prior to project approval. |
| Tantangara Reservoir | There will be minor impacts to the former Snowy Mountains Authority (SMA) Tantangara Works Centre (est. 1950s) which was built halfway between the Snowy Mountains Highway and Tantangara Reservoir. However, impacts to the Tantangara Works Centre will only be linear from road upgrades but may impact some of the more isolated residential building foundations in the proposed road corridor construction footprint. The main building complexes of Tantangara Works Centre occur to the east and west of the project disturbance footprint.<br>Impacts to historical heritage values at Tantangara Reservoir includes impacts to quarrying, pastoral and SMA historical items and landscapes. The impact of the proposed Tantangara intake and construction compound and associated infrastructure is compared against the Snowy Scheme National Heritage listing as it will occur at a key component of the existing SMA Tantangara Dam and infrastructure. Impacts to the Snowy Scheme listing at Tantangara along with heritage landscape features is discussed further in Section 6.8.1.<br>The overall impacts to pastoral, mining, SMA and transport items will result in impacts to items of local significance and local contributory significance. The overall heritage impacts at Tantangara will be moderate, particularly with regard to impacts at pastoral items and SMA items, and the overall impacts to the broader cultural landscape of the Snowy Mountains will be low. |
| Rock Forest | Impacts to historical heritage items at Rock Forest is anticipated to be low to negligible. Rock Forest is outside of the National Heritage place listings of the AANP and Snowy Mountains Scheme and also outside of the KNP.<br>It is currently assumed that all of Rock Forest has the potential to be disturbed by construction activities. However, the actual disturbance footprint at Rock Forest is anticipated to be much smaller than that mapped as it accounts for a broader area from which the proposed logistics yard will placed within.<br>Historical items at Rock Forest include those relating to mining, agriculture and pastoralism and have limited local contributory significance. The proposed impacts at Rock Forest would result in direct (physical) impacts to five items of contributory significance only. An old cultivation paddock outside the project disturbance footprint was identified to have local significance for its insights on cultivation practices in the area.<br>The southern half of the Rock Forest disturbance footprint has not yet been surveyed but is predicted to have similar values to the areas surveyed. This area will be investigated and assessed prior to project approval. |

### 6.8.3 Mitigation measures

The mitigation measures presented in Table 6.24 consider the following:

- the significance of the historical heritage values identified in the HA&SoHI investigation; and
- and the type and scale of impacts proposed by the project, the Exploratory Works and the Snowy 2.0 Transmission Connection Project.

Overall, the historical heritage items and landscapes do not surpass significance thresholds which would act to preclude the proposed Snowy 2.0 Main Works impacts. Management and mitigation of impacts is proposed according to a tiered approach appropriate for each complex/item/feature, the nature of impacts proposed and their assessed level of significance.

**Table 6.24 Summary of mitigation measures for historic heritage**

| Impacts/risks | Reference# | Measures |
|---|---|---|
| Loss of historic heritage | HER03 | Salvage and/or archival recording of potential and known heritage items to be conducted in respect of certain items that warrant that level of impact mitigation. |
| | HER04 | Specific management and mitigation measures are listed for each individual heritage item in Appendix P.2 and will be included in a cultural heritage management plan (CHMP). A series of management recommendations will be presented. In some instances, no impact mitigation is required. For others a range of measures are recommended ranging the establishment of no-zones to ensure the protection of items, salvage of movable heritage to salvage excavation and archival recording.<br>Appropriate avoidance measures will be taken for Washington Hotel (site R20) and Ravine Cemetery (R118).<br>A minimum 20 m project construction avoidance buffer will be applied to the Washington Hotel (site R20) structure.<br>No ground disturbance will occur within the cadastral boundary of Ravine Cemetery as shown on Figure 6.20. Some non-ground invasive vegetation clearance will be required at the western and northern boundaries of the cadastral boundary of Ravine Cemetery (refer to bush fire risk and hazard assessment, Appendix T). |

### 6.8.4 Summary and conclusion

The historical assessments for the Exploratory Works and Snowy 2.0 Main Works project have contributed significantly to our understanding of the archaeological record of the KNP and the range of historical events that have left archaeological traces across the landscape. Although impacts to historical items and landscapes are unavoidable, mitigation strategies including the avoidance of Washington Hotel (site R20) and Ravine Cemetery (R118), and salvage excavation and archival recording where warranted will aim to recover and record contribute further to our understanding of historical occupation and events.

CHAPTER 6.9

# TRANSPORT

## 6.9 Transport

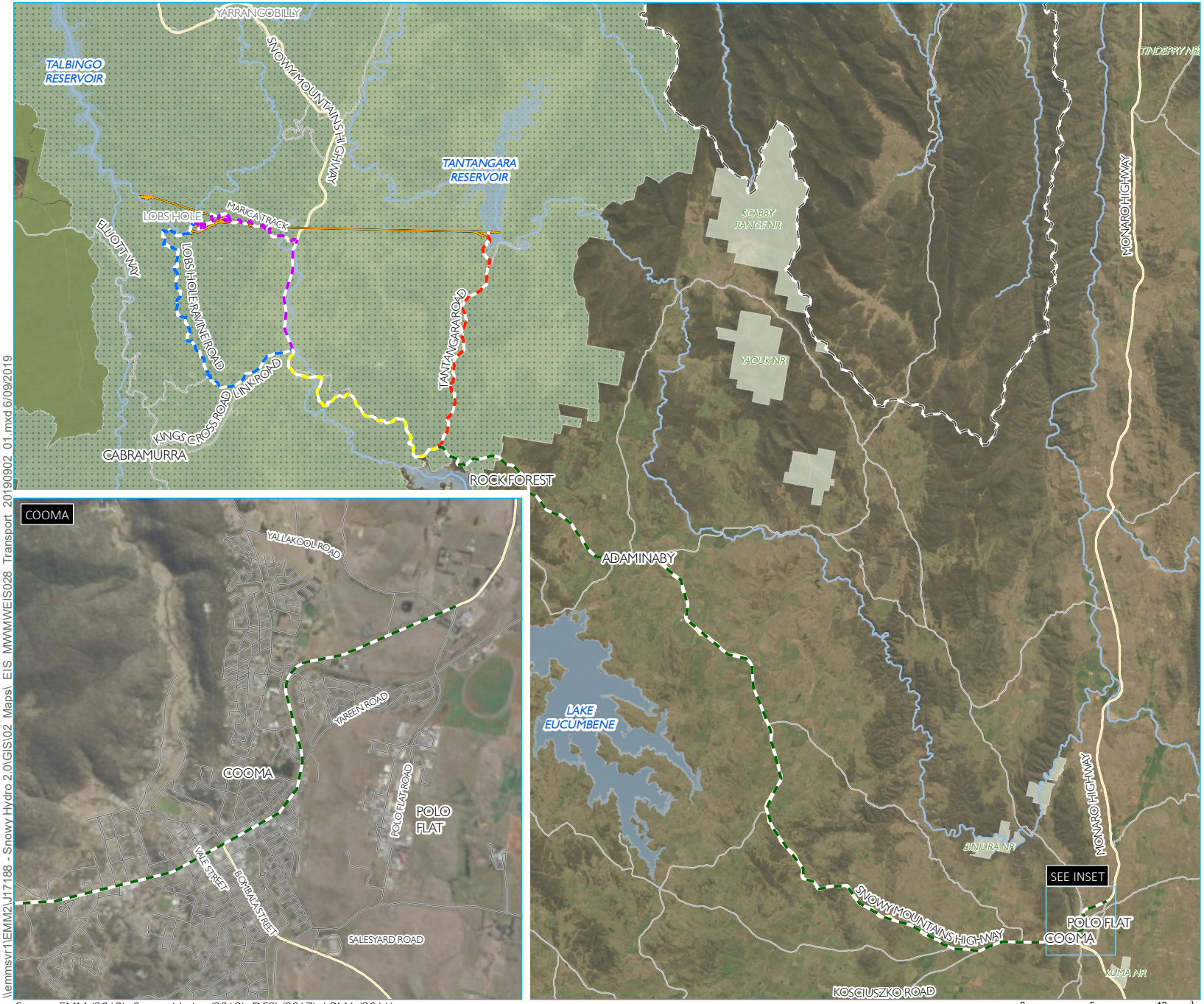
Potential impacts of Snowy 2.0 Main Works on traffic and transport have been assessed. The assessment relies on technical specialist reports prepared for the project and should be referred to for detailed information, including:

- Traffic and Transport Assessment prepared by SCT Consulting and provided in Appendix Q;
- Road Safety Audit prepared by Safe System Solutions and provided in Appendix Q; and
- Navigation Assessment prepared by Royal HaskoningDHV and provided in Appendix W.

These technical reports collectively address potential impacts to traffic and transport from Snowy 2.0 Main Works and are summarised in this section.

### 6.9.1 Existing environment

The Traffic and Transport Assessment considered a study area encompassing the main transport route and the surrounding regional road network. The predominant mode of transport within the study area is car travel with bus services available in Cooma and Tumut and the nearest train station in Canberra. There are a number of walking and cycling trails within the study area including within the KNP. The KNP and nearby ski resorts mean that the study area attracts an influx of visitors during the snow season resulting in increased traffic volumes. The proposed main transport route and regional road network providing access to the project area are shown in Figure 6.22. Key roads and intersections that will be used by the project construction traffic were identified and are summarised for each of the project areas in the following section.




KEY

Primary transport route

- All site access from Cooma to KNP and Rock Forest
- Route to Tantangara Reservoir
- Route to Talbingo Reservoir and Lobs Hole
- Route to Marica and Lobs Hole
- Route to Marica, and alternative access to Lobs Hole

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Kosciuszko National Park
- NPWS reserve
- State forest
- State boundary

\\emmsvr1\EMM2\J17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWEIS028 Transport 20190902 01.mxd 6/09/2019

*Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)*

Primary transport routes and regional road network

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.22

snowy 2.0

EMM creating opportunities

### i Existing road network – KNP

Key roads and intersections within the KNP and predominantly on the Plateau are discussed in this section.

#### a Snowy Mountains Highway

The Snowy Mountains Highway comprises the majority of the proposed main transport route and is a 333 km long State highway which connects from the Princes Highway north of Bega, via Bemboka to the Monaro Highway south of Nimmitabel, then from the Monaro Highway at Cooma via Adaminaby, Kiandra, Tumut and Adelong to the Hume Highway near Hillas Creek.

Within the KNP, the Snowy Mountains Highway has a two-lane two-way sealed carriageway, generally varying between 6 to 8 m wide. The speed limit varies along the main transport route and is generally 100 km/h on the rural sections with reductions in speed where it passes through residential areas and town centres. In the higher altitude regions, above 1,000 m altitude, where the highway is subject to snow and ice cover over the winter months, distinctive yellow line marking and tall red reflector posts are used for better visibility of the road and vehicles can be required to use snow chains when travelling on these higher sections of the highway, with speed reductions to 80km/hr. The road is an approved B-Double route from Talbingo to Adaminaby and is approved throughout its length within the KNP for 19 m long vehicles.

The Snowy Mountains Highway intersects with Link Road, Miles Franklin Drive and other local roads nearer to the project area. The Snowy Mountains Highway from Cooma to Adaminaby is outside the KNP area and is approximately 50 km long. It runs west from Cooma, then north-west after the intersection with Kosciuszko Road 6 km west of Cooma. It is a two-lane two-way highway with a road width varying from 6.6 to 7.2 m. The speed limit is generally 100 km/h, but it is reduced to 80 km/h when approaching Adaminaby.

The Snowy Mountains Highway passes through the Cooma town centre where the road environment is representative of an urban local road network, with a lower speed environment ranging between 50-60km/hr and roundabouts controlling the major intersections. The physical traits of the road reserve also differ in Cooma, with widened road reserves catering for on-street parking, kerb and guttering, footpaths and street lighting installed at short intervals. During the winter snow season, traffic volumes along Snowy Mountains Highway increases with visitors destined for the ski fields within Kosciuszko National Park. With Cooma serving as the main rest stop for visitors during the snow season, drivers can experience congestion at peak times along the main road of Sharp Street (an extension of Snowy Mountains Highway and Monaro Highway).

The Snowy Mountains Highway also travels north to the north of the project area, passing Talbingo, Adelong and turning north-east after the intersection with Batlow Road to reach Tumut.

North of Link Road the non-winter period the recorded baseline daily traffic volumes are 436 light vehicles (LV) and 79 heavy vehicles (HV). Where the Snowy Mountains Highway passes through Cooma township daily traffic volumes are much higher with traffic counts recording 4,888 LV and 1,509 HV. During the winter peak these volumes are higher again. A traffic count was taken on the Sunday of the Queen's Birthday long weekend 2019 there were 9,311 vehicle movements.

In the period 2013-2017 there were several recorded crashes resulting in injury on Snowy Mountains Highway including 7 West of Bombala Street to Chapman Street, 55 in the township of Cooma, 16 from Cooma to Adaminaby, 30 from Adaminaby to Snowy Monaro LGA boundary, 10 from Snowy Monaro LGA boundary to Talbingo, 4 from Talbingo to Tumut and 45 in the Township of Tumut.

### b Link Road

Link Road is a two-way rural road varying from 5.3 to 6.6 m wide between Elliott Way to the west and Snowy Mountains Highway to the east. This road provides connection between the Snowy Mountains Highway and Cabramurra, which is accessible via the Link Road and Goat Ridge Road. It also provides access to the Selwyn Snow Resort during the winter season, which is accessible via Snowy Mountains Highway, the Link Road and Kings Cross Road. The road is approximately 15 km long and is fully sealed. Link Road is an undulating road with numerous bends with lower advisory speed limit signs on approaches. The signposted speed limit is 80 km/h. All intersections on Link Road are basic T-intersections, except for its intersection with Snowy Mountains Highway where an auxiliary right turn (AUR) and auxiliary left turn (AUL) is provided on the major road to allow left and right turning movements to access Link Road. Link Road is not an approved B-Double route.

Baseline daily traffic volumes were recorded between Kings Cross Road and Lobs Hole Ravine Road with 206 LV and 22 HV and between Kings Cross Road and Snowy Mountains Highway with 316 LV and 44 HV. A traffic count was taken on the Sunday of the Queen's Birthday long weekend 2019 there were 1,382 vehicle movements.

Traffic recorded on Link Road by NPWS shows that traffic peak occurred in the month of July with 13,608 vehicles, which is more than double of the average monthly traffic volume (5,935 vehicles) across the year.

### c Kings Cross Road

This road, although mostly unsealed, provides a shorter connection between Link Road, near the Selwyn Snow Resort and Cabramurra village, compared to the fully sealed route via Link Road and Goat Ridge Road.

Kings Cross Road is sealed for the initial 3 km of its length between Link Road and the Selwyn Snow Resort. The road is unsealed at about 1 km at the western end near Cabramurra, but nevertheless generally straight and level. It is a two-lane two-way road with a general speed limit of 100 km/h, although lower speed limits apply in the vicinity of the Selwyn Snow Resort. The centre line of the road is not marked. Sealed sections have a width between 5-6 m, while the unsealed section has a width of approximately 7 m. All intersections are of a basic T-form. Kings Cross Road is not an approved B-Double route.

### d Key intersections – Plateau

Intersections that will be used by the project construction traffic were identified and assessed. A summary of key intersections on the Plateau is provided in Table 6.25.

**Table 6.25 Key intersections – Plateau**

| Intersection | Description |
|---|---|
| Link Road / Lobs Hole Ravine Road | The current configuration of Link Road/Lobs Hole Ravine Road intersection is a T-junction. Lobs Hole Ravine Road has an unsealed surface up to the edge of the through traffic lane on Link Road. |
| Snowy Mountains Highway / Link Road | The current configuration of the Snowy Mountains Highway/Link Road intersection is a T-junction with an auxiliary left-turn (AUL) and a channelised right-turn (CHR) on the major road of Snowy Mountains Highway to allow left and right turning movements to access Link Road. |
| Snowy Mountains Highway / Tantangara Road | The current configuration of the Snowy Mountains Highway/Tantangara Road intersection is a basic T-junction. There is some additional shoulder width covered with gravels to provide spaces for vehicle turning movements. In addition there is an extremely large shoulder on the inside radius of the Snowy Mountain Highway. |

### ii Existing road network – Cooma

Key roads and intersections that are predominantly within Cooma are discussed in this section.

### a Monaro Highway

The Monaro Highway is a 285 km long north-south highway connecting Canberra and Cooma where it joins the Snowy Mountains Highway. It continues further south, cross the Victoria border and eventually joins the Princes Highway, near Cann River. The Monaro Highway is the major access for most traffic to and from Canberra.

Within the project transport route, Monaro Highway is a two-lane two-way highway with road width varying from 7.4 to 10.3 m. The speed limit is generally between 80 km/h and 100 km/h in the rural area, reducing to 60 km/h on the approaches to Cooma. When entering school zones, speed limit reduces to 40 km/h between 8:00 am to 9:30 am and 2:30 pm to 4:00 pm.

Daily baseline traffic volumes for the non-winter period were recorded south of Cooma with 1,524 LV and 971 HV and east of Polo Flat with 4,198 LV and 683 HV. A traffic count was taken on the Sunday of the Queen's Birthday long weekend 2019 there were 10,953 vehicle movements.

In the period 2013-2017 there were 10 recorded crashes resulting in injury on Monaro Highway East of Bombala Street to Polo Flat Road (north). In the same period there were 4 crashes resulting in injury recorded for Monaro Highway South of Polo Flat Road (south).

### b Polo Flat Road

Polo Flat Road is a 4 km long fully sealed road, connecting Monaro Highway to the north and the Snowy Mountain Highway to the south. It runs through the middle of the Polo Flat industrial area. The road width varies from 6 to 8.6 m with speed limit capped at 80 km/h within the industrial area. The centre line of the road is marked.

There is an active railway level crossing approximately 645 m south of Monaro Highway to the north. The railway level crossing is controlled by give way signs. There is a railway bridge on Polo Flat Road with low clearance of 4.1 m. Polo Flat Road is an approved B-Double route.

Baseline daily traffic counts were recorded at Polo Flat North with 1,036 LV and 806 HV and Polo Flat South with 1,102 LV and 1,067 HV.

In the period 2013-2017 there were 4 recorded crashes resulting in injury on Polo Flat Road.

### c Salesyard Road

Saleyards Road is a 209 m long fully sealed road, connecting Snowy Mountains Highway to the south and Polo Flat Road to the north. It is a two-lane two-way local road with a road width varying from 10 to 13 m. It provides a bypass route from Monaro Highway to Polo Flat Road for heavy vehicles more than 4.1 m in height. Saleyards Road is an approved B-Double route.

In the period 2013-2017 there were no crashes resulting in injury on Salesyard Road.

### d Yareen Road

Yareen Road is a 1.6 km long fully sealed local road, connecting Monaro Highway to the west and Polo Flat Road to the east. There are residential dwellings on both sides of the road. The road width varies from 7.3 to 8.8 m with a speed limit of 60 km/h. There is a non-operational railway level crossing approximately 93 m west of Monaro Highway, which was controlled by flashing lights and stop signs.

Yareen Road is an approved 19 m B-Double route with travel conditions: no travel is permitted between 7:00 am to 9:00 am and 3:00 pm to 5:00 pm on school days.

### e Key intersections – Cooma

Intersections that will be used by the project construction traffic were identified and assessed. A summary of key intersections in Cooma is provided in below Table 6.26.

### Table 6.26 Key intersections – Cooma

| Intersection | Description |
|---|---|
| Snowy Mountains Highway / Kosciuszko Road | The current configuration of the Snowy Mountains Highway/ Kosciuszko Road intersection is a T-junction with both rural auxiliary left-turn (AUL) and right-turn (AUR) treatments provided along the major road to allow left and right turning movements for cars and trucks to access the minor arm of Snowy Mountains Highway. |
| Snowy Mountains Highway / Vale Street | The current configuration of the Snowy Mountains Highway/Vale Street intersection is a single lane roundabout with 13 m diameter island. All approaches to the intersection are two-lane two-way roads including Snowy Mountains Highway that runs in an east-west direction as a B-Double route. The intersection is in the Cooma township with large number of angled on-street parking provided on Vale Street and Snowy Mountains Highway to service the local centre. |
| Monaro Highway (Snowy Mountains Highway) / Bombala Street | The current configuration of Monaro Highway (Snowy Mountains Highway) /Bombala Street intersection is a single lane roundabout with 13 m diameter island. All approaches to the intersection are two-lane two-way roads including Snowy Mountains Highway and Monaro Highway that runs in an east-west direction as a B-Double route. The intersection is in the Cooma township with large number of angled on-street parking provided on all approaches to service the local centre. |
| Monaro Highway / Yallakool Road | The current configuration of Monaro Highway/ Yallakool Road intersection is a basic T-junction. This intersection is within 100 m of the Polo Flat Road intersection along Monaro Highway. |
| Monaro Highway / Polo Flat Road (north end) | The current configuration of the Monaro Highway/Polo Flat Road (north end) intersection is a basic T-junction with a rural auxiliary left-turn treatment (AUL) on the major road to allow left turning movements for cars and trucks to access the minor road. |
| Monaro Highway / Saleyards Road (south of Polo Flat Road) | The current configuration of the Monaro Highway/Saleyards Road intersection is a basic T-junction with a rural basic BAR/BAL treatment (ie parallel widened shoulder) to allow turning movements for cars and trucks. |

An intersection warrants review according to Austroads (2017) was carried out for key intersections under existing traffic conditions. Under existing traffic conditions, only two intersections should require channelised right turning lane or auxiliary left turning lanes:

- Monaro Highway / Polo Flat Road (north end); and
- Monaro Highway / Yallakool Road.

An auxiliary left turn lane already exists on the approach to Polo Flat Road, hence a right turn bay may be required to cater for the right turn demand into Polo Flat Road.

#### iii Roads to be upgraded

The proposed Snowy 2.0 Main Works road upgrades are detailed in Section 2.3.4, key existing roads that will be upgraded and form part of the main internal construction transport route include:

- Lobs Hole Ravine Road;
- Marica Track; and
- Tantangara Road.

These roads are within the Snowy 2.0 Main Works construction area and will be used for construction traffic, noting that limited and facilitated access will be provided along Tantangara Road where determined in consultation with the contractor and where safety requirements can be guaranteed.

### 6.9.2 Community and stakeholder views

Key stakeholders that were engaged and provided feedback regarding traffic and transport impacts include RMS, NPWS, SMRC, SVC and the community. Key issues raised during the preparation of the EIS relating to traffic and transport impacts are listed below:

- impact of construction traffic on main and local roads
- transport of large equipment;
- local road upgrades; and
- closure of roads due to construction.

### 6.9.3 Avoidance and minimisation through design

Several measures have been taken through the project design to minimise and avoid impacts to traffic and transport. This section provides a summary of these measures.

#### i Road safety

A road safety audit of the haulage route in its current condition was carried out for the primary transport route and is provided in Appendix Q.

#### ii Minimisation of seasonal traffic impacts

The peak construction traffic volumes are predicted to fall outside of the peak winter season between the months of January and February. Baseline traffic counts for the winter ski season has identified peak traffic periods on Friday afternoon and the middle of day on Sunday for some weekends.

#### iii Internal road network design

All roads that will be upgraded as part of the Snowy 2.0 Main Works construction will be upgraded to facilitate the movement of heavy vehicles. As part of the design, the internal road network will be designed to minimise any delays of construction vehicle operations, including appropriate road widths to safely accommodate heavy vehicle movements. Given the remoteness of these from the external public road network, it is unlikely that the operation of the internal road network would impact the performance of Link Road or Snowy Mountains Highway.

### 6.9.4 Predicted impacts

Impacts to the capacity, condition, safety and efficiency of the road network were assessed and key issues identified. Key issues identified include the suitability of existing intersections within the KNP and in Cooma township. Traffic and transport impacts were assessed with consideration to other developments in the area including Snowy 2.0 Exploratory Works, Snowy 2.0 Transmission Connection Project, and proposed segment factory at Polo Flat.

Cumulative traffic impacts are expected due to additional traffic volumes that will be generated by the proposed segment factory at Polo Flat. These projects will share the external road network, in particular Snowy Mountains Highway. The assessment of road network impacts has therefore considered a scenario that combines the Snowy 2.0 Main Works and Polo Flat traffic generation. The Snowy 2.0 Transmission Connection Project is expected to utilise a largely different main transport route and is expected to have a peak construction period that does not coincide with the Snowy 2.0 Main Works.

Three scenarios were considered to assess the impacts of the project on the road network:

- 2022 Baseline (No Project);
- 2022 Snowy 2.0 Main Works only; and
- 2022 Snowy 2.0 Main Works and segment factory works proposed at Polo Flat (cumulative impacts).

A summary of predicted impacts is provided in this section.

### i Road network impacts – KNP

Impacts to key roads and intersections within the KNP and predominantly on the Plateau are summarised in this section. Impacts associated with the Rock Forest logistics laydown are also addressed in this section due to their proximity to the KNP.

#### a Construction traffic volume impacts in the KNP

Average and peak daily heavy and light traffic movements were determined for key road sections. A summary of estimated daily traffic generation on the Plateau in the peak month for each scenario is provided in Table 6.27.

**Table 6.27 Predicted daily traffic volumes by road section – KNP**

| Road | Location | Baseline traffic (Non-winter) | | Main Works only | | Main Works + Polo Flat | |
|---|---|---|---|---|---|---|---|
| | | LV | HV | LV | HV | LV | HV |
| Link Road | Between Kings Cross Road and Snowy Mountains Highway | 316 | 44 | 150 | 224 | 114 | 402 |
| Link Road | Between Kings Cross Road and Ravine Road | 208 | 22 | 48 | 44 | 48 | 44 |
| Snowy Mountains Highway | North of Link Road (Garden Gully Creek) | 436 | 79 | 42 | 106 | 42 | 108 |
| Snowy Mountains Highway | North of Yarrangobilly Caves intersection | 385 | 70 | 24 | 64 | 24 | 64 |

It is forecast that the largest number of HV would be travelling on Link Road (between Kings Cross Road and Snowy Mountains Highway) and Snowy Mountains Highway (between Link Road and Cooma). During the peak month, it is expected up to 410 heavy vehicles (205 in each direction) could be travelling on these sections of Link Road and Snowy Mountains Highway each day, when Mains Works are assessed together with segment factory works proposed at Polo Flat cumulatively. Snowy 2.0 Main Works itself would only be expected to generate up to 250 heavy vehicles per day (125 in each direction) during the peak month along Snowy Mountains Highway.

Due to the locations of the works sites for Snowy 2.0 Main Works, the largest increase of light vehicles is also expected on Link Road and Snowy Mountains Highway. The largest increase of light vehicles is expected to be around 150 (75 in each direction) per day at Link Road (between Kings Cross Road and Snowy Mountains Highway). However, during the Polo Flat Works, up to 308 daily light vehicles (154 in each direction) are expected to be generated.

This level of daily increase of LV and HV movements as a result of Main Works and Polo Flat Works – approximately 550 total vehicles (up to 1,350 Passenger Car Units (PCU) assuming a PCU factor of 2.9 for heavy vehicles) in a day will not have any significant impacts to the mid-block capacity of the study network given the network is currently operating at very low volume / capacity ratios with significant amount of spare capacity.

Predicted impacts to road sections are summarise in Table 6.28.

**Table 6.28 Predicted impacts to road sections from construction traffic volumes**

| Road | Predicted impacts |
|---|---|
| Link Road | Link Road is expected to have the largest increase in both light and heavy vehicles, especially during the peak month. This level of increase on Link Road is less than the increase of traffic during peak winter days – an increase of approximately 1,000 vehicles per day travelling in both directions.<br>However, the cumulative increase of peak construction traffic as well as winter holidays traffic may cause some localised congestion to occur, especially near the Selwyn Snow Resort.<br>Due to the increase of both light and heavy vehicle traffic along Link Road, the number of incidents could also increase especially where Link Road is below 6 m road-width, where sight-lines are limited and on sections of road with sharp curves. Safety risks could increase due to increased traffic and high percentage of heavy vehicles unless suitable management measures are applied. |
| Snowy Mountains Highway | Although the Snowy Mountains Highway is the main project traffic route, the traffic volume increase due to the project is less than the normal traffic during peak winter days – an increase of over 5,000 vehicles per day travelling in both directions between Cooma and Kosciuszko Road.<br>Due to the increase of both light and heavy vehicle traffic along Snowy Mountains Highway, the number of incidents could also increase especially where road-widths may be considered inadequate, where sight-lines are limited and on sections of road with sharp curves. |

### b Impacts to intersections in the KNP

Intersection capacity assessment using SIDRA has been undertaken for all key intersections. The SIDRA modelling confirmed that all key intersections will continue to operate satisfactorily with overall intersection LoS C or better, when considered under non-winter baseline traffic and all scenarios of construction (light and heavy) vehicles traffic. The predicted future intersection performance within KNP is provided in Table 6.29.

### Table 6.29 Future intersection performance summary in KNP

| Intersection | Performance (LoS) | | |
|---|---|---|---|
| | Existing | Main Works | Main Works + Polo Flat |
| Link Road / Lobs Hole Ravine Road | A | A | A |
| Snowy Mountains Highway / Link Road | A | A | A |
| Snowy Mountains Highway / Tantangara Road | A | A | A |
| Snowy Mountains Highway / Marica Access | - | A | A |
| Snowy Mountains Highway / Rock Forest Access | - | A | B |

The intersection of Snowy Mountains Highway with Link Road does not achieve minimum safe intersection sight distance (SISD) requirements. Given the expected increase of construction traffic at this intersection, mitigation measures such as localised speed reduction on the approaches to this intersection should be considered to mitigate the risks. New construction access intersections will be established for Marica Track and Rock Forest.

#### ii Road network impacts – Cooma

Impacts to key roads and intersections within Cooma are summarised in this section.

#### a Construction traffic volume impacts – Cooma

Average and peak daily heavy and light traffic movements were determined for key road sections. A summary of estimated daily traffic generation in Cooma in the peak month for each scenario is provided in Table 6.30.

### Table 6.30 Predicted daily traffic volumes by road section – Cooma

| Road | Location | Baseline traffic (Non-winter) | | Main Works only | | Main Works+ Polo Flat | |
|---|---|---|---|---|---|---|---|
| | | LV | HV | LV | HV | LV | HV |
| Snowy Mountains Highway | West of Cooma | 3,499 | 477 | 98 | 252 | 124 | 410 |
| Snowy Mountains Highway | SMEC Offices | 4,261 | 586 | 98 | 252 | 194 | 410 |
| Snowy Mountains Highway | Cooma | 4,888 | 1,509 | 94 | 252 | 264 | 390 |
| Monaro Highway | South of Cooma | 1,524 | 971 | 36 | 82 | 50 | 78 |
| Monaro Highway | East of Polo Flat | 4,198 | 683 | 48 | 176 | 74 | 230 |
| Polo Flat Road | Polo Flat North | 1,036 | 806 | 26 | 82 | 196 | 252 |
| Polo Flat Road | Polo Flat South | 1,102 | 1,067 | 42 | 82 | 308 | 78 |

The combination of baseline traffic (less than 2,000 vehicles per day) and construction traffic (less than 500 vehicles per day) is not expected to cause any capacity issues on Polo Flat Road or Monaro Highway. Polo Flat Road as a local collector road serving the industrial area of Polo Flat is unlikely to be impacted by winter holidays traffic.

### b Impacts to key intersections in Cooma

Intersection capacity assessment using SIDRA has been undertaken for a number of critical intersections across the study area. The SIDRA modelling confirmed that all the critical intersections within the study area will continue to operate satisfactorily with overall intersection LoS C or better, when considered under non-winter baseline traffic and all scenarios of construction (light and heavy) vehicles traffic. The predicted future performance for key intersections in Cooma is provided in Table 6.31.

**Table 6.31 Future intersection performance summary**

| Intersection | Performance (LoS) | | |
|---|---|---|---|
| | Existing | Main Works | Main Works + Polo Flat |
| Snowy Mountains Highway / Kosciuszko Road | B | B | B |
| Snowy Mountains Highway / Vale Street | A | B | B |
| Monaro Highway (Snowy Mountains Highway) / Bombala Street | B | B | C |
| Monaro Highway / Yallakool Road | A | A | A |
| Monaro Highway / Polo Flat Road (north end) | A | B | B |
| Monaro Highway / Saleyards Road (south of Polo Flat Road) | A | A | A |

An intersection warrants review according to Austroads (2017) was completed for the construction traffic scenarios. The following intersections warrant upgrades due to the increased traffic volumes at the intersections:

- Monaro Highway / Yallakool Road;
- Monaro Highway / Polo Flat Road; and
- Monaro Highway / Salesyards Road.

It should be noted that intersections of Monaro Highway / Yallakool Road and Monaro Highway / Polo Flat Road require upgrades even without the construction vehicles, based on the forecast growth of the corridor.

In addition to the upgrades identified based on typical (non-winter) traffic conditions, there may be some upgrades carried out for the existing roundabout intersection of Monaro Highway (Snowy Mountains Highway) / Bombala Street to provide adequate performance during winter peak conditions when considered together with construction traffic. It should be noted this roundabout is expected to fail (ie performs poorly) under existing winter peak traffic conditions (during the peak hours on the weekends of the ski season) regardless of construction traffic. Snowy Hydro is continuing to engage with roads authorities (SMRC, NPWS and RMS) to determine the most appropriate measures to address traffic performance during this peak period.

#### iii Oversize and over-mass vehicles

A review was undertaken to understand the requirements for the transport of the largest oversize over-mass (OSOM) vehicle required to transport transformers between Port Kembla and the Snowy Mountains Highway at Yarrangobilly. The review has identified a number of critical constraints on the network for the transportation of OSOM items to and from site. These critical constraints have been addressed by including any road widening works required within the Snowy 2.0 Main Works construction footprint including minor widening to two sections of Snowy Mountains Highway between Adaminaby and Link Road. Minor changes to the existing roundabout intersection of Monaro Highway / Vale Street to facilitate some OSOM associated with Exploratory Works are being sought approval for through a modification to the current Exploratory Works approval (Modification 2) expected to be submitted to DPIE in October 2019.

#### iv Marine transport

The Snowy 2.0 Main Works will involve some marine transport due to the use of barges for construction works on Tantangara and Talbingo reservoirs. A navigation safety assessment was prepared and identified risks associated with the proposed marine transport during construction. The navigation assessment found that some risks may arise from interactions between proposed marine transport and public boating. Management measures will be implemented to minimise these risks including establishing exclusion areas around in-reservoir construction sites and appropriate controls for marine vehicles, equipment and infrastructure.

#### v Emergency access

Access for emergency vehicles will be unaffected during as there are no plans to close any roads to emergency vehicles. During upgrades of the internal roads, unhindered access will be available and maintained for emergency vehicles at all times. In addition, consultations with emergency service providers would be required as part of the finalisation of the Construction Traffic Management Plan.

#### vi Public access

As described in Section 2.5.2 there will be some road closures during construction that will impact access to recreational areas within KNP. Proposed public access arrangements during construction and operations are provided in Figure 2.32 and Figure 2.33. An assessment of impacts to recreational users was prepared and is discussed further in Section 6.13. There will be no impact to public transport from the proposed works.

### 6.9.5 Mitigation measures

Mitigation measures were identified to minimise the identified traffic and transport impacts of the project. Traffic and transport mitigation measures are summarised in Table 6.32.

## Table 6.32 Mitigation measures for traffic impacts

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| Speed limit reductions | TRA01 | At locations where minimum sight distances cannot be achieved, due to the existing road alignments, the posted speed limits adjacent to the intersections will be reduced to satisfy the sight distance requirements and maintain safe manoeuvring conditions for motorists. These intersections and the proposed speeds are:<br>• Snowy Mountains Highway/ Tantangara Road – 60 km/hr<br>• Snowy Mountains Highway/ Rock Forest – 80 km/hr<br>• Link Road / Lobs Hole Ravine Road – 60 km/hr<br>• Link Road / Snowy Mountains Highway – 80 km/hr<br>Based on feedback from community consultation speed limit reductions are also being considered for Snowy Mountains Highway through the township of Adaminaby to 60 km/h. Any speed limit changes will be discussed with the relevant roads authority and documented in the construction traffic management plan as required. | Construction | Contractor |
| Intersection upgrades | TRA02 | Based on the consideration of construction activities as well as intersection capacity assessment following intersections will be upgraded:<br>• Snowy Mountains Highway / Marica access - establish **n**ew construction access (BAR / BAL); and<br>• Snowy Mountains Highway /Rock Forest access **-** establish **n**ew construction access (BAR / BAL). | Construction | Contractor |
| OSOM vehicle movements | TRA03 | The TMPs will be prepared, submitted and approved by the RMS under permit, prior to the commencement of any deliveries considered 'high risk' OSOM movements in accordance with RMS guidelines. | Construction | Contractor |
| Road maintenance | TRA04 | Road maintenance will be managed through the following measures:<br>• a Road Dilapidation Report will be prepared and approved prior to and following Snowy 2.0 Main Works;<br>• routine defect identification and rectification of the internal road network will be managed as part of the project maintenance procedure; and<br>• internal access roads will be designed in accordance with the relevant vehicle loading requirements. | Construction | Contractor |
| Traffic control | TRA05 | Road works associated with pavement widening, such as those associated with intersection upgrades, that require temporary occupation of traffic lanes or working adjacent to the road, a Traffic Control Plan (TCP) will be prepared identifying the traffic control measures. | Construction | Contractor |
| Community consultation | TRA06 | Affected communities, visitors and emergency services will be notified in advance of any disruptions to traffic and restriction of access to areas of KNP impacted by project activities. | Pre-construction, construction, operations | Snowy Hydro/ Contractor |
| Construction traffic management | TRA07 | A Construction Traffic Management Plan will be prepared and will include guidelines, general requirements and procedures to be used when construction activities have a potential impact on existing traffic arrangements. | Pre-construction | Contractor |

**Table 6.31 Mitigation measures for traffic impacts**

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| Marine transport | NAV01 | The following measures will be implemented to manage interactions between marine transport and public boating activities during construction:<br>• public exclusion zones will be established around all in-reservoir construction areas;<br>• an aquatic license will be obtained from RMS for all in-reservoir construction activities and exclusion zones;<br>• all work vessels will be limited to 4 knots;<br>• all vessels and barges will be fitted with Automatic Identification System and comply with all licensing requirements of Australian Maritime Safety Authority and Roads and Maritime Services including specific requirements for Alpine Waters;<br>• any fixed obstruction such as marker buoys and moorings will comply with Roads and Maritime Services requirements and are adequately lit at night; and<br>• notification signs advising of the works and public closures at:<br>– the intersection of Snowy Mountains Highway and Tantangara Road;<br>– the intersection of Snowy Mountains Highway and Long Plain Road; and,<br>– Tantangara Boat Ramp. | Construction | Contractor |

### 6.9.6 Summary and conclusion

Impacts to the capacity, condition, safety and efficiency of the road network were assessed and key issues identified. Key issues include the suitability of existing intersections within the KNP and in Cooma township.

New intersections will be established for construction access at Snowy Mountains Highway / Marica Track and Snowy Mountains Highway / Rock Forest Access. Upgrades to existing intersections will be undertaken as part of the Polo Flat segment factory application at Monaro Highway/ Yallakool Road, Monaro Highway / Polo Flat Road and Monaro Highway / Salesyard Road. Reduced speed limits are proposed to ensure intersection sight distance requirements are met at the intersection of Snowy Mountains Highway/ Tantangara Road, Snowy Mountains Highway/ Rock Forest and Link Road / Lobs Hole Ravine Road. Construction management protocols will be implemented to manage road maintenance, traffic control and community consultation requirements arising from the project traffic.

The use of navigable waters was also considered in Tantangara and Talbingo reservoirs. Suitable management measures will be implemented to ensure safety of reservoir users around construction areas and project vessels. There will be no access restrictions for emergency management within KNP as a result of the works and Snowy Hydro will consult closely with emergency services. There will be some public access restrictions during construction and operations but careful planning has been undertaken to minimise and mitigate these impacts.

The Snowy 2.0 Main Works will consider traffic and transport impacts as part of the project design and scheduling. Where impacts to traffic and transport are predicted, management measures will be implemented. In the long term the Snowy 2.0 Main Works will provide improved access infrastructure within the project area and wider region.

CHAPTER 6.10

# AMENITY

## 6.10 Amenity

Amenity is a key consideration for the project due to the recognised KNP landscape values and the quiet, rural nature of the surrounding area and its townships. This chapter provides an assessment of the:

- construction, operational and road noise impacts of the project;
- blasting impacts of the project; and
- visual impacts of the project, including lighting impacts and potential impacts on views of the project from key vantage points in KNP.

The assessment of amenity relies on the landscape character and visual impact assessment (Appendix S) and noise and vibration assessment (Appendix R) prepared for the project and should be referred to for further information and detail on the assessment methodology and results.

### 6.10.1 Existing environment

KNP is an area recognised for its natural and heritage values, as described earlier in this EIS, and provides opportunity for remote experiences within a unique, natural landscape setting. The ambient noise environment is reflective of this uninhabited setting, with background noise levels controlled by natural elements. Industrial infrastructure does occur within areas of KNP proximate to the project area and these include the existing Snowy Scheme, Cabramurra township, electricity transmission lines and associated switchyards as well as evidence of former mining activities.

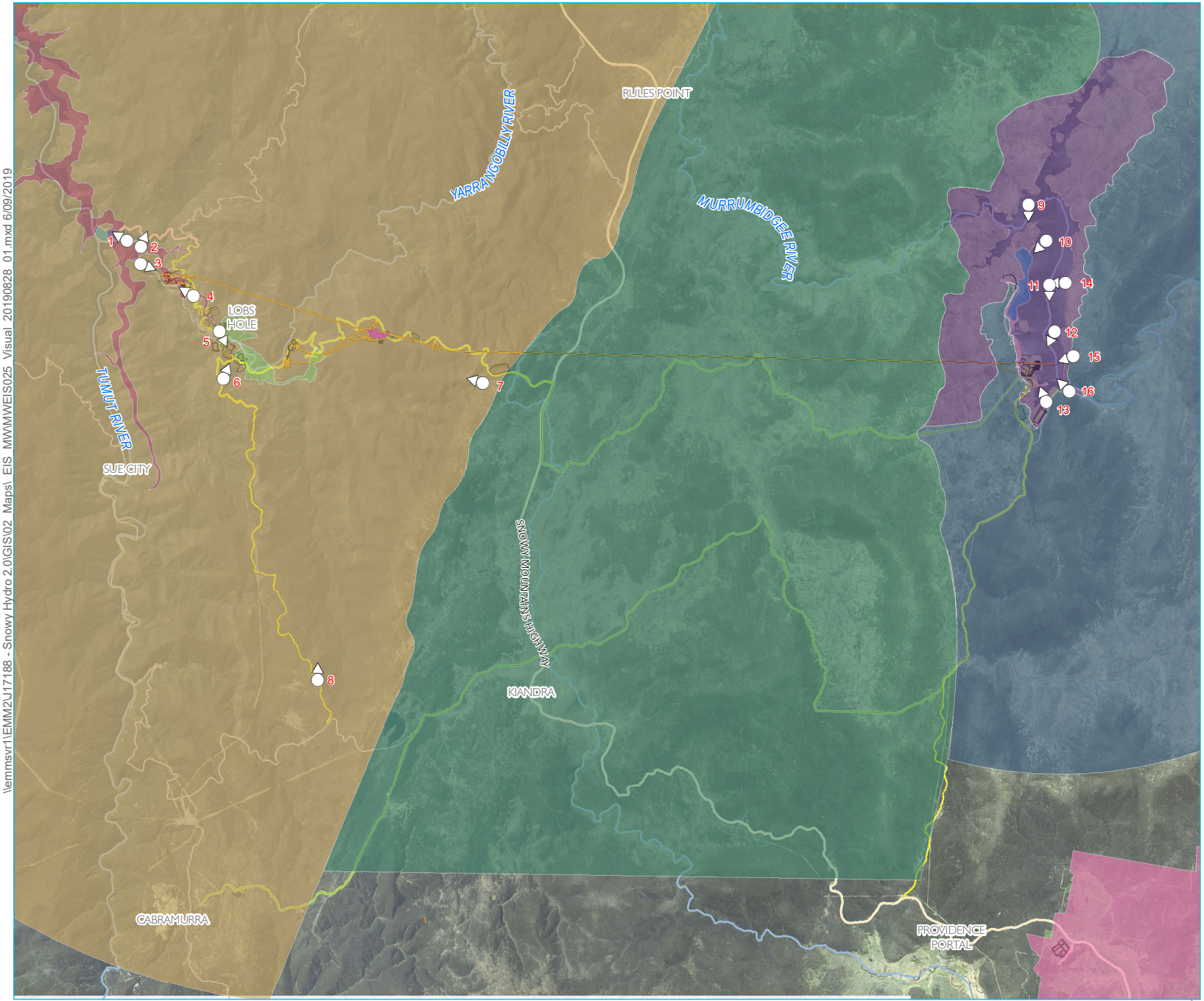
Intrusive noise sources are primarily limited to intermittent traffic along roads and boating activities by recreational users on the reservoirs. Landscape character zones have been derived based on the distinctive environments within the project area, which are shown on Figure 6.23. The road network to be utilised for primary haulage to and from the project is a source for current noise generation and is shown on Figure 6.24, as well as the assessment locations used in the noise assessment.

#### i Talbingo Reservoir

Talbingo Reservoir is characterised by the artificial lake created by the impounding of the Tumut River and the steep, rugged topography and dense woodland that surrounds it. Typically, vegetation is present all the way to the water's edge, with water quality and clarity high. Submerged trees are visible evidence of the inundation of the valley as part of the reservoir's creation. Noise sources are natural elements, except for minimal human activity associated with recreational pursuits on the reservoir.

In summer, water activities on the reservoir increase and include the use of motorised boats or small vessels such as kayaks or canoes. There are some 4WD fire trails in the surrounding area with views to the reservoir, and an existing transmission line and cleared easement through the woodland associated with the existing Snowy Scheme.

While there is visual evidence of built infrastructure due to the Snowy Scheme (transmission lines and the reservoir itself), there is a perceived naturalness to the reservoir that provides a scenic amenity with limited ability to absorb new built elements into the landscape. As such, the landscape character sensitivity of Talbingo Reservoir is assessed as high.

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KEY

Viewpoints

Landscape character zone
- LCZ 1 Talbingo Reservoir
- LCZ 2 Talbingo rugged woodland
- LCZ 3 Lobs Hole
- LCZ 4 Gooandra Plateau
- LCZ 5 Tantangara woodland
- LCZ 6 Tantangara Reservoir and foreshore
- LCZ 7 Rock Forest

Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements
- Temporary construction compounds and surface works
- Temporary access road
- Indicative rock emplacement area

Existing environment
- Main road
- Local road
- Watercourse

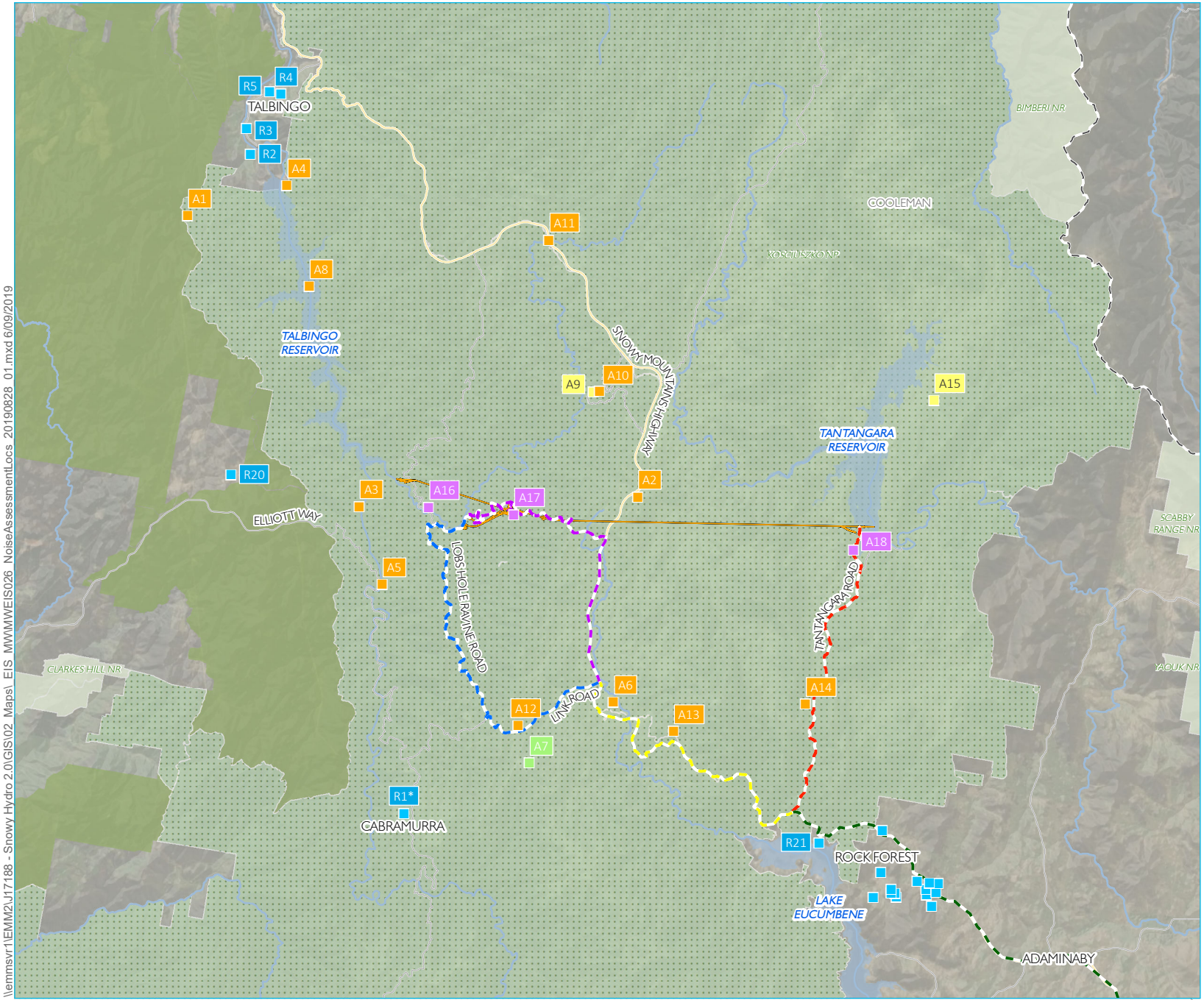
*Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)*

# Landscape character zones and assessment locations

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.23

snowy 2.0

EMM creating opportunities

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*Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)*

## KEY

Noise assessment location
- Residential
- Commercial
- Passive recreation
- Active recreation
- Project accommodation

Primary transport route
- All site access from Cooma to KNP and Rock Forest
- Route to Tantangara Reservoir
- Route to Talbingo Reservoir and Lobs Hole
- Route to Marica and Lobs Hole
- Route to Marica, and alternative access to Lobs Hole

Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
- Power station

Existing environment
- Main road
- Local road
- Watercourse
- Waterbodies
- Kosciuszko National Park
- NPWS reserve
- State forest
- State boundary

Noise assessment locations

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.24

snowy 2.0

EMM creating opportunities

### ii Lobs Hole

Lobs Hole is a previously disturbed area which retains remnants of an old settlement where copper mining took place in the late 1800s/early 1900s. Large areas of land were cleared for the township along the Yarrangobilly River. The area is now frequented by visitors wishing to experience the remote nature of the site and its peaceful setting, as well as historical relics such as the Washington Hotel whose building footprint remains as a mud brick remnant. An existing transmission line and cleared easement also traverses the Lobs Hole area. Due to this previous disturbance there is a greater ability to absorb visual change.

### iii Marica

Marica is characterised by steep, rugged topography and dense woodland that covers the landforms. The scenic qualities are typical of the Australian bushland aesthetic, and several lookouts have distant views toward Marica. The area is not frequented by visitors, with limited 4WD fire trail access available. Despite the low level of visitors, the largely undisturbed environment results in a high landscape character sensitivity susceptible to visual impacts, and consistent with other parts of KNP, low background noise levels.

### iv Plateau

The Plateau represents a geomorphological change within the project area, with a clear visual change in topography and vegetation across the landscape. Visible qualities such as the bogs and fens represent fragile ecosystems that exist in this zone with built form minimal in size and scale but comprising campgrounds (such as Bullocks Hill campground) and unique heritage sites (such as the Kiandra Courthouse and Chalet and the Wolgal Hut). A transmission line easement runs north-south across the landscape, as does the primary road corridor of the Snowy Mountains Highway. The highway presents the primary noise source in this landscape. Due to the presence of infrastructure that supports recreational use, transmission lines and transport movements throughout the zone, the overall landscape character is of moderate sensitivity to change.

### v Tantangara Reservoir

Tantangara Reservoir is characterised by a backdrop of undulating woodland that surrounds the grassland of the reservoir foreshore. The area provides spaces for camping accessible by most vehicles, with visitors to the area seeking an isolated experience in a natural setting. While the reservoir is not a natural feature (as evidenced by the dam wall, transmission lines and buildings near the wall), it provides the aesthetic of such. Visitors recreate along the foreshore and on the reservoir, particularly for fishing activities, travel to nearby historic sites such as Currango Homestead, or experience the high plains via horseback. These recreational uses (boating activities and vehicular travel) are the dominant noise sources in this setting.

As the higher of the two reservoirs, Tantangara Reservoir will experience snow during winter. While there is presence of existing infrastructure of the Snowy Scheme it is set amongst clear water and the slow growth alpine vegetation and backdrop to the Snowy Mountains. The landscape character sensitivity is considered to be high.

### vi Rock Forest

Rock Forest is characterised by its grazing uses and pockets of vegetation spread throughout the private property. The adjacent Snowy Mountains Highway provides the dominant source of noise, with traffic travelling along the road at the border of the KNP. The sensitivity of the landscape character is moderate, due to the private nature of the site and the transient means in which observers experience the zone.

### 6.10.2 Community and stakeholder views

Community and stakeholder views relating to amenity have been raised throughout the consultation period to date for Snowy 2.0. The key amenity related matters raised include the need to minimise landscape and visual impacts within KNP, retaining remote recreational opportunities and minimising amenity impacts to park users. This was raised by NPWS, special interest groups and members of the community to ensure the KNP values are preserved.

### 6.10.3 Avoidance and minimisation through design

A number of avoidance and minimisation measures have been incorporated into the design, either as part of the DIAA process or to respond to community and stakeholder views. These measures include:

- removal of plateau substation, where it would have been a prominent visual feature in the landscape;
- the layout of Rock Forest was reoriented to reduce noise emissions to nearby residences. The proposed use of the site was also reduced in scale resulting in improved amenity outcomes; and
- location, arrangement, design and rehabilitation of intake structures to minimise the visual and aesthetic impact on the natural surrounding environmental where possible while meeting all technical requirements.

### 6.10.4 Predicted impacts

#### i Overview

The key amenity impacts of the project relate to changes to the landscape and visual impacts associated with the introduction of new infrastructure into the landscape, as well as noise impacts that have the potential to interrupt recreational users of KNP or residences along the key haulage route to construction sites. Impacts to amenity resulting from noise are anticipated to be limited primarily to the construction phase of the project, whereas landscape and visual impacts will be experienced during both construction and operation.

A total of 17 viewpoints were considered representative of key receptors within KNP and surrounds (shown on Figure 6.23), and assessments of each of these are summarised in Table 6.33 and provided in further detail in Appendix S (LCVIA). All viewpoints were representative of 'passive recreation' and the majority of landscape sensitivity is high due to their location within the natural settings provided by KNP. As construction works are 24/7, lighting may be visible from some vantage points during evening and night-time periods (eg views to Marica from Wallaces Creek fire trail), however the number of visitors to these vantage points during these hours is likely to be low. Impacts identified in the table below need to be considered in the context that these areas are not frequently accessed by the public throughout the year.

## Table 6.33 Overview of predicted impacts on views of the project from key vantage points within KNP

| Viewpoint | Location and representative receptor | Impact during construction | Impact during operation |
|---|---|---|---|
| **Talbingo Reservoir** | | | |
| 1 | Within Talbingo Reservoir looking north-west towards shoreline. Water-based receptors: Fishers, boaters and swimmers within the reservoir | High – there would be a visible change in water turbidity as well new cleared areas and construction activity along the previously scenic shoreline | Moderate to High – due to the sensitivity of the landscape and visibility of placed rock within the reservoir when water levels are below FSL. However, this impact will occur in a location isolated from the main recreational user areas on Talbingo Reservoir |
| 2 | Within Talbingo Reservoir looking north. Water-based receptors only: Fishers, boaters and swimmers within the reservoir | High – clearing for the access road to the placement area will be visible and change the aesthetic of the shoreline | Low – the area will be rehabilitated, and the setting returned to a wooded landscape |
| 3 | Within Talbingo Reservoir looking south-east towards shoreline, on the edge of the public exclusion zone. Water-based receptors only: Fishers, boaters and swimmers within the reservoir | High – there would be a substantial change from a largely undisturbed shoreline to one cleared of vegetation | High – the nature and scale of permanent elements in view are contrast to the largely undisturbed woodland setting. However, this impact will occur in a location isolated from the main recreational user areas on Talbingo Reservoir |
| **Lobs Hole** | | | |
| 4 | Lobs Hole Ravine Road looking west towards Talbingo Reservoir. Walkers, bike riders, horse riders, vehicles, campers using Lobs Hole Ravine Road | N/A – viewpoint is not publicly accessible during construction | Moderate to High – existing transmission line intersects the view however the alteration of land for the intake would be contrasting to the landscape setting |
| 5 | View towards the south, within Lobs Hole. Walkers, bike riders, horse riders, vehicles, campers using Lobs Hole | N/A – viewpoint is not publicly accessible during construction | Moderate to High - the substation in this location is a change to the semi-rural to natural character of this view and surrounding setting |
| 6 | Looking north from Lobs Hole Ravine Road along existing transmission line easement. Walkers, Bike riders, Horse Riders, Campers, Vehicles using Lobs Hole Ravine Road | N/A – viewpoint is not publicly accessible during construction | Low to Moderate – only the top of gantries for the substation would be visible and the transient nature of users of the access road |
| **Marica** | | | |
| 7 | Looking west from Wallaces Creek Fire Trail towards Talbingo Reservoir. Campers, walkers, bike riders, horse riders | Moderate – visibility of elements would be difficult but possible, and lighting impacts during evening and night time would be possible | Moderate – the visual analysis suggests this location as having some visibility of the surge shaft. However the majority is likely to be screened by the existing vegetation from this viewpoint |
| 8 | View north from Wallaces Creek Lookout. Wheel chair accessible lookout. Walkers, campers at Lobs Hole, visitors to the Lookout | N/A – viewpoint is not publicly accessible during construction | Negligible – unlikely to be visible at this distance |

## Table 6.32 Overview of predicted impacts on views of the project from key vantage points within KNP

| Viewpoint | Location and representative receptor | Impact during construction | Impact during operation |
|---|---|---|---|
| **Plateau** | | | |
| N/A | N/A | N/A | N/A |
| **Tantangara Reservoir** | | | |
| 9 | Looking south from within Tantangara Reservoir. Water-based receptors: Fishers, boaters and swimmers within the reservoir | High – extensive disturbance to shoreline would be visible during placement of excavated rock | Moderate to High – the intake would only just be visible however a changed shoreline condition would be visible |
| 10 | From within Tantangara Reservoir looking southwest. Water-based receptors: Fishers, boaters and swimmers within the reservoir | Moderate to High – extensive disturbance to shoreline would be visible during placement of excavated rock | Moderate to High – the change to landscape from rock placement will contrast with grasses of the shoreline and impact aesthetic value |
| 11 | Looking south toward Tantangara Road from within the reservoir. Water-based receptors only: Fishers, boaters and swimmers within the reservoir | Moderate – the view is more distant to intake construction but an abundance of construction activity that would be seen from this location | Moderate – multiple permanent elements would be seen but at a distance which reduces the scale of impact from this location |
| 12 | Looking south-west towards proposed Intake location from within Tantangara Reservoir, on edge of public exclusion zone. Water-based receptors only: Fishers, boaters and swimmers within the reservoir | High – due the proximity of the view to construction and obtrusive elements within the landscape setting | Moderate to High – grassy areas will be replaced with permanent structure of the intake that is only partially visible |
| 13 | Looking north-west from Tantangara boat ramp into the reservoir. Campers in Tantangara, Walkers, Horse and Bike Riders, 4WD's, Visitors | N/A – viewpoint is only accessible to the public via limited, escorted access by the contractor | High - the view from this location would be altered by the introduction of new permanent infrastructure. The intake would be on the peninsula in the centre of the view and contrast the natural setting |
| 14 | Looking west from shoreline towards the excavated rock placement location. Campers in Tantangara, Walkers, Horse and Bike Riders, 4WD's, Visitors | Moderate to High - substantial disturbance and change to the view during construction | Moderate to High – the change in view is influenced by the rock placed on the shoreline |
| 15 | Looking west from Pocket Saddle Road into Tantangara Reservoir. Campers in Tantangara, Walkers, Horse and Bike Riders, 4WD's, Visitors | Moderate to High – a high magnitude of change would result from construction activities visible in this view | Moderate to High - the grassed shoreline used by recreational users will be closed to the public, with multiple permanent operational elements atop it |
| 16 | Looking north-west into Tantangara Reservoir from the existing dam wall. Campers in Tantangara, Walkers, Horse and Bike Riders, 4WD's, Visitors | Moderate to High - Construction activities would be obtrusive from this angle. Large amounts of clearing and machinery would be noted | Moderate - the existing dam wall is within the view however new permanent operational elements would cause change to the existing landscape seen in the distant outlook |

### Table 6.32 Overview of predicted impacts on views of the project from key vantage points within KNP

| Viewpoint | Location and representative receptor | Impact during construction | Impact during operation |
|---|---|---|---|
| **Rock Forest** | | | |
| 17 | Rock Forest, looking south from Snowy Mountains Highway. Commuters, workers, tourists predominantly from vehicle, using Snow Mountains Highway, residents from neighbouring properties | Moderate - the magnitude of change to this observer location is high. However, there exists potential in this location to retain vegetation for screening purposes | N/A – the site will be rehabilitated and not needed during operation |

Noise assessment locations considered for the project are widely spread within the project area and include passive and active recreation receptors, residential receptors near Rock Forest (including Providence Portal), and commercial premises. Assessment of predicted noise and vibration impacts at each of these receptors is provided in further detail in Appendix R (NVIA). Assessment of vibration and blasting impacts of the project and changes to road traffic noise levels has also been undertaken. A summary of predicted noise and vibration impacts is provided at Table 6.34.

### Table 6.34 Summary of predicted construction (including blasting), operational and road noise impacts of the project

| Assessment | Predicted impacts |
|---|---|
| Construction noise | Construction noise levels satisfy noise management levels (NMLs) at all assessment locations with exception of the nearest receiver (R6) at 6560 Snowy Mountains Highway, Adaminaby where exceedance of 11-14 dB is predicted for the day and out of hours periods during calm and adverse weather conditions, respectively. While noise levels at passive recreation areas satisfy the required NML, noise generated by construction would still be perceptible and clearly audible at these locations. |
| Sleep disturbance | Predicted noise levels from the project satisfy sleep disturbance screening criteria at all assessment locations with the exception of the nearest receiver (R6) at 6560 Snowy Mountains Highway, Adaminaby where exceedances of 5-6 dB are predicted. |
| Construction vibration | The nearest residence to construction activity is assessment location R6 which is more than 300 m away from the Rock Forest construction site. This assessment location is beyond the safe working distances for human response considerations. Vibration impacts from construction at residential assessment locations are therefore highly unlikely. |
| Blasting | All rock structures/transmission lines/and heritage structures in the vicinity of the proposed blasting areas are outside the minimum calculated offset distances. A number of specific sites recorded in the HA&SoHI (EMM 2019) relating to a rock shelter at Tantangara, and exposed cliff-edge tufa deposits identified in Cenozoic Geodiversity Report (Troedson 2019) were identified as high value and worthy of protection. These areas well outside of blast offset zones.<br>Residential receivers surrounding the project are also well outside the blast offset distances required to maintain acceptable emission levels from road construction, portal and early stage tunnel excavation. Therefore, blast impacts on residential receivers are considered highly unlikely. |

**Table 6.33 Summary of predicted construction (including blasting), operational and road noise impacts of the project**

| Assessment | Predicted impacts |
|---|---|
| Road traffic noise | Road traffic noise levels are predicted to increase due to the project in both day and night hours.<br>The increase is most significant on Lobs Hole Ravine Road and Tantangara Road which are within the project area, as the two main access roads to work sites they will experience the greatest level of change in overall traffic volumes. Lobs Hole Ravine Road will be restricted from public access therefore impacts to users in this area is not expected. Tantangara Road will be closed during road construction works and when any high risk activities are being undertaken (eg transport of oversized equipment). Access along Tantangara will be maintained at other times with measures in place (car escort, traffic lights) to achieve the required level of safety. Road traffic noise will satisfy NMLs at Wares Yards along Tantangara Road, however noise will be audible for recreational users of this area.<br>Road traffic noise levels relevant to the township of Adaminaby and properties along Snowy Mountains Highway between Cooma and Link Road will remain within baseline levels of the NSW Road Noise Policy. The predicted increase in construction traffic will result in increases in noise levels up to 7 dB, a perceptible to notable difference in noise level during the day. Louder impacts are anticipated at night with up to 11 dB change in noise level expected. Notwithstanding this increase, baseline levels of the NSW Road Noise Policy are satisfied. As discussed in Section 6.9 reductions in the speed limit on Snowy Mountains Highway through the Adaminaby town centre are also under consideration and would further reduce impacts from road traffic noise.<br>Increases in noise levels are also expected along Link Road. However, limited receptors are along Link Road that would be susceptible to these changes.<br>Road noise level changes in Cooma would not be perceptible during daytime hours, and unlikely to be perceptible during night-time hours.<br>No significant changes to road traffic volumes or noise is expected during operation. |
| Operational noise | No residential assessment locations are within the vicinity (<1,000 m) of the operational sites associated with Snowy 2.0 Main Works. Noise from the operation of Snowy 2.0 Main Works facilities would be less than $L_{Aeq}$ 30dB(A) at Lobs Hole campground and other camping areas within the vicinity of Talbingo Reservoir and across the Plateau and Tantangara Reservoir. |

### ii Talbingo Reservoir

Construction works will include the clearance of vegetation to establish construction sites and involve excavation for the Talbingo portal and compound area, the intake and roads to the reservoir emplacement area. The extent of clearing and excavation will be a significant change to a section of the landscape. Placement of excavated rock will also result in temporary elevated levels of turbidity in the water in the area surrounding the emplacement area. However, as construction sites, will be restricted and no public access will be available (including water-based areas surrounding the intake and placement areas), there will be limited views for the duration of the six-year construction period. Upon completion however, public access will be reinstated (with the exception of some areas that will be restricted to ensure public safety) and views of the landscape will include permanent infrastructure that is contrasting to the previously undisturbed natural setting.

The predicted change in landscape is shown visually in the photomontage provided at Figure 6.25, which is representative of water-based users of Talbingo Reservoir. Rehabilitation objectives are set out in the Rehabilitation Strategy (Appendix F) with guidance on different types of revegetation that would better enable integration with the landscape, where possible. However, as seen in the photomontage, the steep batters of the intake limit the extent of stable revegetation that can occur. The visual impact during both construction and operation is high.

While exceedance is not expected at passive recreation receptors during construction, the change in noise environment would be perceptible. During operation however, noise impacts at these receptors is negligible.

### iii Marica

There will be no public access to Marica during construction, and limited access during operation as the upgraded Marica trail will be the primary access for Snowy Hydro to access the surge shaft and ventilation shaft. The nearest public viewpoint is from Wallaces Creek Firetrail. Dense vegetation is expected to screen views of the surge shaft and ventilation shaft, therefore negligible visual impacts are expected during both construction and operation. No exceedance of noise levels is predicted however impacts may be audible at nearby recreational sites such as Bullocks Hill campground, during construction.

### iv Plateau

No viewpoints were selected within the Plateau as visual elements would be limited to temporary plant and machinery needed during construction for utilities along access roads. During operation, these utilities will be buried and not visible.

### v Tantangara Reservoir

Construction works will include the clearance of vegetation to establish construction sites and involve excavation for the Tantangara portal and compound area, the intake and roads to the reservoir emplacement area. The extent of clearing and excavation will be a significant change to the landscape, both temporarily during construction and permanently following completion of the project given public accessibility along the foreshore, the openness of the landscape, and the popularity of the reservoir for recreational boating and fishing activities. Public access will be available from parts of Tantangara Reservoir during construction; therefore impacts are expected during both construction and operation.

A recreation plan is proposed to be prepared in consultation with NPWS to allow for rehabilitation of the foreshore to accommodate more formalised recreational facilities. However, details of likely improvements are yet to be determined.

The predicted change in landscape is shown visually in the photomontage provided at Figure 6.26, which is representative of recreational users accessing Tantangara Reservoir. Rehabilitation objectives are set out in the Rehabilitation Strategy (Appendix F) with guidance on different types of revegetation that would better enable integration with the landscape, where possible.

While exceedance is not expected at passive recreation receptors during construction, the change in noise environment would be perceptible. During operation however, noise impacts at these receptors is negligible.

### vi Rock Forest

Construction works at Rock Forest will require the clearing and movement of land to provide level hardstand areas. Trucks will be entering and leaving the site with material storage and would be one of the primary noise sources heard in the surrounding area. While only used during construction, the six year period presents a magnitude of change to its current use, and the noise generating activities are predicted to exceed criteria (day and night) at the nearest residential receiver (to the north-east along Snowy Mountains Highway).

Existing view from water, edge of (indicative) public exclusion zone

During construction – typical operating level

15 year operation – typical operating level

**Figure 6.25 Talbingo Reservoir viewpoint assessment – View from water, edge of public exclusion zone**

**Figure 6.26 Tantangara Reservoir viewpoint assessment – View from Tantangara Road**

### 6.10.5 Mitigation measures

Mitigation measures identified to minimise amenity impacts are provided in Table 6.35.

**Table 6.35 Mitigation measures for amenity impacts**

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| Visual and landscape impacts resulting from permanent placement of excavated material | LCV01 | The placement of excavated material in Talbingo, Lobs Hole and Tantangara Reservoir will be rehabilitated as guided by the Rehabilitation Strategy and in consultation with NPWS. | Detailed design | Contractor<br>Snowy Hydro<br>NPWS |
| Visual and landscape impacts resulting from permanent infrastructure | LCV01 | Detailed design is to consider:<br>• materials and finishes that complement or where possible recede into the surrounding landscape;<br>• the use of vegetation to screen project elements and re-vegetation of disturbed areas in line with the Rehabilitation Strategy; and<br>• lighting to avoid spill that might affect sensitive areas or receivers. | Detailed design | Contractor |
| Construction impacts | NV01 | Prepare a construction noise and vibration management plan (CNVMP) that will address noise and vibration management and mitigation options (where required). The CNVMP will include as a minimum:<br>• identification of nearby residences and sensitive land uses;<br>• a description of approved hours of work and what work will be undertaken;<br>• a description of what work practices will be applied to minimise construction noise, in particular how construction noise levels will be managed where predicted noise levels above the NMLs have been identified;<br>• a description of what work practices will be applied to minimise vibration;<br>• a description of the complaints handling process; and<br>• a description of monitoring that is required. | Construction | Contractor |
| Exceedance of day and night-time criteria at assessment location: R6 | NV02 | Affected landholders should be consulted prior to and during construction and should be notified of proposed mitigation measures that will be used to manage construction noise levels to below Interim Construction Noise Guideline (EPA 2009) NMLs where practicable. | Pre-construction<br>Construction | Contractor |
| Vibration impacts in the vicinity of heritage items | NV03 | If the safe working distances are encroached vibration monitoring will be carried out at nearby heritage items. If required, the monitoring system will be fitted with an auditory and visual alarm that triggers when vibration levels reach the nominated criteria. This would indicate if and when alternate work practices should be adopted (such as decrease vibratory intensity, alternate equipment selection, or other measure). | Construction | Contractor |

**Table 6.34 Mitigation measures for amenity impacts**

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| Blasting in the vicinity of sensitive receptors and heritage items | NV04 | A Blasting Management Plan be prepared including specific details to:<br>• address the potential for wet drill and blast activities at Talbingo and Tantangara intakes to ensure potential impacts are managed;<br>• allow for blast practices to be reviewed as needed when blasting occurs in the vicinity of significant heritage items; and<br>• allow for blast practices to be reviewed and adapted if complaints are received from residents due to night blasting. | Construction | Contractor |
| Operational noise | NV05 | The design of operational structures, plant and equipment is to consider:<br>• All operational plant and equipment including ventilation, pumps, generators, transformers, variable speed drives or other plant associated with the surface structures of Snowy 2.0 shall be subject to detailed acoustic review prior to final specification.<br>• Design shall be assessed against the requirements of the Noise Policy for Industry (EPA 2017) and consider the amenity criteria for passive recreation.<br>• Building and equipment shall be designed to satisfy the Snowy Hydro design limits of $L_{Aeq}$ 80dB(A) internal. | Operation | Contractor<br>Snowy Hydro |

### 6.10.6 Summary and conclusion

The amenity values of the project area are reflective of its location within a national park setting. NPWS, special interest groups and members of the community have expressed views on the need to protect KNP and these amenity values, which include conserving the natural landscapes and visual character unique to the Australian Alps. The assessment completed for the project incorporates these views in classifying the sensitivity of the landscape to change, and the magnitude of impacts likely to be experienced.

The assessment concluded that noise and visual impacts are greatest during construction, but as public access will be restricted during construction, these impacts will largely not be experienced. The exception is for properties along Snowy Mountains Highway between Rock Forest and Cooma, where there will be an increase in road traffic noise, and one residential property nearest to Rock Forest that exceeds NMLs and requires mitigation. While noise levels are within NMLs for identified recreational sites within KNP, they will be audible and may affect the amenity of recreational user experience.

The introduction of new permanent elements into the landscape results in a permanent change to the landscape character and visual setting of KNP in the publicly accessible areas of Talbingo Reservoir, Lobs Hole and Tantangara Reservoir. However, opportunities to provide recreational facilities as part of the permanent rehabilitation of these sites is proposed to be determined in consultation with NPWS, which may mitigate the magnitude of predicted impacts during operation.

CHAPTER 6.11

# HAZARDS

## 6.11 Hazards

### 6.11.1 Context

Potentially hazardous impacts of the project and public safety risks, including bushfire and flooding risks have been assessed. The assessment relies on technical reports prepared for the project and should be referred to for detailed information, including a Hazard Identification and Risk Assessment prepared by Sherpa in line with AS/ISO 31000:2018 Risk Management Guidelines, and a Bushfire Risk and Hazard Assessment (BFRHA) prepared by Eco Logical Australia in line with the NSW Rural Fire Service (RFS) *Planning for Bush Fire Protection Guideline* (PBP) (NSW RFS 2018). These reports are provided at Appendix T and U respectively. A flood assessment has also been completed and provided at Appendix J.

An overview of the existing environment as it relates to hazard is provided in Table 6.36, along with relevant community and stakeholder views and project design considerations relevant to the assessment of these hazards.

**Table 6.36 Context of hazards for Snowy 2.0 Main Works**

| | |
|---|---|
| **Existing environment** | The Snowy 2.0 Main Works sites west of the Snowy Mountains Highway including Talbingo Reservoir, Lobs Hole and Marica occur within the Southern Slopes Fire Weather Area and the Snowy Valleys Bush Fire Management Committee (BFMC) Area. The sites east of the Snowy Mountains Highway including Plateau, Tantangara Reservoir and Rock Forest are within the western extent of the Monaro Alpine Fire Weather Area and the Snowy Monaro BFMC Area.<br>The typical bushfire potential of vegetation within the KNP varies throughout the year, with typical fire risk levels being moderate from September to December, high from January to April and low from May to August. During an average bush fire season, the State Forests to the west of Lobs Hole/Ravine Main Works sites experience 31 very high fire danger days and one total fire ban (Severe fire danger or greater) day per annum (CSIRO 2018). This equates to on average more than two days each week during the summer in which very high or greater fire danger occurs, and at least one total fire ban day (severe or greater fire danger) each fire season.<br>Historically and average of eleven bush fires per year are recorded within the KNP with severe bushfire occurring approximately once every ten years. The most recent severe fire in 2003 burnt approximately 478,000 ha of KNP, including the project area (DECC 2008).<br>One of the key challenges for management of hazards and bushfire for the project is that the Snowy 2.0 Main Works are remotely within the KNP and existing access is constrained by topography and limited existing road infrastructure. The Main Works construction sites are a large distance from the nearest residential or commercial land uses and publicly accessible areas. Access to parts of the project area will be closed to the public for the duration of Main Works to ensure public safety.<br>Watercourses and flood characteristics within the project area are discussed in detail in Section 6.2. |
| **Community and stakeholder views** | The RFS and NPWS were consulted regarding secondary access to Lobs Hole. RFS advised that Lobs Hole Ravine Road North is planned to be a strategic fire trail in the Draft Fire Trail and Access Plan.<br>Matters relating to public safety were also raised by the community during consultation, including concern regarding impacts to recreational users within the KNP. These community views have been considered in the recreational user assessment completed for the project (Appendix X.2). |
| **Avoidance and minimisation through design** | Bushfire risk assessment was included within the DIAA process for the project with the following changes incorporated:<br>• re-location of the Tantangara accommodation camp to a downslope location with improved secondary access;<br>• expansion of the disturbance area where required to include adequate Asset Protection Zone (APZ) clearances around all proposed construction areas for bushfire protection; and<br>• identification and design of suitable access routes for access and egress for emergency services, and safe evacuation if required. |

### 6.11.2 Predicted impacts

While bushfires occur naturally in the environment, the project has the potential to exacerbate the risk of bushfire if construction and operation activities are not designed or carried out in a way that minimises this risk. This same principle applies to flooding impacts and requires the project to be designed in a way that minimises risk to public safety. The transport and storage of dangerous goods (which includes flammables, explosives, or other chemicals) is a potentially hazardous impact of the project if not appropriately managed.

The key matters assessed and summarised in Table 6.37 relate to the provision of adequate APZs, the suitability of primary and secondary access and the storage of dangerous goods, and potential flood risks.

**Table 6.37 Summary of impacts – Hazards**

| APZs | Emergency access and evacuation | Dangerous goods | Flood risks |
|---|---|---|---|
| **Talbingo Reservoir** | | | |
| Assessment of APZs was completed for Talbingo construction yard and the Talbingo intake. All sites were found to fully comply with the PBP APZ requirements for radiant heat levels, slope and maintenance for a nominated BAL-29. | Access to sites in this area will be provided as follows:<br>• Primary Access: South on Lobs Hole Ravine Road to Link Road;<br>• Secondary Access: North on Lobs Hole Ravine Road to Snowy Mountains Highway; and<br>• Secondary Access (once constructed): Mine Trail Road, Marica Trail West and Marica Trail East to Snowy Mountains Highway.<br>The proposed access will comply with all requirements for primary and secondary access under PBP 2018. The performance criteria for NSW RFS Fire trail standards can be largely achieved by the proposed access. Lobs Hole Ravine Road cannot practically achieve the acceptable solution for turnarounds due to very steep slopes. The performance criteria can be achieved by sign-posting and mapping identified turnaround points.<br>A section of Lobs Hole Ravine Road North between the Blue Creek Trail intersection and Middle Bay cannot practically achieve the acceptable solution for vehicle passing due to very steep side slopes. However, the performance criteria in this section can be achieved by establishing sign-posted passing bays with hold points and radio call-in/out procedures to manage traffic flow in the event of emergency. | The Risk Assessment identified no potentially hazardous activities at the Talbingo Reservoir sites. | No significant change to flooding characteristics for Talbingo Reservoir is anticipated. |

## Table 6.36 Summary of impacts – Hazards

| APZs | Emergency access and evacuation | Dangerous goods | Flood risks |
|---|---|---|---|
| **Lobs Hole** | | | |
| Assessment of APZs was completed for Lobs Hole Camp, Main Yard, ECVT portal and cableyard and the MAT portal. All sites were found to fully comply with the PBP APZ requirements for radiant heat levels, slope and maintenance for a nominated BAL-29. | Access to sites in this area will be provided as follows:<br>• Primary: South on Lobs Hole Ravine Road to Link Road;<br>• Secondary: North on Lobs Hole Ravine Road to Snowy Mountains Highway; and<br>• Secondary (once constructed): Mine Trail Road, Marica Trail West and Marica Trail East to Snowy Mountains Highway.<br>The proposed access will comply with all requirements for access under PBP 2018. The performance criteria for NSW RFS Fire trail standards can be largely achieved by the proposed access. Lobs Hole Ravine Road cannot practically achieve the acceptable solution for turnarounds due to very steep slopes. However, the performance criteria can be achieved by sign-posting and mapping identified turnaround points.<br>A section of Lobs Hole Ravine Road North between the Blue Creek Trail intersection and Middle Bay cannot practically achieve the acceptable solution for vehicle passing due to very steep side slopes. However, the performance criteria in this section can be achieved by establishing sign-posted passing bays with hold points and radio call-in/out procedures to manage traffic flow in the event of emergency.<br>A bushfire refuge building is required at the Lobs Hole Camp in order to comply with the PBP. | Storage of explosives during construction at the Main Yard, MAT portal and ECVT portal magazine stores were identified as potentially hazardous.<br>The Risk Assessment found that the magazine stores achieve acceptable separation distances to surrounding land uses and the construction accommodation camps. | Temporary and permanent surface infrastructure will unavoidably need to be constructed on flood prone land around Lobs Hole. This includes temporary infrastructure and construction support sites (eg associated with construction phase works, such as the accommodation camp and main yard) and permanent infrastructure (eg infrastructure associated with ongoing operation, such as roads, bridges and tunnel portal sites and buildings).<br>Whilst the spatial extent and magnitude of impacts is extensive throughout Lobs Hole, in particular for floods of 1% AEP and above, these impacts are not anticipated to impact on existing infrastructure or other areas of significance, and the design of temporary works can accommodate the changed flooding characteristics. |

## Table 6.36 Summary of impacts – Hazards

| APZs | Emergency access and evacuation | Dangerous goods | Flood risks |
|---|---|---|---|
| **Marica** | | | |
| Assessment of APZs was completed for the Vent Shaft, Marica Camp and Surge Shaft. All sites were found to fully comply with the PBP APZ requirements for radiant heat levels, slope and maintenance for a nominated BAL-29. | Access to sites in this area will be provided as follows:<br>• Primary: East on Marica Trail East to Snowy Mountains Highway;<br>• Secondary: North on Lobs Hole Ravine Road to Snowy Mountains Highway; and<br>• Secondary (once constructed): West on Marica Trail West to Mine Trail Road, and south on Lobs Hole Ravine Road to Link Road.<br>The proposed access will comply with all requirements for access under PBP 2018 and achieve all performance criteria and acceptable solution requirements for NSW RFS Fire trail standards.<br>A bushfire refuge building is required at the Marica Camp in order to comply with the PBP. | The Risk Assessment identified no potentially hazardous activities at the Marica sites. | No flooding impacts will occur at Marica |
| **Plateau** | | | |
| No sites requiring APZs are in this area. | No sites requiring access are in the plateau area. | The Risk Assessment identified no potentially hazardous activities on the Plateau. | Proposed temporary surface infrastructure in the vicinity of Kellys Plain Creek (eg accommodation camp and stockpile area), largely avoids flood prone land and therefore will not impact on existing flooding characteristics. Minor increases to peak flood levels along Kellys Plain Creek are expected to occur from the proposed upgraded road crossing of this watercourse, however these impacts would be localised are not anticipated to impact on infrastructure or other areas of significance. |

### Table 6.36 Summary of impacts – Hazards

| APZs | Emergency access and evacuation | Dangerous goods | Flood risks |
|---|---|---|---|
| **Tantangara Reservoir** | | | |
| Assessment of APZs was completed for Tantangara Intake and Tantangara Camp. All sites were found to fully comply with the PBP APZ requirements for radiant heat levels, slope and maintenance for a nominated BAL-29. | Access to sites in this area will be provided as follows:<br>• Primary: Quarry Road and south on Tantangara Road to Snowy Mountains Highway; and<br>• Secondary: East on Tantangara Road to Dam wall as an option for refuge. Numerous fire trails east to Yaouk Valley and west (including Port Phillip Trail) to Snowy Mountains Highway.<br>The proposed access will comply with all requirements for access under PBP 2018 and achieve all performance criteria and acceptable solution requirements for NSW RFS Fire trail standards.<br>A bushfire refuge building is required at the Tantangara Camp in order to comply with the PBP. | Storage of explosives during construction at the Tantangara Portal magazine store was identified as potentially hazardous.<br>The Risk Assessment found that the magazine store achieves acceptable separation distances to surrounding land uses and the construction accommodation camps. | No significant change to flooding characteristics for Tantangara Reservoir is anticipated. |
| **Rock Forest** | | | |
| An assessment of APZs was completed for the Rock Forest logistics hub. It was found to fully comply with the PBP APZ requirements for radiant heat levels, slope and maintenance for a nominated BAL-29. | Primary and secondary: East on Snowy Mountains Highway to Adaminaby, or west to Kiandra.<br>The proposed access will comply with all requirements for access under PBP 2018 and achieve all performance criteria and acceptable solution requirements for NSW RFS Fire trail standards. | The Risk Assessment identified no potentially hazardous activities at Rock Forest. | No flooding impacts are expected at Rock Forest. |

## 6.11.3 Mitigation measures

Mitigation measures required to manage hazard impacts are all associated with the management of bushfire. Management measures for flooding impacts are provided in Section 6.2.5. Mitigation measures for hazard impacts are provided in Table 6.38.

### Table 6.38 Mitigation measures for hazards impacts

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| APZs | HAZ 01 | APZs are established for all Snowy 2.0 Main Works sites to achieve BAL 29. | Construction and operation | Contractor<br>Snowy Hydro |
| | HAZ 02 | Vegetation is managed within operational APZs in perpetuity. | Construction | Contractor |

**Table 6.37 Mitigation measures for hazards impacts**

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| Construction Standards | HAZ 03 | All buildings proposed within each development site shall comply with BAL-29 construction standards of Australian Standard AS3959-2018 'Construction of buildings in bush fire-prone areas' or NASH Standard (1.7.14 updated) 'National Standard Steel Framed Construction in Bush fire Areas -2014' as appropriate. | Construction | Contractor |
| On-site Refuge | HAZ 04 | All On-site Refuge buildings will be within the centre of each Snowy 2.0 Main Works Accommodation site, constructed to BAL-29 construction standard, be of appropriate capacity, signposted and mapped. | Construction | Contractor |
| Access | HAZ 05 | Primary and secondary access is maintained, upgraded and/or constructed to comply where possible with performance criteria and/or acceptable solution requirements of PBP 2018 and NSWRFS Fire Trail Standards (NSWRFS 2019). Consultation with the NSW RFS will be undertaken where compliance is constrained. | Construction | Contractor |
| Water supply | HAZ 06 | Water supply requirements for firefighting, including the provision of hydrants and hose reels, is designed, constructed in accordance with the relevant Standards and PBP 2018. | Construction | Contractor |
| Electricity supply | HAZ 07 | Electricity supply and distribution is provided in accordance with the requirements of PBP 2018 and the relevant standards. | Construction | Contractor |
| Emergency management and response | HAZ 08 | A Bushfire Emergency Management Plan is prepared for the project area and includes responsibilities associated with and details of:<br>• site specific hazards and risk at each Snowy 2.0 Main Works site;<br>• procedures to maintain bushfire awareness;<br>• bushfire mitigation measures;<br>• fire preparedness actions;<br>• fire response actions including responses to Emergency Alerts issued by emergency services; and<br>• bushfire recovery requirements. | Pre-construction | Contractor |
| | HAZ 09 | Each main works accommodation camp shall have a full time, onsite Emergency Response Team (ERT), with an appropriate level of training and equipment to respond to potential bushfire and initial structural fire events. | Construction | Contractor |

### 6.11.4 Summary and conclusion

Potentially hazardous activities and public safety risks were assessed in project development and incorporated into the design where possible, to minimise public safety risks. Mitigation measures have been identified to enable the project to achieve compliance with the relevant requirements for bushfire protection (such as establishing APZs, bushfire refuges, and maintaining emergency access and egress routes).

The proposed storage and handling of hazardous chemicals was found to meet the DPIE risk criteria for surrounding land uses and is therefore not 'hazardous' as defined by the SEPP 33.

CHAPTER 6.12

# AIR

## 6.12 Air

An air quality impact assessment (AQIA) has been prepared for the project in general accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA 2016) (the Approved Methods for Modelling), and the air quality impact assessment criteria specified therein. The AQIA is provided at Appendix V and focuses on the potential air quality emissions and associated impacts from Snowy 2.0 Main Works construction activities only, as operation of Snowy 2.0 Main Works will not generate significant air pollution emissions warranting detailed assessment. Detailed information on the methodology can be obtained from the AQIA (Appendix V) however, it generally involved:

- defining meteorological conditions using monitoring data from BoM and project-related stations, in combination with meteorological modelling;
- dispersion modelling using the CALPUFF modelling system, for the 2017 calendar year;
- assessing emissions and ambient concentrations of total suspended particulate matter (TSP), particles smaller than 10 micrometres (µm) in diameter ($PM_{10}$) and particles smaller than 2.5 µm in diameter ($PM_{2.5}$) and nitrogen dioxide ($NO_2$). Dust deposition impacts are also considered; and
- estimating greenhouse gas (GHG) emissions using the methodologies outlined in the National Greenhouse Accounts Factors (NGAF) workbook (DEE 2018).

### 6.12.1 Context

An overview of existing air quality is provided in Table 6.39, along with relevant community and stakeholder views and project design considerations relevant to the AQIA.

**Table 6.39 Context of air quality for Snowy 2.0 Main Works**

| | |
|---|---|
| Existing environment | Background air quality is representative of an area with primarily natural influences, with little daily variation in particulate matter concentration but experiencing seasonal fluctuation. In the absence of significant industrial sources, the primary contributing sources of air pollutant emissions in the project area include:<br>• dust entrainment due to vehicle movements along unpaved and paved town and rural roads with high silt loadings;<br>• fuel combustion-related emissions from on-road and non-road engines;<br>• wind generated dust from exposed areas within the surrounding region;<br>• seasonal emissions from household wood burning; and<br>• episodic emissions from vegetation fires.<br>More remote sources which contribute episodically to suspended particulates in the region include dust storms and bushfires. |
| Community and stakeholder views | No substantial air quality issues were identified during the community consultation process. |
| Avoidance and minimisation through design | The project design incorporated the following dust mitigation and management measures:<br>• watering of dozer working areas; and<br>• watering of unpaved project-related roads.<br>Modelling has been completed as part of the DIAA process to identify the level of controls required to achieve relevant criteria at accommodation camps proximate to Lobs Hole Road and Tantangara Road. Adoption of mitigation similar to sealing 1 km each side of the camps to minimise dust impacts to acceptable levels will achieve health-based criteria for the accommodation camp. |

### 6.12.2 Predicted impacts

#### i Particulate matter and other emissions

In total, 29 assessment locations representative of the nearest sensitive locations to Snowy 2.0 Main Works were considered, although most of these are beyond the identified construction areas of the project. These locations were mainly classified as 'passive recreation' or 'residential'. The passive recreational locations included, for example, Yarrangobilly Caves and the campgrounds at Bullocks Hill, Wares Yards, Rocky Plain and Three Mile Dam.

During construction, emissions will be generated from fugitive sources (eg material handling, processing, movement of equipment, wind erosion) and combustion sources (exhaust emissions from construction equipment). The most important source of emissions for the project is the movement of vehicles across unpaved road surfaces, resulting in elevated dust. The unpaved roads with the largest estimated emissions were Lobs Hole Ravine Road and Tantangara Road and require mitigation to reduce impacts at accommodation camps at Lobs Hole and Tantangara. Mitigation measures have been considered in the emissions estimation and modelling of the project.

Table 6.40 summarises the predicted cumulative impacts at assessment locations. Relatively small exceedances of the 24-hour criterion for $PM_{2.5}$ were predicted at the assessment locations in the Lobs Hole and Tantangara Reservoir areas, however these exceedances were dominated by elevated background concentrations.

**Table 6.40 Predicted air quality impacts**

| Area | Assessment location | Predicted impacts |
|---|---|---|
| Talbingo Reservoir | None | None |
| Lobs Hole | R27: Snowy 2.0 Lobs Hole Accommodation Camp | Two days in the modelled year were predicted to be above the impact assessment criterion for 24-hour $PM_{2.5}$ concentrations [(a)]. The highest and second highest 24-hour $PM_{2.5}$ concentrations were 29.3 µg/m$^3$ and 25.7 µg/m$^3$. Overall, this is considered to be a minor impact. |
| Marica | R28: Snowy 2.0 Marica Accommodation Camp | Pollutant concentrations below impact assessment criteria. |
| Plateau | R1: Bullocks Hill campground | Pollutant concentrations below impact assessment criteria. |
| Tantangara Reservoir | R29: Snowy 2.0 Tantangara Accommodation Camp | One day in the modelled year were predicted to be above the impact assessment criterion for 24-hour $PM_{2.5}$ concentrations. The highest 24-hour $PM_{2.5}$ concentration was 26.8 µg/m$^3$. Overall, this is considered to be a minor impact. |
| Rock Forest | R2: Cabramurra town | Pollutant concentrations well below impact assessment criteria. |

Note (a) - The impact assessment criterion for 24-hour PM2.5 is 25 µg/m3.

In general, the predicted concentrations at locations outside of the construction areas were below the impact assessment criteria. The main exception to this was assessment location R24 (Wares Yards Campground). Here, there were two predicted exceedances of the 24-hour $PM_{10}$ criterion (50 µg/m$^3$), with concentrations of 57.2 µg/m$^3$ and 57.1 µg/m$^3$. There were also two exceedances of the 24-hour $PM_{2.5}$ criterion (25 µg/m$^3$), with predicted concentrations of 28.6 µg/m$^3$ and 26.4 µg/m$^3$. In the case of the highest $PM_{10}$ concentrations, there were similar contributions from the background and the project, whereas for $PM_{2.5}$ the background was the dominant contribution.

The main project contribution at this assessment location was from vehicle movements on unpaved roads. The Wares Yard Campground is within 500 m of Tantangara Road, which was assumed unpaved for purpose of the assessment. The campground will remain open during construction of the project, noting that limited and facilitated access will be provided along Tantangara Road where determined in consultation with the contractor and where safety requirements can be guaranteed.

The predicted cumulative concentrations of TSP and $NO_2$ were well below the respective air quality criteria at all assessment locations. Similarly, the incremental contribution to dust deposition from Snowy 2.0 Main Works construction activities was below the criterion (2 g/m$^2$/month) at all assessment locations.

#### ii Greenhouse gas emissions

GHG emissions are defined as 'direct' and 'indirect' emissions. The emission sources included in the GHG assessment for the project are listed in Table 6.41.

**Table 6.41 Scope 1, 2 and 3 emission sources**

| Scope 1 (direct) | Scope 2 (indirect) | Scope 3 (indirect) |
|---|---|---|
| • Fuel combustion (diesel) by onsite plant and equipment<br>• Vegetation clearing | • Consumption of purchased electricity | • Upstream emissions from the extraction, production and transport of diesel<br>• Upstream emissions from electricity lost in delivery in the transmission and distribution network<br>• Transport of construction materials to site |

The estimated GHG emissions for the construction phase of the project were around 150,000 tonnes of $CO_2$-equivalents per year and 515,000 tonnes of $CO_2$-equivalents per year during operations.

Annual average total GHG emissions (Scope 1, 2 and 3) generated by the Snowy 2.0 Main Works construction represents approximately 0.12% of total GHG emissions for NSW and 0.03% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2017.

Annual average total GHG emissions (Scope 1, 2 and 3) generated by the Snowy 2.0 Main Works operations represent approximately 0.40% of total GHG emissions for NSW and 0.10% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2017.

### 6.12.3 Mitigation measures

Table 6.42 shows that mitigation should focus on the control of emissions from unpaved roads close to the Lobs Hole and Tantangara accommodation camps. Review of three kinds of mitigation options for unpaved roads (water suppression, chemical suppression and paving of the unpaved surface) was undertaken, with sealed roads shown to predominantly achieve criteria with a significantly higher emission reduction than the treatment of unpaved roads.

**Table 6.42 Mitigation measures for air quality impacts**

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| Exceedances of air quality criteria for $PM_{10}$ and $PM_{2.5}$ | AQ01 | Sealed treatment of roads 1 km each side of the Lobs Hole and Tantangara accommodation camps | Pre-construction | Contractor |

### 6.12.4 Summary and conclusion

The AQIA showed that the predicted cumulative concentrations for $PM_{10}$ and $PM_{2.5}$ were below the impact assessment criteria at most assessment locations. At the Wares Yards Campground, the criteria for 24-hour $PM_{10}$ and 24-hour $PM_{2.5}$ were both exceeded on two days in an entire year. However, the campground may not be in use at time of Snowy 2.0 Main Works construction. The criterion for 24-hour $PM_{2.5}$ was exceeded on two days at the Lobs Hole accommodation camp and one day at the Tantangara accommodation camp. The background was the dominant contributor to peak $PM_{2.5}$ cumulative concentrations.

The predicted cumulative concentrations of TSP and $NO_2$ were well below the respective air quality criteria at all assessment locations. Similarly, the incremental contribution from Snowy 2.0 Main Works construction activities to dust deposition was below the criterion (2 $g/m^2$/month) at all assessment locations.

Mitigation should focus on the control of emissions from unpaved roads close to the Lobs Hole and Tantangara accommodation camps.

CHAPTER 6.13

# SOCIAL

## 6.13 Social

Social impacts relate to people and the way they live and move around a geographic area. This chapter provides an overview of the existing social environment of communities living within the area of social influence. It provides an assessment of the project on:

- the locality, including Tumut, Talbingo, Adaminaby and Cooma;
- the demand for infrastructure and services in the Snowy Valleys and Snow Monaro LGAs; and
- users of KNP, including recreational fishing, bushwalking, camping and boating;

A strategy to offset the impacts of the KNP has been developed (Appendix M.3) and includes offset to impacts on recreational users.

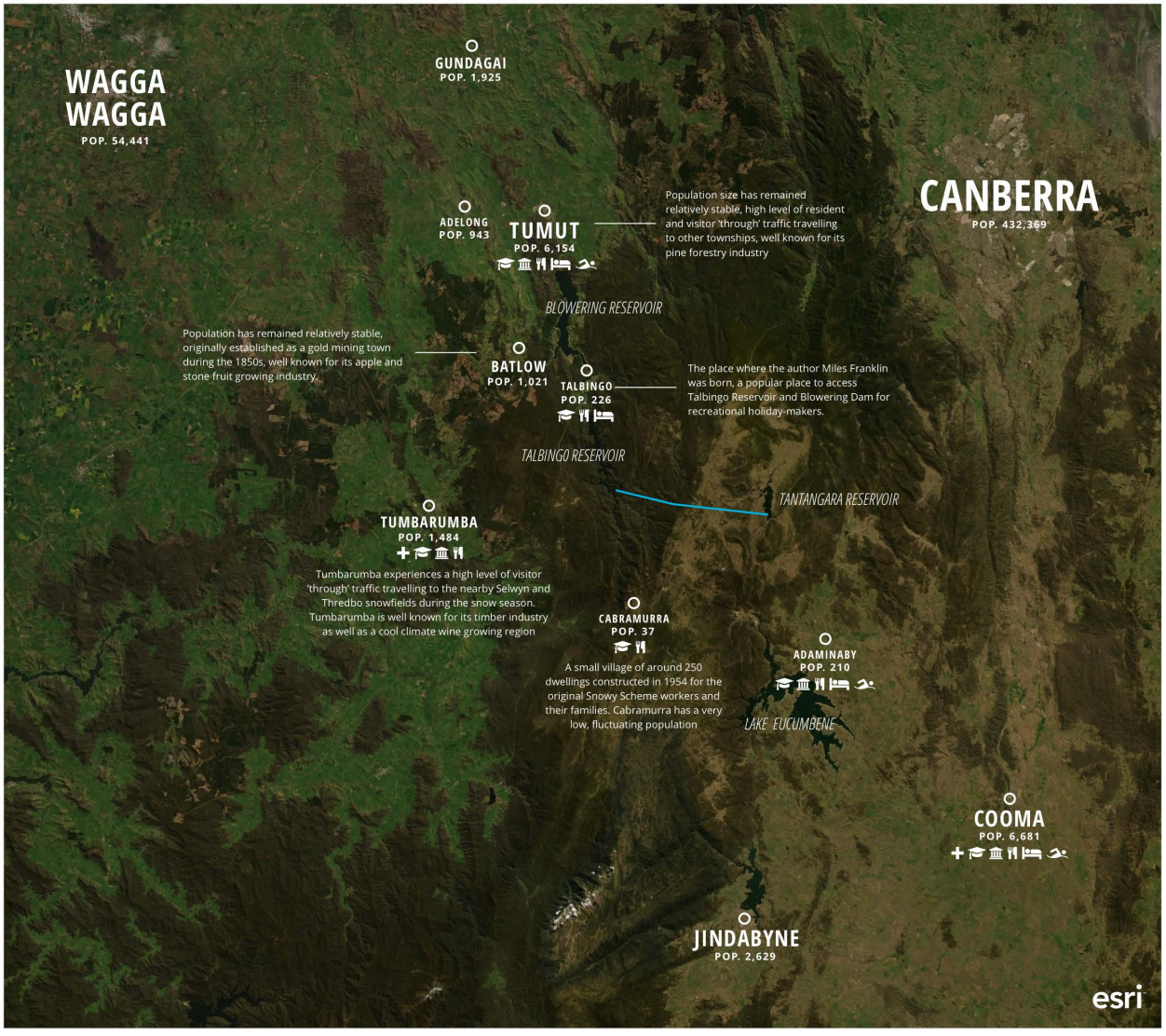
The assessment of social impacts relies on the social impact assessment (SIA) and supporting recreational user assessment prepared for the project, provided at Appendix X.1. The SIA was prepared in accordance with relevant and involved the steps highlighted in Figure 6.27. The recreational user study (Appendix X.2) involved the collection of qualitative and quantitative data on the use and visitation of KNP, including field (visitor) surveys, email surveys, and visitor counts, as well as consultation with NPWS.


**Figure 6.27 Steps in the social impact assessment process**

## 6.13.1 Existing environment

### i Social context of communities

The area of social influence for the project is much broader than the project area discussed in other assessments in this EIS. While material environmental impacts will tend to be largely contained within the KNP, social impacts will fundamentally be felt within inhabited areas, namely the worker accommodation camps and nearby villages and townships. The social area of influence for the project extends from Canberra to Cooma to Jindabyne and across to Wagga Wagga. The key place-based communities that fall within the area of social influence are shown on Figure 6.28 and include Cooma, Adaminaby, Jindabyne, Tumbarumba, Talbingo, Batlow, Tumut, Adelong, Gundagai, Wagga Wagga and Canberra.




Satellite image © Esri, CGIAR | Vicmap, Esri, HERE, Garmin, METI/NASA, USGS | Earthstar Geographics

**Figure 6.28 Social area of influence & community profile**

Adapted from Elton Consulting, 2019

- Proposed Tunnel
- Hospital
- Schools/TAFE
- Museum/Historical
- Food/Art/Entertainment
- Accommodation
- Pool

NOTE: ALL POPULATIONS FIGURES FROM 2016

### ii Recreation and KNP users

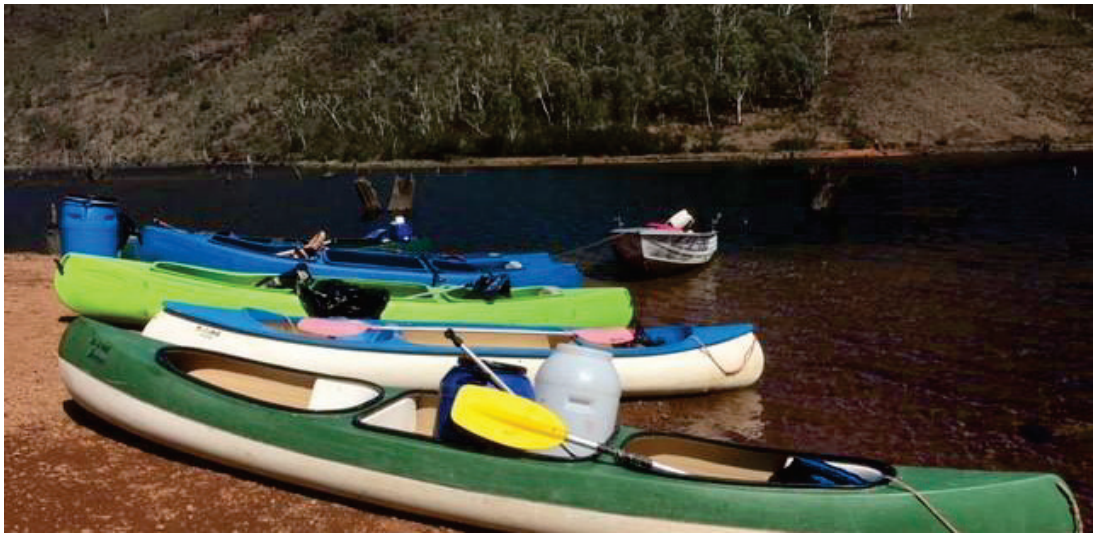
The primary recreational resource in the project area is KNP. The project area is within the northern area of KNP and includes Talbingo Reservoir and the surrounding Lobs Hole area as well Tantangara Reservoir and surrounds. Recreational activities undertaken in the northern area of KNP include drive touring, picnicking, camping, walking, horse riding, cross country skiing, downhill skiing, snowboarding, snow play, cycling, climbing, caving, canoeing and rafting, boating and fishing. Popular sites for recreational activities are shown in Figure 6.29.

Visitation to KNP has increased significantly over the last decade (144% increase since 2008) and is the fourth most visited national park in NSW (almost 3.8 million domestic visitors in 2018). However, there is little visitor data available on visitation to the northern end of KNP, where the project will be built and operated. Visitor counts of the area shows that the busiest periods of visitation to campgrounds within the project area coincided with public holidays and occurred around Christmas, Australia Day and Easter. While campgrounds are busy at these times compared to other times of the year, they are not full.

#### a Talbingo Reservoir

Talbingo Reservoir is used for a range of water sports and activities. It is a popular fishing spot for trout and some native species, however surveys undertaken for the project indicate that Redfin is the predominant species. Many Talbingo Reservoir users are repeat visitors who have been using the area for many years.

Public access to the reservoir for boats is from either a concrete boat ramp on the western side of the dam wall or the spillway on the eastern side. The reservoir is also accessible from points within KNP including Lobs Hole Ravine campground (see Photograph 6.5) and O'Hares Camping and Rest Area.



**Photograph 6.5 Canoes and a boat on Talbingo Reservoir at the Ravine** (Source: TRC Tourism 2018)

Some of the visitors to Talbingo Reservoir stay in the township of Talbingo, which is on the shores of Jounama Pondage to the north of the reservoir. For safety reasons however there is no swimming or boating allowed on Jounama Pondage and fishing is allowed from the shore only (due to operational requirements of the Tumut 3 power station). Talbingo Reservoir and nearby Blowering Dam provide recreational opportunities for residents and visitors to Talbingo.

Snowy Hydro has approval to close the spillway as part of the Exploratory Works approval. Closure has not yet been required for Exploratory Works. Should it be closed, Snowy Hydro has committed to upgrade the boat ramp on the opposite side of the reservoir.

### b Lobs Hole

Lobs Hole Ravine is a remote campground situated beside the Yarrangobilly River. Campsites are unmarked and there are no facilities (toilets or water supply) provided. Fishing and swimming in the Yarrangobilly River, drive touring and the remote nature of the location are the main appeals of the Lobs Hole Ravine area for visitors. Lobs Hole Ravine was closed to visitors in early February 2019 on commencement of the Snowy 2.0 Exploratory Works, with the commitment to return the land for use as camping and recreation at completion.

### c Tantangara Reservoir and surrounds

The area around the foreshores of Tantangara Reservoir is a popular part of the northern part of KNP. It can be accessed at all times of the year via Tantangara Road (which provides access to the southern part of the reservoir) or Long Plain Road and Port Phillip Trail (which provides access to the northern part of the reservoir). Access on Port Phillip Trail is restricted during winter when the road is closed. Tantangara Road and Port Phillip Trail are linked by Pocket Saddle Road on the eastern side of the reservoir.

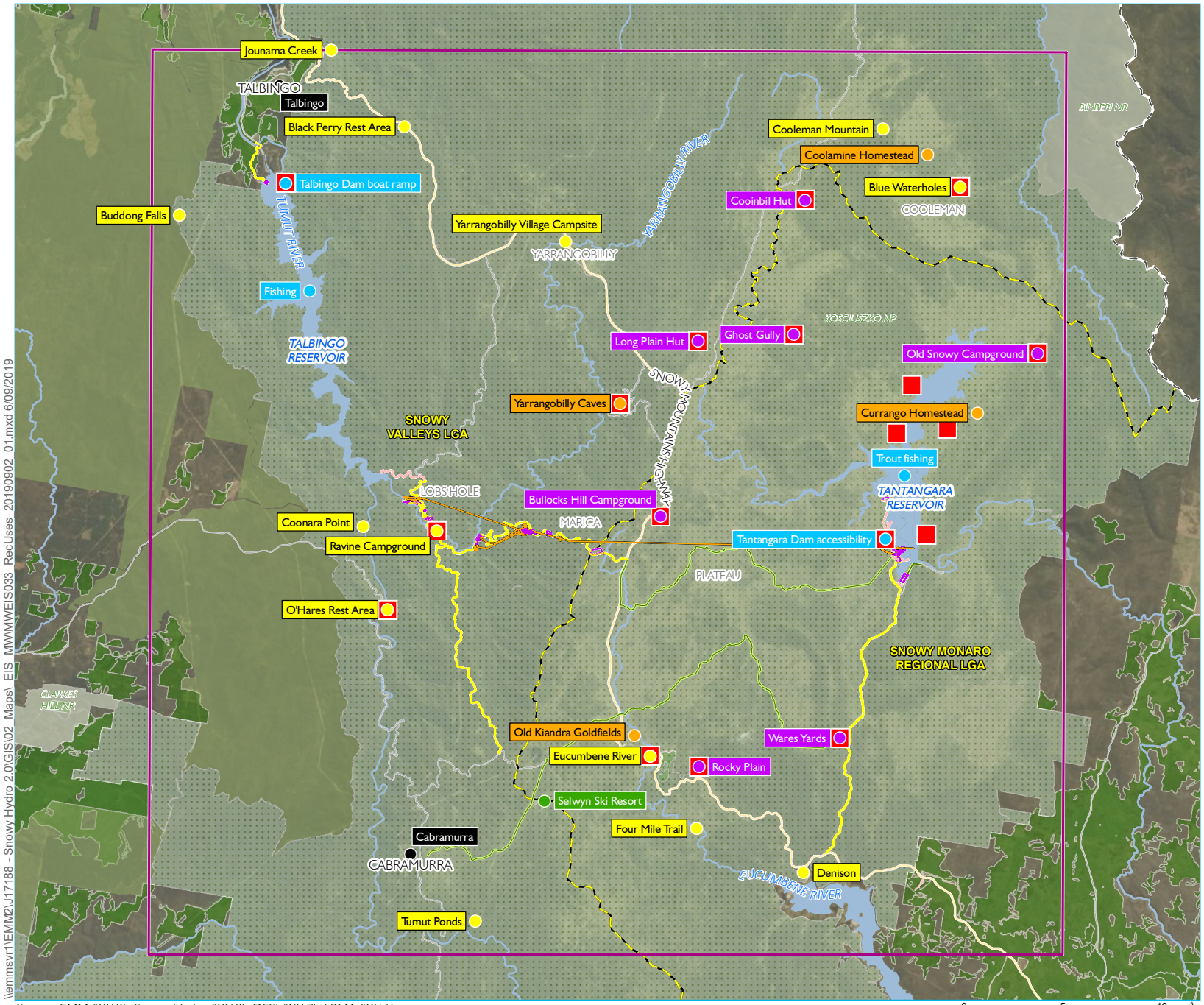
There are no designated camping areas around the reservoir and no facilities available, and visitors camp in the area of their choice around their vehicles (Photograph 6.6). There is enough space for each group to camp in their own area well away from others regardless of group size.

On the busiest days during the survey period, around sixty vehicles[5] were parked around the foreshores of Tantangara. Many Tantangara users are repeat visitors who have been using the area for many years. The most popular activities undertaken at the reservoir are fishing, camping, swimming, and relaxing. Fishing is undertaken from the waters' edge, from a boat, by trolling and fly-fishing.

There are also some well used campgrounds to the south and east of the reservoir that allow camping with horses: Wares Yard and Old Snowy Camp situated on Tantangara Road are overnight stops for horse riders including commercial operators offering horse riding tours. The historic Currango Homestead is along the Pockets Saddle Road and is a popular accommodation from which people walk, mountain bike ride, horse ride, drive tour and fish.

**Photograph 6.6 Campers along the foreshores of Tantangara Reservoir**

[5] Estimated from TRC visitor counts 2018-19




KEY

Survey location

Project area

Recreational use areas

- Camping
- Camping - horses permitted
- Fishing and boating
- Place of interest
- Ski resort
- Township

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements

- Temporary construction compounds and surface works
- Temporary access road

Existing environment

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

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

\\emmsvr1\EMM2\J17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWEIS033 RecUses 20190902 01.mxd 6/09/2019

# Recreational sites relevant to the project area

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.29

snowy 2.0

EMM
creating opportunities

### 6.13.2 Community and stakeholder views

Community and stakeholder views were considered through the development of the project, with these views obtained through community consultation and government agency meetings (described in Chapter 5). More targeted consultation was carried out for the purpose of the SIA and recreational user study for the EIS, to determine the current level of understanding of the project and its potential impacts, and possible measures or opportunities that would be considered suitable by the community to mitigate or offset those impacts.

#### i Surveys and consultation carried out for the social impact assessment

Community surveys were carried out in addition to the engagement activities undertaken by Snowy Hydro in order to apply a social impact-specific lens to inform the development of the social impact assessment. The surveys included computer assisted telephone interviews (CATI), op-in online surveys, two community focus groups, and local service provider interviews. The surveys were designed to understand the public's current level of understanding of predicted impacts likely to affect them. The results are shown graphically in Figure 6.30.

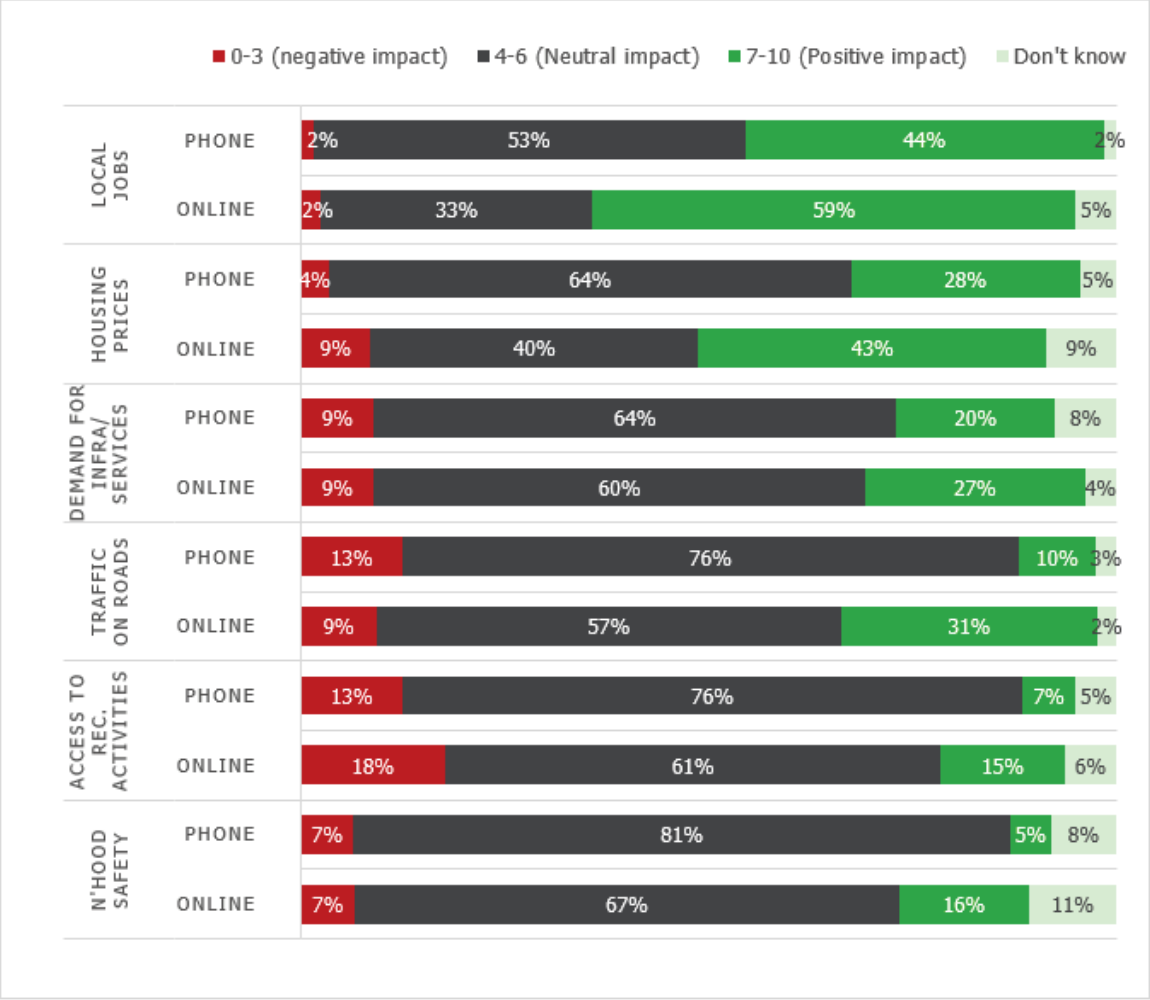



**Figure 6.30 Results of SIA surveys (Elton Consulting 2019)**

Overall, the majority of respondents believed the social impacts presented to them would lead to neutral impacts for themselves and their families. In addition, more people felt collectively more positive toward the potential social impacts than negatively. Other key observations obtained from the surveys are:

- there was strong preference and expectation for the proponent to source labour from local town (expressed in open-ended responses to surveys);
- house prices were considered the second most positive impact expected to occur as a result of the project; and
- restricted access to recreational activities as a result of construction was thought to be the most negative potential impact from the project, followed by the perception of traffic on roads.

#### ii Surveys and consultation carried out for the recreational assessment

Qualitative and quantitative data has been collected (by TRC) through face to face and online surveys, with the aim of contributing to the understanding of scale of visitor numbers and to gain insights into the motivations for use and the values of the area for KNP users.

Camping and day use areas likely to be impacted by the project (both directly and indirectly) were surveyed (primarily over weekends or public holidays) between September 2018 and April 2019, building on the previously conducted survey for Exploratory Works phase of the project (which concluded in April 2018). In addition to engagement activities with NPWS by Snowy Hydro, TRC met with NPWS representatives by phone on two occasions during the assessment period to discuss the identified impacts and potential mitigation strategies.

The KNP values identified by recreational users generally included:

- Talbingo - scenery, activities and the unspoiled nature of the site;
- Lobs Hole – fishing, remote camping, bushwalking and family connection to the area; and
- Tantangara – the lack of crowds, quality of fishing and scenery.

Survey results included views on mitigation and management, in particular of Tantangara Road. It has been communicated previously that the closure of this road is uncertain, with NPWS and recreational users stating a preference for maintaining some level of access to Tantangara Reservoir and surrounds via Tantangara Road.

### 6.13.3 Avoidance and minimisation through design

Engagement with community and stakeholders has been a key part of avoidance and minimisation of impacts throughout the design process. Keeping the community informed of project developments and predicted impacts enables the community to prepare for and predict how the project might cause changes to their way of life. In addition to community and stakeholder engagement, the following avoidance and minimisation measures have been considered and adopted for the project:

- maintaining some level of access on Tantangara Road;
- providing future recreational opportunities through consultation with NPWS; and
- incorporating relevant road works to improve safety and access to KNP in the long term.

Importantly, it is noted that at the commencement of the period of assessment for the EIS, it was considered likely that Tantangara Road would be closed to all traffic for the duration of Snowy 2.0 Main Works. It is now proposed that Tantangara Road will be closed during road upgrade works and when any high-risk activities are being undertaken during Snowy 2.0 Main Works (eg transport of oversized equipment). Access along Tantangara Road will be maintained at other times with measures in place to achieve the required level of safety. This change to the project methodology has significantly mitigated the impact to users of the parts of KNP accessed by Tantangara Road.

### 6.13.4 Predicted impacts

#### i Social impacts

The SIA has been completed in line with the relevant SIA guidelines and identifies social impacts according to broad categories. Using this methodology, several social impacts were identified (refer to Appendix X.1 for further detail on all impacts identified). The highest rated positive and negative impacts identified after implementation of mitigation or enhancement responses are:

- benefits arising from increased economic opportunity; and
- reductions in housing availability and decreased housing affordability;

#### a Benefits arising from increased economic opportunity

Communities are positive about anticipated economic opportunities that can arise from the project, particularly regarding local employment and local procurement. The potential income derived from these economic opportunities will shape other social aspects of people's lives such as their access to health, housing, education and transport. It was identified that if the project can maximise this local content, this is potentially the largest potential social benefit of the project. It is also noted that effective project closure will be required to reduce any potential negative impacts of post-construction workforce and economic decline.

#### b Reductions in housing availability and decreased housing affordability

It was previously predicted there was sufficient capacity within the local region to accommodate project workers who may choose to relocate to or visit the area as a result of construction for the Exploratory Works phase of Snowy 2.0 (EMM 2018). Due to the extended duration and large-scale nature of construction activity and workforce needed for Snowy 2.0 Main Works, it is predicted that much of this existing capacity is likely to be absorbed. Impacts to the availability and affordability of long-term housing options across the area of social influence are predicted, and likely to be greatest in Cooma.

This social impact arises from both increased demand by project employees that choose to relocate to the local area for the duration of their work contract, as well as indirect employment workforces that will seek to take advantage of ancillary employment opportunities in the area. It is identified that there is minimal ability for the local housing market to adapt to this likely housing 'squeeze', requiring offsetting of impacts, and the likelihood that some existing residents may choose to leave their towns for the duration of construction. It is noted that Snowy Hydro has been investigating options to provide accommodation for workers within Cooma, to minimise risk of housing pressure on the community. As a result, Snowy Hydro propose to provide temporary accommodation at a site in Cooma which was also used to provide accommodation during the construction of the Snowy Scheme. A separate application will be lodged with SMRC for the provision of accommodation on this site.

A small percentage of workers are predicted to take advantage of recreational opportunities during off-shift swings. This is predicted to have a minor impact on the availability and affordability of short-term housing options across the area of social influence, particularly in Jindabyne. However, it is identified that there is reasonable ability for the short-term accommodation market to adapt to this change, as is currently experienced during peak holiday seasons.

### ii Recreational user impacts

Recreational impacts are greatest during the construction phase of the project, as several sites within KNP will be closed or restricted in access for an extended period. Once these works are completed and the area rehabilitated however, access will be reinstated and improved. There will be permanent exclusion zones needed around the intakes in both Talbingo and Tantangara reservoirs for public safety, and the extent of these zones are still to be determined. There are a number of opportunities to enhance the recreational value of impacted sites as part of the final rehabilitation of the project. These opportunities are being investigated with NPWS as part of ongoing consultation.

The following aspects of the project are assessed as resulting in impacts to recreational users during construction:

- temporary closure of Tantangara Road;
- exclusion zones on Talbingo and Tantangara Reservoir and restriction of access to these sites;
- increased traffic movements on the road network;
- noise and air quality impacts experienced at passive and active recreation sites and campgrounds; and
- the extension of the period of closure of Lobs Hole Ravine Road and the Lobs Hole Ravine campground.

As a result of prolonged construction impacts and site access restrictions, there is also likely to be an increase in demand placed on other recreational sites in the area and a need for alternative camping sites. A Master Plan for camping and day use across KNP to consider alternative sites was committed during the Exploratory Works and Snowy Hydro will continue this approach for Main Works.

The following aspects of the project are relevant to recreational users during operation:

- potential impacts on the quality of fishing;
- visual impacts of permanent elements in the landscape; and
- increased variable fluctuations in water levels at Tantangara Reservoir.

These are summarised in Table 6.43.

### Table 6.43 Summary of recreational user impacts

| Impact scenario | Description of impact should scenario occur | Recreational sites impacted | Recommended mitigation or offset to minimise impact |
|---|---|---|---|
| Construction | | | |
| Temporary closure of Tantangara Road – for duration of construction or for period of road upgrade works only | • Loss of access to recreational sites from Tantangara Road, including campgrounds and access to the reservoir for fishing<br>• Overlap of closure period with the closure of Long Plain Road and Port Phillip Trail will result in loss of primary and alternative access to Tantangara Reservoir and Currango Homestead<br>• Impact to commercial tour operators who will be unable to operate some existing tours | • Tantangara Reservoir<br>• Wares Yard<br>• Currango Homestead | • Maintain access along Tantangara Road with measures in place (car escort, traffic lights) other than during periods of high-risk activities<br>• Advance communication to stakeholders and visitors<br>• Offset strategy developed in consultation with NPWS |
| Facilitated access along Tantangara Road | • Access to recreational sites limited to specific times (yet to be determined) | • Tantangara Reservoir<br>• Wares Yard | • Advance communication to stakeholders and visitors<br>• Periods of public access to Wares Yard to be developed in consultation with NPWS as part of recreational management plan, and/or development of alternative horse campgrounds in collaboration with NPWS |
| Exclusion zones on Talbingo and Tantangara Reservoir and restriction of access to these sites | • Reduced opportunity for fishing and boating, remaining accessible areas may become more crowded | • Tantangara Reservoir<br>• Talbingo Reservoir | • Appropriate recreational offset will be detailed in recreational management plans and will include measures such as: advance communication to stakeholders and visitors when closures are expected, construction of temporary or permanent boat ramps in collaboration with NPWS |
| Impacts on the quality of fishing in Tantangara Reservoir | • Potential decline in quality of fishing from foreshore due to changes in water levels, water quality impacts, transfer of Redfin perch possible, also Climbing galaxias and mosquito fish | • Tantangara Reservoir | • Mitigation measures to manage transfer to fish species are provided in Section 6.4, based on the aquatic ecology assessment for the project (Appendix M.2) |

## Table 6.42 Summary of recreational user impacts

| Impact scenario | Description of impact should scenario occur | Recreational sites impacted | Recommended mitigation or offset to minimise impact |
|---|---|---|---|
| Traffic impacts | • Increase in construction traffic<br>• Drive tourists and skiers will experience extended journey times, increased traffic and delays at winter pinch points such as Sawyers Hill, Mt Selwyn and Roaring Meg | • Selwyn Snow Resort<br>• 3 Mile Dam<br>• Other campgrounds along the road haulage route | • Manage traffic to avoid peak times in winter such as mornings and afternoons during ski season |
| Visual impacts | • Visual impacts of construction phase work (accommodation camp, stockpile) and any permanent elements visible from and around publicly accessible parts of the reservoirs<br>• Potential visible turbidity impacts experienced by fishers and boat users on Talbingo Reservoir | • Talbingo Reservoir<br>• Tantangara Reservoir | • N/A |
| Noise and air quality | • Construction noise, while typically below the noise management level (criteria) for recreation sites, will be audible and a perceptible change to amenity<br>• Due to increase in construction traffic along Tantangara Road (unsealed), dust impacts are predicted at Wares Yard | • Tantangara Reservoir<br>• Wares Yard<br>• 3 Mile Dam<br>• Other campgrounds along the road haulage route | • Construction Noise and Vibration management Plan to address noise and vibration management and mitigation options where required<br>• Mitigation measures to impact on horse campground are accounted for in the offset strategy |
| Extended closure of Lobs Hole Ravine Campground and Middle Bay boat ramp, including access from Lobs Hole Ravine Road and Talbingo Reservoir | • Loss of access and use of Lobs Hole Ravine Campground for an extended period<br>• Access via boat or canoe to and from Lobs Hole Ravine will be restricted<br>• Limits opportunities to access water by small craft | • Lobs Hole | • Consistent with commitments made during Exploratory Works, a recreation master plan for camping and day use across KNP to consider alternative sites to develop to consider access to and camping alternative locations elsewhere in the park that offer a similar experience to Lobs Hole<br>• Ensure visitors are aware of alternative options, including alternative locations for camping with access to water<br>• Boat launch to Talbingo Reservoir used during construction to be retained and available for public use at completion of works |

## Table 6.42 Summary of recreational user impacts

| Impact scenario | Description of impact should scenario occur | Recreational sites impacted | Recommended mitigation or offset to minimise impact |
|---|---|---|---|
| Operation | | | |
| Exclusion zones on Talbingo and Tantangara Reservoir and restriction of access to these sites | • Reduced opportunity for fishing and boating, remaining accessible areas may become more crowded | • Tantangara Reservoir<br>• Talbingo Reservoir | • Appropriate recreational offset will be detailed in recreational management plans and will include measures such as: advance communication to stakeholders and visitors when closures are expected, construction of temporary or permanent boat ramps in collaboration with NPWS |
| Visual impacts | • Views of the landscape around Talbingo and Tantangara will include permanent infrastructure that is contrasting to the previously undisturbed natural setting<br>• Lobs Hole will involve some landforming as part of rehabilitation, which will be consistent with the surrounding area but changed from its current state | • Talbingo Reservoir<br>• Lobs Hole<br>• Tantangara Reservoir | • Rehabilitation plan to include vegetation to better enable integration with the landscape |

### 6.13.5 Mitigation measures

A Social Impact Management and Monitoring Plan (SIMMP) has been prepared to identify reasonable and feasible measures the project can implement to minimise and monitor social impacts (and is provided with the social impact assessment at Appendix X.1). The SIMMP includes measures adopted as part of design or operation methodologies to avoid impacts, as well as additional measures recommended to mitigate potential residual impacts.

A recreational users management plan is proposed to minimise impacts to recreational users within KNP, but also to identify offset opportunities to be developed by Snowy Hydro and NPWS.

Measures identified to minimise social and recreational user impacts are provided in Table 6.44.

**Table 6.44 Mitigation measures for social and recreational impacts**

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| General | SOC1 | Refine and implement the SIMMP provided with the EIS | As specified by the SIMMP | Contractor<br>Snowy Hydro |
| General | SOC2 | As part of the Community and Stakeholder Management Plans for Snowy 2.0 Main Works, develop and implement bi-annual liaison with representatives from SVC and SMRC to monitor and report change in indicators relating to:<br>• population change<br>• housing availability and affordability<br>• local employment and training rates<br>• incidents of traffic congestion<br>• recreation user visitations<br>• demand for health, education and welfare services<br>• Aboriginal cultural heritage<br>• cumulative impacts of Snowy 2.0 Main Works | Bi-annual | Contractor<br>SVC<br>SMRC |
| Recreational user impacts | REC01 | A recreational plan is to be prepared for sites impacted by the project and should:<br>• be prepared in consultation with NPWS<br>• detail recreational offsets to be provided by the project such as:<br>– permanent boat launch areas in Talbingo and Tantangara Reservoirs<br>– Lobs Hole campground<br>• describe measures to be implemented to minimise impacts during construction, including a process for advance communication to stakeholders and visitors when closures are expected | Pre-construction | Snowy Hydro |

### 6.13.6 Summary and conclusion

Overall, construction of Snowy 2.0 Main Works will generate social change processes within surrounding communities. The characteristics of many social impacts can be both positive and negative, spatially and temporarily dynamic, and experienced by people differently depending on their individual circumstances. People within the area of social influence are considered highly resilient and are informed about how their community may be impacted, positively and negatively. There is an expectation within the community that the project provides economic benefit to the localities within the area of influence. Should these benefits not materialises, a knock-on effect is anticipated. These benefits have been quantified in the economic assessment and are likely to be substantial (see Section 6.14.3).

The key social impacts described relate to economic benefits, but also some negative impacts associated with housing affordability and increased demand for access to community services and infrastructure during the construction phase as a result of the incoming worker population and their families. It is important for the project to monitor social changes relating to these potential impacts and consult with relevant government agencies to provide a collaborative response if needed, to social impacts.

As the project will be built and operated within KNP, recreational users of KNP will also experience social impacts. On balance, these impacts are considered acceptable on the basis that:

- the closure of Tantangara Road has been limited to a period of nine months, which does not fall over the busiest period of January to April and access has been facilitated for the remainder of the construction period;
- most impacts, once mitigation strategies are implemented, will be low;
- some long term impacts will be positive such as improved access and facilities at Lobs Hole and improved access along Tantangara Road; and
- displacement, both temporary and long term, is not expected to occur at high levels and will be to sites that generally have the capacity to absorb some extra visitation.

CHAPTER 6.14

# ECONOMICS

## 6.14 Economics

An economic assessment of Main Works was been prepared by Gillespie Economics Pty Limited (Appendix Y) using two economic methods:

- a computable general equilibrium (CGE) analysis of the project's impact on the National Electricity Market, (NEM), and hence the NSW and Australia economies; and
- an assessment of the economic impact of construction in the local economy, (Snowy Monaro Regional and Snowy Valleys LGAs), using input-output (IO) analysis.

### 6.14.1 Existing environment

This section provides an overview of the economic characteristics of the region in which Main Works will be constructed and in which Snowy 2.0 will be operated.

The Snowy Monaro Regional and Snowy Valleys LGAs cover an area of 15,162 and 8,960 $km^2$, respectively. Snowy Monaro Regional LGA takes in the higher slopes of the eastern side of the Great Dividing Range between the ACT to the north and the state boundary with Victoria to the south, while Snowy Valleys LGA includes the western side of the southern-most portion of the Great Dividing Range and foothills in NSW, with large sections of the LGA contained within national parks.

Three sets of indicators were used to characterise the economies of the region:

- changes in population—provides an indication of the health of an economy;
- place of work employment by industry—gives a broad indication of the nature of economies; and
- those from the regional input-output table—provides more detailed information on the economy.

The population of the Snowy Monaro Regional LGA has grown slightly since 2006 while the Snowy Valleys LGA has been relatively static. The combined population of the LGAs has grown at a rate of 2.4% since 2006, less than the NSW population growth rate of 14.2% between 2006 and 2016, and less than that for regional NSW. Population projections for the combined two LGAs, from DPIE, suggest declining population in the region beyond 2026.

Place of work employment by industry data indicates the significance of the accommodation and food services sector and retail trade sector (reflecting the importance of tourism), and the agriculture, forestry and fishing sector (sheep and beef cattle farming) to the Snowy Monaro Regional LGA. For the Snowy Valleys LGA, significant industry sectors identified are agriculture, forestry and fishing (predominantly beef cattle farming, sheep farming, fruit growing, forestry and logging), and manufacturing (timber and paper production manufacturing).

A 2016-17 IO table developed for the regional economy estimated output at $8,000 M and value-added at $2,000 M, comprising $975 M to households as wages and salaries and $991 M in other value added. The total employment in the regional economy is 15,416 jobs. A comparison of the economic structure of the regional economy to NSW indicated that the agriculture/forest/fishing, manufacturing, utilities and trade/accommodation sectors in the regional economy are of greater relative importance than they are to the NSW economy, while the mining, and business services sectors are of less relative importance than they are to the NSW economy.

### 6.14.2 Community and stakeholder views

Engagement on Snowy 2.0 commenced in early 2017 and has been ongoing.

Predominantly feedback and sentiment about Snowy 2.0 has been positive because of perceived economic benefits of the project on the NEM and local region. Business and employment opportunities, local economic benefits and broader energy consumer benefits were highlighted as key positives for most stakeholders, particularly stakeholders in the local region.

Stakeholders recognised the importance of Snowy 2.0 in contributing to the stability of the electricity network as the NEM decarbonises.

There was interest in the proposed workforce arrangements of the project, potential employment opportunities for local people and how local people could position themselves for jobs or contracts with Snowy Hydro or FGJV.

Notwithstanding this, some concerns were expressed that the project may lead to employment competition and become a 'drain' on the local workforce.

### 6.14.3 Predicted impacts

CGE analysis identified the project's impact to NSW/ACT and other NEM state economies is driven by three key features of the project:

- investment to establish the project, with reduced levels of investment required in the remainder of the NEM;
- reduced fuel cost across the NEM as a result of increased hydroelectric capacity reducing the requirement for fossil fuel generation; and
- a flow-on impact to electricity prices across the NEM.

The CGE analysis estimated the economic impact of Main Works for three economic indicators; gross state product (GSP[6]), gross state income (GSI[7]), and employment. All economic indicators were modelled to increase as a result of the project.

GSP is expected to increase most significantly in the NSW/ACT region, adding $2,692 M in net present value terms. Once Snowy 2.0 operations begin other NEM states are expected to experience increased economic activity, driven by the combination of ongoing NEM fuel savings and indirect economic activity through trade of goods and services. In aggregate across all NEM states, the project is expected to increase GSP by $4,176 M in net present value terms.

Gross state income (GSI) is estimated to increase as a result of the project by $1,608 M in net present value terms in the NSW/ACT modelling region, with an aggregate NEM region impact of $2,982 M.

Employment is estimated to rise most significantly during the construction period in NSW/ACT region, peaking in 2021/22, during which time other NEM regions experience only small increases or decreases in employment.

Economic impacts to the local economy are associated with spending that is captured by the region rather than leaking outside to other economies. Expenditure from the Main Works project that can potentially be captured by local economy arise from non-labour inputs and expenditure of wages by labour.

6 the state equivalent of gross domestic product

7 the state equivalent of gross national income

Non-labour inputs to the Main Works project would include, but are not limited to, excavation and earthworks, buildings and sheds, reinforced concrete pipes, plant and equipment, concrete manufacturing, haulage and engineering services. It is assumed that there would be limited scope for the local supply of the major non-labour inputs to the project. Notwithstanding, some small regional businesses may be able to supply some of the minor non-labour inputs to production.

Most economic activity in the region will be associated with the expenditure of wages by labour. The average annual additional wage expenditure in the regional economy across the period to 2026 is estimated to be $8 M, from jobs where employees are either sourced from the region, migrate to the region with their families, or commute to the region and remain as a visitor when off swing. The economic impact of the average annual additional wage expenditure ($8 M) in the regional economy would be:

- $11.60 M in annual direct and indirect regional output;
- $6.76 M in annual direct and indirect value-added; and
- $2.58 M in annual direct and indirect income.

Employment is also modelled to increase, with direct local employment engaged in Snowy 2.0 expected to provide additional flow-on positions over the project construction.

### 6.14.4 Mitigation measures

**Table 6.45 Mitigation measures for economic impacts**

| Impact/risk | ID# | Measure(s) | Timing | Responsibility |
|---|---|---|---|---|
| Positive local employment | ECON1 | Provision of employment opportunities for local workers where they have the necessary skills and experience. | Construction | Snowy Hydro and contractor |
| Positive local employment | ECON2 | Providing and/or collaborating with local education facilities to provide, ongoing training and certification opportunities for local workers to ensure they have the necessary skills to work on the project. | Construction | Contractor |
| Positive business opportunities | ECON3 | Collaborating with SMRC, SVC, economic development organisations, local chambers of commerce and State Government to:<br>• inform local businesses of the goods and services required of the project, service provision opportunities and compliance requirements of business to secure contracts;<br>• encourage and provide local businesses on how to meet the requirements of the project for supply contracts; and<br>• develop relevant networks to assist qualified local and regional businesses tender for provision of goods and services to support the project. | Construction | Contractor |

### 6.14.5 Summary and conclusion

The economic activity impacts of the Main Works have been assessed and are shown to be positive for all regions and economic measures, with key drivers being the direct investment to establish the project, reduced ongoing electricity fuel costs, reduced electricity prices and wage expenditure.

Main Works is predicted to have the greatest impact on the NSW/ACT economy, with GSP modelled to increase by $2,692 M (net present value terms), GSI by $1,608 M (net present value terms). Employment is estimated to rise most significantly during the construction period in NSW/ACT region, peaking in 2021/22.

The aggregated economic impact of Main Works across all NEM states is predicted to be an increase in GSP of $4,176 M (net present value terms) and an increase in GSI of $2,982 M (net present value terms).

The impact of Snowy 2.0 on the regional economy of the Snowy Monaro Regional and Snowy Valleys LGAs is also predicted to be positive, increasing the average annual additional wage expenditure by $8 M, and increasing employment of local workers through flow-on effects. Adoption and implementation of the mitigation measures described in Section 6.14.4 would maximise these positive impacts on the regional economy.

Overall, economic benefits of Snowy 2.0 Main Works on the regional economy, NSW and NEM states are predicted to be substantial. These benefits are in addition to the economic benefits of Exploratory Works which are currently being realised, particularly in the regional economy.

CHAPTER 7

# EVALUATION AND CONCLUSIONS

# 7 Evaluation and conclusions

This chapter provides an overall evaluation of the Snowy 2.0 Main Works, with regard to the strategic need for the project and its environmental, social and economic impacts.

## 7.1 Design development

### 7.1.1 Principles

Consistent with the principles of ESD, Snowy 2.0 Main Works has been designed to avoid and minimise impacts where possible. These principles were implemented through an iterative approach (known as DIAA), supported by consultation with numerous technical specialists and government agencies. The NPWS, as land manager of KNP, was consulted throughout design development and as part of the preparation of this EIS.

Throughout the design process, the objective was to identify and avoid sensitive locations, to minimise the construction footprint and maintain as much of the existing natural environment as is reasonable and feasible. In the first instance this included environmental conditions and consideration of site suitability based on design and construction needs, existing Snowy Scheme assets (including Talbingo and Tantangara reservoirs) and infrastructure (such as road access).

### 7.1.2 Design challenges

The challenges for the design team included the need to develop solutions that balance the need to preserve and protect the values of the KNP and the environmental constraints of the location, with the need for ensuring a safe working environment for the construction of Snowy 2.0 Main Works, including the safe movement of plant, equipment, materials and personnel across the sites.

As previously stated, Snowy Hydro has appointed a highly experienced contractor (FGJV) for the design and construction of Snowy 2.0 Main Works. The EIS is based on the design provided by FGJV during the tender process, noting that adjustments to the design may be made with a detailed design process now underway.

Construction sites make use of existing cleared and disturbed areas and access tracks at Lobs Hole, across the Plateau and near Tantangara Reservoir. This has contributed to the ability to avoid and minimise impacts, in particular, impacts that would otherwise be associated with additional new access roads and clearing through undisturbed sites. As far as possible, works have been limited to previously disturbed land in the KNP.

The design principles also provide for the rehabilitation of disturbed areas which will be returned to NPWS and the KNP. Snowy Hydro has been working with NPWS since the announcement of Snowy 2.0 in early 2017. Specific consultation with NPWS on Snowy 2.0 Main Works has been to ensure its development and design avoids and minimises impacts to biodiversity, heritage and recreation and considers their long term objectives for land management in KNP.

The DIAA process developed during the design of Exploratory Works has been carried through Snowy 2.0 Main Works. This process has been described throughout this EIS (see Chapter 2 and 6). Snowy 2.0 Main Works has been informed and refined by the results of field surveys and consultation with key stakeholders, in particular NPWS and OEH. On this basis, a number of potential significant impacts on biodiversity, heritage, recreation and land use have been avoided and minimised.

### 7.1.3 Avoidance and minimisation

Implementation of the DIAA process to optimise the design resulted in some significant environmental improvements and outcomes. Primary design improvements include:

- Discounting construction of a power station, and associated access adits, beneath the Plateau rather than Marica. This avoided significant impacts to threatened ecological communities, such as Alpine bogs and fens, and species, such as Alpine she-oak skink.
- Significant reduction in the disturbance footprint for the Marica West track down to Lobs Hole. There were further design improvements in this area through the removal of a construction adit and associated construction area to facilitate these excavations. Together, these improvements have avoided significant impacts to the critically endangered Smoky Mouse.
- Reduction in overall excavated materials due to revised tunnelling layouts and alignments, including removal of adits and relocation of the power station further west minimising the currently approved exploratory tunnel (which would be the MAT if Snowy 2.0 Main Works is approved). This reduced the volumes of materials to be handled and placed within the reservoirs.
- Removal of some construction areas and requirements from the footprint within KNP by choosing to construct a segment factory at Polo Flat in Cooma (subject to a separate application) which significantly reduced traffic volumes for the construction materials for these segments within KNP, and reduced the amount of land required to be cleared in the park by about 32 ha.
- Establish a logistics yard at Rock Forest, just outside the KNP (rather than within the project area), to store materials and manage traffic when required such as during adverse conditions. This improves Snowy Hydro's ability to manage impacts to the road network and improves road user safety during adverse conditions.
- Reuse 1,000,000 $m^3$ of materials to landform and rehabilitate areas at Lobs Hole disturbed from construction, reducing the footprint volumes and timeframe of the Ravine Bay placement which reduces potential water quality impacts to Talbingo Reservoir.
- Reduction in barge infrastructure resulting in avoidance of areas being disturbed and longer term potential for disruption to the Talbingo community.
- Removal of an option to construct a road east of Tantangara Reservoir to a nearby private property, just outside KNP, to place excavated rock materials rather than in the reservoir. This avoided significant impacts to the critically endangered flora, Clover Glycine.
- Reduction in excavated rock emplacement footprint within the reservoirs to focus on a single location within Talbingo Reservoir and within active (and dry during construction) storage at Tantangara Reservoir. This avoids direct impacts to previously proposed emplacement areas.
- Maintenance of the 50 m buffer around the Yarrangobilly River to protect its values and habitat to the endangered Booroolong Frog.
- Reduction of access road works by some 20 km which avoids further environmental impacts through disturbance activities.

- Removal of the need to augment the existing Essential Energy transmission line for power for power to infrastructure at Tantangara Reservoir. This avoids further environmental impacts through disturbance activities.

- Avoidance of the Ravine cemetery within Lobs Hole which preserves the heritage values of this location.

## 7.2 Strategic context

Snowy 2.0 is the largest committed renewable energy project in Australia. By expanding the current Snowy Scheme's renewable energy capacity by almost 50%, the NEM will be served with an additional 2,000 MW of on-demand generating capacity and large-scale storage. Changes to the NSW and Australian energy system and market are creating a need for large scale energy storage projects such as Snowy 2.0. As with many electricity markets around the world, the NEM is undergoing a paradigm transformation that has been brought about by significant shifts in energy efficiency, rapidly decreasing costs of wind and solar generation (or VRE), coal power station retirements, increasing coal and gas costs and Australia's participation in global commitments to reduce carbon emissions.

While VRE provide energy during model conditions, the challenge for these sources are they are dependent on weather conditions and during prolonged wind and/or solar droughts when they would not operate. Energy storage helps build power system resilience to weather events by storing surplus renewable generation for use at times when these resources are scarce and allowing more constant operation of less flexible existing generation. This, in turn, creates a more dispatchable and reliable power system, while helping to keep prices down for consumers including by maximising use of existing, low-cost, thermal generation assets. A large pumped hydro system such as Snowy 2.0 (with approximately 350,000 MWh of energy storage) can provide significant energy storage capable of delivering large-scale generation within minutes in times when VRE is not operating.

The key benefits of Snowy 2.0 are summarised as follows:

- Snowy 2.0 makes a significant contribution to the continued decarbonisation of the economy;

- Snowy 2.0 provides large-scale energy storages at the least cost to allow more flexibility to respond to seasonal variability when compared to other VRE and batteries;

- Snowy 2.0 will improve the overall efficiency of the NEM by absorbing and storing excess energy from the system at times of excess demand (through pumping) and generate at the critical times of peak times;

- Snowy 2.0, being a closed system, can move water between reservoirs and not rely on natural inflows that may vary seasonally, offering valuable seasonal storage and insurance against drought risk;

- Snowy 2.0 will have the capability to run for over seven days continuously before it needs to be 'recharged'. By comparison, small and large-scale batteries have limited storage (typically one to four hours) and their already high prices increase significantly when used for more than one charge/discharge cycle per day; and

- Snowy 2.0 has a 100 year design life and will operate for generations to come.

Snowy 2.0 would result in benefits distributed to the wholesale market, retailers, and consumers. The scale and centralised location of Snowy 2.0 in the NEM enables the system stability, energy reliability and firming capability benefits to be enjoyed by all segments of the NEM.

Snowy 2.0 has strong support from the community with consultation identifying the public expect the project will create economic opportunities for the region, improve the reliability of the electricity network, lower energy prices and increase and expand sources of reliable, renewable energy to reduce reliance on fossil fuels which will have an overall benefit to the environment.

The development of Snowy 2.0 is consistent with Commonwealth and NSW strategic planning and policy objectives, including the NSW Renewable Energy Action Plan and the Australian Renewable Energy Target.

In recognition of the need to manage the transition and future energy mix in the NEM, Snowy 2.0 was declared CSSI by the former NSW Minister for Planning under the NSW EP&A Act in March 2018. It was declared as critical for the energy security and reliability needs of NSW. At the time of the declaration the Minister stated that that Snowy 2.0 was "essential for the future security of our energy system, the economy and the environment." The declaration signifies the critical role that Snowy 2.0, together with the upgrades to the NSW transmission network, will play in providing reliable energy and large-scale storage to NSW as it transitions to a low emissions economy.

## 7.3 Engagement

Snowy Hydro has a proactive, flexible and transparent stakeholder engagement strategy for Snowy 2.0, which is applicable to all phases of Snowy 2.0, including Main Works. It aims to meet the needs of a diverse range of stakeholders who have different levels of involvement in the project and a wide range of interests.

A range of tools and established communication channels continue to be used to support communication and engagement for Snowy 2.0 Main Works. Feedback from the local community, local industry groups and special interest groups on Snowy 2.0 has been mainly positive, with the most recent survey results indicating that matters such as employment, business opportunities, energy reliability, renewable energy and environmental interests are still very important to the community as the project progresses into Snowy 2.0 Main Works.

Engagement with government agencies during the Snowy 2.0 Main Works EIS development was a priority for Snowy Hydro. Primary matters raised during these engagement sessions include potential impacts to local water quality during construction, potential impacts on reservoir water quality from the excavated material placement, impacts on native and threatened species, and traffic impacts across the project.

The proposed approach to community engagement if the project is approved is to focus on providing engagement activities and communication materials that provide up to date project information to those likely to be affected during construction and also allow the community to communicate concerns with the project.

A stakeholder engagement framework has been developed for Snowy 2.0 that provides a structure for the management of stakeholder relations and communication related to the project. The proposed engagement approach is tailored to each stakeholder group, is flexible and will be reviewed regularly following Snowy 2.0 engagement activities. The proposed approach to community engagement if the project is approved, is to focus on providing engagement activities and communication materials that provide up to date project information to those stakeholders likely to be affected during construction. It will also ensure there are opportunities for stakeholders, is particular the community to communicate their concerns with the project.

## 7.4 Statutory context

Two main approvals are required for Snowy 2.0 Main Works; an approval under the CSSI provisions of the EP&A Act from the NSW Minister for Planning and Public Spaces, and an approval under the EPBC Act from the Commonwealth Minister for the Environment.

The existing Snowy Scheme has been operating successfully in the KNP in accordance with a range of administrative and management arrangements for many years, and similar arrangements would be put in place for Snowy 2.0, if approved.

Snowy Hydro has a number of arrangements with NPWS for the existing Snowy Scheme that have been in place since 2002 when it was corporatized. These arrangements allow Snowy Hydro to occupy and operate the Snowy Scheme within the KNP, and include the Snowy Park Lease, a Roads Maintenance Agreement and the Snowy Management Plan.

Prior to Snowy 2.0 Main Works proceeding, Snowy Hydro would require a new lease for the project from the NSW Minister for the Environment under the NPW Act, and the existing management plans and agreements would need to be updated and revised to incorporate the approved project.

## 7.5 Long term benefits

As discussed in Section 7.2 above, once operational, Snowy 2.0 will provide numerous benefits to the NEM and energy consumers. Snowy 2.0 will provide broad-scale environmental benefits through its long-term provision of low emission energy and by physically firming and financially supporting VRE coming online. Snowy 2.0 will also improve the drought resilience of the Snowy Scheme and the existing Tantangara and Talbingo reservoirs by providing capability to pump water between the two and reuse available inflows. Snowy 2.0 Main Works will also provide numerous long-term benefits to the local region including within the KNP and the community. The project development has identified several opportunities to provide a legacy of environmental, social and economic benefits through the comprehensive environmental impact assessment process and extensive community consultation.

Snowy Hydro has responsibly and carefully operated the Snowy Scheme in the KNP for more than half a century and will continue to act in an environmentally responsible manner throughout the construction and operation of Snowy 2.0. Some of the key long-term benefits that will be provided by the Snowy 2.0 Main Works to the KNP and local region include improved infrastructure and access, enhanced recreational areas, contributions to scientific research within the KNP, provision of biodiversity offsets and creating economic growth in the region.

While there will be some impacts to recreational uses at Lobs Hole and Tantangara, it is proposed to rehabilitate these impacted areas to provide improved recreational facilities in the long term. There is opportunity to improve the social values of KNP by providing improved access and facilities at these locations post construction. Similarly, several geodiversity sites have been identified where the proposed works provide an opportunity to enhance the geotourism potential of the KNP by providing improved access and educational signage. The rehabilitation and master planning of potential recreational facilities will be determined in consultation with NPWS, to ensure relevant KNP values are maintained. In the long-term improved access infrastructure in KNP and along the project main transport route will provide permanent access infrastructure assets to the community.

The additional scientific research that has been completed for the Snowy 2.0 investigations and EIS will constitute a positive contribution to knowledge about the environmental values of the KNP. This includes significant ecological findings (eg larger population of the endangered Smoky Mouse and mapping of more bogs and fens), additional investigations into the geology and hydrogeology of the KNP, geodiversity sites and their public accessibility and interpretation, and increased evidence of Aboriginal and historical occupation of the KNP.

As detailed in Section 6.14, Snowy 2.0 Main Works will provide economic opportunities for the local region. To date more than 100 local businesses have been part of Snowy 2.0 and more opportunities are expected to follow. The Main Works will provide opportunities for sub-contracting jobs and training associated with the project construction and would provide economic growth to the local region. Community consultation for Snowy 2.0 has shown that the community is highly supportive and expects that Snowy 2.0 will provide lasting benefits for the region. There is also community recognition of the economic benefit that the project has generated with work undertaken since the Feasibility Study.

Snowy Hydro will provide biodiversity offsets for the project impacts to native vegetation, ecological communities and threatened species. Snowy Hydro supports the use of this funding to undertake conservation projects in the local region and recognises the opportunity this provides for improved environmental management within the KNP. It is expected that in consultation with DPIE and NPWS the funding provided for biodiversity offsets for the project will be used to provide lasting environmental benefits for the KNP and NSW.

## 7.6 Likely or predicted impacts

Potential impacts of the project have been comprehensively assessed and are detailed in Chapter 6. This section provides a summary of the key predicted impacts from the Snowy 2.0 Main Works.

### 7.6.1 Broader region

Some of the project's predicted impacts are expected to be experienced at a regional level rather than on a site by site basis. These include economic, social and transport impacts that would have a broad area of influence.

The key social impacts relate to economic benefits, but also some potential negative impacts associated with housing affordability and increased demand for access to community services and infrastructure. Social changes relating to these potential impacts and consult with relevant government agencies to provide a collaborative response if needed, to social impacts.

Construction activities within KNP is expected to have some impacts on recreational users of KNP. On balance these impacts are considered acceptable as management measures have been identified to minimise disruptions to recreational activities, displacement is not expected to occur at high levels and will be to sites with capacity to absorb extra visitors and in the long-term impacts to recreation will be positive through improved access and facilities.

Snowy 2.0 Main Works will deliver substantial economic benefits to the local region, NSW and NEM states, with key drivers being the direct investment to establish the project, wage expenditure, reduced ongoing electricity fuel costs, and reduced electricity costs. The greatest effect will be experienced by the NSW/ACT economies with GSP expected to increase by $2,692 M and additional employment during peak construction.

The aggregated beneficial effect across the remaining NEM participants is predicted to be an increase in GSP of $4,176 M and an increase in employment. The local economies of Snowy Monaro Regional and Snowy Valleys LGAs will also benefit from Snowy 2.0 Main Works, increasing the average annual additional wage expenditure by $8 M, and increasing average annual employment through flow-on effects.

The key traffic and transport impacts include the generation of suitability of existing intersections within the KNP and in Cooma township. Two new intersections will be established for construction access from the Snowy Mountains Highway (Marica Track and Rock Forest) with potential improvements carried out within Cooma to address existing peak traffic conditions in the winter period to accommodate Snowy 2.0 Main Works traffic. Further engagement with RMS will be carried out to determine appropriate solutions during these peak periods.

Some temporary reductions in speed limits are proposed to ensure intersection sight distance requirements are met at the intersection of Snowy Mountains Highway/Tantangara Road, Snowy Mountains Highway/Rock Forest access and Link Road/Lobs Hole Ravine Road. Construction management protocols will be implemented to manage road maintenance, traffic control and community consultation requirements arising from the project traffic.

### 7.6.2 Talbingo Reservoir

Likely impacts to Talbingo Reservoir include water quality and aquatic ecology impacts due to the placement of excavated rock at Ravine Bay. There will also be temporary impacts to visual and recreational values.

Ravine Bay placement will take about two years to complete. The predicted maximum TSS concentrations in surface waters are predicted to exceed the reservoir's baseline concentrations at times. This will occur primarily in summer when the reservoir water column is stratified, trapping suspended solids in the upper layers of the water column. Surface turbidity will return to close to background levels within approximately 8 months of the completion of Ravine Bay placement. Elevated TSS levels from excavated rock placement will result in a moderate aquatic ecology risk which will require monitoring. During placement, it is predicted that increased sediment deposition rates will occur in the reservoir with the deposition rate highest (above 150 mm/year) closest to the placement location, 7–45 mm/year in the southern half of the reservoir, 2–15 mm/year in the northern half of the reservoir and higher in shallow parts of the reservoir (ie reservoir edges) than in the deeper parts.

Alternatives were assessed for further reducing volumes and types of material to be emplaced in Talbingo Reservoir. Adoption of these alternative provides an opportunity to reduce and/or remove the water quality impacts within the reservoir by adopting a land based approach for managing fine materials. Should alternatives be pursued, further detailed engagement with relevant agencies, including NPWS, and an integrated design and assessment approach be carried out with particular consideration needed for water quality, biodiversity, heritage, visual amenity and long-term end use within KNP.

During commissioning of the power station's turbines, fine settled material from the placement activities and some existing reservoir sediments may be disturbed by generation and pumping flows. Rock armouring placed on the upper slope of the Ravine Bay placement will not be disturbed by these flows and, if the drill and blast material diameter on the lower part of the slope is greater than 8 mm, it is also unlikely to be disturbed. Sediment will also be discharged from the reservoir via the T3 Power Station.

Some direct impacts from construction of the intake and dredging works are expected on some aquatic ecology habitat and species, including Murray crayfish. In-reservoir blast management controls will be implemented to minimise blasting impacts to aquatic fauna. Suitable management measures, such as pre-clearance surveys and translocation, will be implemented to avoid and minimise effects to the Murray crayfish.

The extent of clearing and excavation to facilitate construction will be a significant change to a section of the landscape, changing its visual appearance. As stated above, placement of excavated rock will also result in temporary elevated levels of turbidity in the water in the area surrounding the emplacement area. However, there will be limited public views to these areas for the duration of the emplacement period. Upon completion, public access will be reinstated, and views of the landscape will include some permanent infrastructure contrasting to the previously undisturbed natural setting. Revegetation activities will be implemented to improve the infrastructure's integration with the landscape, where possible. There are some likely limitations to some infrastructure components such as the steep batters of the intake where stable revegetation may not be able to successfully establish. In summary, the visual impact during construction is high, but temporary with most construction areas having limited public views.

Snowy 2.0 Main Works will impact on-reservoir recreational users through establishment of exclusion zones around the in-reservoir construction areas as well as the operational intake and will restrict boat access to some areas of the reservoir.

### 7.6.3 Lobs Hole

Likely impacts to Lobs Hole include stormwater discharges to the Yarrangobilly River from temporary disturbed areas, permanent placement of excavated material, contamination risks, impacts to known geodiversity sites and restricted access to recreational users during construction.

There will be temporary impacts to recreation activities at Lobs Hole as it will be closed for the duration of construction of Snowy 2.0 Main Works. Accordingly, closure from Exploratory Works will be extended for about another six years. The existing use of Lobs Hole as a remote campground within KNP presents opportunities for the project to enhance recreational values within the KNP. Key enhancements to recreation values at Lobs Hole include improving access roads as well as enhancing the geotourism potential of several geodiversity sites. A recreation master plan will be prepared for impacted recreational areas including Lobs Hole.

Approximately 1,000,000 $m^3$ of surplus material will be used to landform and rehabilitate disturbed areas at Lobs Hole following construction. Snowy Hydro will continue to engage with NPWS regarding the longer term use and design of Lobs Hole for recreational purposes. Detailed design will follow the principles and concepts in the Rehabilitation Strategy to achieve stable non-polluting landforms and recreational areas.

There is potential for impacts to water quality of the Yarrangobilly River during the initial establishment phases of construction when the greatest area of disturbance and poorest water quality will occur due to surface construction activities. Suitable erosion and sediment controls will be implemented during construction to minimise this risk.

There are some contamination risks in this area associated with disturbance to the existing excavated rock stockpiles at the former Lobs Hole copper mine as well as potential to intercept PAF rock through site excavations for site establishment. Contamination risks will be minimised through further contamination investigations and suitable controls implemented during construction.

The road upgrades on Lobs Hole Ravine Road will directly impact on three known geodiversity features; the Ravine block streams, the Ravine tufa and the Devonian fossil beds. The road works will be further optimised through the detailed design process to minimise impacts to these geodiversity features. While the proposed works will impact the visible geodiversity features, they will remain largely intact. Post-construction, the access road works adjacent to these geodiversity features provide an opportunity to enhance the geotourism potential of these features through the establishment of educational signage and a suitable stopping area from which to view the features. Snowy Hydro will continue to engage with NPWS regarding these opportunities.

Likely impacts to historical heritage complexes at Lobs Hole include items from the former settlement. Importantly, two prominent heritage features have been avoided, Ravine cemetery and the Washington Hotel.

There will also be some impacts to biodiversity at Lobs Hole with impacts to threatened species including the Smoky Mouse from road upgrades to Lobs Hole Ravine Road. Upgrades to this road are currently being undertaken as part of Exploratory Works. Targeted Smoky Mouse surveys during the design development improved the scientific knowledge of the Smoky Mouse population and distribution in the local area, with records spread over a very large area providing valuable context for the design of an important access road for the project. As such, the population of Smoky Mouse is much larger than previously thought. Notwithstanding, impacts to Smoky Mouse have been minimised where possible whilst ensuring that the project has a safe and reliable access to facilitate the construction and long-term operation of Snowy 2.0.

### 7.6.4 Marica

As previously mentioned, significant environmental improvements were realised through the DIAA process with the design with surface disturbance greatly reduced.

Likely surface impacts in the Marica area include impacts to threatened fauna and their habitat including the Smoky Mouse. Approximately 174.63 ha of potential Smoky Mouse habitat will be removed. This represents less than 3% of the estimated available habitat in the region based on regional surveys undertaken for the project. However, these impacts will be offset to provide for long-term improvements and conservation outcomes for KNP.

Most construction activities within Marica occur underground through excavation of access tunnels and the cavern. Minimal groundwater impacts are anticipated in Marica due to these activities.

### 7.6.5 Plateau

Likely impacts to the Plateau area are limited due to the minimal surface infrastructure proposed. Like Marica, impacts at the Plateau area were reduced through the DIAA process.

There will be impacts to about 4 ha of Alpine bogs and fens, and some threatened species including Alpine She-oak skink, Broad-toothed rat and Alpine tree frog, directly affected due to the construction of communications cable. As previously discussed, the route of the communications cable was thoroughly investigated using the DIAA process to avoid and minimise impacts.

Excavation of the power waterway will result in some groundwater drawdown along the tunnel alignment with some 17 ha of Alpine bogs and fens expected to experience a drawdown of greater than 0.5 m. This represents 0.2% of the mapped extent of the community in the Snowy Mountains (OEH 2012b) and 0.15% of the 11,100 ha mapped at a national scale (TSSC 2009). Overall, this is considered to be a low risk to the listed community.

### 7.6.6 Tantangara Reservoir

Likely impacts to Tantangara Reservoir include aquatic ecology impacts due to transfer of biota between reservoirs during operations as well as construction impacts to visual, recreational and historic heritage values. Snowy Hydro has proposed several management measures to minimise these impacts including the development of fish barrier controls.

During operations there is potential to transfer pest fish species such as Redfin perch, Eastern gambusia and Wild goldfish from Talbingo Reservoir to Tantangara Reservoir via the power waterway. If these species reach Tantangara Reservoir, there is potential that they could establish breeding populations in the reservoir. Breeding populations of these species could negatively impact species already established in the reservoir, including non-native species of trout that support a recreational fishery. If established in the reservoir, the pest species could eventually spread upstream and downstream into the Murrumbidgee River catchment and downstream into Lake Eucumbene and connected reservoirs, unless adequately contained.

Introduction of breeding populations of Redfin perch and/or Eastern gambusia into the mid-Murrumbidgee River catchment and Lake Eucumbene and connected reservoirs below Tantangara Reservoir would inevitably pressure native and threatened species. Non-endemic native species transferred into Tantangara Reservoir could also negatively impact the local species if not contained. For example, if the Climbing galaxias is transferred to Tantangara Reservoir, it could compete with local species, such as the Stocky galaxiid that has a restricted local distribution in the upper reaches of Tantangara Creek.

For these reasons, Snowy Hydro has implemented investigation of using fish barrier controls aimed at preventing the transfer/movement of fish into this key area of habitat should they successfully transfer from Talbingo Reservoir to Tantangara Reservoir. These secondary controls form part of the Snowy 2.0 Main Works project.

Impacts to water quality from excavated rock emplacement are expected to be much less than those in Talbingo Reservoir. This is due to the excavated rock emplacement being constructed predominantly above the water level in Tantangara Reservoir with suitable erosion and sediment control measures in place. The specifications and locations of these measures will be determined as part of detailed design.

During commissioning of the turbines, the existing reservoir sediments within the intake channel and areas directly offshore and adjacent (mostly to the north) may be disturbed by generation and pumping flows. The Tantangara Reservoir excavated rock emplacement will be well to the north of the intake structure and not be intersected by generation and pumping flows to any material extent.

Clearing and excavation activities will change the landscape, both temporarily during construction and permanently following completion of the project given public accessibility along the foreshore, the openness of the landscape, and the popularity of the reservoir for recreational boating and fishing activities. Public access will generally be available from parts of Tantangara Reservoir during construction.

Public access using Tantangara Road will be facilitated through the construction period but may be temporarily restricted or require additional safety measures. Disturbed areas will be rehabilitated with Snowy Hydro continuing to engage with NPWS regarding opportunities to allow for future recreational uses and facilities. Exclusion zones around the construction areas and operational intake will be established including some existing recreational areas on Tantangara foreshore within the active storage of the reservoir.

Some minor impacts to historic heritage values are expected with overall impacts to the broader cultural landscape of the Snowy Mountains considered to be low. Importantly a highly significant Aboriginal heritage rock shelter was identified during the project investigations and has been avoided.

### 7.6.7 Rock Forest

Negligible environmental impacts are anticipated at Rock Forest, with the key matter related to construction noise received at the nearest residential receiver. Noise generating activities are predicted to exceed criteria (day and night) at one residential receiver to the north-east along Snowy Mountains Highway.

## 7.7 Public interest

Snowy 2.0 is the largest committed renewable energy project in Australia. It would provide an additional 2,000 MW of dispatchable generating capacity, and make approximately 350,000 MWh (about 175 hours at full power) of storage available to the NEM at any one time. It will provide more flexibility for the NEM to respond to seasonal variability when compared to other VRE and batteries. Most importantly, Snowy 2.0 will make a significant contribution to the continued decarbonisation of the economy.

Stakeholder engagement clearly indicates that Snowy 2.0 has strong support from the community with consultation identifying the public expect the project will contribute to reliability in the electricity network, lower energy prices, increasing and expanding sources of reliable, renewable energy and minimising reliance on fossil fuels, minimising environmental impacts, increased drought-proofing and providing economic benefits to local communities.

The development of Snowy 2.0 is consistent with Commonwealth and NSW strategic planning and policy objectives, including the NSW Renewable Energy Action Plan and the Australian Renewable Energy Target.

Snowy 2.0 was declared CSSI by the former NSW Minister for Planning under the NSW EP&A Act in March 2018. At the time of the declaration the Minister stated that that Snowy 2.0 was “essential for the future security of our energy system, the economy and the environment.” The declaration signifies the critical role that Snowy 2.0, together with the upgrades to the NSW transmission network, will play in providing reliable energy and large-scale storage to NSW as it transitions to a low emissions economy.

Snowy 2.0 Main Works has been designed to avoid and minimise impacts where possible in accordance with the principles of ESD. These principles were implemented through an iterative approach (known as DIAA), supported by consultation with relevant technical advisors and government agencies. The land manager of KNP, the NPWS, was consulted throughout design development and as part of the preparation of this EIS. Throughout the design process, the objective was to identify and avoid sensitive locations, to minimise the construction footprint and maintain as much of the existing natural environment as is reasonable and feasible.

Most impacts from construction are localised and temporary and will generally be experienced for the duration of the six year construction period. These impacts will be managed through the implementation of appropriate environmental controls which will be documented in management plans and publicly reported against for consent and licensing purposes. However, some impacts will be permanent with the introduction of infrastructure into the KNP to operate Snowy 2.0. These permanent impacts will predominantly be changes to the existing natural landscape and its setting, affecting biodiversity, aquatic ecology and recreational users of the disturbed area. To offset these impacts, Snowy Hydro will prepare an offset strategy to deliver actions which provide for long-term improvements and conservation outcomes for KNP.

Snowy 2.0 Main Works will deliver substantial economic benefits to the local region, NSW and NEM states, with key drivers being the direct investment to establish the project, wage expenditure, reduced ongoing electricity fuel costs, and reduced electricity costs. The greatest effect will be experienced by the NSW/ACT economies with GSP expected to increase by $2,692 M. The aggregated beneficial effect across the remaining NEM participants is predicted to be an increase in GSP of $4,176 M. The local economies of Snowy Monaro Regional and Snowy Valleys LGAs will also benefit from Snowy 2.0 Main Works, increasing the average annual additional wage expenditure by $8 M.

Snowy Hydro will continue to consult and engage with the stakeholders as the Snowy 2.0 Main Works progresses through the assessment phase, and if approved, through the construction phase. Snowy Hydro will continue to engagement with government agencies, to refine mitigation measures and develop and enhance long-term recreational values for the KNP. The proposed approach to community engagement is to focus on providing engagement activities and communication materials that provide up to date project information to those likely to be affected during construction and also allow the community to communicate their concerns with the project.

Through the implementation of proposed mitigation, management and offsetting measures, this EIS demonstrates that Snowy 2.0 Main Works could be undertaken without any significant long term impacts on the local environment. As such, Snowy 2.0 is considered to be in the public interest.

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# ABBREVIATIONS

# Abbreviations

| | |
|---|---|
| AANP | Australian Alps National Parks and Reserves |
| ACHA | Aboriginal Cultural Heritage Assessment |
| ACHAR | Aboriginal Cultural Heritage Assessment Report |
| ACM | Asbestos Containing Materials |
| ACT | Australian Capital Territory |
| AEMO | Australian Energy Market Operator |
| AEP | Annual exceedance probability |
| AFL | Agreement for Lease |
| AHD | Australian height datum |
| AHIMS | Aboriginal Heritage Management Information System |
| AHMP | Aboriginal Heritage Management Plan |
| AIP | NSW Aquifer Interference Policy |
| AMP | Asbestos management plan |
| APZ | Asset protection zone |
| AQIA | Air Quality Impact Assessment |
| AqHMP | Aquatic Habitat Management Plan |
| AUR | Auxiliary right turn |
| AUL | Auxiliary left turn |
| BAM | Biodiversity assessment method |
| BDAR | Biodiversity Development Assessment Report |
| BFMC | Bush Fire Management Committee |
| BFRHA | Bushfire Risk and Hazard Assessment |
| BOS | Biodiversity Offset Scheme |
| CATI | Computer assisted telephone interviews |
| CBP | Concrete batching plant |
| CGE | Computable general equilibrium |
| CHL | Commonwealth Heritage List |
| CHMP | Cultural Heritage Management Plan |
| CHR | Channelised right turn |

| | |
|---|---|
| CNVMP | Construction Noise and Vibration Management Plan |
| CPESC | Certified Professional in Erosion and Sediment Control |
| CSMP | Community and Stakeholder Management Plan |
| CSSI | Critical State significant infrastructure |
| DEE | Commonwealth Department of the Environment and Energy |
| DIAA | Design integration and assessment approach |
| DPIE | NSW Department of Planning, Industry and Environment |
| ECVT | Egress, cabling and ventilation tunnel |
| EEC | Endangered ecology community |
| EHNV | Epizootic haematopoietic necrosis virus |
| EIS | Environmental impact statement |
| EMM | EMM Consulting Pty Limited |
| EP&A Act | NSW *Environmental Planning and Assessment Act 1979* |
| EP&A Regulation | *NSW Environmental Planning and Assessment Regulation 2000* |
| EPA | NSW Environment Protection Authority |
| EPBC Act | Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* |
| EPIs | Environmental planning instruments |
| EPL | Environment protection licence |
| ERT | Emergency Response Team |
| ESCP | Erosion and Sediment Control Plan |
| ESD | Ecologically sustainable development |
| FGJV | Future Generation Joint Venture |
| FIFO | Fly-in fly-out |
| FSL | Full supply level |
| FID | Final investment decision |
| FTE | Full time equivalent |
| GDE | Groundwater dependent ecosystem |
| GHG | Greenhouse gas |
| GIS | Gas insulated switchgear |
| GL | Gigalitre |
| GSP | Gross state product |
| GWh | Gigawatt hour |

| | |
|---|---|
| ha | Hectares |
| HA&SoHI | Heritage Assessment and Statement of Heritage Impact |
| HABs | Harmful algal blooms |
| HV | Heavy vehicle |
| ICNG | Interim construction noise guideline |
| IO | Input - output |
| ISQG | Interim sediment quality guidelines |
| IPB | Isolated Phase Busduct |
| KFH | Key fish habitat |
| KGAP | Kosciuszko National Park Geodiversity Action Plan |
| KHA | Kosciuszko Huts Association |
| km | Kilometre |
| km² | Square kilometre |
| KNP | Kosciuszko National Park |
| KTP | Key threatening processes |
| LFB | Lachlan Fold Belt |
| LG Act | *Local Government Act 1993* |
| LGA | Local government area |
| LPF | Long Plain Fault |
| LV | Light vehicle |
| m | Metre |
| M | Million |
| m² | Square metre |
| m³ | Cubic metre |
| M2 | Murray 2 Reservoir Catchment |
| MAT | Main access tunnel |
| MJA | Marsden Jacob Associates |
| mm | Millimetre |
| MNES | Matters of National Environmental Significance |
| MOL | Minimum operating level |
| MVA | Megavolt amps |
| MW | Megawatt |

| | |
|---|---|
| MWh | Megawatt hour |
| NEM | National Electricity Market |
| NGAF | National Greenhouse Accounts Factors |
| NHL | National Heritage List |
| NML | Noise management level |
| $NO_2$ | Nitrogen dioxide |
| NOA | Naturally occurring asbestos |
| NPW Act | NSW *National Parks and Wildlife Act 1995* |
| NPW Regulation | NSW *National Parks and Wildlife Regulation 2009* |
| NPWS | NSW National Parks and Wildlife Service |
| NSW | New South Wales |
| OSOM | Oversize over-mass |
| PAF | Potentially acid forming |
| PBP | *Planning for Bush Fire Protection Guideline* |
| PCTs | Plant community types |
| PCU | Passenger Car Units |
| PHA | Preliminary Hazard Assessment |
| $PM_{2.5}$ | Particulate matter smaller than 2.5 micrometres in diameter |
| $PM_{10}$ | Particulate matter smaller than 10 micrometres in diameter |
| POEO Act | *Protection of the Environment Operations Act 1997* |
| PoM | Plan of Management |
| PSI | Preliminary Site Investigation |
| Q&As | Questions and answers |
| RAPS | Registered Aboriginal Parties |
| RFS | NSW Rural Fire Service |
| RMS | NSW Roads and Maritime Services |
| SEARs | Secretary's environmental assessment requirements |
| SEPP | State Environmental Planning Policy |
| SEPP 33 | *State Environmental Planning Policy No. 33 – Hazardous and Offensive Development* |
| SEPP 44 | *State Environmental Planning Policy No. 44 – Koala Habitat Protection* |
| SEPP 55 | *State Environmental Planning Policy No. 55 – Remediation of Land* |
| SHC Act | NSW *Snowy Hydro Corporatisation Act 1997* |

| | |
|---|---|
| SHR | State Heritage Register |
| SIMMP | Social Impact management and Monitoring Plan |
| SISD | Safe intersection sight distance |
| SMA | Snowy Mountains Authority |
| SMCC | Snowy Mountains Control Centre |
| Snowy Scheme | Snowy Mountains Hydro-electric Scheme |
| Snowy Hydro | Snowy Hydro Limited |
| SLA | Soils and Land Assessment |
| SMRC | Snowy Monaro Regional Council |
| SRD SEPP | *State Environmental Planning Policy (State and Regional Development) 2011* |
| SSI | State significant infrastructure |
| SVC | Snowy Valleys Council |
| TARP | Trigger action response plan |
| TCP | Traffic Control Plan |
| TBM | Tunnel boring machine |
| TF | Tantangara Fault |
| TSP | Total suspended particulate matter |
| VENM | Virgin Excavated Natural Material |
| WHL | World Heritage List |
| WM Act | *Water Management Act 2000* |
| WQO | Water Quality Objectives |
| µm | micrometre |

# GLOSSARY

# Glossary

| Term | Definition |
|---|---|
| Accommodation camp | Area used for temporary housing and facilities for construction personnel |
| Adit | Temporary access tunnel for access to underground construction areas |
| Ancillary construction facilities | Facilities required to support construction activities such as concrete batching plants, crushing plants, warehouses and laydown, stockpiles |
| Backfill | Refill an excavated hole with the material dug out of it |
| Baseflow | The component of streamflow supplied by groundwater discharge. Baseflow is characterised by an exponential decay curve following the cessation of surface runoff. |
| Bifurcation | Division into two branches |
| Biodiversity offsets | Management actions that are undertaken to achieve a gain in biodiversity values on areas of land in order to compensate for losses to biodiversity values from the impacts of development (OEH 2017) |
| Blasting | Rock blasting is the controlled use of explosives and other methods to excavate, break down or remove rock |
| Blind sink | Excavating a vertical or near-vertical tunnel from the top down, where there is initially no access to the bottom |
| Boring / shaft boring | Excavating a shaft downwards, usually from the surface |
| Cable yard | Permanent site for the high voltage transmission connection from the NEM to Snowy 2.0 |
| Capital investment value | All costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment |
| Communications cable | Fibre optic cable to provide a communications connection |
| Construction compound | A temporary site used for construction ancillary facilities and laydown |
| Construction footprint / disturbance area | The area subject to clearing and ground disturbance. The disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design |
| Contractor | Contractor engaged by Snowy Hydro Limited to construct Snowy 2.0 |
| Detailed design | The phase of the project where the design is refined into drawings, plans, specifications and estimates, suitable for construction |
| Diffuser | A duct, chamber, or section in which high-velocity flow is converted to low-velocity, high-pressure flow |
| Drawdown | The lowering of water levels in a surface water or groundwater storage resulting from the loss or take of water from the storage |
| Drill and blast | The controlled use of explosives to break rock for excavation |
| ECVT | Emergency egress, cabling and ventilation tunnel |
| Earthworks | All works involving the loosening, excavating, placing, shaping and compacting of soil or rock |
| Ecosystem | A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit |
| Excavated rock | Hard, compacted, or cemented materials that have been removed using blasting or other excavation methods |
| Exploratory Works | A program of exploratory works for Snowy 2.0, approved by the former NSW Minister for Planning on 7 February 2019 as a separate project application to DPIE (SSI 9208) |
| Firming capacity | Energy available within the network to respond to demand when other energy sources, such as intermittent renewables are not operating (due to low wind or low sunlight) |

| Term | Definition |
|---|---|
| Full supply level | The normal maximum operating water level of a surface water storage when not affected by floods. This water level corresponds to 100% capacity |
| Gate shaft | A shaft for the gate tower bored at the highest ground along the wet tunnel alignment, approximately 200 m away from the intake mouth |
| Generating mode | When water flows from Tantangara Reservoir into Talbingo Reservoir, providing on-demand energy generation |
| Geodiversity | Geodiversity refers to the variety of the geological and physical elements of nature, such as minerals, rocks, soils, fossils and landforms, and active geological and geomorphological processes |
| Groundwater dependent ecosystem (GDE) | Natural ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis, so as to maintain their communities of plants and animals, ecosystem processes and ecosystem services. |
| Headrace surge shaft | A shaft structure constructed from the surface and breaking through to the headrace tunnel, most likely using a blind sink method |
| Headrace tunnel | The upstream tunnel between Tantangara Reservoir and the underground power station |
| Hydro-electric | Generation of electricity using flowing water (typically from a reservoir held behind a dam or barrage) to drive a turbine which powers a generator |
| Intake gate | A gate installed at the entrance of the headrace or tailrace tunnels to allow/stop water from entering the tunnels |
| Karst | Karst is a distinctive topography in which the landscape is largely shaped by the dissolution of carbonate bedrocks (usually limestone, dolomite, or marble) |
| Kosciuszko National Park | A National Park protected under the NSW *National Parks and Wildlife Act 1974* and managed by NSW National Parks and Wildlife Service. It covers an area of 673,543 hectares and forms part of Australia's only Alpine area |
| Laydown area | An area for laydown and maintenance of construction plant, equipment and materials storage |
| Lobs Hole | A remote campsite and former settlement location within Kosciuszko National Park |
| Lobs Hole camp | Main Works accommodation camp at Lobs Hole |
| Lobs Hole Road | The road at Lobs Hole, not the main access down to Lobs Hole |
| Lobs Hole Ravine Road | The main access road to Lobs Hole |
| Lower Lobs Hole Ravine Road | The section of Lobs Hole Ravine Road from Link Road to where it crosses the transmission easement |
| Marica camp | Main Works accommodation camp at Marica |
| Marica West Track | New access road proposed from the MAT to Marica, above the proposed power station location |
| Marica Trail | Access road to Marica from the Snowy Mountains Highway |
| Mine Trail Road | The access road from the intersection with Lower Lobs Hole Ravine Road and the MAT |
| Minimum operating level | The lowest level to which a reservoir can be drawn down under normal operating conditions and is the lower limit of active storage |
| National Electricity Market (NEM) | The wholesale exchange of electricity operated by AEMO under the National Electricity Rules (NER). It is the wholesale market for the supply of electricity in all states of Australia except Western Australia and the Northern Territory. |
| Open cut | Method of excavating a trench from the surface and building the structure within the trench |
| Portal | Location of surface connection with underground access tunnels |
| Power station | The 2,000MW underground pumped hydro-electric power station proposed for Snowy 2.0 |
| Project area | The area required to access and build project infrastructure, including surface and tunnel components of the project |

| Term | Definition |
|---|---|
| Reference design | Design for Snowy 2.0 prepared by SMEC on behalf of Snowy Hydro, for the purpose of specifying Snowy Hydro's functional and performance requirements for tenders for the detailed design and construction of Snowy 2.0 |
| Residual impact | Those effects that remain following the application of mitigation measures to reduce adverse impacts from the project |
| Riparian | An area or zone within or along the banks of a stream or adjacent to a watercourse or wetland; relating to a riverbank and its environment, particularly to the vegetation. |
| Snowy 2.0 | A pumped hydro-electric expansion of the Snowy Scheme that will link the two existing reservoirs of Tantangara and Talbingo through underground tunnels, and include a new underground power station with pumping capabilities |
| Snowy 2.0 Transmission Connection Project | Project proposed by TransGrid to connect Snowy 2.0 with the existing high voltage transmission network subject to a separate application |
| Storage mode | When water is pumped out of Talbingo Reservoir to Tantangara Reservoir, to provide large-scale energy storage |
| Streamflow | The flow of water in streams, rivers and other channels |
| Subaqueous | Existing, formed, or taking place under water |
| Surface water | Water that flows over or is stored on the surface of the earth that includes: (a) water in a watercourse, lake or wetland and (b) any water flowing over or lying on land: (i) after having precipitated naturally or (ii) after having risen to the surface naturally from underground |
| Surge shaft | A hydraulic structure designed to control pressure and flow fluctuations in the tunnel |
| Tailrace surge tank | An underground shaft structure off the tailrace tunnel west of the power station complex at the start of the tailrace tunnel |
| Tailrace tunnel | The downstream tunnel between the underground power station and Talbingo Reservoir |
| Talbingo intake | Water intake structure to be constructed at Talbingo Reservoir |
| Talbingo rock emplacement area | Location for permanent rock emplacement within Talbingo Reservoir |
| Tantangara camp | Main Works accommodation camp at Tantangara |
| Tantangara rock emplacement area | Location for permanent rock emplacement within Tantangara Reservoir |
| Transformer | An electromagnetic device used to change the velocity of ac electricity |
| Transmission | The conveyance of electric energy |
| Trashrack | A rack or screen of parallel bars installed to prevent debris from entering the turbine |
| Tumut 2 power station | Underground power station south of Talbingo Reservoir |
| Tumut 3 power station | Power station at the northern end of Talbingo Reservoir |
| Turbidity | The measure of the light scattering properties of water and is an indicator of the presence of suspended solids |
| Turbine | A machine which converts the energy of water to mechanical energy |
| Variable renewable generation | Intermittent renewable wind and solar energy sources that are non-dispatchable and fluctuating in nature |
| Water intake | Structures at Talbingo and Tantangara reservoirs used to take water in and out of the headrace and tailrace tunnels |

# STUDY TEAM

# Study Team

## Environmental study team

| Role | Person | Qualification |
|---|---|---|
| **Direction and management** | | |
| Project Director | Brett McLennan | BTP (Hons) |
| Project Manager | Duncan Peake | BSc (Hons) |
| Deputy Project Manager | Alex Frolich | BSc(Marine) |
| Project Coordinator | Lawrence Wallis | BA, BSc |
| **EIS preparation** | | |
| Authors | Alex Frolich | BSc(Marine) |
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| | Allan Reid | BTP (Hons), GradDEnv |
| | Lawrence Wallis | BA, BSc |
| | Duncan Peake | BSc(Hons) |
| | Brett McLennan | BTP(Hons) |
| | Emily McIntosh | BSc, BA |
| | Ryan Desic | BA (Hons) |
| | Anthony Knox | BEnv |
| GIS analysis and spatial solutions | Antony Edenhofner | BSc (Hons) |
| | Peter Tolley | MSciTech, BBiot (Hons), GradDSIS |
| | Amy O'Brien | BSc |
| | Jackie Clifford | BA, MMarScMgt |
| Graphics | Brett Tweedie | |
| | Gayle Bruggemann | |
| **Specialist technical study leads** | | |
| Aboriginal heritage | Dr Julie Dibden (NSW Archaeology) | PhD, BA (Hons) |
| Air quality | Francine Manansala | BA |
| | Dr Paul Boulter | BSc (Hons), MSc, PhD |
| | Scott Fishwick | BSc |
| Aquatic ecology | Dr Paul Goldsworthy | PhD, BSc (Hons) |
| | Dr Brendan Alderson (Cardno) | PhD, BSc (Hons) |
| | Dr Lachlan Barnes (Cardno) | PhD, BSc (Hons) |
| | Dr Craig Blount (Cardno) | PhD, BSc (Hons) |
| | Dr Marcus Lincoln Smith (Cardno) | PhD, MSc, BSc (Hons), BA |
| | Dan Pygas (Cardno) | BSc (Hons) |
| | Kate Reeds (Cardno) | MSc, BSc (Hons) |
| | Kevin Roberts (Cardno) | MPubAdm, MEnv, BSc (Hons) |
| Biodiversity | Nathan Garvey | BSc, GradDBioSc |
| | Cassandra Kottaras | BSc |
| Bushfire | Dominic Adshead (ELA) | BSc, GradCert |
| | Letara Judd (ELA) | BEnvSc, GradCert |

## Environmental study team

| Role | Person | Qualification |
|---|---|---|
| | Kris Rixon (ELA) | BEnvSc |
| | Peter Hawke (ELA) | BSc, MPhil |
| Contamination | Nina Baulch | BSc |
| | Anthony Davis | BSc (Hons, DipB |
| | Lachlan Lewis | BE |
| | Tavis Kleinig | MSc, BSc (Hons) |
| Economics | Dr Robert Gillespie (Gillespie Economics) | PhD, MEc, MPlan, BEc, BSc |
| Flooding Assessment | Nick Bartho | B Eng (Hons) |
| | Zac Richards (GRC Hydro) | BE (Hons) |
| | Nathan Cheah (GRC Hydro) | BE, PhD |
| | Beth Marson (GRC Hydro) | BE, DipEngPrac |
| | William Tang (GRC Hydro) | BE, ME (Environment) |
| | Nicola De Paolis | BE, ME (Hydraulics) |
| Geodiversity | Dr Ian Percival | PhD, BSc (Hons) |
| | Dr Alexa Troedson | PhD, BSc (Hons) |
| Hazard and Risk | Phil Johnson (Sherpa) | MSc(Eng), BEng, AMIChemE, CFSP |
| | Giles Peach (Sherpa) | CEng, BEng, MIMechE, MIChemE, Professional Process Safety Engineer |
| | Vahishta Bhasin (Sherpa) | BEng, BSc |
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| | Andrew Pearce (NSW Archaeology) | BArchAnth |
| Landscape character and visual impact assessment | Michael Wright (Spackman Mossop Michaels) | BAppSci, MLArch |
| | Lewis Haig (Spackman Mossop Michaels) | BLArch |
| | Andrew Coruzzi (Spackman Mossop Michaels) | BLArch |
| | Michael Wong (Spackman Mossop Michaels) | BLArch (Hons) |
| Navigation assessment | Rick Plain (Royal Haskoning DHV, Australia) | BEng (Hons 1), BCom (Dist) |
| Noise and vibration | Carl Fokkema | BSc |
| | Najah Ishac | MEng, BEng |
| Recreational users | Janet Mackay (TRC Tourism) | MAppSc, BA, GradDRecPlan, GradDEd, |
| | Penny McLennan (TRC Tourism) | BCA, GradDLaw |
| Rehabilitation strategy | Nathan Archer (SLR) | |
| | Rod Master (SLR) | |
| Reservoir assessment overview | Dr Philip Towler | PhD, Bsc (Hons) |
| | Greg Britton (Royal Haskoning DHV Australia) | MEngSc, BEng (Hons) |
| | Martin Budd (Royal Haskoning DHV Australia) | PhD, BSc |
| | Ali Watters (Royal Haskoning DHV, Australia) | BEng (Hons) |
| | Luke Kidd (Royal Haskoning DHV, Australia) | BEng (Hons), MEnvSc |
| | Rick Plain (Royal Haskoning DHV, Australia) | BEng (Hons 1), BCom (Dist) |

## Environmental study team

| Role | Person | Qualification |
|---|---|---|
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| | Arjen Overduin (Royal Haskoning, DHV, Australia) | BEng (Civil Eng), MSc |
| | Benjamin Williams (Royal Haskoning DHV, Australia) | PhD (Coastal Eng), MSc, BSc (Hons) |
| Social | Felicity Richards (Elton Consulting) | GradCertSIA, MIntlBus BA, BIntlDev |
| | Sonia Dalitz (Elton Consulting) | MPP, GradDipEd |
| | Steve Rossiter (Elton Consulting) | MScRegPlan, GradDipEd |
| Soils and land assessment | Justin Claridge | MLand, BLand (Hons) |
| | Nicholas Jamson | BEnvSc (Hons) |
| Stakeholder engagement | Brett McLennan | BTP (Hons) |
| | Emily McIntosh | BSc, BA |
| | Heather Quinlan (Snowy Hydro) | |
| Strategic context and the need for Snowy 2.0 | Duncan Peake | BSc (Hons) |
| | Alex Frolich | BSc(Marine) |
| Traffic and transport | Seamus Christley (SCT Consulting) | MTrnspMngt, BSocSc |
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| | Andy Yung (SCT Consulting) | MTrnsp, BEng (Hons) |
| Water assessment | Nick Bartho | BEng (Hons) |
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| | Dr Doug Weatherill | PhD, BSc (Hons) |
| | Jarrah Muller | BEng, BSc |
| | Anya Jones-Gill | BEng (Hons), GradDip WRM |
| | Jason O'Brien | BEng |
| | Craig Vincent | MSc |
| | Jonathon Tait | BSc (Hons) |
| | Imogen Frawley | BEng (Hons), BA |
| | Dr Phil Towler | PhD, BSc (Hons) |
| | John Ross | BSc |
| | Patrick Carolan | BEng |
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| | Brian Gardoll | |
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| | James Duggleby | MSc, MGeol (Hons) |
| | Kate Holder | BSc (Hons) |
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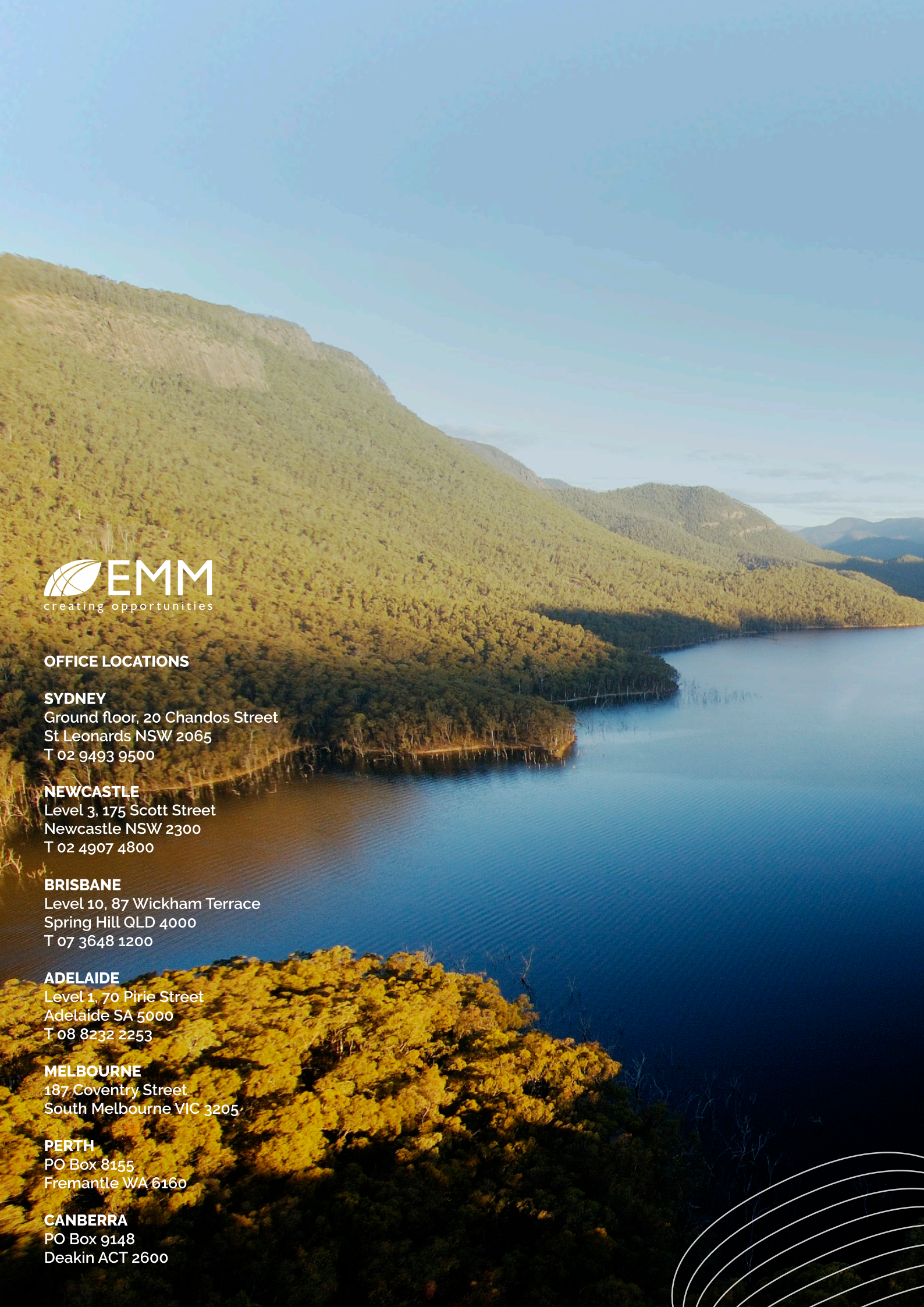

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