NSW GOVERNMENT

Snowy 2.0 Main Works

Critical State Significant Infrastructure Assessment (SSI 9687)

May 2020

Cover photo

Lobs Hole, Department of Planning, Industry and Environment 2019

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Glossary

Abbreviation	Definition
BCD	Biodiversity and Conservation Division of the Department
CIV	Capital Investment Value
Council	Snowy Monaro Regional Council
CSSI	Critical State Significant Infrastructure
Department	Department of Planning, Industry and Environment
DPI	Department of Primary industries
DPIE - Water	Department of Planning, Industry and Environment – Water Division
EHNV	Epizootic Haematopoietic Necrosis Virus
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPI	Environmental Planning Instrument
EPL	Environment Protection Licence
ESD	Ecologically Sustainable Development
LEP	Local Environmental Plan
Minister	Minister for Planning and Public Spaces
NEM	National Electricity Market
NRAR	Natural Resources Access Regulator
Planning Secretary	Secretary of the Department of Planning, Industry and Environment
RMS	Roads and Maritime Services
RtS	Response to Submissions
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SRD SEPP	*State Environmental Planning Policy (State and Regional Development) 2011*
SSI	State Significant Infrastructure
TfNSW	Transport for NSW

Executive Summary

Background

Snowy Hydro Limited (Snowy Hydro) is proposing to expand the existing Snowy Mountains Hydro-electric Scheme and build a new underground power station in the Kosciuszko National Park.

The Snowy 2.0 Project involves connecting the Talbingo and Tantangara reservoirs to the new power station via a series of underground tunnels and generating up to 2,000 megawatts (MW) of electricity and providing up to 350 gigawatt hours (GWh) of energy storage for the National Electricity Market (NEM).

The project is essential for the NSW economy as it would provide a reliable supply of electricity to the NEM as it transitions away from a long-standing reliance on coal-fired power stations to a reliance on renewable energy.

On 7 February 2019, Snowy Hydro received approval for Exploratory Works to find out more about the geology of the site and investigate the proposed location of the power station, and on 31 March 2020 it received approval for a Segment Factory in the Cooma industrial area to make concrete segments for lining the tunnels of the project.

Project

Snowy Hydro is now seeking approval to construct and operate the Main Works component of Snowy 2.0. The project involves:

- connecting the existing Talbingo and Tantangara reservoirs with 29.7 kilometres of concrete-lined underground waterway tunnels; and
- developing a new underground power station and associated infrastructure with capacity to generate 2,000 MW of electricity and provide up to 350 GWh of energy storage for the NEM by transferring water through the tunnels between the reservoirs.

The Main Works project would create 2,000 construction jobs over a 6-year period and has a capital investment of around $4.6 billion.

Statutory Context

The Snowy 2.0 Project, including the Main Works project, is classified as Critical State Significant Infrastructure (CSSI) under the *Environmental Planning and Assessment Act 1979* (EP&A Act), as is specified as CSSI under Clause 9 of Schedule 5 of *State Environmental Planning Policy (State & Regional Development) 2011*. Consequently, it requires the approval of the Minister for Planning and Public Spaces before it may proceed.

Engagement

The Department has consulted widely on the project over the last two years.

The Department exhibited the application and Environmental Impact Statement (EIS) for the Main Works from 26 September 2019 until 6 November 2019, held public information sessions in the local area, worked closely with government agencies, consulted and met with key stakeholders, published all submissions on the project and required Snowy Hydro to provide a formal response to the issues raised in submissions.

The Department received 222 submissions, including 10 from government agencies, 30 from special interest groups and 182 from the general public.

Of the 222 submissions, 73% objected to the project, 5% supported the project and 22% provided comments. Of the public submissions, 8% were from areas close to the project, including Cooma, Adaminaby and Talbingo.

Submissions from special interest groups, included conservation organisations, wildlife societies and recreational groups. Most of these groups objected to the project. The National Parks Association of NSW (NPA) strongly objects to the project and considers it would have a destructive impact on the KNP and should not be approved as there are better alternatives.

Most of the submissions (73%) were strongly opposed to the project and supported the NPA's submission. Submissions also expressed concern about the potential impacts of the project on local businesses, tourism and amenity. The submissions in support of the project supported its economic benefits.

The key matters raised by government agencies related to the spoil emplacement strategy, biodiversity impacts and offsets, biosecurity matters, water quality, impacts on recreation and the management of traffic. Snowy Monaro Regional Council strongly supported the project subject to conditions.

Snowy Hydro responded to the issues raised in submissions, making changes to the project to address the key impacts. These are described in a Preferred Infrastructure Report (PIR) and include a reduction in the disturbance footprint of the project, a revised spoil emplacement strategy and revised groundwater modelling and traffic studies.

Assessment and Evaluation

The Department has carried out a detailed assessment of the merits of the project, considering the issues raised during consultation, Snowy Hydro's assessment of the environmental impacts and independent expert advice.

The critical merit issues are energy security and reliability, impacts during construction including spoil management and impacts on flora and fauna flora and impacts during operation on the aquatic environment.

The Department considered relevant Commonwealth and State energy policies, plans and reviews and concluded that the project is critical for energy security and reliability in NSW.

The NEM is likely to require the delivery of up to 21,000 MW of dispatchable energy and up to 15,000 MW of energy storage over the next 20 years to stabilise the operation of the NEM and ensure energy security and reliability. In theory, this energy could be delivered in several ways. However, the Snowy 2.0 Project is one of the only committed projects in NSW that could make a substantial contribution to the NEM over the next 5-10 years by providing both peaking supply of up to 2,000 MW of dispatchable energy and "deep" backup supply of up to 350 GWH of energy storage.

These attributes will be critical with the scheduled closure of the Liddell and Vales Point coal-fired power stations over the next decade (3,820 MW of generation capacity), and the Eraring, Bayswater and Mount Piper power stations in the following decade (7.020 MW). Consequently, the Department is satisfied that the Snowy 2.0 Project

is critical for energy security and reliability in NSW and notes that it features prominently in all the scenarios modelled in AEMO's Integrated System Plan.

Over the last two years, Snowy Hydro has refined the design of the project to reduce its impacts. Following exhibition, however, the Department required Snowy Hydro to consider making further changes to the design of the project to address agency concerns.

Subsequent changes have reduced the overall disturbance area of the Main Works by 62% to a maximum of 504 hectares, taking the total disturbance area for the whole project to 630 hectares; made significant changes to the proposed spoil disposal strategy including reducing the spoil generated, where it is disposed and improving the design of all of the spoil emplacement areas to develop natural, free-draining landforms; and confirmed through updates to the groundwater modelling that the lining of the tunnels would significantly reduce groundwater inflows and that using grouting would reduce this even further.

With these changes, the Department is satisfied that Snowy Hydro has designed the project to minimise its impacts on the KNP. The Department recognises that even with careful design, the project would adversely affect some parts of the back country of the KNP during the 5-6 years of construction when up to 593 hectares of surface disturbance (around 0.09% of the KNP), native vegetation would be cleared, some recreation areas would be closed to the public, and there would be extensive heavy vehicle traffic and more dust and noise in the KNP than normal.

The Department notes that following construction, all disturbed areas would be rehabilitated to a high standard and returned mostly to woodland, leaving a small residual surface footprint of around 92 hectares. This footprint would be concentrated mostly around the Talbingo and Tantangara reservoirs, as most of the other operational components of the project would be located underground or screened from public view.

The Department has worked closely with key government agencies to reduce the construction impacts of the project as much as possible. Following changes to the project and the provision of additional information by Snowy Hydro, none of the government agencies object to the project. However, several agencies have recommended conditions for the project which have been incorporated into the recommended conditions of approval.

The recommended conditions require Snowy Hydro to:

- minimise the water quality, dust, noise, visual and traffic impacts of the project;
- test, classify and manage all spoil in accordance with strict requirements, and to implement special procedures to manage any reactive or contaminated spoil;
- develop detailed plans for all spoil disposal in the KNP to ensure any landforms created are natural, free-draining, and blend into the surrounding landscape;
- rehabilitate the site to a high standard following construction, including restoring native vegetation and threatened species habit and providing enhanced recreational facilities at Lobs Hole and the Tantangara Reservoir;
- pay the NPWS up to $73.8 million (on top of the $8.49 million already paid for the exploratory works) to carry out actions to significantly improve catchment health, strengthen ecosystems, protect threatened species and communities and deliver long-term strategic conservation benefits for the KNP;
- keep Tantangara Road open to the public once it has been upgraded;
- pay the NPWS up to $1. 995 million (on top of the $4.96 million already paid for the exploratory works) to improve certain recreational facilities in the KNP surrounding the site;

- develop an interactive digital application for users of the KNP, using information gathered for the project to enhance their enjoyment of the KNP;
- prepare detailed archival records of and/or salvage the small number of heritage items within the disturbance area that have conservation significance;
- prepare detailed management plans for the project prior to construction;
- monitor and publicly report on compliance; and
- commission and pay the full costs of regular independent environmental audits of the performance of the project.

The key risk during operation is associated with the movement of pest fish (particularly Redfin Perch and Climbing Galaxias) or diseases from the Talbingo Reservoir to Tantangara Reservoir, and potentially downstream to the mid-Murrumbidgee River and Lake Eucumbene.

The Department acknowledges that Snowy Hydro has proposed to restock Tantangara Reservoir and Lake Eucumbene with salmonid fish to offset any adverse impacts on recreational fishing in these waterbodies, install large fish screens to prevent the spread of pest fish and disease downstream of the Tantangara Reservoir and protect a population of the endangered Macquarie Perch in the mid-Murrumbidgee River; and install a fish barrier on Tantangara Creek to protect the only remaining population of the critically endangered Stocky Galaxias.

While these measures are expected to minimise any adverse biosecurity impacts of the project as far as is reasonably practicable, there is some uncertainty about how effective the fish screens and fish barrier will be over the operational life of the project (potentially 100 years).

To address this risk, the Department has developed conditions in consultation with the NSW Department of Primary Industries requiring Snowy Hydro to:

- prepare a detailed Biosecurity Management Plan for the project to minimise the development-related biosecurity risks of the project, including the movement or spread of weeds, pests and pathogens;
- develop a detailed captive breeding program involving the spending of $5 million over the first 5 years to establish self-sustaining, "insurance" populations of the Macquarie Parch and Stocky Galaxias;
- review this program after five years, and develop a detailed trigger, action and response plan for the expansion of this program over time if necessary;
- develop a detailed Recreational Fishing Management Plan for the project involving the spending of $5 million over the first 5 years to restock, the Tantangara Reservoir and Lake Eucumbene with salmonid fish, and then to continue restocking if there are any adverse impacts on recreational fishing due to the project.

With these conditions in place, the NSW Department of Primary Industries has advised the Department that it would be prepared to grant Snowy Hydro the authorisations it requires under the *Biosecurity Act 2015* in order to be able to operate the project.

Summary

The Main Works project is critical for energy security and reliability in NSW as it would deliver up to 2,000 MW of reliable electricity supply and 350 GWh of "deep" energy storage to the NEM as it transitions away from a long-standing reliance on coal-fired power stations to a reliance on renewable energy and would maximise the use of the existing Snowy scheme's infrastructure.

The project would also deliver significant economic benefits to NSW and the Snowy Mountains region including capital investment of $4.6 billion, the creation of 2,000 construction jobs and helping to reduce electricity prices.

The Department has carried out a detailed assessment of the merits of the project and has considered all relevant issues raised by the community, special interest groups and agencies in submissions.

Based on this assessment, the Department has concluded that the project has been designed to minimise any impacts on the KNP, including reducing the footprint to less than 0.09% of the KNP during construction and 0.014% during operations; and that the residual impacts can be reduced to an acceptable level by requiring Snowy Hydro to rehabilitate the site to a high standard and contribute at least $85.8 million (to add to $13.46 million it has already paid) to improve the biodiversity and recreational values of the KNP and address any remaining environmental risks.

On balance, the Department has found that the Snowy 2.0 Main Works project is in the public interest and should be approved subject to strict conditions.

Contents

1. Introduction

1.1. Overview

Snowy Hydro Limited (Snowy Hydro) is proposing to expand the existing Snowy Mountains Hydro-electric Scheme and build a new underground power station in the Kosciuszko National Park (KNP).

The Snowy 2.0 Project (see **Figure 1**) involves connecting the Talbingo and Tantangara Reservoirs to a new underground power station via a network of tunnels to generate up to 2,000 megawatts (MW) of electricity and provide up to 350 gigawatt hours (GWh) of energy storage for the National Electricity Market (NEM).

The project is critical for energy security and reliability and would play an essential role as NEM transitions away from a long-standing reliance on coal-fired power stations to a reliance on renewable energy (wind and solar).

Consequently, all components of the Snowy 2.0 Project have been classified as Critical State Significant Infrastructure (CSSI) under the *Environmental Planning and Assessment Act 1979* (EP&A Act) and require the approval of the Minister for Planning & Public Spaces before they may proceed.

Snowy Hydro is now seeking approval for the Main Works component of the project which involves developing the new underground power station and associated infrastructure.

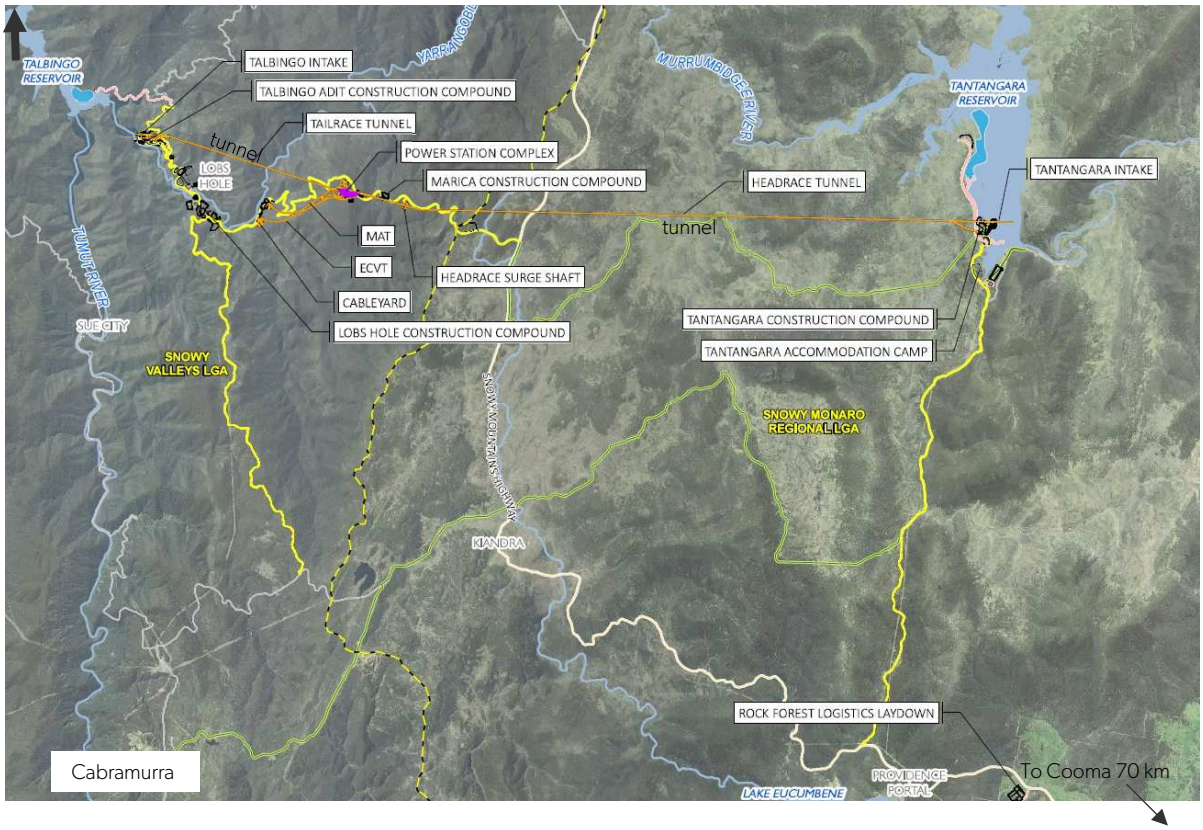


Figure 1 | Snowy 2.0 Project

1.2. Background

History of the Main Works Project

Construction of the existing Snowy Scheme commenced in 1949, with full operation from 1974. The existing scheme consists of nine power stations, 16 major dams, 145 kilometres (km) of tunnels and produces an average of 4,500 gigawatt hours of renewable energy each year.

Plans to link the Talbingo and Tantangara Reservoirs were included in original design but were not constructed due to economic constraints at the time and the emerging availability of cheap coal-fired power.

Many coal-fired power stations in NSW are nearing the end of their operational life and the NEM is shifting away from traditional fossil fuels to renewable energy sources. In 2017, the Commonwealth Government identified the need for large-scale energy storage and announced a proposal to expand the Snowy Scheme to provide energy security, improve reliability in the NEM and increase the amount of renewable energy generated in NSW.

Snowy Hydro proposes to expand the existing scheme (known as Snowy 2.0) by linking the Talbingo and Tantangara Reservoirs, to increase the power generating capacity of the scheme by nearly 50%. **Figure 6** shows the existing Snowy Scheme and the proposed Snowy 2.0 project.

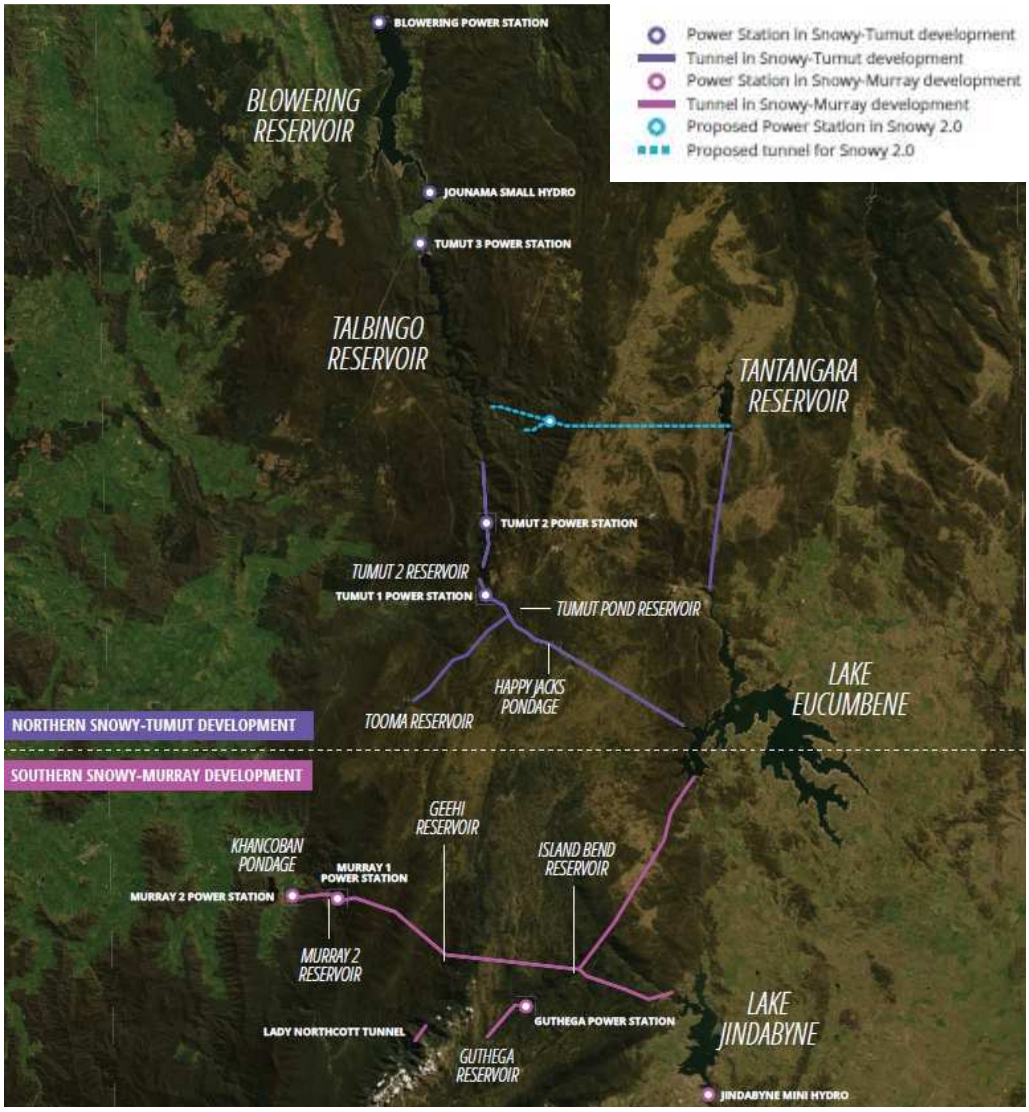


Figure 2 | Existing Snowy Scheme and Proposed Snowy 2.0 Project

Development of the Project Design

Snowy Hydro investigated a range of options within the project, considering constructability, environmental, economic and social factors.

Alternative locations and designs were considered for the power station, waterway tunnel alignments and water intakes at the Talbingo and Tantangara Reservoirs. Different tunnelling methods were considered, with the final design using a combination of drill and blast and tunnel boring machines.

Snowy Hydro also considered various options for managing the excavated spoil material, including placement within Talbingo and Tantangara Reservoirs, on land emplacement within KNP and removal of all spoil outside of KNP. Alternatives to reduce the overall disturbance footprint of the project included changes to construction compounds, design of the road upgrades and consideration of alternative routes for the transmission line connections.

1.3. Related Development

The Snowy 2.0 project includes four components, Exploratory Works, Main Works, a Segment Factory and the Transmission Connections.

Exploratory Works

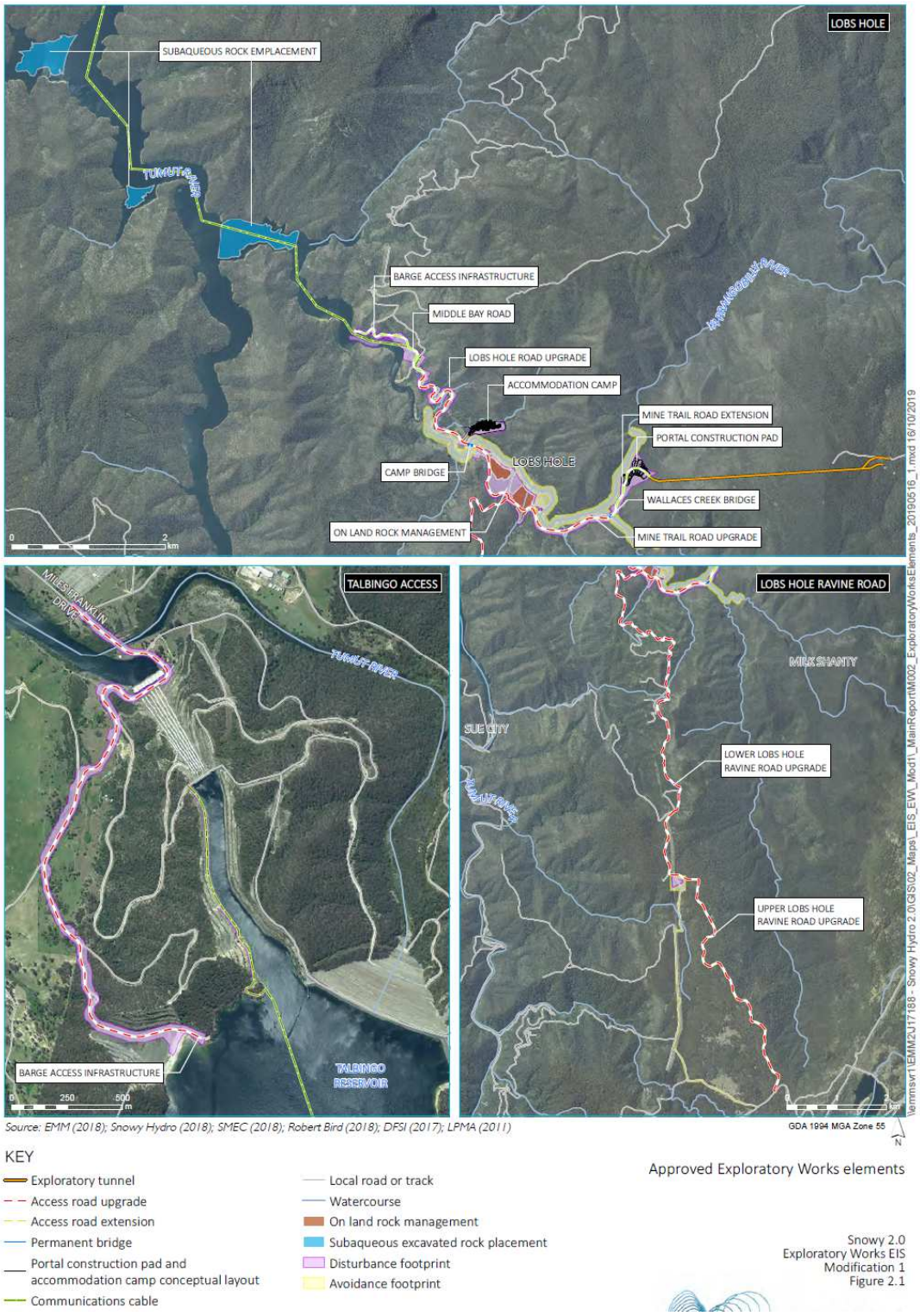
On 7 February 2019, the then Minister for Planning approved an application from Snowy Hydro to carry out Exploratory Works for the Snowy 2.0 Project to gain a better understanding of the geology of the site and inform the design of the proposed power station.

On 2 December 2019, this approval was modified to allow Snowy Hydro to carry out further geotechnical investigations and develop additional supporting infrastructure, including a new electricity sub-station at Lobs Hole within KNP. On 27 March 2020, the approval was further modified to revise the location of some of the exploratory works, shorten the length of tunnel, use a tunnel boring machine to expedite construction and change the proposed barge infrastructure on Talbingo Reservoir.

The Exploratory Works and relevant conditions would be integrated into the Main Works project. The approved Exploratory Works are summarised in **Table 1** and shown in **Figure 3** and **Figure 4**.

Table 1 | Approved Exploratory Works

Aspect	Description
Exploratory tunnel	2.5 km long exploratory tunnel with a portal at the western end, in the location of the proposed power station at Marica
Boreholes	Boreholes for geotechnical investigations at Lobs Hole, Tantangara Reservoir and Marica
Portal construction pad	• concrete batching plant, offices, workshops, storage areas and magazine (explosives) • power, communications and water supply connections
Talbingo Reservoir	• barge access at Middle Bay and dredging a navigation channel • use of Talbingo boat ramp and temporary closures to the public for short periods
Lobs Hole	A new substation and grid connection for power supply
Spoil management	Temporary stockpiling of 685,000 cubic metres (m^3) of spoil on land (eastern and western areas) for later removal off-site, within 5 years
Worker accommodation	Accommodation camp for around 250 workers including sewage and water treatment plants
Road works	• upgrades and widening of roads within KNP including Lobs Hole Ravine Road, Lobs Hole Road, Mine Trail Road and Spillway Road • temporary construction roads, new roads and bridges



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

Figure 3 | Location of Approved Exploratory Works

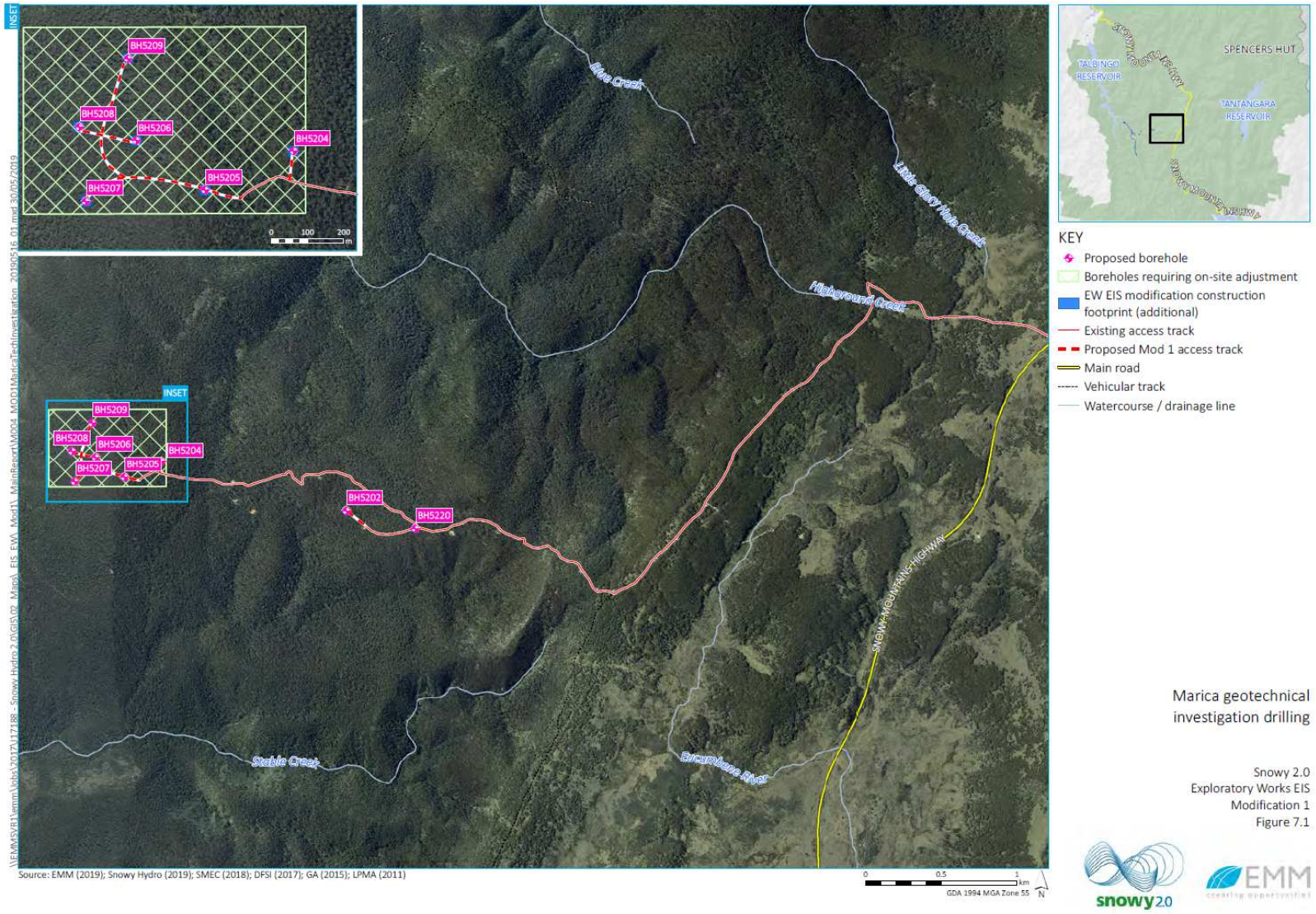


Figure 4 | Location of Approved Exploratory Works - Boreholes

Segment Factory

On 31 March 2020, the Minister for Planning and Public Spaces approved an application from Snowy Hydro to construct and operate a Segment Factory in the industrial area of Cooma. The factory would produce concrete segments to line the underground tunnels for Snowy 2.0. The factory would operate for 3 to 4 years, with the concrete segments transported from Cooma to KNP via the Monaro and Snowy Mountains Highways.

Initially the concrete segments would be transported to the Lobs Hole construction site near the Talbingo Reservoir, where Snowy Hydro is constructing the exploratory works tunnel. If the Main Works proceed, the concrete segments would also be delivered to a construction site adjacent to the Tantangara Reservoir and to a construction laydown area at Rock Forest, just outside KNP.

Transmission Connections for Snowy 2.0

New electricity transmission lines and a substation would be constructed by TransGrid, to connect the Snowy 2.0 power station to the electricity grid. The proposed transmission connections are summarised in **Table 2** and shown in **Figure 5**. A separate CSSI application for these works would be lodged by TransGrid at a later stage.

Table 2 | Proposed Transmission Connections

Aspect	Description
Substation	A new 330/500 kilovolt (kV) substation to the west of Talbingo Reservoir, to connect to the existing transmission network at Nurenmerenmong
Transmission lines	• Two new 330 kV double-circuit transmission lines and easements from the Snowy 2.0 cable yard in KNP, to the new substation • One new transmission line between the new substation and the existing 330 kV line 64
Ancillary infrastructure	• Brake and winch sites, crane pads, helicopter landing pad, site compounds and equipment laydown areas

Broader Transmission Network Upgrades

As the NEM transitions to more dispersed renewable energy generation, additional upgrades of the transmission network will be required. The 2018 Integrated System Plan and Draft 2020 Integrated System Plan prepared by the Australian Energy Market Operator (AEMO) identified the priority transmission network upgrades needed to prepare for the closure of coal-fired power stations, support renewables and lower costs. These projects include:

- Project EnergyConnect (or River Link) – a major interconnection upgrade between NSW and South Australia;
- Hume Link - new transmission connections between substations at Bannaby, Maragle and Wagga Wagga to reinforce the southern NSW network and increase transfer capacity between Snowy 2.0 and NSW's demand centres;
- Queensland to NSW Interconnector (QNI) and Victoria to NSW Interconnector (VNI) upgrades to increase transfer capacity; and
- VNI West – a new interconnector between Victoria and NSW.

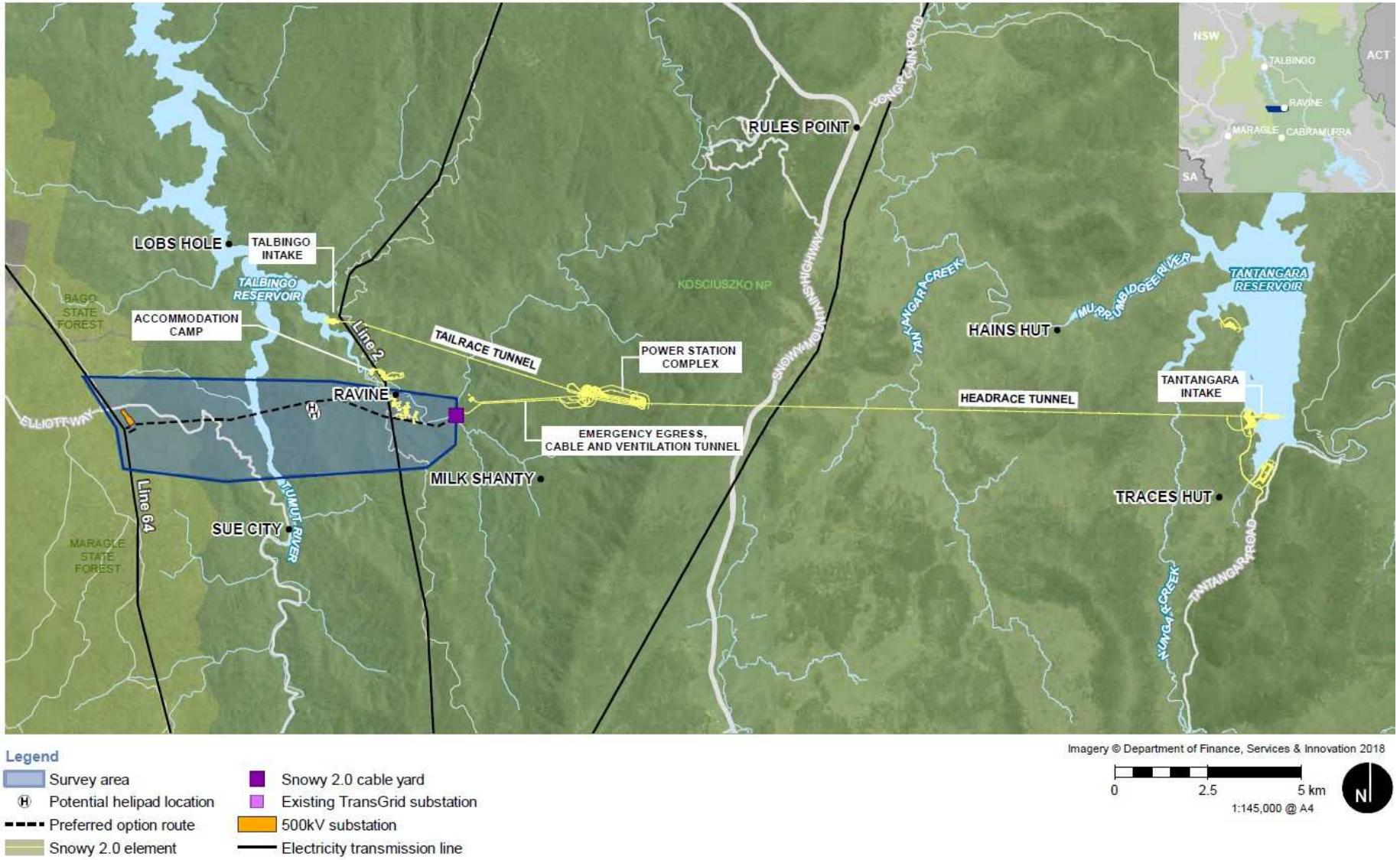


Figure 5 | Location of Proposed Transmission Connections

2. Project

2.1. Summary

The Snowy 2.0 Main Works (the project) involves:

- connecting the existing Talbingo and Tantangara reservoirs with a network of tunnels covering nearly 30 kilometres;
- developing a new underground power station to generate 2,000 MW of electricity and provide up to 350 GWh of energy storage for the NEM by transferring water through the tunnels between the two reservoirs; and
- developing ancillary infrastructure including a substation, cable yard and permanent access roads.

Figure 6 presents a schematic of the project, with a full description provided in the Preferred Infrastructure Report (PIR) in **Appendix C**.

The major components of the project are summarised in **Table 3**, shown on **Figure 7** to **Figure 14**, with further detail provided in sections 2.2 to 2.8.

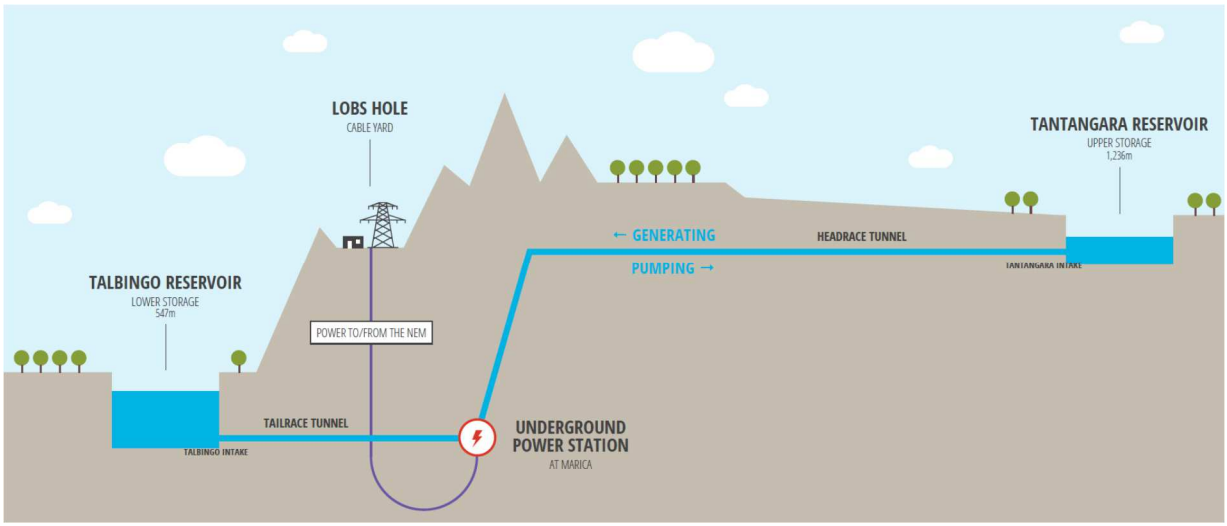


Figure 6 | Project Overview

Table 3 | Key Components of the Project

Aspect	Description
Project Summary	**Construct and operate a new underground power station and power waterway tunnels connecting the existing Talbingo and Tantangara reservoirs**
Capacity	2,000 megawatt (MW) generating capacity and 350 gigawatt hours (GWH) of energy storage available to the NEM
Disturbance area	• 504 hectares (ha) in addition to the 126 ha approved under exploratory works • rehabilitation and revegetation of construction compounds and accommodation camps • final operational footprint of 92 ha
Talbingo Reservoir and Lobs Hole	• tailrace tunnel from Talbingo (lower reservoir) to the power station • water intake structure and surface building • emplacement of excavated spoil at Ravine Bay and Lobs Hole • construction and operation of a hydro-electric power station, 800 metres (m) underground, including reversible turbines, transformers and electrical equipment • main access tunnel (MAT) and emergency access, cabling and ventilation tunnel (ECVT) for the power station
Marica and Plateau	• ventilation shaft for the power station and surge shaft for the headrace tunnel at Marica • buried communications and power supply cable across the Plateau
Tantangara	• headrace tunnel from Tantangara (upper reservoir) to the power station • water intake structure and surface building • fish control structures at Tantangara Reservoir and on Tantangara Creek • emplacement of excavated spoil at Tantangara
Rock Forest	• construction logistics and laydown site • emplacement area for excavated spoil
Ancillary infrastructure	• construction compounds at Talbingo Reservoir, Tantangara Reservoir, Lobs Hole, Marica and Rock Forest • barge launch ramps at Talbingo and Tantangara reservoirs • temporary utilities including water supply, wastewater treatment, communications and power supply • accommodation camps at Lobs Hole, Marica and Tantangara for up to 2,000 workers
Traffic	• temporary access roads and temporary road closures • construction of new accesses to operational areas at Talbingo and Tantangara • widening, sealing and extension of existing roads within KNP including Lobs Hole Ravine Road, Marica Trail, Link Road and Tantangara Road • upgrade of three existing intersections on Snowy Mountains Highway and Link Road
Capital Investment Value	$4.6 billion
Jobs	• Construction – 2,000 workers during peak construction period • Operation – 8 - 16 workers
Duration and hours of work	• Construction– 6 years (estimated 2020 – 2026), 24 hours / 7 days • Rehabilitation – 6 – 18 months • Operation – on-going, 24 hours / 7 days

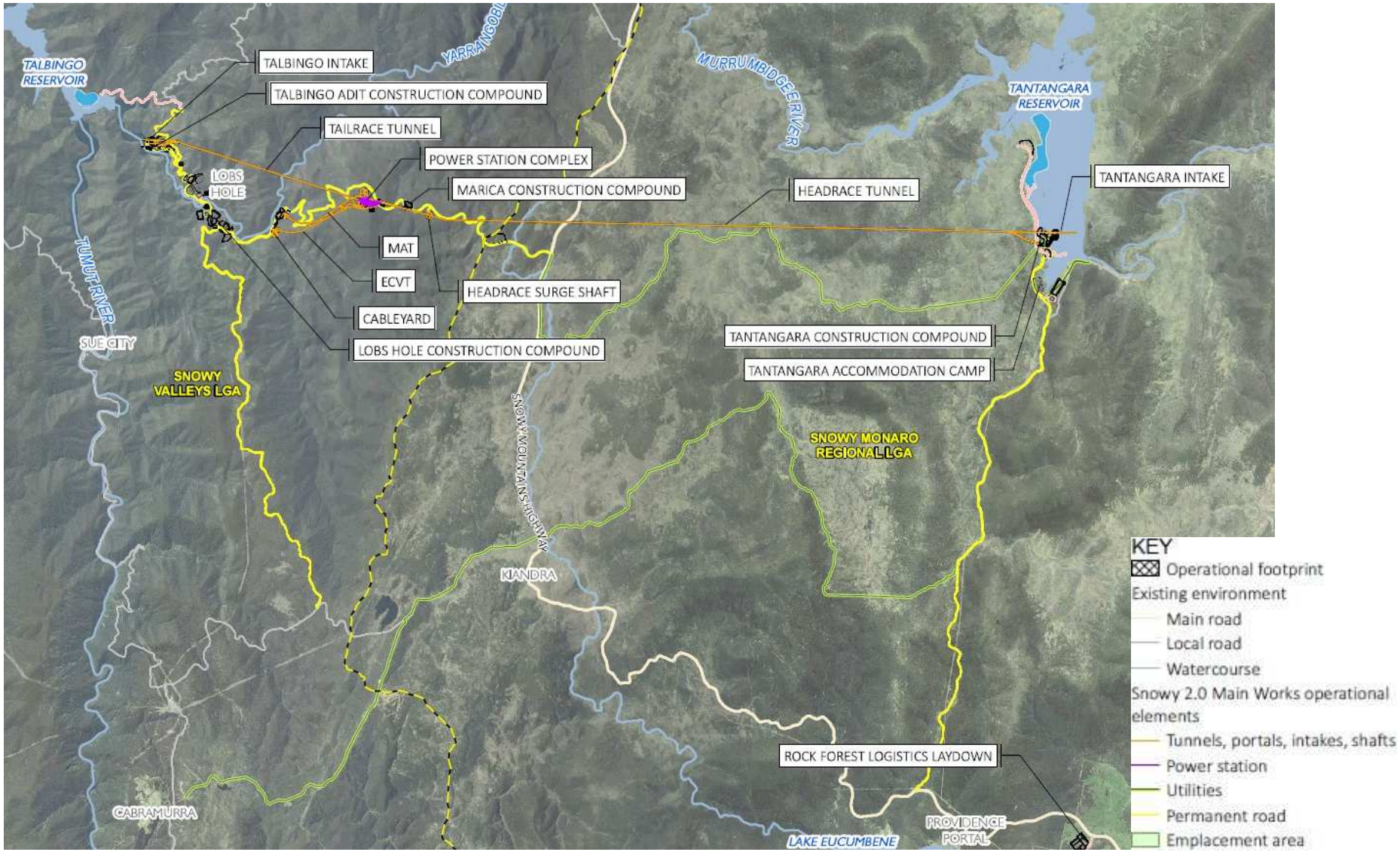


Figure 7 | Location of Snowy 2.0 Main Works Components

2.2. Talbingo Reservoir and Lobs Hole

Talbingo Reservoir would receive water in power generating mode and pump water back during storage mode. The reservoir would have a submerged water intake, tailrace tunnel connecting to the power station, gate structures and control building. Construction works at Talbingo Reservoir would include a construction compound, barge launch ramp and portal for the TBM. The tailrace tunnel would be constructed using a TBM and drill and blasting would be used for the water intake and gate structures. Removal of the rock plug (between the reservoir and intake) would be undertaken using water-based equipment, underwater blasting and dredging. Excavated materials would be transported by road to the Ravine Bay emplacement area around Talbingo Reservoir. This area would be shaped and rehabilitated to achieve natural free-draining landforms.

Figure 8 shows the location of works at Talbingo Reservoir and the associated disturbance footprint.

Lobs Hole would be the main construction work site for the project. Works commenced under the Exploratory Works approval would continue, with the exploratory works tunnel forming the Main Access Tunnel (MAT) to the power station. Other permanent infrastructure would include the main portal building for operational access to the power station, an emergency egress, cable and ventilation tunnel (ECVT) for high voltage cables from the power station, and a cable yard at ground level to connect to the NEM. A substation, approved under exploratory works, would provide power supply during construction and operation.

The Lobs Hole site would include a large construction compound with excavated rock stockpiles and an accommodation camp for 1,250 workers. Excavated material would be placed at the construction compound and GF01 emplacement areas and rehabilitated, enabling future recreational use at Lobs Hole.

Figure 9 shows the location of works at Lobs Hole and the associated disturbance footprint.

2.3. Marica and Plateau

The power station complex would be located at Marica (see **Figure 10**). Works include construction of the power station, ventilation shaft and surface building, a headrace surge shaft and a series of pressure tunnels, draft tubes and collector tunnels. The Marica site would include an accommodation camp for 100 workers, a construction yard, utilities and wastewater treatment facilities. Excavated material would be transported to Rock Forest for emplacement. On completion, the site would be rehabilitated, with the Marica Trail retained for permanent access by Snowy Hydro.

At the Plateau, the majority of works would be underground (see **Figure 11**) including construction of the headrace tunnel using a TBM and communications cable, primarily within road reserves, connecting Tantangara, the power station and the Upper Tumut switchyard at Cabramurra. A fish barrier would be constructed on Tantangara Creek and sections of the Snowy Mountains Highway would have minor upgrades to allow for OSOM vehicle deliveries.

2.4. Tantangara

Tantangara Reservoir would have similar components to Talbingo (see **Figure 12**). Permanent infrastructure would include tailrace tunnel, a submerged water intake and floating boom, gate structures and a control building. Construction works would include a construction compound, laydown area, barge launch ramp and a portal for a TBM. The site would include an accommodation camp for 500 workers. Excavated material from the headrace tunnel would be placed at the Peninsula emplacement area, which would be rehabilitated to achieve a natural free-draining landform. A fish control structure would be built upstream of the reservoir wall to prevent pest fish movement through the Murrumbidgee-Eucumbene tunnel. Tantangara Road would be upgraded, including intersection works at the Snowy Mountains Highway and a bridge over Nungar Creek.

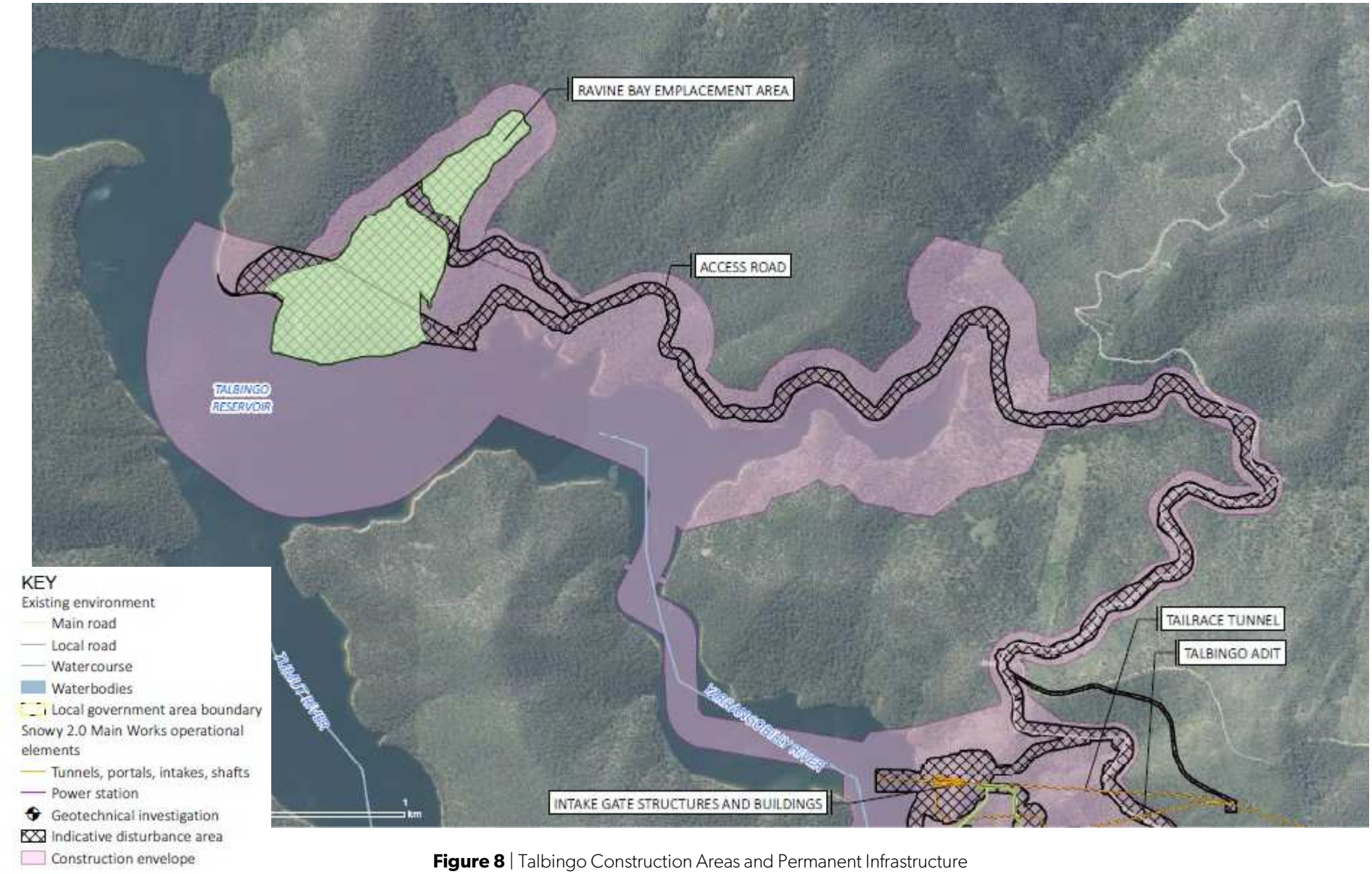


Figure 8 | Talbingo Construction Areas and Permanent Infrastructure

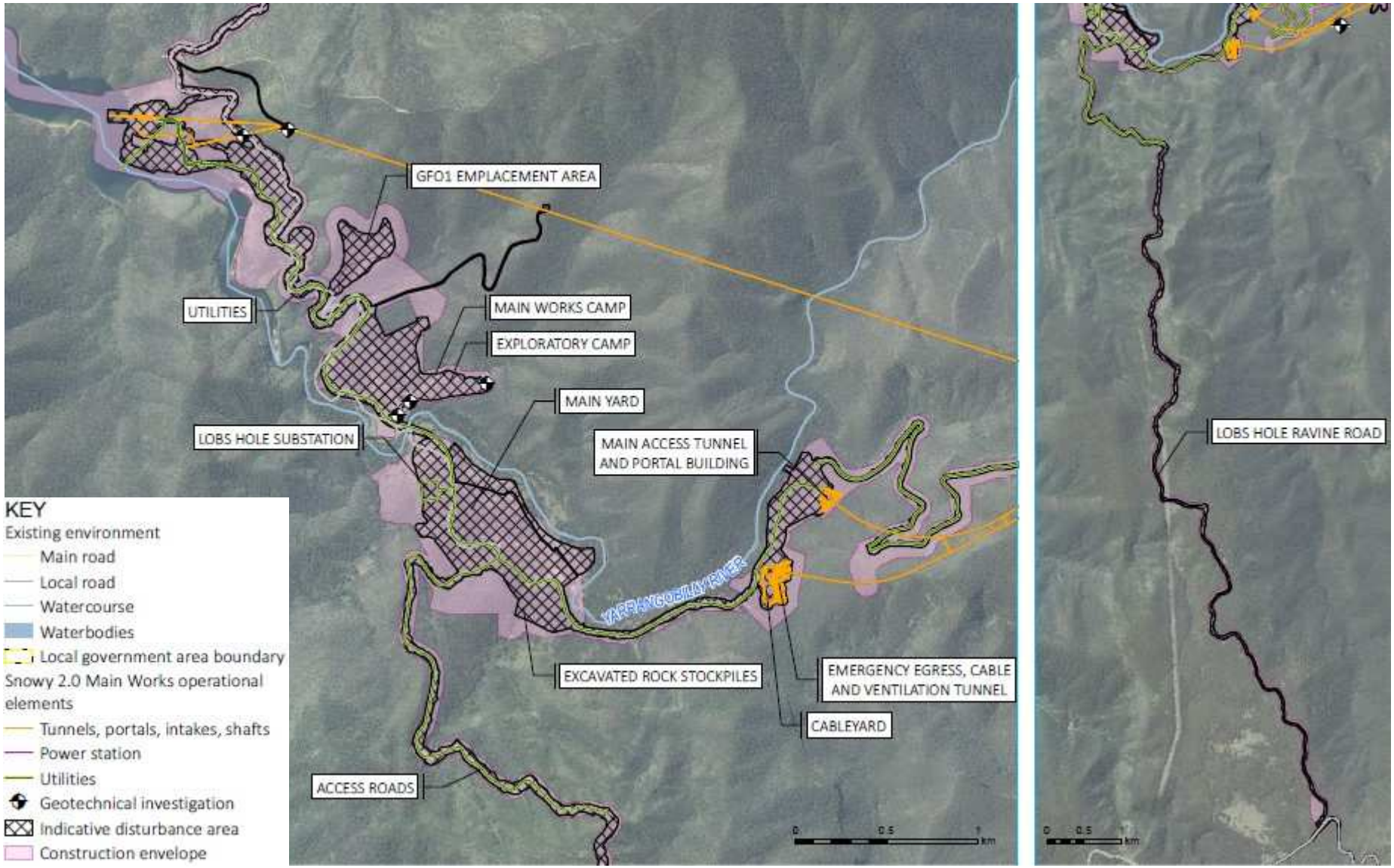


Figure 9 | Lobs Hole Construction Areas and Permanent Infrastructure

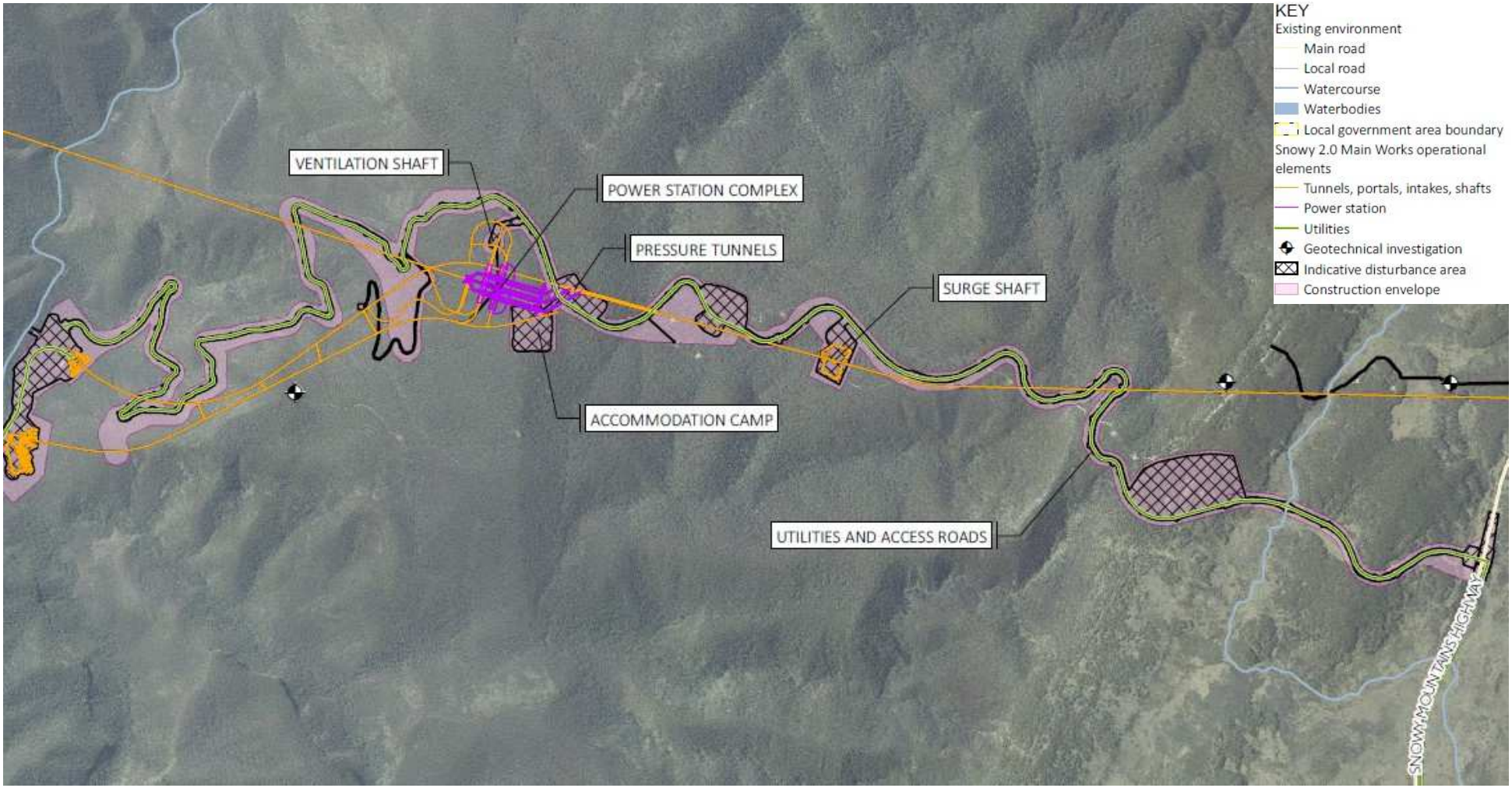


Figure 10 | Marica Construction Areas and Permanent Infrastructure

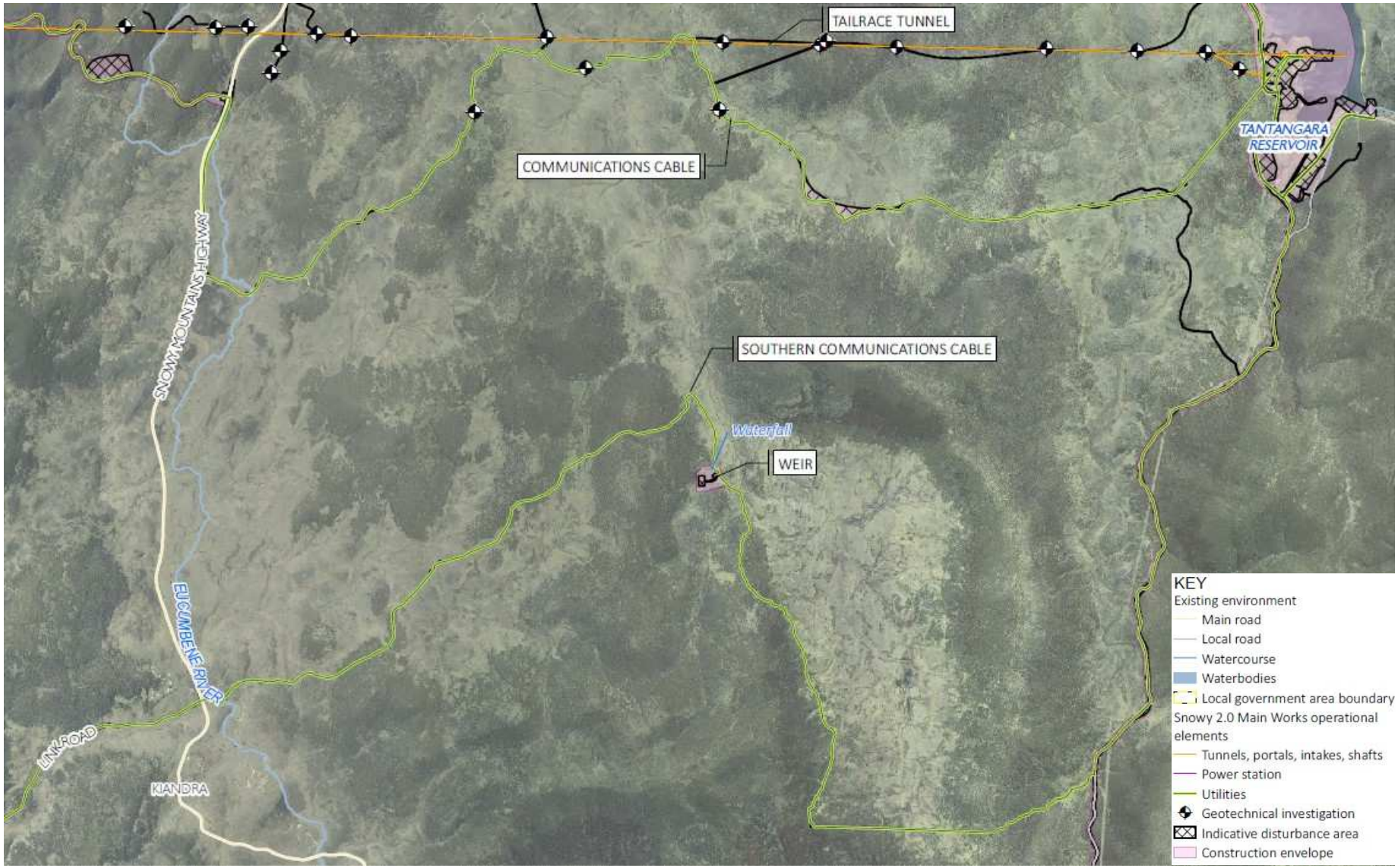


Figure 11 | Plateau Construction Areas and Permanent Infrastructure

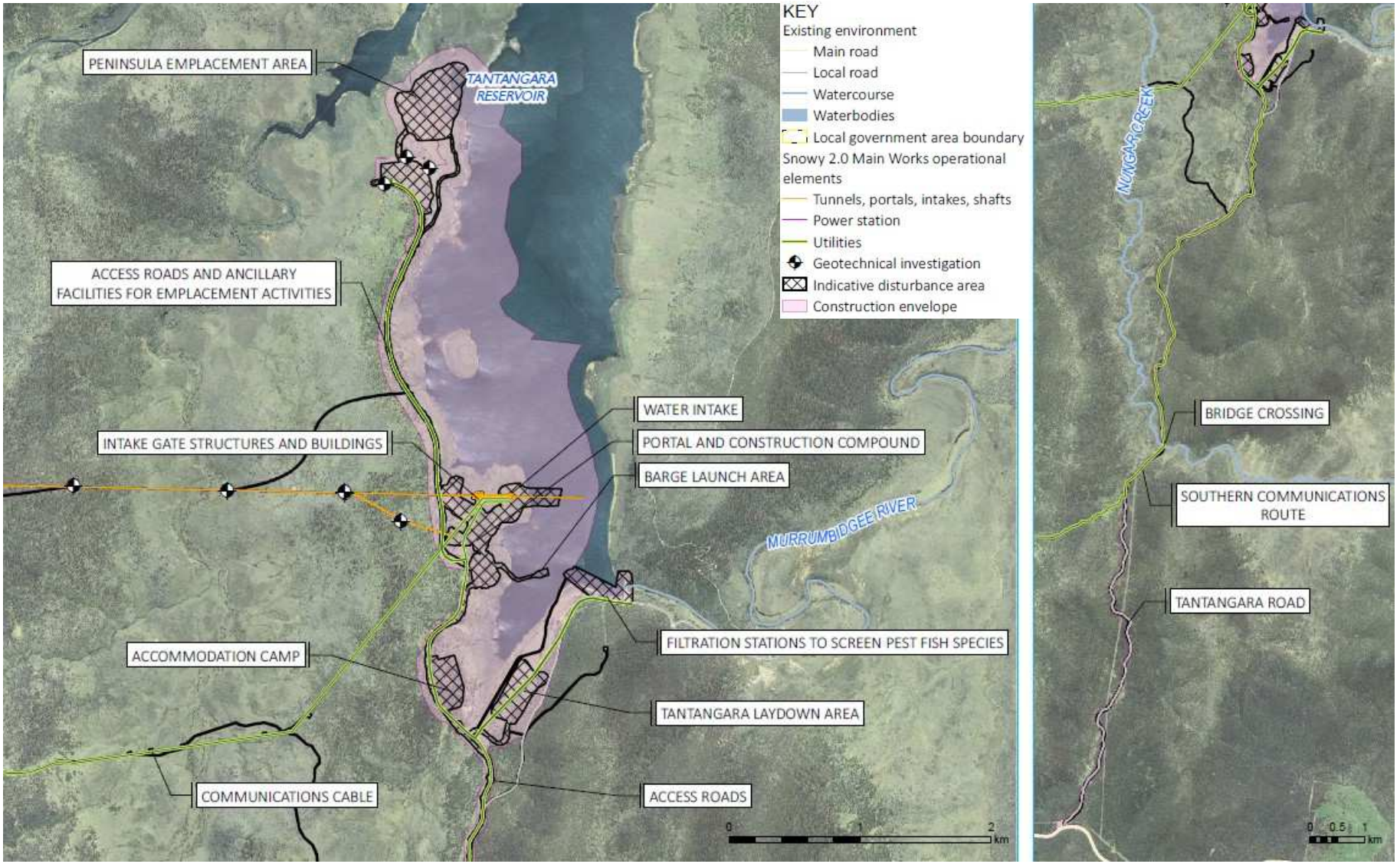


Figure 12 | Tantangara Construction Areas and Permanent Infrastructure

2.5. Rock Forest

A site at Rock Forest, located outside the entrance to KNP would be used as a logistics and laydown yard (see **Figure 13**). Heavy vehicles would transport materials including concrete segments for the tunnels to Rock Forest. When road and weather conditions are unfavourable, materials would be temporarily stored at Rock Forest for later transport to construction sites within the park. The Rock Forest site would also be used for permanent placement of excavated material from the Marica construction site.

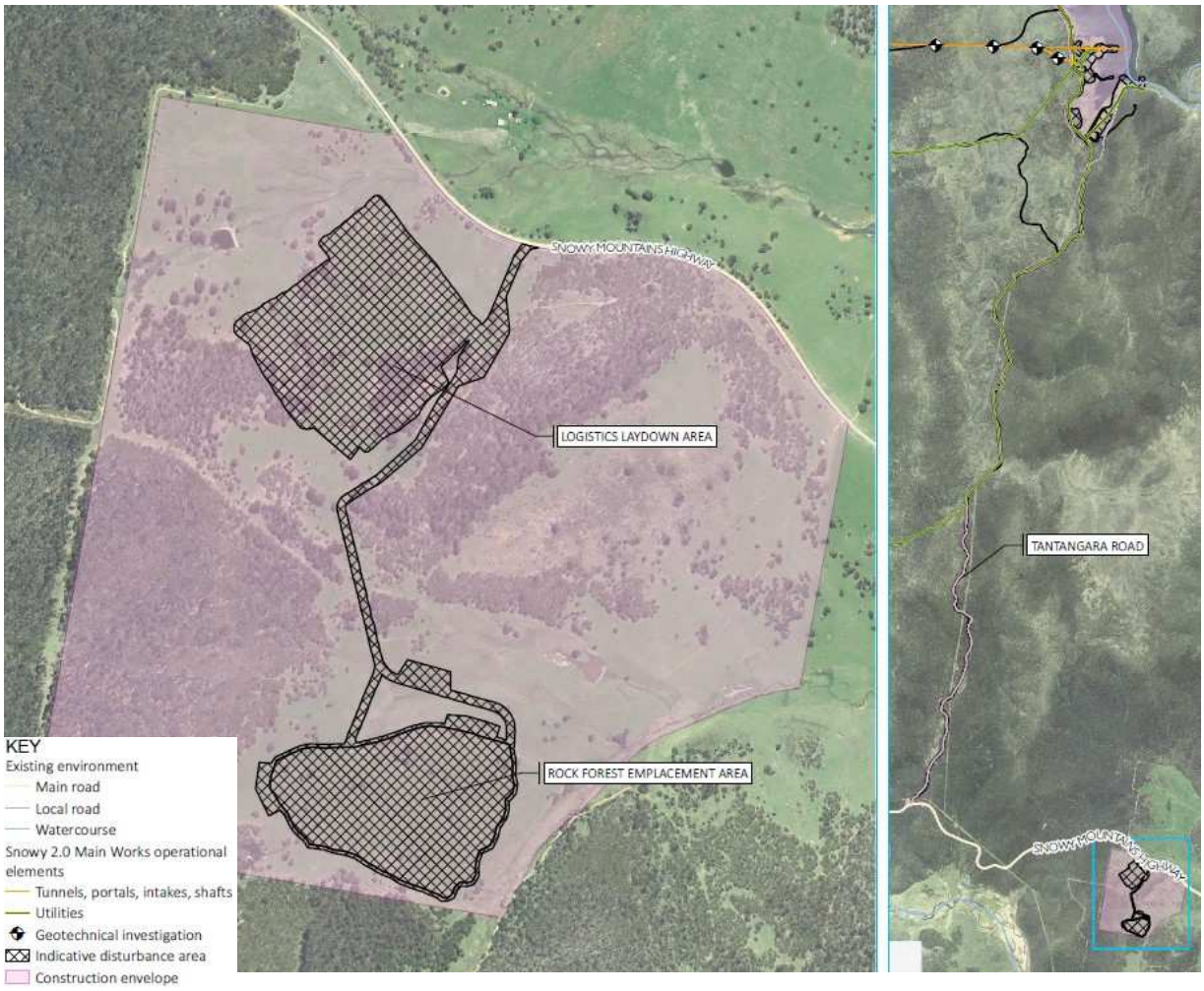


Figure 13 | Rock Forest Laydown and Emplacement Areas

2.6. Ancillary Infrastructure

Other infrastructure required to support construction and operation of the project includes, temporary and permanent access roads, utilities and communications cables, power and water supply and wastewater infrastructure. Works to connect Snowy 2.0 to the NEM are described in section 1.3. These works include a substation and transmission lines, to be completed by TransGrid at a later stage.

2.7. Traffic

The transport routes for the project are shown on **Figure 14**. Construction staff, materials and equipment would be transported from Cooma using the Monaro and Snowy Mountains Highways. The key transport routes within KNP include Link Road, Tantangara Road, Lobs Hole Ravine Road and the Marica Trail.

Several roads and intersections would be upgraded to accommodate the construction traffic. The key works include:

- widening Link Road (commenced as part of exploratory works);
- providing turning areas on Lobs Hole Ravine Road;
- upgrading Tantangara Road including a bridge over Nungar Creek;
- upgrading the Marica Trail and extending it to the west to connect to Lobs Hole;
- upgrading intersections on the Snowy Mountains Highway at Link Road, Tantangara Road, Marica Trail, Rock Forest and two in Cooma (Vale Street and Bombala Street); and
- upgrading the intersection of Link Road and Lobs Hole Ravine Road.

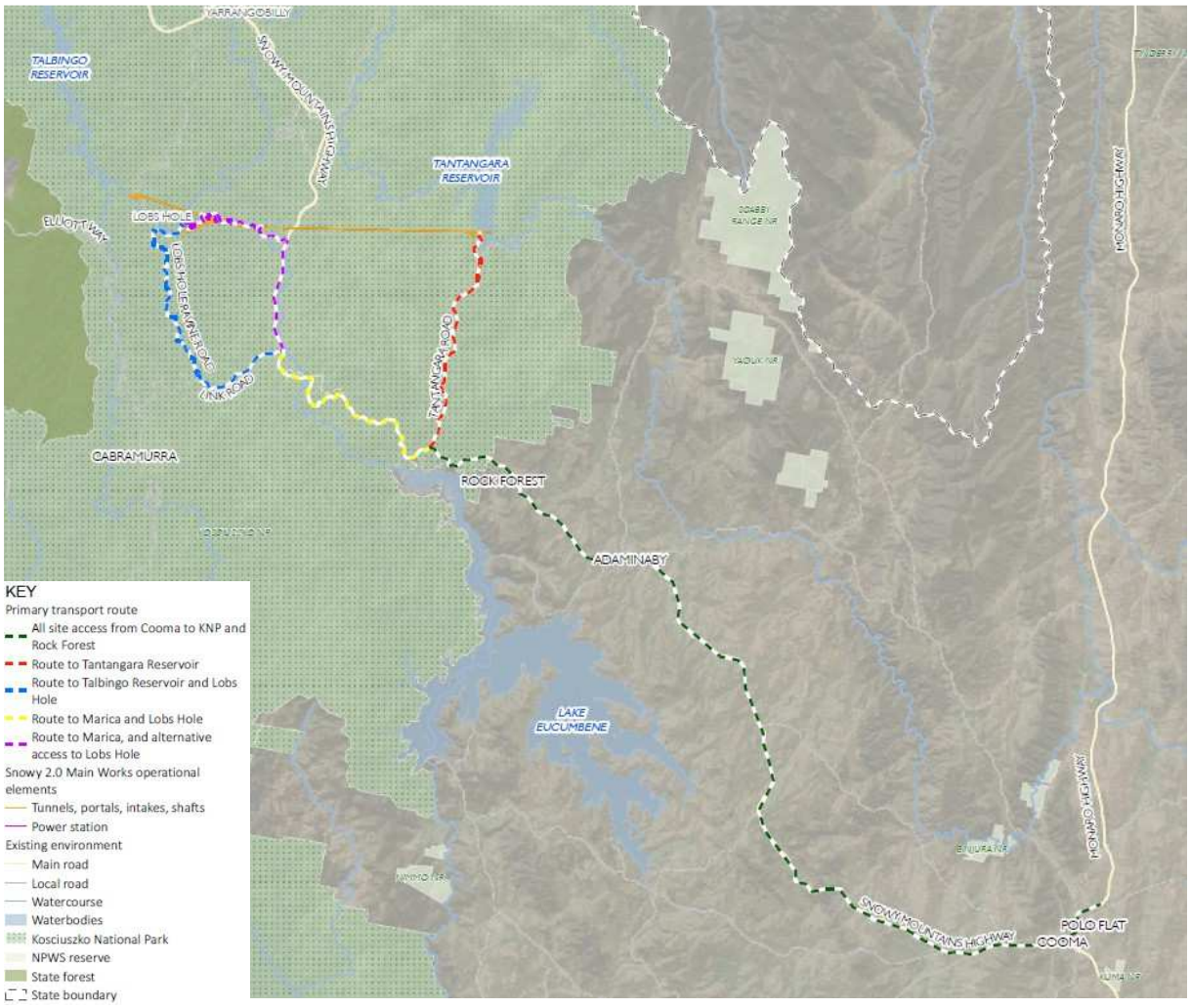


Figure 14 | Transport Routes for the Project

2.8. Timing

Construction of the project would take six years. The key phases of work and indicative timing are shown on **Figure 15**.

Exploratory Works commenced in early 2019 and are on-going.

Pre-construction activities for the Main Works, including clearing, heritage salvage, establishing construction areas and installing environmental controls would take around 9 months. Upgrades to road accesses and intersections would be carried out concurrently.

The primary construction activities including excavations, tunnelling and intake and gate construction would take five years, commencing mid-2020 and completing in mid-2025. Progressive rehabilitation would be undertaken throughout construction as temporary works are completed and decommissioned. Final fit-out, testing and commissioning of the power station and tunnels would be carried out over 18 months. Operation is scheduled to commence by late 2026. Operations would be on-going, with Snowy Hydro required to decommission and rehabilitate the permanent infrastructure at the end of its operational life.

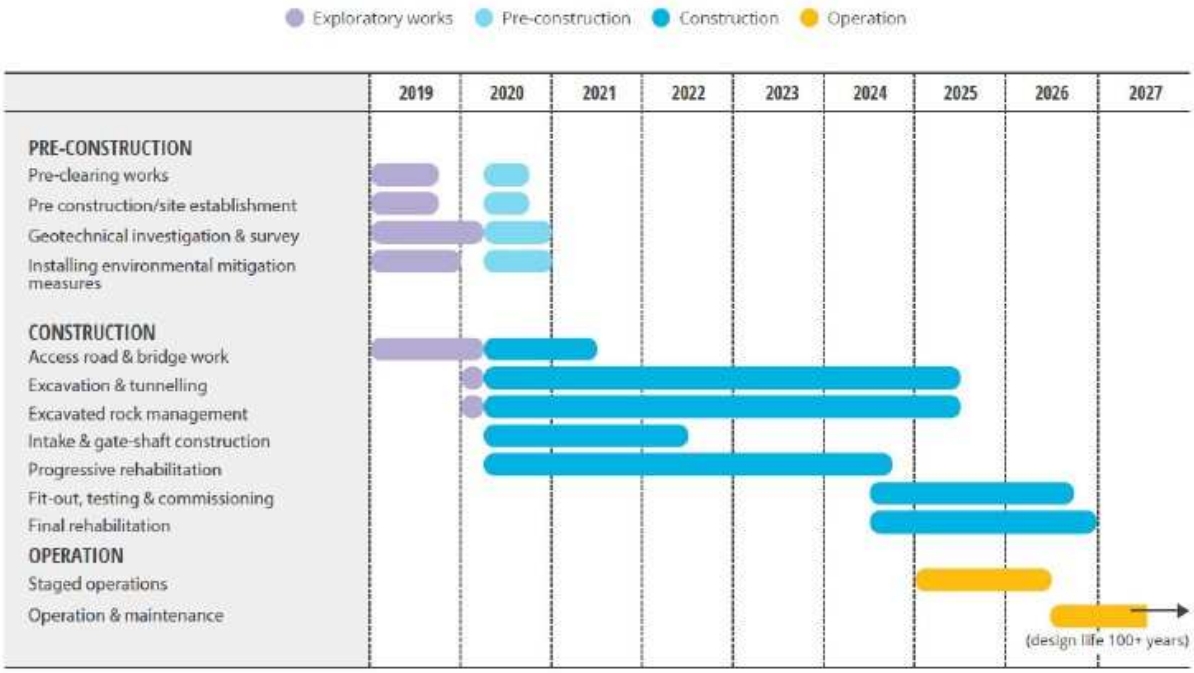


Figure 15 | Estimated Construction Sequence

3. Strategic Context

3.1. Energy Security

The NSW energy system and broader NEM is entering a complex and accelerating transition period with 15,000 MW or 63% of Australia's traditional coal-fired generators set to retire by 2040 with no plans for the development of new coal-fired generators in NSW. To ensure an orderly transition from the traditional reliance of the grid on coal-fired generators, there must be sufficient generation in place before each major generator exits the grid.

These challenges have been recognised in the 2017 *Independent Review into the Future Security of the National Electricity Market* (the Finkel Review), which identified large scale pumped hydro as an important generation technology and the need for better system planning to ensure energy security is preserved, and costs managed as the generation mix evolves.

In response to recommendations in the Finkel Review, the Australian Energy Market Operator (AEMO) released its first Integrated System Plan (ISP) in 2018. The ISP is a whole-of-system plan providing an integrated roadmap for the development of the NEM over the next 20 years and beyond. It is updated every two years to respond to the latest technology, economic, policy and system developments. AEMO also released its report on *Building Power System Resilience with Pumped Hydro Energy Storage* in 2019 to support action to increase the future resilience of the power system in the NEM in advance of the 2020 ISP.

The Draft 2020 ISP predicts the NEM will become a diverse portfolio dominated by consumer-led distributed energy resources (DER) such as rooftop solar and batteries, and variable renewable energy generation like wind and solar farms. It estimates there is a need for up to 21,000 MW of dispatchable energy consisting of pumped hydro or battery storage, distributed batteries and demand side participation by 2040 to ensure the power system can reliably meet demand at all times.

As of 26 February 2020, there is currently one large scale energy storage project with a nameplate capacity of 25 MW in commissioning and another 43 MW of energy storage capacity projects committed and listed in AEMOs Generation Information database.

Snowy 2.0 would add up to 2,000 MW of pumped hydro capacity and up to a week's worth of energy storage potential. The development of Snowy 2.0 therefore has the potential to:

- improve security and reliability by dispatching electricity in peak periods or at times when generation from VREs is low; and
- diversify the electricity supply and contribute significantly to NSW's transition to renewable energy and facilitating reduced reliance on other forms of non-renewable electricity generation.

3.2. Kosciuszko National Park

KNP covers 690,000 hectares in the alpine region of southern NSW. The park contains Australia's ski resorts and is used recreationally for fishing, mountain biking, skiing, horse riding and camping. The park also contains numerous reservoirs and infrastructure associated with the existing Snowy Mountains hydro-electric scheme.

The project would be located within the northern section of the park, between Cooma and Tumut. The project has an overall footprint of 630 ha and would be centred around four discrete areas in the park. There are two

distinct geographic zones in this area of the park, including the ravine area in the west, and the plateau area in the east.

The majority of construction works in the western area would be focused around the southern end of Talbingo reservoir, Lobs Hole Ravine and Marica. In the east, works would be centred around the southern end of Tantangara reservoir. Works across the Plateau would be primarily underground, including the headrace tunnel and buried utility and communications cables. One construction area would be located outside the park at Rock Forest, adjacent to the Snowy Mountains Highway near the village of Providence Portal.

The key areas for permanent infrastructure for the Main Works project include buildings and portals at the southern end of Talbingo and Tantangara reservoirs, the power station access and substation at Lobs Hole and the ventilation and surge shafts at Marica.

Talbingo and Tantangara reservoirs form part of the original Snowy Scheme and are popular areas for water-based recreation, camping and horse-trail riding. The Yarrangobilly River is a permanent watercourse in this area, feeding into Talbingo reservoir.

The Lobs Hole area is relatively isolated and was used for camping, prior to the commencement of the exploratory works. Historically the area was used for mining and grazing and there are remnants of the old township associated with the former mining era.

The Marica and Plateau areas are less accessible with gravel trails and four-wheel drive tracks.

Key watercourses in the project area include the Yarrangobilly and Eucumbene rivers, the headwaters of the Murrumbidgee river and smaller tributaries including Nungar, Gooandra and Tantangara creeks. Yarrangobilly Caves, a popular tourist location and a groundwater dependent ecosystem, are located to the north of the proposed construction areas.

3.3. Key Infrastructure

The nearest population centres to the project area are Cooma, 50 km to the south-east and Tumut, 35 km to the north-west. The small villages of Adaminaby, Cabramurra and Talbingo are closest to the project area, with Cabramurra established as a 'Snowy' town for the original scheme and still owned by Snowy Hydro.

This area of the park is accessed via the Snowy Mountains Highway, which runs through Cooma, Adaminaby, Talbingo and Tumut. The highway would be the primary access route for the project delivering construction materials and workers to the site, with the majority of movements generated from the south through Cooma. Smaller roads within this section of the park, include Link Road, Lobs Hole Ravine Road, Tantangara Road and the Marica Trail. These roads carry low volumes of traffic and some are single lane gravel roads. Most roads are winding and experience snow and ice during the winter months.

3.4. Transmission Connection and Augmentation

Snowy 2.0 also requires a direct connection to the NSW transmission system to enable the additional 2,000 MW of energy to be transferred to and from the project. The current transmission network that connects the existing Snowy Scheme was not established to accommodate the additional capacity of Snowy 2.0 and therefore augmentation is required. New electricity transmission lines and a substation would be constructed by TransGrid, and a CSSI application for these works would be lodged at a later date.

More broadly, the augmentation of the grid to provide capacity, balance resources and unlock Renewable Energy Zones is required. The 2018 ISP identified the priority transmission network upgrades needed to prepare for the closure of coal-fired power stations, support renewables and lower costs.

4. Statutory Context

4.1. Approval under EP&A Act

4.1.1. Critical State Significant Infrastructure

The project is classified as Critical State Significant Infrastructure (CSSI) under Section 5.13 of the EP&A Act because it forms part of the Snowy 2.0 and Transmission Project, which is listed as CSSI under Clause 9 of Schedule 5 of *State Environmental Planning Policy (State and Regional Development) 2011*.

Consequently, it requires the approval of the Minister for Planning and Public Spaces before it may proceed.

4.1.2. Permissibility

The project is permissible without development consent under Clause 16 of the State and Regional Development SEPP.

4.1.3. Administrative and Procedural Requirements

Under the EP&A Act and Regulation, there are several administrative and procedural requirements that must be met before the Minister may determine the application.

These requirements include:

- Snowy Hydro applying to the Minister for approval;
- Snowy Hydro preparing an Environmental Impact Statement (EIS) for the project in accordance with the Secretary's environmental assessment requirements and the general requirements for the form and content of an EIS in the Schedule 2 of the EP&A Act Regulation, including the obligation to include an analysis of any feasible alternatives to the carrying out of the project and cumulative impacts of the components of the project;
- exhibiting the EIS for at least 28 days;
- requiring Snowy Hydro to provide a formal response to the issues raised in submissions; and
- making key documents publicly available on the Department's website, including the EIS, public submissions and Snowy Hydro's response to submissions.

Submissions, particularly from special interest groups (see section 5.2.3), were critical of the analysis of alternatives to the project and whether it met the requirements of the EP&A Act Regulation. The Department notes that while the special interest groups may not agree with the outcomes of Snowy Hydro's evaluation, it considers that the EIS and Preferred Infrastructure Report has provided sufficient analysis of the alternatives to the project including other storage options and other types of generation.

Special interest groups were also critical of the assessment of the impact of all components of Snowy 2.0 (including Exploratory Works and the proposed transmission line connection). The Department has considered the cumulative impacts of the project to include the exploratory works and the proposed transmission line to the extent possible, in particular for the key issues of vegetation clearing (see section 6.4) and spoil disposal (see section 6.3).

Following a detailed review, the Department is satisfied that all these requirements have been met and that the Minister may now determine the application.

4.1.4. Preferred Infrastructure Report

On 10 February 2020, Snowy Hydro was required to prepare a Preferred Infrastructure Report (PIR) for the project under section 5.17(6)(b) of the EP&A Act to respond to the significant concerns raised by agencies about the extensive surface disturbance of the project, the proposed spoil disposal strategy, and the likely water quality impacts of the project on the Talbingo Reservoir.

Snowy Hydro submitted this PIR to the Department in late February.

The PIR included several changes to the project, including:

- reducing the overall disturbance area by 62%, which resulted in significant reductions to the impacts of the project on the KNP;
- making significant changes to the spoil disposal strategy, including:
    - reducing the amount of spoil generated;
    - minimising the volumes of spoil disposal in both the Talbingo Reservoir and Tantangara Reservoir, leading to major reductions in the likely water quality impacts of the project;
    - introducing a new spoil emplacement area on land at the Lobs Hole site;
    - removing the spoil generated at the Marica site from the KNP and disposing of it at the Rock Forest site; and
    - amending the design of all the spoil emplacement areas, using geomorphic design to make the landforms more natural and improve the way they blend into the surrounding landscape;
- reducing the traffic volumes of the project; and
- refining the groundwater model to better reflect the likely groundwater impacts of the project, which resulted in significant reductions to the likely groundwater take of the project, loss of local stream flows above the tunnel and the amount of water that would need to be managed on site.

The PIR also included a revised assessment of the impacts of the project to accommodate these changes.

4.1.5. Application of Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) applies to the project. In particular,

- under Section 7.9 of the BC Act, the EIS for the project must be accompanied by a biodiversity development assessment report (BDAR); and
- under Section 7.14, the Minister must consider the likely impact of the project on biodiversity values as assessed under the BDAR.

The EIS for the project included a BDAR, which was prepared in accordance with the Biodiversity Assessment Methodology (see Appendix M of the EIS, which is included in Appendix A). This BDAR was updated in the PIR to accommodate the changes made to the EIS following exhibition, which significantly reduced the biodiversity impacts of the project (see Appendix G of the PIR, which is included in Appendix C).

The Department has considered the findings of the updated BDAR as well as the independent expert advice from Alex Cockerill of WSP (see Appendix F) in its assessment (see section 6.4). This assessment concluded that the project is unlikely to have significant impacts on any biodiversity values of the area provided the site is rehabilitated to a high standard, including detailed ecological rehabilitation to restore native vegetation and threatened species habitat, and up to $73.8 million is paid to the NPWS to offset the residual biodiversity impacts of the project. The NPWS will use these funds to carry out a range of works to enhance the biodiversity values of the Kosciuszko National Park, including specific conservation actions for certain threatened species and endangered ecological communities.

4.1.6. Exempt Approvals

Under Section 5.23 of the EP&A Act, the following approvals are not required for CSSI projects:

- permits under Sections 201 and 219 of the *Fisheries Management Act 1994;*
- various heritage approvals under the *National Parks and Wildlife Act 1974* and *Heritage Act 1977;*
- a bushfire safety authority under Section 100B of the *Rural Fires Act 1997;* and
- various water-related approvals under Sections 89-91 of the *Water Management Act 2000.*

However, the assessment of these matters has been integrated with the assessment of all other matters under the EP&A Act.

The Department has considered all the relevant matters associated with these authorisations in its detailed assessment, consulted with the agencies responsible for administering these authorisations, and included conditions in the recommended conditions of approval (see **Appendix G**) to ensure Snowy Hydro minimises the fish, heritage, bushfire and water impacts of the project.

4.1.7. Environmental Planning Instruments

Although environmental planning instruments do not apply to CSSI projects under Section 5.22 of the EP&A Act, the Department has assessed the project against the provisions of several instruments and concluded that:

- the section of communications infrastructure along Kings Cross Road corridor traversing the Selwyn Snow Resort would not significantly alter the natural environment or character of this alpine resort covered by *SEPP (Kosciuszko National Park – Alpine Resorts) 2007*;
- the project is not potentially hazardous or offensive development under *SEPP 33 – Hazardous and Offensive Development*;
- the site does not contain any core koala habitat under *SEPP (Koala Habitat Protection) 2019*; and
- the land is suitable for the project under *SEPP 55 – Remediation of Land*.

4.1.8. Matters for Consideration

When deciding whether or not to approve the carrying out of the project under Section 5.19 of the EP&A Act, the Minister is required to consider the reports, advice and recommendations contained in this report, which includes the:

- EIS and PIR for the project;
- public submissions and Snowy Hydro's response to the issues raised in these submissions;
- advice provided by public authorities on the project;
- expert advice obtained by the Department;
- Department's whole-of-government assessment of the merits of the project; and
- recommended conditions of approval for the project.

4.2. Other NSW Approvals

4.2.1. National Parks and Wildlife Act 1974

Following its corporatisation in 2002, Snowy Hydro was granted a lease under the *National Parks and Wildlife Act 1977* (NP&W Act) for the existing hydro-electric scheme within the KNP. This lease expires on 31 May 2077 and can only be extended by an Act.

Given most of the Snowy 2.0 Project would be located in the KNP, and that the project would be integrated into the existing hydro-electric scheme, Snowy Hydro will need to obtain further leases/licences for the construction and operation of the project under the NP&W Act before it may proceed.

Under Clause 37A of the *Snowy Hydro Corporatisation Act 1997* (SHC Act), the Minister for Energy and Environment may grant these leases/licences for the project - regardless of any other provisions of the NP&W Act

(including the objects and management principles of the Act) that may prevent the grant of these leases/licences - provided the project receives planning approval under the CSSI provisions of the EP&A Act. However, any leases/licences granted for the project will also expire on 31 May 2077.

On 18 December 2018, Snowy Hydro entered into an agreement for lease with the Minister for Energy and Environment for the granting of the relevant leases/licences for the project under the NP&W Act, including a lease and worker access licences for the construction of the project and an operational lease following the practical completion of construction.

In February 2019, the Minister for Planning and Public Spaces approved the Snowy 2.0 Exploratory Works under the EP&A Act. Shortly thereafter, Snowy Hydro was granted the relevant leases/licences for the exploratory works under the NP&W Act and is now carrying these works out in accordance with the conditions of the planning approval and these leases/licences.

The Department has worked closely with the NPWS during the assessment of the Snowy 2.0 Main Works and required Snowy Hydro to make several changes to the project (see **section 5.3**).

With these changes, the Department is satisfied that the impacts of the project on the KNP can be reduced to an acceptable level and has worked with NPWS to develop the recommended conditions to implement of a range of measures to mitigate and/or offset the residual impacts of the development.

NPWS has also advised that Snowy Hydro will be required to update its existing Snowy Management Plan, which forms part of the Plan of Management for the KNP, to incorporate the project.

4.2.2. Biosecurity Act 2015

The project, if approved, will link two catchments by an underground tunnel used to convey water between the Talbingo and Tantangara Reservoirs.

During operations, there is a risk that this link will result in the movement of pest fish (Redfin Perch, Eastern Gambusia, Climbing Galaxias, etc.) and diseases (Epizootic Haematopoietic Necrosis Virus – EHNV) from the Talbingo Reservoir to the Tantangara Reservoir and the waters connected to the reservoir, including the mid-Murrumbidgee River and Lake Eucumbene.

If this occurs, the project could result in significant impacts on certain threatened species in these waters, such as the Macquarie Perch and Stocky Galaxias, as well as the recreational fishing in Tantangara Reservoir and Lake Eucumbene.

Under the *Biosecurity Act 2015,* Snowy Hydro is required to comply with:

- the general biosecurity duty in Section 22 of the Act, which requires Snowy Hydro to prevent, eliminate or minimise the biodiversity risks of the project so far as is reasonably practicable; and
- the mandatory measures in Section 24 of the Act and Clause 18 of the *Biosecurity Regulation 2017*, which prohibit Snowy Hydro from engaging in any dealings that would result in the movement or release of specified aquatic pests or diseases, such as the Redfin Perch and EHNV.

Failure to comply with these requirements is an offence under the Act unless the relevant authorisations are obtained under the Act. Under the legislation, these authorisations can be granted by issuing a permit under Part 21 of the Act, exempting a person from the operation of all or part of the Act under Section 402 of the Act, making an order to permit certain activities under Section 404A of the Act or making a regulation.

Based on its detailed assessment in the EIS, Snowy Hydro has concluded that the project is almost certain to involve the movement of pest fish between the two reservoirs, and that it would need to obtain the relevant authorisations under the Act before it would be able to start commissioning or operating the project.

On 2 October 2019, Snowy Hydro wrote to the NSW Department of Primary Industries (NSW DPI) seeking an exemption for the project from both the general duty and mandatory measures under Section 402 of the Act.

Although the assessment of this request is not formally integrated into the CSSI assessment under the EP&A Act, NSW DPI's decision on whether to grant an authorisation for the project under the biosecurity legislation is a determinative issue for the project. To put it simply: without some form of authorisation, the project cannot proceed.

Consequently, the Department has work closely with NSW DPI to assess the biosecurity risks and impacts of the project.

Following this assessment, NSW DPI has advised that it would be willing to provide the necessary authorisations for the project subject to strict conditions, including requiring Snowy Hydro to:

- install fish screens at Tantangara and a fish barrier on Tantangara Creek;
- prepare detailed biosecurity, threatened fish and recreational fishing management plans for the project;
- carry out captive breeding programs to establish self-sustaining, "insurance" populations of Macquarie Perch and Stocky Galaxias; and
- restock both Tantangara Reservoir and Lake Eucumbene with salmonid fish.

The Department has incorporated these conditions into the recommended conditions of approval for the project.

4.2.3. Environment Protection Licence

Snowy Hydro requires an environment protection licence for the project from the Environment Protection Authority (EPA) under the *Protection of the Environment Operations Act 1997*.

Under Section 5.23 of the EP&A Act, the EPA cannot refuse to grant the EPL if the project is approved under the EP&A Act, and the terms of any EPL must be consistent with the terms of the CSSI approval.

The Department has worked closely with the EPA during the assessment of the Main Works application, and received advice from the EPA that it is willing to grant an EPL for the project subject to conditions requiring Snowy Hydro to minimise the noise, dust, waste and water quality impacts of the project.

The Department has incorporated these conditions into the recommended conditions of approval for the Main Works (see **Appendix G**).

4.2.4. Roads Act 1993

The project requires several upgrades to the public road network, which require consent under Section 138 of the *Roads Act 1993*.

Under Section 5.23 of the EP&A Act, the relevant roads authority cannot refuse to grant consent for these road works if the project is approved, and the terms of the consent must be consistent with the terms of the CSSI approval.

The Department has worked closely with Transport for NSW (TfNSW), the NPWS, Snowy Monaro Regional Council and Snowy Valleys Council to assess the transport impacts of the project, and recommended conditions requiring Snowy Hydro to carry out the road upgrades to the satisfaction of the relevant roads authority and to minimise the transport impacts of the project (see Appendix G).

All the relevant agencies support these conditions.

4.2.5. Water Rights

Snowy Hydro has a special purpose water licence for the existing hydro-electric scheme that was issued under Part 5 of the SHC Act, which expires in 2077. This licence confers a series of rights and obligations on Snowy Hydro, including the:

- right to collect, divert and store all water from the rivers, streams and lakes within the Snowy water catchment and to use that water to generate electricity or for purposes that are incidental or related to the generation of electricity; and
- obligation to release water from storage into Murrumbidgee and Murray Rivers for environmental flows and other uses, including irrigation.

As the Snowy 2.0 Project would be integrated into the existing hydro-electric scheme and use the water contained in the existing storages to generate electricity for the NEM, Snowy Hydro does not need to obtain any additional water licences to be able to operate the Snowy 2.0 Project: it can simply use its existing water licence to do this.

However, Snowy Hydro will need to obtain water licences under both the *Water Management Act 2000* and *Water Act 1912* for the surface water and groundwater take associated with the construction of the project.

The Department has consulted with its Water Group and the Natural Resources Access Regulator about the likelihood of Snowy Hydro being able to obtain these licences and has been advised that Snowy Hydro is unlikely to have any difficulties in securing the necessary licences in the existing water market.

4.3. Commonwealth Approval

On 5 December 2018, the Snowy 2.0 Main Works was declared to be a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This declaration was made because the project:

- could have a significant impact on several Matters of National Environment Significance, including:
  - two National Heritage Places (Sections 15 B and C): the Australian Alps National Parks and Reserves (Place ID 05891) and the existing Snowy Mountains Scheme (ID 5919);
  - listed threatened species and communities (Sections 18 and 18 A); and
  - listed migratory species (Section 28); and
- is a Commonwealth action (Section 28) that could have a significant impact on the environment as Snowy Hydro is considered to be a "Commonwealth agency" for the purposes of the EPBC Act because the Commonwealth Government is the only shareholder of the company.

Consequently, the project requires the approval of the Commonwealth Minister for the Environment in addition to any State approvals before the project may proceed.

The Commonwealth has accredited the NSW assessment process under EP&A Act for the assessment of all Commonwealth matters under the EPBC Act.

Under this accreditation, the Department is required to:

- ensure the relevant procedural requirements in the EPBC Act are met, including the exhibition of the EIS for the project;
- assess the likely impacts of the project on Commonwealth matters in accordance with any relevant agreement, policies or guidelines; and
- prepare an assessment for the Commonwealth Minister including any recommended conditions.

The Commonwealth Minister will then consider the Department's assessment report and any other relevant information before making a final decision on the project under the EPBC Act.

During its assessment of the project, the Department has worked closely with the Department of Water, Agriculture and the Environment (DAWE) to minimise the impacts of the project on the relevant Commonwealth matters, and has concluded that the project is unlikely to have a significant impact on the environment or any of the Commonwealth subject to the imposition of the recommended conditions of approval (see Appendix G).

These conditions include requiring Snowy Hydro to pay the NPWS up to $73,800,000 to carry out conservation actions to offset the residual biodiversity impacts of the project, including the potential impact on several Commonwealth-list threatened species and communities.

The NPWS is proposing to develop a detailed strategy and action plans for the spending of these funds, and will work closely with DAWE to ensure these detailed action plans deliver positive conservation outcomes for all of the relevant Commonwealth-listed threatened species and communities.

5. Engagement

5.1. Department's Engagement

The Department has consulted widely with the community, special interest groups and government agencies during the assessment of the Main Works. This engagement has included:

- making all the information associated with the project publicly available on the Department's website;
- exhibiting the EIS from 26 September to 6 November 2019 (42 days);
- publishing copies of all the submissions received online;
- requiring Snowy Hydro to provide a formal response to the issues raised in submissions;
- holding several public information sessions in the local area including at Cooma, Cabramurra, Talbingo and Tumut;
- meetings with the National Parks Association;
- inspecting the site and surrounding area; and
- working closely with government agencies on the assessment of key issues, including:
  - Commonwealth Department of Energy and Environment;
  - National Parks and Wildlife Service, Environment Protection Authority, Transport for NSW, Heritage NSW and within the Department's Cluster (Biodiversity and Conservation Division, Fisheries, Water Group, Natural Resources Access Regulator, Resources & Geosciences)
  - Local Councils: Snowy Monaro Regional Council and Snowy Valleys Council.

5.2. Analysis of Submissions

5.2.1. Summary

The Department received 222 submissions during exhibition of the EIS, including 10 from government agencies, 30 from special interest groups and 182 from the general public (see **Appendix B** and **Table 4**). The majority of submissions objected (73%) to the project, with 5% supporting and 22% providing comments.

Table 4 | Summary of Submissions

Group	Total	Support	Object	Comment
Public	182	9	146	27
Special interest groups	30	1	17	12
Government agencies	10	1	0	9
Total	**222**	**11**	**163**	**48**
Percentage		5%	73%	22%

Note: the total count includes submissions received on the Snowy 2.0 Segment Factory that related to the Main Works project.

Key issues raised across submissions related to the project's potential impacts on KNP, including biodiversity, water quality, heritage and recreation. Submissions also raised concerns about the economic viability and energy benefits of the project.

Public submissions from the local area represented around 8% of all public submissions and raised concerns about impacts on local businesses, recreation and heritage.

The submissions in support of the project (5%), supported pumped hydro storage to supplement renewable energy generation.

Table 5 summarises the issues raised in agency submissions and **Table 6** summaries the issues raised by special interest groups. Community submissions are discussed in **section 5.2.4**.

Table 5 | Government Agency Submissions

Agency	Key Issues	Position
Environment, Energy & Science, including National Parks and Wildlife Service	Biodiversity, rehabilitation, spoil emplacement, biosecurity, recreation, water quality	Comment
Department of Primary Industries - Fisheries	Impacts on threatened species, habitat loss, water quality, translocation, pests and diseases	Comment
Snowy Monaro Regional Council	Traffic management, protection of trout fishing and maintenance of existing flows	Support
Environment Protection Authority	Spoil emplacement, water quality, aquatic ecology, groundwater, surface water management	Comment
DPIE Water and the NSW Natural Resources Access Regulator	Groundwater extraction and monitoring, water entitlements	Comment
Transport for NSW	Cumulative traffic impacts with Segment Factory and traffic management measures	Comment
Heritage Council of NSW	Recommendations for heritage management	Comment
Division of Resources and Geoscience	No issues	Support
Commissioner for Sustainability and the Environment	Biosecurity, impacts on endangered fish, environmental flows and indigenous cultural water interests	Comment
ACT Conservator of Flora and Fauna	Biosecurity, impacts on endangered fish, maintenance of environmental flows to Murray-Darling basin	Comment

Table 6 | Special Interest Group Submissions

Position	Groups	Key issues
Support (1)	Ampcontrol	Employment growth, enhance viability of other renewable energy projects.
Object (17)	Australian Wildlife Society, Ryde Gladesville Climate Change Action Group, STEP Inc, Australian Association of Bush Regenerators, Tamworth Namoi Branch of National Parks Association of NSW, The Colong Foundation for Wilderness Ltd, The Nature Conservation Society of South Australia, National Parks Association of the ACT, Snowy River Alliance, David G. Stead Memorial Wild Life Research Foundation of Australia, Gippsland Environment Group Inc, National Parks Australia Council, National Parks Association of NSW, Australian Brumby Board Inc, Nature Conservation Council,	Impacts on KNP, including biodiversity, spoil emplacement, cumulative impacts, groundwater, biosecurity, park amenity, climate change, success of rehabilitation, environmental flows. Inadequate consideration of alternatives, economic costs and energy benefits.

Position	Groups	Key issues
	Oatley Flora and Fauna Conservation Society, Inland Rivers Network	
Comment (12)	Friends of Grasslands, Monaro Acclimatisation Society, Cochran Horse Treks, Illawarra Horse Trail Riders, Centre of Applied Water Science University of Canberra, Upper Murrumbidgee Demonstration Reach, Australian Society for Fish Biology, Snowy Mountains Bush Users Group, Friends of Currango, Reynella Rides, Queanbeyan Anglers Club, Kosciuszko Huts Association	Cumulative impacts of Snowy 2.0 projects, on-going funding in offset strategy, transfer of pests and impacts on endangered species and recreational fishing, water quality, groundwater drawdown, climate change, public access, impact on commercial horse trek operations.

5.2.2. Key Issues – Government

The key matters raised across Government agency submissions related to the spoil emplacement strategy, biodiversity, biosecurity and water quality.

The spoil emplacement strategy proposed in the EIS was not supported by EES and NPWS due to the potential for significant water quality impacts from placing fine sediments within the reservoirs. The EPA also raised concerns about the water quality and ecological impacts on the reservoirs and downstream watercourses.

The impacts of the project on biodiversity was a key concern, with NPWS noting the EIS had not identified how impacts would be avoided, nor clearly delineated the disturbance footprint and resulting biodiversity impacts. NPWS raised concerns with the proposed offset strategy, funding, the rehabilitation plan and long-term management.

Biosecurity concerns were also raised in particular by DPI and Council, with the key issue relating to the transfer of pest fish species and diseases during water transfers from Talbingo to Tantangara Reservoir. Concerns were also raised about the potential transfer of pest species to downstream catchments including the Murrumbidgee River and Eucumbene Reservoir, impacting on threatened species and recreational fishing.

In regard to water quality, the EPA requested further detail on proposed surface water and process water management, wastewater treatment systems and discharges. The EPA recommended further management measures to address groundwater impacts and additional measures to manage water quality during underwater works. DPIE Water and NRAR provided recommendations regarding water entitlements, groundwater take and management of works on waterfront land.

Other matters raised included impacts on recreation, with NPWS not supporting the proposed closure of Tantangara Road, and traffic management aspects raised by TfNSW and Snowy Monaro Regional Council.

5.2.3. Key Issues – National Parks Association

The National Parks Association of NSW (NPA) made a number of submissions during the Department's assessment noting its strong objection to the project (see **Appendices B** and **E**). The matters raised by NPA can be broadly summarised in three areas:

- Procedural Matters: NPA questioned the approach of lodging separate environmental impact assessments for each of the Snowy 2.0 components, indicating it does not allow for adequate consideration of cumulative impacts. NPA also questioned the level of evaluation of viable alternatives to the project.
- Benefits of Snowy 2.0: NPA questioned the stated energy benefits of Snowy 2.0, indicating the project was inefficient and uneconomic as the pumped hydro operation would experience 30 - 40% energy losses and would rely on coal-fired power for the next decade to store energy and that the project would not generate as much as 350 GWH. NPA questioned the need for this scale of energy storage for the NEM and noted

investment in distributed storage, such as local-scale batteries would provide improved benefits and lower cost.

- Development within Kosciuszko National Park: NPA fundamentally objected to development with KNP, noting the project is inconsistent with the principles of ecologically sustainable development and the objectives of the NPW Act. Key concerns included the scale and significance of impacts on the unique alpine environments, the inadequacy of approaches to offset these impacts and the cumulative impacts on the natural, cultural and heritage values of the park.

5.2.4. Other Issues – Community

Of the 182 public submissions, 14 (<8%) were from residences living close to the project area. Issues of importance to residences from Adaminaby, Cooma, Yarrangobilly, Talbingo and other local areas included:

- impacts on recreation (fishing, camping and horse camps);
- economic impacts to commercial horse-riding and tourism operators;
- impacts of spoil emplacement on water quality and fishing;
- impacts on fish stocks from the potential transfer of pest fish;
- geological impacts on fossil beds, tufa deposits and Yarrangobilly Caves;
- amenity impacts on Adaminaby from increased traffic, noise and dust;
- road safety on Snowy Mountains Highway and Link Road for local traffic and stock crossings;
- limited job creation in Adaminaby; and
- retention of access to maintain heritage items and mountain huts.

A summary of issues raised in public submissions from other areas including the ACT, east coast of NSW and Victoria is provided in **Table 7**. A summary of how these issues have been addressed is in **Appendix H.**

Table 7 | Key Issues – All other public submissions

Key Issues	Detail
Development within KNP	• inconsistent with the objectives of the *National Parks and Wildlife Act, 1974* to conserve the natural and heritage values of national parks • impacts on unique alpine and sub-alpine environments and critically important habitat • impact of permanent infrastructure on aesthetics, visitor experience and tourism
Biodiversity	• scale of disturbance and cumulative impact with transmission lines and road upgrades • inadequate offsets for alpine habitats • impacts on threatened fish
Spoil	• disposal within KNP unacceptable due to water quality impacts and reduction in reservoir capacity • impacts from potential asbestos and acidic contaminants in spoil
Groundwater	• significant drawdown, drying up of creeks, loss of inflows to reservoirs, impacts on Yarrangobilly River and groundwater dependent ecosystems
Biosecurity	• transfer of pests and viruses from Talbingo to Tantangara Reservoir, including Redfin perch, Eastern Gambusia, wild goldfish, EHNV and elodea weed • inadequate measures to prevent transfer of pests and viruses downstream to the Murrumbidgee River and Lake Eucumbene

Key Issues	Detail
Recreation	• proposed closure of Tantangara Road unacceptable • impacts on recreational fishing due to transfer of pests and viruses to Tantangara and downstream
Energy storage and alternatives	• inadequate consideration of alternatives, including lower cost options • project economically unviable • project's energy storage benefits overstated
Fragmented assessment	• need to consider cumulative impacts of all project components.

5.3. Response to Submissions

In February 2020, Snowy Hydro provided a detailed response to the issues raised in submissions and a Preferred Infrastructure Report (PIR) describing changes to the project to address the issues raised. The document is publicly available on the Department's website (see **Appendix C**). The PIR detailed:

- reductions in the project disturbance footprint by 62%;
- a revised spoil management strategy to improve water quality outcomes in Talbingo and Tantangara reservoirs;
- revised groundwater modelling reflecting the proposed concrete lining of the tunnels, reducing groundwater drawdown and associated impacts on biodiversity, stream flows and process water management;
- changes to construction methods, staging and design of certain structures; and
- a revised traffic assessment considering half the traffic volumes, as they had been double counted in the original traffic assessment.

The PIR provided further assessment of biodiversity, heritage, water quality, transport and amenity and presented additional mitigation and management measures.

5.4. Residual Issues - Government

Following changes to the project and the provision of additional information by Snowy Hydro, none of the government agencies object to the project and all of them support the recommended conditions of approval including:

- biodiversity: NPWS and BCD were supportive of the reduced disturbance footprint and worked with the Department to develop detailed requirements for minimising biodiversity impacts, rehabilitation criteria and a final offset strategy that was acceptable to NPWS.
- spoil emplacement: NPWS and the EPA were supportive of the revised emplacement strategy to reduce the water quality impacts of the project. The EPA recommended conditions for a water management plan and NPWS provided recommendations for the design and rehabilitation of the final emplacements.
- biosecurity / aquatic ecology: DPI worked closely with the Department to develop conditions for the protection of threatened fish and measures to prevent the transfer of pest fish and diseases. DPI confirmed it would be willing to grant Snowy Hydro the authorisations it requires under the *Biosecurity Act 2015* to operate the project.
- TfNSW, Heritage Council of NSW, DPIE Water and Snowy Monaro Regional Council provided recommended conditions for the project.

6. Assessment

6.1. Overview

The Department has assessed the merits of the project in accordance with the requirements of the EP&A Act, strategic energy policies for NSW and other applicable NSW and Commonwealth Government policies and guidelines. The Department has reviewed the EIS, submissions, RTS and PIR, consulted with key stakeholders, visited the site and held community information sessions. The Department has considered detailed submissions and representations from key stakeholders, advice from experts within Government and independent expert advice on spoil emplacement, water quality, aquatic ecology and groundwater.

Based on this assessment, the Department considers the project may result in residual impacts, which are assessed in detail in **sections 6.2** to **6.5** of this report. The key issues relate to energy security, spoil management, flora and fauna, aquatic ecology and biosecurity. The Department's consideration of other issues is included in **section 6.6**.

6.2. Energy Security and Reliability

The NPA and several energy experts were extremely critical of the benefits of the Snowy 2.0 Project, saying it is inefficient and uneconomic and that there are better alternatives.

These alternatives include using different methods to provide dispatchable energy and energy storage for the NEM (gas, batteries, hydrogen, etc), pursuing different hydro or pumped hydro projects and increasing the use of demand management.

To some extent these submissions were reflective of the broader energy debate occurring in Australia at the moment where there are divergent views on the best way to replace the scheduled closure of the remaining coal-fired power stations on the east coast over the next two decades, and the role that the government should play in helping to facilitate Australia's transition to a low emission economy. These are matters for discussions on energy policy, and not matters for detailed consideration of the merits of CSSI projects under the EP&A Act.

The Department has conducted a thorough investigation of the criticisms in relation to the energy benefits of Snowy 2.0, which has included:

- reviewing relevant Commonwealth and State policies and plans, including AEMO's ISP for the NEM, which seeks "to maximise consumer benefits in the NEM at the lowest system cost while meeting reliability, security and emissions expectations";
- considering the findings of the Commonwealth Chief Scientist's *Independent Review into the Future Security of the NEM* in 2017, which concluded that pumped hydro was currently the only viable commercial technology to provide large grid-scale energy storage; and
- consulting with AEMO and key agencies in the Commonwealth government.

This investigation found that the NEM is likely to require the delivery of up to 21,000 megawatts (MW) of dispatchable energy and up to 15,000 MW of energy storage over the next 20 years to ensure energy security and reliability and stabilise the operation of the NEM.

In theory, this energy could be delivered in several ways; but in practice, there are currently very few committed projects in the NEM that could deliver this energy over the next 5 to 10 years:

- although several gas-fired power stations were approved in NSW over 10 years ago (including Tallawarra, Marulan), none of them have been built yet due to uncertainties about future gas supplies and cost; and while the proposed Tomago gas-fired power station has been declared CSSI, it has not yet been approved;
- while several large-scale batteries have been approved in NSW over the last few years, very few of these batteries have been built at this stage; and while there is renewed interest from the market to deliver additional battery storage, this storage remains expensive and is unlikely play a major role in large grid-scale energy storage in the NEM for several years;
- although there is extensive potential for pumped hydro projects in NSW, there are only two projects that are close to being "shovel ready": Snowy 2.0 and the proposed expansion of the existing Shoalhaven Pumped Hydro Scheme; and the Shoalhaven project would only add another 235 MW of dispatchable energy to the NEM if it proceeds; and
- hydrogen energy is still in the early stages of development and is unlikely to be feasible for many years.

The Snowy 2.0 Project is one of the only committed projects that could make a substantial contribution to the NEM providing both peaking supply of up to 2,000 MW of dispatchable energy and "deep" backup supply of up to around 350 GWh. In addition, it would support the growth of renewable energy in NSW by providing essential storage for any excess electricity generated by wind and solar farms.

These attributes will be critical with the scheduled closure of the Liddell and Vales Point coal-fired power stations over the next decade (3,820 MW); and then the closure of the Eraring, Bayswater and Mount Piper coal-fired power stations over the next decade (7,020 MW).

Consequently, the Department is satisfied that the Snowy 2.0 is critical for energy security and reliability in NSW and can see why it features prominently in all the scenarios modelled in AEMO's ISP for the NEM.

Along with the Australian Competition and Consumer Commissions, it is also satisfied that the project would help to reduce electricity prices in NSW by increasing competition in electricity generation and providing energy storage to support the growth of renewable energy.

6.3. Spoil Management

6.3.1. Background

Excavation of the underground tunnels and power station would generate significant volumes of soil and rock (spoil), requiring a strategy for permanent emplacement and rehabilitation.

Initial estimates by Snowy Hydro indicated around 12 million cubic metres (m^3) of spoil would require management. This reflected the 'banked' volume, which would further expand once excavated, with conservative estimates putting it at 18 million m^3 bulked volume.

Snowy Hydro proposed in the EIS to place the majority of the spoil material into the Talbingo and Tantangara reservoirs using a combination of barge mounted fall pipes for placement under the water and excavators at the foreshore edge to push in the remaining material.

Studies to characterise the physical and geochemical properties within the spoil indicated some material would contain naturally occurring contaminants such as potentially acid forming (PAF) material and naturally occurring asbestos (NOA). Snowy Hydro proposed to manage these materials within the emplacements.

Several government agencies, the Department and two independent experts (Golder and the Water Research Laboratory (WRL) of the University of NSW, see **Appendix F**), identified concerns about the proposed emplacement strategy, the potential for significant water quality impacts on the Talbingo and Tantangara reservoirs and the creation of several unnatural landforms within the KNP requiring long-term maintenance. The potential

water quality impacts resulted primarily from the suspension of sediments within the reservoirs from the placement under water of fine materials.

To address these concerns, the Department required Snowy Hydro to make further changes to the design of the project and consider a geomorphic landform design approach for the emplacements. The process resulted in:

- changes to the project design, including reduced tunnel diameters, relocation of the power station to reduce the length of the access tunnels (MAT and ECVT) and removal of an additional access tunnel;
- reduction in the width of road widening for the Marica Trail west;
- revised compaction densities based on specific material types; and
- optimising reuse of the material within construction areas, for permanent infrastructure and for use by NPWS.

These changes reduced the volume of 'banked' material for emplacement down to 8.9 million m^3, with revised compaction densities providing a 'bulked' volume of 11 million m^3. Snowy Hydro also identified that an additional 315,000 m^3 of material from construction of the associated transmission line connections could be incorporated into the proposed landforms.

Snowy Hydro undertook further work, in consultation with NPWS and other key agencies, on options for disposing of the material. The options considered included all material placed within the reservoirs, all material placed on land within KNP, all material removed from the park and hybrids of these options. The process also considered the composition of excavated material to inform the emplacement strategy, with the coarser particles from drill and blast methods suitable for emplacement under water and the finer particles from tunnel boring machines suitable for placement on land above the full supply level (FSL) of the reservoirs and in other areas on land. The resulting emplacement strategy reflects a design outcome that minimises the impacts of the project on the KNP.

6.3.2. Revised Emplacement Strategy

The revised emplacement strategy involves minimising spoil disposal to the Talbingo and Tantangara reservoirs and improves the design of the emplacement areas to create natural, free-draining landforms that mimic the existing topography in KNP and supports rehabilitation. Spoil material would be permanently emplaced and rehabilitated in four landforms within KNP and one outside the park at Rock Forest (see **Table 8** and **Figure 16**). The geomorphic design approach reduced the cumulative disturbance area for the emplacements by 43 ha. **Figure 17** shows the proposed geomorphic landforms at Talbingo and Tantangara reservoirs.

Table 8 | Emplacement Areas

Location	Volume (m^3)	Area (ha)	Key Features
Ravine Bay (Talbingo)	2,800,000	18	• Sub-aqueous edge placement of drill & blast coarse material. • Geomorphic landform above FSL using TBM fine material. • Include an additional 315,000m^3 from the transmission line connection project.
GF01 (Talbingo)	1,000,000	7	• On-land, in-fill valley landform composed of both coarse and fine material.
Lobs Hole (Main Yard)	1,800,000	24	• On-land, rehabilitation of construction area for future recreational use.
Peninsula (Tantangara)	2,900,000	22	• Emplaced in dry conditions. • Drill & blast coarse material below FSL and a geomorphic landform using TBM fine material above FSL.
Rock Forest	400,000	14	• On-land emplacement using material transported from excavations at Marica.

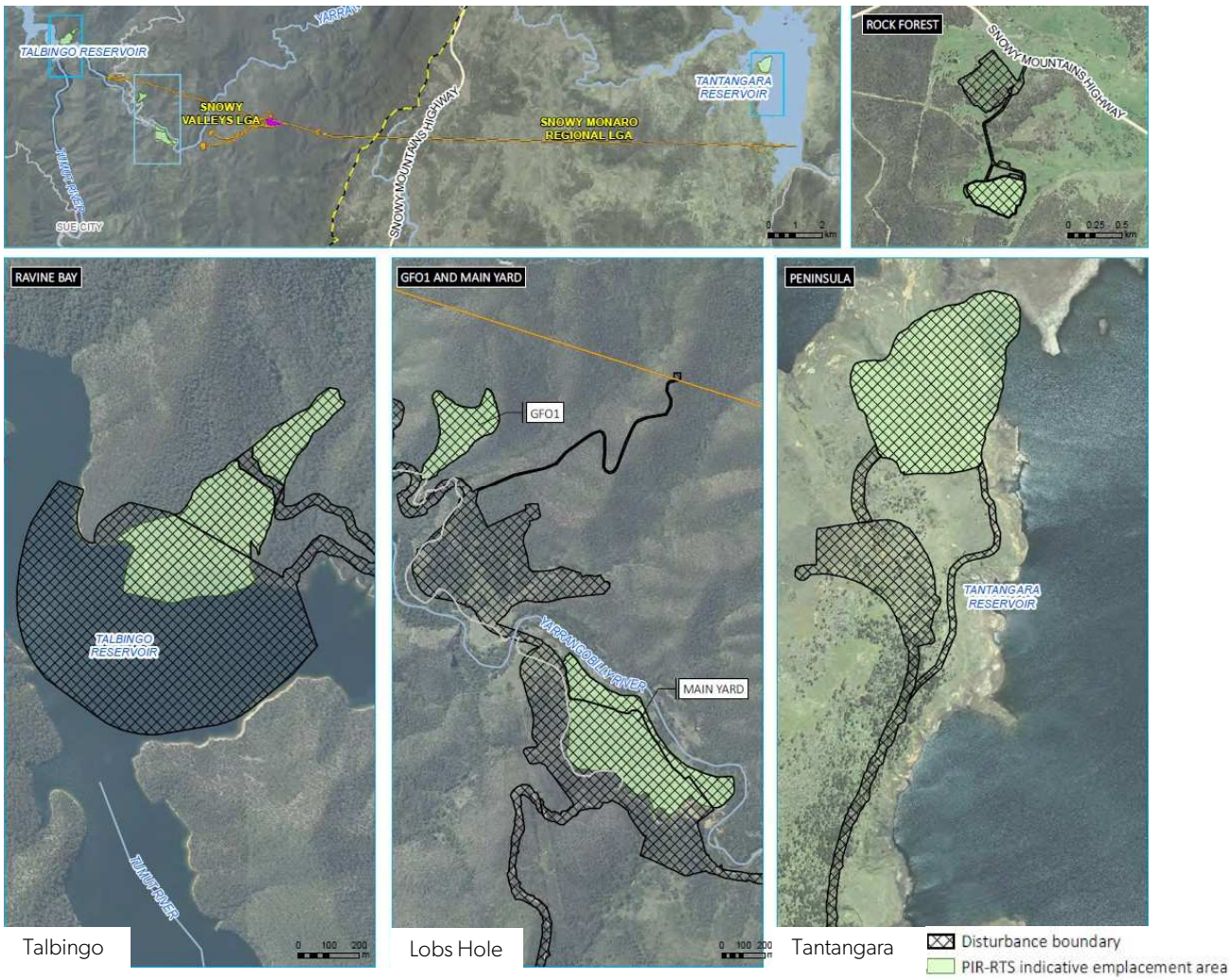


Figure 16 | Permanent Emplacement Areas

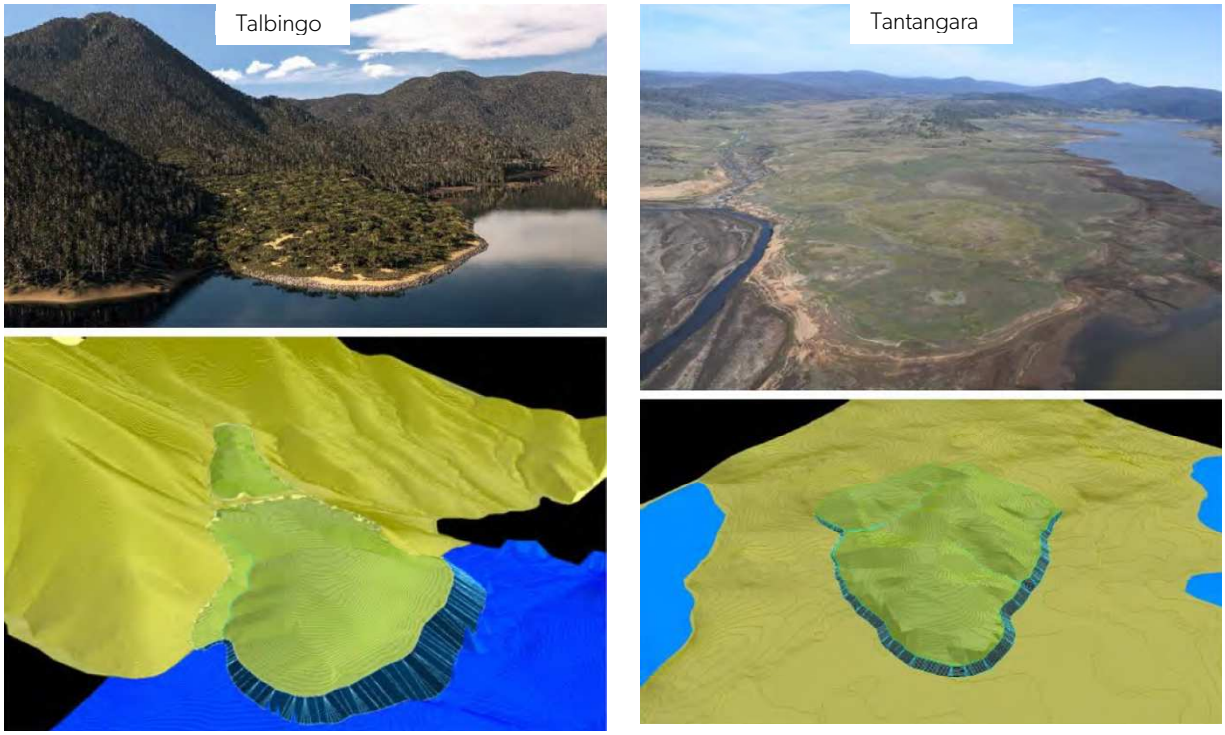


Figure 17 | Talbingo and Tantangara Emplacement Areas (shown in green)

6.3.3. Landform Design

The Department and its independent expert, Golder, identified that landforms proposed in the EIS were geometric, engineered structures or valley in-fill that did not integrate with the steep terrain of the area and presented challenges for successful drainage and required a higher level of engineered structures and on-going maintenance.

Golder confirmed that a geomorphic approach with a focus on surface water management would be more successful, reduce water quality and erosion risks and require less intensive maintenance. Golder's independent review is provided in **Appendix F**.

The revised emplacement strategy involves the creation of natural geomorphic landforms that complement the existing landscape. The geomorphic approach involves extending existing ridgelines and managing surface water flows to avoid erosion, maintain landform stability and reduce water quality impacts.

Golder reviewed the revised emplacement strategy against key design objectives, including water management, constructability, erosional stability and final land use. Golder concluded the proposed landforms can be constructed to provide an environmentally acceptable outcome and recommended objectives for the detailed design. These include:

- establishing the availability of topsoil and determining the erosional risks of the material;
- confirming adequate space is available for the required sediment controls during construction;
- developing the design for surface water diversions around the emplacements;
- determining appropriate slopes, stability and accessibility during construction, for maintenance and ultimately for recreation; and
- developing a revegetation strategy.

The focus of the revised strategy is to create landforms that will blend with the existing topography and integrate the emplaced spoil into the landscape as rehabilitation establishes over time. Further detailed design is required to ensure surface water is managed and the landforms are stable and non-polluting for the long-term.

The Department, in consultation with NPWS, has recommended conditions including design objectives for landform design, water management, erosional stability, constructability and final land use.

With these changes, the Department is satisfied that Snowy Hydro has designed the project to minimise its impacts on the KNP.

6.3.4. Water Management

The revised emplacement strategy addressed the key risks to water quality by excluding the placement of fine materials within the reservoirs. The concept design also includes the use of geofabric and granular filters between the coarse and fine materials to prevent sediment movement out of the emplacements.

Snowy Hydro proposes to manage the water quality impacts during construction by:

- diverting surface water around the emplacements;
- installing purpose-built drainage systems and sediment basins to capture and dissipate flows;
- progressively rehabilitating the landforms;
- installing filters within the emplacements to prevent the movement of fine materials out of the emplacement; and
- installing silt curtains within the reservoirs to capture sediments and metals entering the waterways and prevent downstream impacts.

The Department's independent expert, WRL (see **Appendix F**) concluded that turbidity and suspended sediments would be within acceptable ranges with the exclusion of fine material from below the FSL of the reservoirs.

The Department has worked closely with the EPA during the assessment and received advice from the EPA that it is willing to grant an EPL for the project subject to conditions.

The Department's recommended conditions require Snowy Hydro to prepare a Water Management Plan in consultation with the EPA, NPWS, the Department's Water Group and DPI. This plan includes a requirement for detailed plans for the temporary and permanent spoil emplacement areas, detailed criteria for determining the surface water impacts of the development, including criteria for triggering remedial action (if necessary) and monitoring and contingency measures to manage risks to water quality.

With the proposed management measures in place, the Department considers the water quality impacts during construction of the emplacements can be adequately monitored and managed to protect the receiving waters.

6.3.5. Contaminated Material Management

Detailed sampling for the project indicated that:

- surface excavations for road upgrades and construction areas as well as tunnel boring around Lobs Hole is likely to encounter PAF rock, however the overall spoil characteristics have acid neutralising capacity in excess of the maximum potential acidity from PAF rock; and
- NOA material would be encountered in two sections of the headrace tunnel (a 5.55 km section and a 0.54 km section) through the Marica and Plateau areas and in surface excavations and utility installations in these areas.

Snowy Hydro proposes to implement a range of management controls when conducting tunnelling and excavations in these areas. These measures would be detailed in a spoil management plan and would include:

- testing and classification of material in accordance with the EPA's Waste Classification Guidelines;
- alternate excavation methods, such as excavating under wet conditions to prevent the release of airborne asbestos fibres from NOA and generation of acid leachate from PAF;
- application of standard work health and safety practices for handling asbestos;
- separate encapsulation of contaminated material within airtight and watertight enclosures and specific management procedures for temporary storage if required;
- placement of PAF within the emplacement areas;
- placement of NOA in encapsulated areas within the emplacements, with geo-synthetic textile wrapping layers to contain the material. Material may also be placed and sealed within the Tantangara adit following completion of construction.

The Department, in consultation with the EPA, has recommended conditions requiring Snowy Hydro to test, classify and manage all spoil in accordance with strict requirements, and to implement special procedures to manage any reactive or contaminated spoil and manage these materials in a spoil management plan to be developed in consultation with NPWS, EPA, the Department's Water Group and DPI.

6.3.6. Rehabilitation

The emplaced spoil would ultimately be rehabilitated as part of a comprehensive rehabilitation plan for the project. Golder noted that successful management of topsoil and revegetation is critical for the overall long-term stability of the landforms and progressive rehabilitation during construction would minimise erosion risk, dust and visual impacts. The geomorphic landform design also provides opportunities for establishing variable habitats and plant community types.

The Department has recommended a range of conditions for rehabilitation of the emplaced spoil to achieve stable, non-polluting landforms that are self-sustaining. The conditions require:

- a topsoil balance for the project, prioritising the use of topsoil for rehabilitation, developing other suitable growth media and importing additional topsoil if required;
- collection and use of locally sourced native seed to establish plant community types, consistent with the overall rehabilitation strategy for the project;
- the rehabilitation to accommodate future recreational uses, including the Lobs Hole emplacement area and the foreshore interfaces at Talbingo and Tantangara reservoirs; and
- completion criteria, performance indicators and implementation of additional measures if effective rehabilitation is not achieved.

6.3.7. Conclusion

The Department has concluded the potential impacts from permanent placement of the excavated spoil can be managed to an acceptable level and rehabilitated to safe, stable and non-polluting landforms.

To ensure this occurs, the Department has recommended conditions requiring Snowy Hydro to:

- test, classify and manage excavated material, including procedures for management of contaminated material;
- maximise reuse of the material;
- exclude fine materials (from TBM, dredging, channel excavation and underwater blasting) from below the full supply level of the reservoirs;

- create stable, geomorphic landforms with integrated drainage and high habitat variability;
- ensure enough topsoil or suitable growth medium to sustain revegetation, consistent with the Rehabilitation Management Plan for the project;
- minimise the water quality impacts of temporary spoil stockpiles and permanent emplacement areas;
- ensure safe recreation on and around emplacement areas, consistent with the Recreation Management Plan for the project; and
- prepare a detailed Spoil Management Plan, in consultation with NPWS, EPA, DPI Fisheries and TfNSW, identifying the specific measures that would be implemented to reduce the impacts of spoil emplacement.

6.4. Flora and Fauna

The KNP is one of the most complex conservation reserves in Australia, having unique glacial landscapes and a rare and unusual assemblage of plants and animals, several of which are found nowhere else in the world.

The key biodiversity issue stems from the scale of disturbance proposed within the National Park. The initial proposal required 1,053 ha of native vegetation clearing, and the proposal drew criticism from conservation groups and the community. Following exhibition, however, the Department required Snowy Hydro to consider making further changes to the project to address agency and community concerns. In response to these concerns, the design was significantly refined, reducing native vegetation clearing to 425 ha, with 37 ha located outside KNP at Rock Forest and reducing the operational footprint from 99 ha to 92 ha.

Of the 425 ha to be cleared, 89 ha consists of heathland and grassland communities, 296 ha is woodland and 36 ha is derived native grassland. Most of these plant community types were in medium to high condition, while an additional 4 ha is in a severely degraded state. Beyond these direct impacts, 691 ha of native vegetation surrounding the proposed disturbance footprint would be indirectly impacted by its proximity to the works.

There is one listed threatened ecological community (TEC), the Alpine Sphagnum Bogs and Fens also listed as a critically endangered ecological community under the EPBC Act that would be impacted, with up to 1.03 ha to be cleared. As a groundwater dependant ecosystem, approximately 6.93 ha of this plant community type (PCT) could also be impacted by the groundwater drawdown resulting from the tunnelling works. No other listed TECs are contained within the proposed disturbance footprint.

Although the majority of the project area was extensively affected by the catastrophic bushfire event in January 2020 (see **Figure 18**) with areas west of the Snowy Mountains Highway severely burnt, biodiversity impacts are based on vegetation data collected before the fire event. This provides a conservative assessment of impacts associated with the development where vegetation that may now be absent are counted as present.

The credit liability required to offset the direct and indirect impacts to native vegetation have been calculated in accordance with the BC Act and are detailed in **Table 9**.

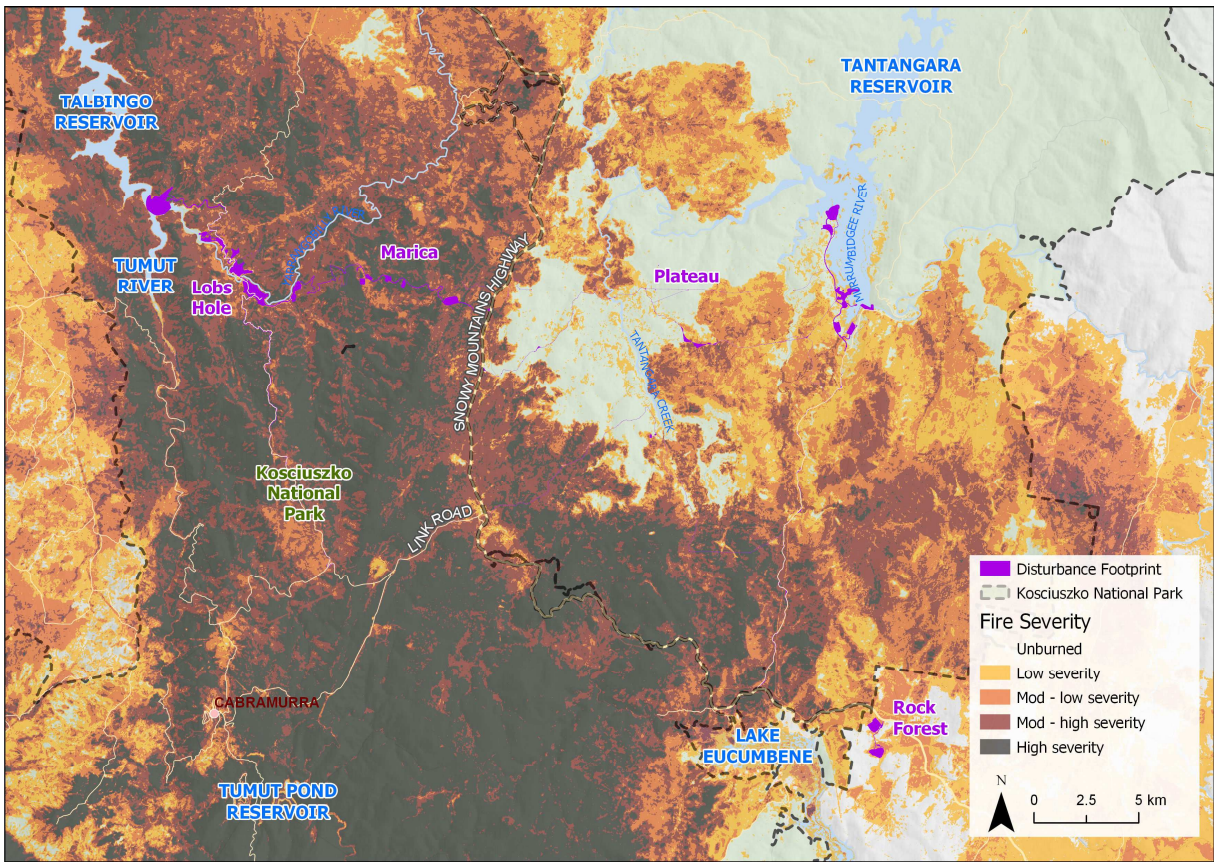


Figure 18 | January 2020 fire severity mapping

Table 9 | Vegetation clearing with credit liability

Species	PCT	Direct disturbance (ha)	Indirect disturbance (ha)	Ecosystem Credit Liability
Broad-leaved Sally grass - sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	285	5.32	0.07	97
Brittle Gum - peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	296	24.59	14.03	602
Riparian Ribbon Gum – Robertsons Peppermint – Apple Box riverine very tall open forest of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	299	1.04	0.5	30
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	300	34.35	28.6	770
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	302	2.83	3.22	59
Black Sally grassy low woodland in valleys in the upper slopes sub-region of the New South Western Slopes Bioregion and western South Eastern Highlands Bioregion	303	26.67	30.84	1,261
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	311	8.92	14.19	213

Species	PCT	Direct disturbance (ha)	Indirect disturbance (ha)	Ecosystem Credit Liability
Alpine and sub-alpine peatlands, damp herbfields and fens, South Eastern Highlands Bioregion and Australian Alps Bioregion	637	1.03	4.39	45
Alpine Ash – Snow Gum shrubby tall open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	639	8.6	14.8	230
Alpine Snow Gum – Snow Gum shrubby woodland at intermediate altitudes in northern Kosciuszko NP, South Eastern Highlands Bioregion and Australian Alps Bioregion	644	60.75	130.56	1,685
Black Sallee – Snow Gum low woodland of montane valleys, South Eastern Highlands Bioregion and Australian Alps bioregion	679	0.04	0.42	2
Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	729	21.38	21.81	569
Mountain Gum – Snow Gum – Broad- leaved Peppermint shrubby open forest of montane ranges, South Eastern Highlands Bioregion and Australian Alps Bioregion	953	7.97	7.35	253
Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	999	12.4	14.75	320
Snowy Gum – Candle Bark woodland on broad valley flats of the tablelands and slopes, South Easter Highlands Bioregion	1191	9.23	5.56	370
Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	1196	108.19	144.78	3,281
Sub alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion	1224	80.83	132.55	2,890
Sub-alpine grasslands of valley floors, southern South Eastern Highlands Bioregion and Australian Alps Bioregion	1225	6.9	16.05	250
Total		**421.04**	**584.47**	**12,927**

6.4.1.Threatened Fauna and Flora

Detailed mapping of over 9,000 ha of native vegetation across the survey area was completed with nine threatened flora species and 25 threatened fauna species found either within or adjacent to the disturbance footprint. Of these, ten species are also listed as threatened under the EPBC Act.

The largest extant population of the Smoky Mouse and Broad-toothed Rat are located within KNP, and important populations of the Alpine Tree Frog and Alpine She-oak Skink are also present. The catastrophic bushfires of January 2020 burnt significant amounts of habitat for these species, including 90 % of habitat surveyed for the Smoky Mouse and 34 % of habitat surveyed for the Broad-toothed Rat.

Most of the native vegetation outside the fire affected areas occurs on the plateau located east of the Snowy Mountains Highway and sections around Tantangara Dam and will play an important role to the recovery for affected species.

The impacts to threatened species habitat requires the following offsets in accordance with the current biodiversity offset policy (see **Table 10**).

6.4.2. Cumulative impacts

Snowy Hydro currently has approval to clear up to 113.98 ha of native vegetation as part of the Exploratory Works project, but will only require 107 ha. While TransGrid are still finalising the Environmental Impact Statement to connect the power station to the transmission network, it is estimated an additional 91 ha of clearing within KNP could be required.

Table 10 | Threatened species liability

Species	BC Act status	EPBC Status	Direct impacts (ha)	Indirect Impacts (ha)	Species credit liability
Birds					
Gang-gang Cockatoo	Vulnerable	-	2.08	2.82	93
White-bellied Sea-Eagle	Vulnerable	-	17.53	5.6	495
Mammals					
Broad-toothed Rat	Vulnerable	Vulnerable	61.47	100.5	2794
Eastern Pygmy-possum	Vulnerable	-	197.55	249.13	7836
Smoky Mouse	Critically Endangered	Endangered	84.29	142.51	5276
Southern Myotis	Vulnerable	-	2.72	1.29	86
Amphibians					
Alpine Tree Frog	Endangered	Vulnerable	22.87	31.54	895
Booroolong Frog	Endangered	Endangered	1.33	3.56	57
Reptile					
Alpine She-oak Skink	Endangered	Endangered	80.83	132.33	3852
Plants					
Caladenia montana	Vulnerable	-	0.77	0.96	24
Glycine latrobeana	Critically Endangered	Vulnerable	0.57	0.95	41
Kiandra Leek Orchid	Vulnerable	Vulnerable	1.45	4.66	108
Leafy Anchor Plant	Vulnerable	-	40^	5^	90
Mauve Burr-daisy	Vulnerable	Vulnerable	7.8	14.1	617
Raleigh Sedge	Endangered	-	0.25	0.59	14
Slender Greenhood	Vulnerable	-	0.28	0	5
Total			**482.19**	**690.54**	**22,283**

Note: ^ denotes individuals

6.4.3. Mitigation

Beyond the standard mitigation measures that would be implemented in accordance with a Biodiversity Management Plan to minimise impacts within and surrounding the project area, the Department recommends several additional measures to reduce the likelihood of fauna strikes by vehicles.

This includes installing underpasses along Lobs Hole Ravine Road and the Marica Trail which are surrounded by important habitat suitable for several threatened species. It is recommended that these are designed and spaced in consultation with NPWS, and that they are installed prior to any project traffic being allowed to use these routes at night.

This is because:

- several of the key threatened species, including the Smoky Mouse, Broad-toothed Rat and Eastern Pygmy-possum are primarily active at night;
- these areas are considered particularly sensitive for the Smoky Mouse and Eastern Pygmy-possum; and
- a large portion of construction traffic would be utilising these routes.

The Department has also recommended speed restrictions between sunset and sunrise on all access routes beyond the Snowy Mountain Highway and Link Road to further reduce the chance of fauna being struck.

6.4.4. Rehabilitation and Offsets

Although Snowy Hydro has significantly reduced the proposed development footprint, 425 ha of native vegetation clearing with 388 ha inside the KNP would be removed. The Department recognises a development of this scale inside an established National Park is unprecedented and requires the completion of rehabilitation to the highest standard and significant offset obligations to be considered acceptable.

The Department is aware of the historic difficulties in successfully rehabilitating areas of KNP particularly in the alpine and sub-alpine regions. However, more recent efforts at rehabilitation by NPWS have achieved improved outcomes. With this evidence, the Department has recommended conditions requiring Snowy Hydro to rehabilitate all areas within the disturbance footprint, and to provide funding to the NPWS to improve the ecosystem health of KNP in areas outside the disturbance footprint.

The Department has included ecological rehabilitation objectives, completion criteria and performance indicators in the recommended conditions that require Snowy Hydro to re-establish PCTs with recognisable vegetation composition, structure and ecosystem function that demonstrates the rehabilitation is self-sustainable or showing a substantial trend towards a self-sustaining state. These would be measured against appropriate reference sites within KNP.

Ecological rehabilitation would need to be completed within 20 years of the completion of construction in areas not required for operations and within 20 years of decommissioning the development for areas used for operations.

This would be managed in accordance with a Rehabilitation Management Plan to be prepared in consultation with key agencies including the NPWS, BCD, EPA and NSW DPI. It would include detailed planning of where each PCT would be established and a comprehensive program to monitor and publicly report on the rehabilitation of the site and its progress against the detailed completion criteria and performance indicators.

The Department notes that all disturbed areas would be rehabilitated to a high standard and returned mostly to woodland, leaving a small residual surface footprint of around 92 ha. This footprint would be concentrated mostly around the Talbingo and Tantangara reservoirs, as most of the other operational components would be located underground.

Snowy Hydro would be liable for 12,927 ecosystem credits and 22,283 species credits to offset the residual impacts of the project. The offset options available under the BC Act allow retirement of like-for-like credits, funding a biodiversity conservation action or payment into the Biodiversity Conservation Fund.

Snowy Hydro initially presented a biodiversity offset strategy with limited detail on the quantification of any direct offset outcomes. A revised offset strategy was submitted as part of the PIR which further quantified the approach to offsets and committed to providing a payment of $36 million to NPWS for the management and conservation of biodiversity in KNP to offset the direct impacts of the project comprising $22 million for broad ecosystem management and $14 million for targeted species actions.

The Department engaged technical expert, Alex Cockerill of WSP, to provide an independent expert review (see **Appendix F**) of the Biodiversity Offset Strategy. The review found the approach presented in the Biodiversity Offset Strategy reasonably quantified the proposed offset against the credit liability, but the review identified several shortfalls in the proposed timeframes, areas and rates of application for specific management actions and a lack of appropriately funded administration.

The Department and WSP, in consultation with BCD and NPWS, costed the management measures and actions required to provide a net improvement in the biodiversity values of KNP at $73.8 million. This comprises of $45.8

million for ecosystem management and $28 million for species management and would augment the $8.49 million already paid to the NPWS to offset the residual impacts of the Exploratory Works.

The NPWS would use these funds to significantly improve catchment health, strengthen ecosystems, deliver direct offset outcomes for all affected candidate species and communities that provide a measurable conservation gain in accordance with State and Commonwealth policy requirements and deliver long-term strategic conservation benefits for the KNP. These would be over and above existing mechanisms and programs already undertaken by NPWS, and would include undertaking direct action to:

- restore Alpine catchments and ecosystems;
- undertake landscape-wide programs to control pests, weeds and feral animals;
- protect and assist the recovery of threatened species and communities, including those affected by the development and also the recent bushfires which have had significant impacts on the KNP; and
- deliver captive breeding programs for key threatened species, including the critically endangered Smoky Mouse.

The Department has recommended a condition requiring Snowy Hydro to provide 20 % of the offset liability ($14.76 million) prior to the commencement of construction. NPWS would have access to this funding to significantly bolster restoration efforts in response to the January 2020 bushfires.

Payments of 20 % increments in yearly intervals from the commencement of construction, i.e. 80 % of the offset liability ($59.04 million) is due within the first 3 years of construction. To create an incentive for Snowy Hydro to further reduce the biodiversity impacts of the development through detailed design, the remaining 20 % can be reduced on a proportionate basis if Snowy Hydro can demonstrate a reduction in the final disturbance area.

The Department has also set performance measures for the Alpine Sphagnum Bogs and Associated Fens, requiring negligible changes to the:

- ecosystem functionality of the PCT; and
- shallow groundwater regime supporting the PCT.

This PCT could potentially be impacted by groundwater drawdown has not been included in the offset liability calculations. The Department notes that the groundwater modelling is conservative and does not account for the benefits provided by grouting which would be implemented during the tunnelling process. Should additional impacts to the Alpine Sphagnum Bogs and Associated Fens occur, the offset liability would be increased accordingly.

To ensure accountability for these funds, the NPWS will develop and implement a detailed program for the allocation of these funds to specific projects, focusing on the ecosystems and species affected by the development, and also monitor, evaluate and publicly report on the progress of the implementation of the detailed program and the effectiveness of the specific projects.

The NPWS will also implement and develop a specific program in consultation with DAWE to address the residual biodiversity impacts on the following EPBC listed community and species considered to be significantly impacted:

- Alpine Sphagnum Bogs and Associated Fens;
- Broad-toothed Rat;
- Smoky Mouse;
- Alpine Tree Frog; and
- Alpine She-oak Skink.

Because Snowy Hydro would be liable for rehabilitating areas directly disturbed by the project, the management actions in the Offset Strategy would be implemented in areas beyond the immediate disturbance footprint.

6.4.5. Vegetation clearing protocol

The Department does not support SHL's proposal to include a Vegetation Clearing Protocol that would allow the removal of "critical vegetation" in proximity to the project for safety reasons subject to providing suitable offsets. In the Department's view, this proposal is too open-ended and could result in further clearing outside the approved disturbance areas for the development without public scrutiny.

Furthermore, Snowy Hydro's proposal to design and microsite a construction footprint within a broader development corridor offers enough flexibility to overcome such issues.

Consequently, the Department has not incorporated the proposal into its conditions.

6.4.6. Conclusion

Even with careful design, the development would be the largest proposed within an established National Park. The Department has worked closely with key government agencies, including the NPWS to reduce the impacts of the development as much as possible, and has recommended conditions requiring Snowy Hydro to:

- rehabilitate the site to a high standard that would restore the vegetation composition, structure and ecosystem function of disturbed areas within set time frames of construction and decommissioning;
- pay the NPWS up to $73.8 million to carry out conservation actions in other parts of the KNP to offset the residual biodiversity impacts of the project (on top of the $8.5 million already paid to the NPWS for the exploratory works);
- limit the disturbance footprint and area of native vegetation that could be cleared;
- prepare and implement a Rehabilitation Management Plan to monitor rehabilitation success; and
- prepare and implement a Biodiversity Management Plan to protect and monitor biodiversity.

The Department has also provided an incentive for Snowy Hydro to further reduce its biodiversity credit liability in the detailed design stage of the project while setting an upper limit on the area of disturbance allowed. As such, the Department considers the environmental impacts would be manageable subject to these strict conditions.

6.5. Aquatic

6.5.1.Background

The key aquatic ecosystem impacts relate to the loss of key fish habitat during construction and providing a pathway for unwanted aquatic species being transferred from Talbingo Reservoir to Tantangara Reservoir during operation.

Tantangara Reservoir is valued as a self-sustaining wild trout fishery and flows via the Murrumbidgee-Eucumbene pipeline into Lake Eucumbene, a premier trout fishing waterbody. Although no listed threatened species inhabit Tantangara Reservoir, the only known population of the critically endangered Stocky Galaxias lives in the headwaters of Tantangara Creek, an upstream tributary of the reservoir (see **Figure 19**).

The reservoir also provides environmental flows via Tantangara Dam into the mid-Murrumbidgee, which is home to a significant population of the endangered Macquarie perch and other listed threatened species including the Trout Cod, Murray Cod, Southern Pygmy-perch and the Murray Crayfish.

Community and special interest group submissions expressed strong concerns about the impacts of the project on aquatic ecology and recreational fisheries. A submission from the Australian Society for Fish Biology highlighted key risks associated with facilitating the movement of Redfin Perch and Climbing Galaxias, survey effort to detect the presence of the Epizootic Haematopoietic Necrosis Virus (EHNV) in Talbingo Reservoir and impacts to Murray Crayfish and water quality impacts associated with disposing spoil within the reservoirs.

The Snowy River catchment, which Lake Eucumbene is a part of, is listed as an aquatic endangered ecological community under the FM Act. This listing includes all native fish and aquatic invertebrates within all rivers, creeks

and streams of the catchment threatened by previous establishment of dam and diversion structures regulating flows.

Snowy 2.0 will not be altering the environmental flow obligations to the Snowy River from Jindabyne into the Snowy River, nor is there a proposal to alter environmental flows from Tantangara Dam into the mid-Murrumbidgee River.

Figure 19 | Regional waterbodies

6.5.2. Key Fish Habitat

The emplacement of spoil and the construction of the tunnel intakes and associated ancillary infrastructure would disturb approximately 16.4 ha or 0.4 % of key fish habitat within the two reservoirs. This is less than the 59 ha of key fish habitat identified for sub-aqueous emplacement at Ravine Bay, Cascade Bay and Plain Creek Bay within Talbingo Reservoir as part of the Exploratory Works.

Murray Crayfish, listed as vulnerable under the FM Act, were identified in surveys within these areas in Talbingo Reservoir, but absent from Tantangara Reservoir. The Department has recommended conditions requiring Snowy Hydro to undertake a program of population monitoring, relocating individuals captured within the proposed disturbance area and to provide habitat enhancement for the species, including the relocation of woody debris salvaged during construction (consistent with the requirements in the Exploratory Works approval). The Department considers the impacts on the crayfish would be minimised with these measures in place.

Snowy Hydro originally proposed to place spoil generated by the TBM methodology below the minimum operating level of each reservoir. However this would have resulted in unacceptable and significant impacts to the water quality and aquatic ecology in each reservoir and downstream waterbodies due to the finer sized particle distribution of the TBM spoil. The revised spoil emplacement strategy commits to placing all TBM spoil above the

full supply level of each reservoir which would achieve acceptable water quality outcomes (see section 6.3) and minimise impact on key fish habitat.

6.5.3. Pest species transfer

There are two species surveyed in Talbingo Reservoir or Yarrangobilly River of particular concern that could cause significant impacts should they be transferred into Tantangara Reservoir and establish a self-sustaining population. These are the introduced Redfin Perch, a declared notifiable species in NSW under Schedule 1 of the *Biosecurity Regulation 2017* and the Climbing Galaxias which is a species originally native to the coastal drainages of eastern Australia.

Climbing Galaxias

The Climbing Galaxias poses a threat to the Stocky Galaxias population which is confined to a 4 km stretch of Tantangara Creek upstream of the reservoir above a waterfall. It is speculated that the home range for the Stocky Galaxias is restricted by the presence of trout, with the waterfall at Tantangara Creek acting as a natural barrier.

The population is listed as critically endangered and already at significant risk to random events including bushfires, introduction of pest species such as trout or the Oriental Weatherloach, overgrazing of the creek's riparian corridor by pest animals and sedimentation of the creek.

Should the Climbing Galaxias, surveyed in the Yarrangobilly River be present in the Talbingo Reservoir, the species could be entrained into Tantangara Reservoir and eventually make its way upstream to Tantangara Creek. The species is renowned for its climbing ability and would be able to scale the waterfall at Tantangara Creek.

The Climbing Galaxias is suspected of having detrimental impacts to other galaxiids through competition for food and space. Should the species scale the waterfall, the vulnerable Stocky Galaxias population would be subject to an additional key threatening process.

A Priority Actions Statement to strengthen the Stocky Galaxias population with the aim to downgrade the species threatened status has been drafted by DPI Fisheries. They have raised concerns the introduction of the Climbing Galaxias would severely limit the ability to establish an insurance Stocky Galaxias population within a separate tributary of Tantangara Reservoir.

Redfin perch and EHNV

The Redfin Perch is an introduced species known to prey on hatching native fish larvae, severely limiting the recruitment success on both native fish and recreational species such as trout. Significant declines in Macquarie Perch populations have been attributed to multiple factors leading to the species endangered listing. Key threatening processes include barriers to their migration, habitat degradation, pollution of waterways, competition and predation by exotic fishes, particularly brown trout, rainbow trout and redfin perch.

Prior to the introduction of the Redfin Perch in 2005, the Upper Lachlan and Abercrombie River Macquarie Perch populations were considered some of the most abundant and robust populations within NSW. Data collected to date identifies significant impacts, with no Macquarie Perch surveyed from any site in the upper Lachlan since 2008, 2 to 3 years after the introduction of the Redfin Perch.

Introduction of Redfin Perch into the mid-Murrumbidgee River could result in significant stress to the Macquarie Perch population, other threatened species in the mid-Murrumbidgee River and trout. For this to occur:

1. Redfin Perch must be entrained at the Talbingo Reservoir intake;
2. survive transfer to Tantangara Reservoir;
3. establish a self-sustaining population in Tantangara Reservoir; and
4. spread into the mid-Murrumbidgee River through Tantangara Reservoir.

The Department considers it is likely that Redfin Perch would be entrained to Tantangara Reservoir as there is a self-sustaining population in Talbingo Reservoir which is known to occur at the depths of the proposed intake structure. Experiments undertaken by Charles Sturt University predict a large proportion of fish entrained through the tunnel would survive the shear, blade strike and pressure stress from the transfer.

Because the species is known for its ability to establish populations from the introduction of a relatively small number of individuals, there is a high likelihood a self-sustaining population of Redfin Perch would eventually become established in Tantangara Reservoir.

The Redfin Perch is more susceptible than other fish species to the Epizootic Haematopoietic Necrosis virus (EHN virus) which is a notifiable disease under Schedule 1 of the *Biosecurity Regulation 2017*. Field observations have only detected EHN virus infections in wild populations of the Redfin Perch and in farmed trout, though laboratory trials have demonstrated native species including the Macquarie Perch and Mountain Galaxias are susceptible to water borne exposure.

The Redfin Perch is considered an amplification host that could increase the infection pressure and probability of effective contact if it occupies the same waterbody as the Macquarie Perch.

To date, the EHN virus has not been recorded in Talbingo Reservoir, but has been observed downstream in the Blowering Reservoir, Burrinjuck Reservoir, Googong Reservoir and Lake Burley Griffin in the Australian Capital Territory. Incidences of epidemics appear infrequent, with the last known outbreak observed affecting Redfin Perch in Victoria in 2012 and no active monitoring program in place.

6.5.4. Mitigation

Several options to restrict the spread of Redfin Perch, Climbing Galaxias and other aquatic pest species were investigated. including a physical screen barrier located near the Talbingo intake structure to prevent transfer into Tantangara Reservoir.

This option would require substantial civil works involving the additional excavation of approximately 3 million m^3 of spoil as the very fine aperture of the fish screen (0.5 mm) requires a significant surface area to meet the flow requirements of the power station. On balance, it was considered unreasonable to install such infrastructure with additional consequential environmental impacts from removal and disposal of the spoil and at a cost of approximately $600 million.

Fish minimisation methods which would reduce the likelihood of fish transfer but not eliminate the possibility were also considered, including the installation of barrier nets, acoustic and visual deterrents and reducing trash rack spacing. Some of these options also required significant areas to meet flow requirements of the power station. In addition, while this could potentially reduce the number of individuals entrained, the high fecundity of the Redfin Perch would mean these installations would be obsolete once enough individuals had transferred into Tantangara to produce a self-sustaining population.

As such, the Department considers a multi-faceted approach to firstly restrict the Redfin Perch from moving beyond Tantangara Reservoir, and prevent the Climbing Galaxias from reaching Tantangara Creek in conjunction with a proactive captive breeding program for the Macquarie Perch and Stocky Galaxias populations in the surrounding region is warranted.

In order to contain pest species within Tantangara Reservoir, Snowy Hydro are proposing to:

- install a fish screen at the southern end of the Tantangara Reservoir for water going into Lake Eucumbene and the mid-Murrumbidgee River;

- install a fish barrier at Tantangara Creek to prevent a Climbing Galaxias reaching the Stocky Galaxias habitat; and
- establish a monitoring program to detect the presence of the EHN virus within the reservoirs where none is currently in place.

Several public submissions raised concerns that while the fish barrier may prevent Redfin Perch from escaping during normal operations, it would not prevent Tantangara Reservoir from overtopping into the mid-Murrumbidgee River during a significant rainfall event which have occurred in the past.

The Department notes that Tantangara Reservoir would transform from a passively managed waterbody to an active waterbody once the development is operational. The diversion capacity at Talbingo Reservoir would significantly increase from 20 cubic metres per second (cumecs) to 400 cumecs, significantly increasing Snowy Hydro's ability to prevent an overtopping event from occurring. The Department has also recommended a condition requiring developing and implement a system to prevent spills from Tantangara Reservoir so far is reasonably practicable.

Should pest fish species such as the Redfin Perch and Climbing Galaxias manage to get through the respective barriers, this could result in significant impacts to the regional Macquarie Perch and the only Stock Galaxias population. In addition to the requirements to install these barriers, the Department's recommended conditions also require Snowy Hydro to proactively establish and invest at least $5 million into a captive breeding program for these two at risk species in alignment with the Priority Action Statements for the species.

The captive breeding program would be informed by monitoring and research on the species within the catchments, surveys to identify suitable receiving sites to establish insurance populations and the breeding, stocking and monitoring with the objective of achieving self-sustaining populations of the species within its known habitat range.

An expert advisory committee would be established to perform an advisory and peer review role on the measures that would be implemented for the captive breeding program and the trigger, action, response plan for any extension to the program.

The Department has also recommended conditions requiring Snowy Hydro to contribute $5 million to develop a program to restock Tantangara Reservoir and Lake Eucumbene with salmonid fish if necessary and implement a program to monitor the impacts of the development on recreational fishing within these waterbodies. This program would be undertaken in consultation with DPI Fisheries and includes detailed trigger, action and response plans for the native fish and recreational fish programs to adaptively respond to adverse effects caused by the project.

6.5.5. Conclusion

The Department acknowledges that Snowy Hydro has proposed to restock Tantangara Reservoir and Lake Eucumbene with salmonid fish if there are any adverse impacts on recreational fishing in these two waterbodies due to the project, install large fish screens to prevent the spread of pest fish and disease downstream of the Tantangara Reservoir; and install a fish barrier on Tantangara Creek to protect the only remaining population of Stocky Galaxias from Climbing Galaxias.

While these measures are expected to minimise any adverse biosecurity impacts of the project as far as is reasonably practicable, there is some uncertainty about how effective the fish screens and fish barrier will be over the long operational life of the project (potentially 100 years).

If pest fish such as the Redfin Perch manage to get through the fish screens, this could result in impacts on a population of the endangered Macquarie Perch in the mid-Murrumbidgee River; and if Climbing Galaxias are able

to get over the fish barrier at Tantangara Creek, this is likely to result in significant impacts on the only known population of the critically endangered Stocky Galaxias.

To avoid this occurring, the Department has recommended conditions requiring Snowy Hydro to:

- develop a detailed captive breeding program for these two fish species involving the spending $5 million over 5 years during construction to establish self-sustaining, "insurance" populations of these species in the surrounding region; and
- review this program after five years, and develop a detailed trigger, action and response plan for the expansion of this program over time, if necessary.
- prepare a detailed Biosecurity Management Plan for the project to minimise the development-related biosecurity risks of the project associated with the movement or spread of aquatic weeds, pest fish and aquatic pathogens;
- minimise the impacts of the project on other threatened fish species and their habitat within the disturbance area; and
- develop a detailed Recreational Fishing Management Plan, which includes a program involving the spending of $5 million over 5 years during construction to develop the capability to restock, and to restock, the Tantangara Reservoir and Lake Eucumbene with salmonid fish.

With these conditions in place, the NSW Department of Primary Industries has advised the Department that it would be willing to grant Snowy Hydro the authorisations it requires under the *Biosecurity Act 2015* in order to be able to operate the project.

6.6. Other Issues

Table 11 | Summary of other issues raised

Issue	Findings	Recommended Conditions
Surface Water	*Construction* • Snowy Hydro proposes to manage surface water by diverting clean water around disturbed areas and capturing sediment laden runoff in basins. There would be no direct discharge to watercourses, with up to 50% of collected surface water reused for construction activities. • Subsurface works, including underwater blasting, dredging, channel excavation and construction of fish screens, require active management for sediments and turbidity in the reservoirs. • The Department acknowledges the potential for short-term impacts to water quality and recommends a range of conditions to minimise impacts. These include limiting the disturbance areas and requiring Snowy Hydro to prepare a detailed water management plan for each construction site. • Snowy Hydro would be required to comply with an Environment Protection Licence and must carry out all instream works in accordance with relevant guidelines. • Process water from construction activities including groundwater inflows into tunnels and excavations may have elevated salinity and metals. This water would be treated in wastewater treatment plants located near the tunnel portals, prior to discharge to the reservoirs. • Wastewater from construction compounds and accommodation camps would be treated and discharged	• Ensure adequate water supply for the development and obtain water licences. • Comply with legislation to ensure no pollution of waters. • Maximise reuse of water on site. • Implement erosion and sediment controls in accordance with *Managing Urban Stormwater: Soils and Construction*. • Carry out instream works in accordance with the *Guidelines for Controlled Activities on Waterfront Land*. • Treat all process water and wastewater prior to discharge.

Issue	Findings	Recommended Conditions
	to the reservoirs and would be designed to a tertiary level of treatment suitable for cold climate conditions. • Water supply for the project would be from groundwater sources and the two reservoirs, supplemented by reuse of surface water. *Operation* • No material changes to water quality are expected during operation. Infrequent dewatering of the tailrace tunnel for maintenance would require specific controls to manage potential impacts. • Snowy Hydro has confirmed there would be no change to the existing downstream water releases from the Snowy Scheme. • The Department has recommended conditions requiring Snowy Hydro to minimise the water quality impacts of all operational activities and detail specific management measures in the water management plan.	• Prepare a water management plan covering all construction sites and operational activities, for the Planning Secretary's approval prior to construction.
Groundwater	• Groundwater modelling predicted the project would result in drawdown (5 m) in the Gooandra Volcanics, between the upper Eucumbene River and Gooandra Creek and drawdown (0.5m) for 2 km either side of the tunnel in the Gooandra Volcanics. • Modelling also predicted there would be an estimated reduction in baseflow to Goondra Creek of 6% and a reduction of around 1% is predicted for the upper Eucumbene River. • There would be negligible impact on the Alpine Sphagnum Bogs and Fens. • The Department notes that the groundwater modelling for the project was conservative and did not include proposed pre and post grouting of the tunnels in areas of high hydraulic connectivity. The modelling did include optimised excavation sequencing (where areas of highest inflow are open for the shortest periods) and concrete lining of the tunnels. • The Department appointed an independent expert, HydroAlgorithmics, to review the modelling. The reviewer confirmed the modelling was conservative and concluded the modelling was prepared in accordance with best practice and demonstrated there would be inconsequential disruption to groundwater systems by tunneling. • The Department recommends Snowy Hydro prepare a groundwater management plan including continued monitoring and re-calibration of the modelling during construction. • The Department has required Snowy Hydro to minimise groundwater take from the Gooandra Volcanics and Kellys Plain Volcanics by pre and post-grouting the tunnel and requires reporting on groundwater inflows and corresponding impacts on aquifers and baseflows.	• Minimise groundwater take from the Gooandra and Kellys Plains Volcanics by pre and post grouting the tunnel in these areas. • Minimise loss of streamflows from Gooandra Creek and the upper Eucumbene River. • Minimise groundwater quality impacts through design of temporary and permanent spoil emplacements and on-site water storages. • Prepare a groundwater management plan including on-going monitoring and reporting on groundwater take and the impacts on aquifers and baseflow. • Re-calibrate the groundwater model with monitoring data, during construction.
Flooding	• The project would result in minor and localised changes in flooding impacts and flood hazard at Lobs Hole along the Yarrangobilly River but would not impact on existing infrastructure.	• Prepare an emergency management plan including flood response procedures.

Issue	Findings	Recommended Conditions
	• Accommodation camps would be constructed above the Probable Maximum Flood (PMF) level and Snowy Hydro would prepare an Emergency Plan including flood response procedures. • Risks to public safety from flooding would be limited as construction areas would be closed to the public. • There would be no significant change to flooding characteristics at Talbingo or Tantangara reservoirs during construction or due to placement of excavated material in the reservoirs. Similarly, there would be no significant change to flooding characteristics at Kellys Plain Creek or Rock Forest. • Final rehabilitation of recreational areas at Lobs Hole would be established above the PMF. • The Department recommends Snowy Hydro detail procedures to manage flood risks in an emergency management plan.	
Heritage	• The project would have minor impacts on the heritage values of the Australian Alps National Parks and Reserves and KNP, including minor impacts on glacial block streams for widening of Lobs Hole Ravine Road. • Construction areas would be rehabilitated on completion and permanent infrastructure located outside of distinctive landscapes to minimise heritage impacts. • The project would directly impact 178 historic heritage items of local significance, including some items around the former Lobs Hole mining area. Impacts would be managed via a heritage management plan, including archival recording and salvage of significant items. • Items of significance at Lobs Hole, including the Washington Hotel and Ravine Cemetery would be avoided and the tufa deposits at Lick Hole Gully and Cave Gully would be avoided. • The project would have full or partial impacts on Aboriginal heritage sites in the disturbance footprint. • The Aboriginal Cultural Heritage Assessment for the project concluded that none of the items are of sufficient significance to warrant avoidance and recommended management via a heritage management plan. • One significant rock shelter site to the west of the disturbance area at Tantangara would be protected.	• Avoid impacts on heritage items outside of the construction envelope, including the rock shelter and tufa deposits. • Archival recording, test excavation and salvage of impacted items. • Conduct detailed recording of the history of Lobs Hole, including the boulder streams and fossiliferous beds on Lobs Hole Ravine Road. • Implement a heritage management plan, prepared in consultation with key stakeholders.
Recreation	• Impacts on recreational users of KNP would be temporary during construction. • Public access to Tantangara reservoir, via Tantangara Road would be restricted whist the road is upgraded (9 months). Works would be scheduled to avoid the peak summer camping period. • There would be extended closure of Lobs Hole Ravine Road and campground for the construction period and it would be rehabilitated following construction. • The Department recommends Snowy Hydro inform the community about temporary closures and re-open recreational areas as soon as possible after construction.	• Pay NPWS $1,995,000 to offset the recreational impacts on KNP. • Develop a digital application for users of KNP to enhance their knowledge and enjoyment of the park. • Reinstate and maintain public access to Tantangara Road once upgraded.

Issue	Findings	Recommended Conditions
	• Amenity impacts, including visual, noise, dust and traffic would be minimised through environmental controls. • Recreational fishing at Tantangara and Talbingo would be impacted during construction with temporary disruptions to boat ramp access and a potential for water quality impacts. These impacts would be minimised through specific recreation mitigation measures and water quality controls. • During operation, there is potential for impacts on recreational fishing in Tantangara reservoir and Lake Eucumbene due to changes in water quality or if pest fish are transferred from Talbingo and establish viable populations to compete with salmonid fish. • These impacts would be offset through a recreational fishing management plan, including a payment of $5,000,000 to develop capability for restocking salmonid fish in Tantangara and Lake Eucumbene. • Permanent exclusion zones would be established around the water intakes at Tantangara and Talbingo. These would not limit recreational access. • There would be long-term improvements for recreational users of KNP, through upgraded road access and new facilities at Tantangara and Lobs Hole. These would be developed through a recreation management plan in consultation with NPWS and DPI-Fisheries. • The Department recommends Snowy Hydro pay $1,995,000 to NPWS (in addition to funds already paid for the Exploratory Works) to offset the recreational impacts on KNP, with the funding used to enhance recreational facilities around Talbingo, Lobs Hole and Tantangara. • The Department also recommends Snowy Hydro develop a digital application for users of KNP to bring to life all information collected during the impact assessment.	• Minimise impacts on KNP users and keep community informed of temporary closures. • Re-open closed areas to the public as soon as possible. • Prepare a recreation management plan incorporating recreational facilities into final rehabilitation. • Prepare a recreational fishing management plan, including payment of $5,000,000 to develop capability for restocking salmonid fish.
Traffic	• The main roads used for the project, including Snowy Mountains Highway (SMH), Link Road and Lobs Hole Ravine Road, have adequate spare capacity to accommodate peak construction traffic from the project and the low volumes associated with operation. • Some upgrades are required to these roads to improve accessibility and safety, including widening of Lobs Hole Ravine Road and Link Road. • Intersection upgrades are also required to access construction areas in KNP and two intersections in Cooma require minor upgrades to enable access for over-size over-mass (OSOM) vehicles delivering tunnel boring machines and transformers to the site. • TfNSW are also undertaking works to the SMH, including passing bays and intersection works in Cooma to ease congestion during the ski-season peaks. • Snowy Hydro would manage peak construction traffic by scheduling heavy vehicle movements, using buses to transfer workers to accommodation camps, maintaining an incident response vehicle for the project and restricting vehicle speeds and volumes on specific routes. • Specific restrictions would be in place to minimise the potential for vehicle strikes of threatened fauna, as well as	• Upgrade roads and intersections. • Survey and repair any damage to roads. • OSOM vehicles to adhere to specified routes. • Restrict vehicle speeds and volumes on specific routes. • Maintain access for NPWS officers. • Schedule heavy vehicle movements and rapidly respond to incidents. • Comply with marine safety legislation. • Implement a transport management plan.

Issue	Findings	Recommended Conditions
	provision of road underpasses and fencing in areas of known habitat. • Access to construction areas within KNP for NPWS officers would be maintained. • The Department requires Snowy Hydro to prepare a long-term strategy in consultation with NPWS for the rehabilitation of roads post construction and details of permanent upgrades required for operation. • The Department also recommends conditions for road dilapidation surveys and repair of damage, as well as compliance with marine safety legislation for barge and boat traffic on Talbingo and Tantangara reservoirs.	• Prepare a long-term transport strategy for KNP covering operational access and rehabilitation.
Visual	• Visual impacts during construction would be high when viewed by recreational users on Talbingo and Tantangara reservoirs. The water intakes, control buildings, barge ramps, portals, stockpiles and accommodation camp would be clearly visible. • Rehabilitation and incorporation of design measures would minimise these impacts over the long term, although the permanent infrastructure would be clearly visible from the water. • The revised spoil emplacement strategy would mimic natural landforms at Talbingo and Tantangara, reducing visual impacts, and ensuring the rehabilitated landforms integrate with the existing landscape. • The Rock Forest site would have adverse visual impacts for passing motorists and the closest residences for the 6 year construction period. • To minimise visual impacts during construction, the Department recommends Snowy Hydro progressively rehabilitate work areas and install suitable screening adjacent to the SMH at Rock Forest. • For the permanent infrastructure, the Department requires Snowy Hydro to submit final designs for approval, incorporating paints, textures and local materials to blend the infrastructure into the landscape.	• Progressively rehabilitate disturbed areas. • Install landscaping or suitable screening to shield the Rock Forest site. • Use paints, textured surfaces and locally sourced stone to blend permanent infrastructure into the landscape. • Incorporate textured surfaces along the shoreline of spoil emplacement areas. • Prepare a visual mitigation plan, including detailed plans for all permanent structures, for the Planning Secretary's approval.
Noise, vibration and blasting	*Noise* • Worst-case construction noise would be well below relevant EPA noise management levels at all recreational, commercial and residential locations, except for one residence located closest to the Rock Forest logistics site. • The Department recommends Snowy Hydro prepare a noise management plan for Rock Forest including measures such as limiting night-time use of the site or establishing a noise mitigation agreement with the landowners. • Road traffic noise was predicted to comply with the Road Noise Policy criteria, except for minor increases through Cooma, which relate primarily to the transport of concrete segments from the Segment Factory. • Noise from operation of the power station and associated infrastructure is predicted to comply with the Noise Policy for Industry at recreational areas in KNP.	• Minimise noise from construction, operation and decommissioning. • Implement a construction noise management plan for the Rock Forest site.

Issue	Findings	Recommended Conditions
	Vibration and Blasting • Snowy Hydro would use real-time vibration monitoring during works within 25 m of sensitive structures, such as Talbingo dam and spillway, Tantangara dam and identified heritage items, to ensure they are protected from structural and cosmetic damage. • Blasting would occur 24/7 for underground works with an estimate of one blast each night. • All rock structures, transmission lines and heritage items (including the rock shelter and cliff-edge Tufa deposits) are located outside the minimum blast offset distances.	
Air quality and greenhouse gas	*Air Quality* • The project would comply with relevant EPA criteria for particulates and nitrogen dioxide at all recreational areas in KNP and residences near the project area. • Due to elevated background levels at certain times, the project may contribute to exceedances of the relevant ambient air quality criteria at the Wares Yards campground. Snowy Hydro will need to adjust its work practices during these times, to minimise cumulative impacts, noting the campground will be closed to the public for parts of the construction period. *Greenhouse Gas (GHG)* • GHG emission estimates (direct and indirect) for construction total 154,281 tonnes of carbon dioxide equivalent per year (t CO_2-e/yr) and 515,789 t CO_2-e/yr for operation. • This equates to 0.03% and 0.10% of total annual GHG emissions for Australia, respectively, with a proportionate contribution to global climate change. • Most of the emissions would be Scope 2 associated with the purchase of electricity when operating the scheme in pumping mode. These emissions would reduce over time as coal-fired power stations are retired and the NEM transitions to renewable energy. • Snowy Hydro would implement measures to minimise construction and operational emissions, including regular maintenance of plant and equipment and minimising construction waste and vegetation clearing.	• Implement all reasonable and feasible measures to minimise dust, odour, fume and blast emissions from the development.
Bushfire and emergency management	• All permanent infrastructure would be designed to meet the requirements of Planning for Bushfire Protection (2018) (PBP) and Australian Standards for buildings in bushfire prone areas. • Snowy Hydro would maintain asset protection zones around each construction site and accommodation camp and ensure these areas are located wholly within the disturbance footprint. • Access and egress for emergency services, defendable spaces, on-site refuges and safe evacuation routes would be provided in accordance with relevant guidelines. • Snowy Hydro would manage bushfire risks via an emergency management plan, which is consistent with the KNP Fire Management Strategy.	• Maintain asset protection zones and design buildings in accordance with PBP and relevant Australian Standards. • Prepare and implement an emergency management plan.

7. Evaluation

The Snowy 2.0 Project is essential for the NSW economy as it would provide up to 2,000 megawatts of electricity to the NEM as it transitions away from a long-standing reliance on coal-fired power stations. Consequently, all components of the project have been classified as CSSI under the EP&A Act and require the approval of the Minister for Planning and Public Spaces before they may proceed.

The Main Works is critical for energy security and reliability in NSW, would maximise the use of the existing Snowy Scheme and would deliver significant economic benefits to NSW and the Snowy Mountains region, including attracting at least $4.6 billion of capital investment, creating 2,000 construction jobs and helping to reduce electricity prices.

The Department has carried out a detailed assessment of the merits of the Main Works in accordance with all relevant NSW legislation, policies and guidelines. It has also consulted widely with the community and key government agencies, and closely considered the issues they have raised during this consultation in its assessment.

The critical issues on this project were the impacts on the KNP including spoil management and impacts on flora and fauna and impacts on aquatic environments.

The Department has worked closely with key government agencies to reduce the construction impacts of the project as much as possible and has prepared recommended conditions of approval for the Main Works requiring a range of controls to minimise the impacts of the project.

Following changes to the project and the provision of additional information by Snowy Hydro, none of the government agencies object to the project and all of them support the recommended conditions of approval.

Based on its assessment, the Department has concluded that the project:

- has been designed to minimise any adverse impacts on the KNP, including reducing the footprint of the project during construction to around 0.1% of the KNP, and that
- the residual impacts of the project can be reduced to an acceptable level by requiring Snowy Hydro to:
    - comply with strict standards and performance measures to minimise the water quality, dust, noise, visual, and safety risks of the project during construction and operations;
    - prepare detailed management plans for the project prior to construction, including plans to reduce any traffic impacts in Cooma and on the Snowy Mountains Highway and plans to respond to any emergencies on site, such as the recent bushfires;
    - monitor and publicly report on the impacts of the project;
    - rehabilitate the site to a high standard following construction, including fully restoring native vegetation and threatened species habitat to the disturbed areas within the KNP and providing enhanced recreational facilities at Lobs Hole and the Tantangara Reservoir;
    - pay the NPWS up to $75.8 million (on top of the $13.46 million already paid for the exploratory works) to fund actions to enhance the values of the rest of the KNP and offset the residual biodiversity and recreational impacts of the project;

- minimise the biosecurity risks of the project during the operations, particularly the movement of pest fish and diseases between the two reservoirs and downstream to Lake Eucumbene and the Murrumbidgee River as this could have significant impacts on threatened fish and recreational fishing in these water bodies;
- install fish screens/barriers to protect the endangered Macquarie Perch and critically endangered Stocky Galaxias from these pest fish and diseases so far as is reasonably practicable;
- spend $5 million in the first 5 years of the project on a captive breeding program to establish self-sustaining, "insurance" populations of the Macquarie Perch and Stocky Galaxias;
- spend $5 million in the first 5 years on a program to restock the Tantangara Reservoir and Lake Eucumbene with salmonid fish to offset any recreational fishing impacts of the project; and
- expand both these programs (if necessary) to address any additional risks identified during monitoring.

If the Main Works are approved, Snowy Hydro will be required to pay the NPWS around $89.26 million to offset the residual impacts of the Snowy 2.0 on the KNP, with around $82.29 million of these funds going towards improving the biodiversity values of the KNP and the remaining funds towards enhancing the existing recreational facilities in the KNP and other conservation initiatives.

From a biodiversity perspective, the NPWS intends to use the funds to significantly improve catchment health in the iconic KNP and deliver real benefits for key threatened species and communities. This includes carrying out actions to:

- restore Alpine catchments and ecosystems;
- undertake landscape-wide programs to control weeds and feral animals across the KNP;
- enhance the protection and recovery of several threatened species and communities within KNP, including those affected by the Snowy 2.0 Project and the recent bushfires; and
- deliver captive breeding programs for key threatened species, such as the critically endangered Smoky Mouse.

On balance, the Department believes the project is in the public interest and should be approved subject to conditions.

8. Recommendation

It is recommended that the Minister for Planning and Public Spaces:

- **considers** the findings and recommendations of this report; and
- **accepts and adopts** all of the findings and recommendations in this report as the reasons for making the decision to grant approval to the application;
- **agrees** with the key reasons for approval listed in the notice of decision;
- **grants approval** for the application in respect of SSI 9687 as amended, subject to the conditions in the attached development project approval; and
- **signs** the attached project approval and recommended conditions of approval (see attachment).

Recommended by:

19/5/20

Nicole Brewer
Director
Energy Assessments

Recommended by:

19/5/20

David Kitto
Executive Director
Special Projects

Appendices

Appendix A – Environmental Impact Statement

See the Department's website at https://www.planningportal.nsw.gov.au/major-projects/project/12891

Appendix B – Submissions

See the Department's website at https://www.planningportal.nsw.gov.au/major-projects/project/12891

Appendix C – Response to Submissions and Preferred Infrastructure Report

See the Department's website at https://www.planningportal.nsw.gov.au/major-projects/project/12891

Appendix D – Additional Information

Including:

- Snowy 2.0 Main Works – Preferred Infrastructure Report – Response to request, prepared by EMM dated 24 March 2020
- Response to DPIE RFI – on land emplacement areas, prepared by EMM dated 7 April 2020

See the Department's website at https://www.planningportal.nsw.gov.au/major-projects/project/12891

Appendix E –Representations from the National Parks Association of NSW

NATIONAL PARKS ASSOCIATION OF NSW
protecting nature through community action

David Kitto
Director Resource and Energy Assessments
Department of Planning, Industry and Environment
By email to: Anthony.Ko@planning.nsw.gov.au

14 January 2020

Dear David,

Thank you for the meeting on 18 December 2019 to discuss NPA's concerns about the Snowy 2.0 project.

NPA recognises the difficult position that the NSW Government faces in assessing a project of unprecedented scale and impact in a National Park, especially one supported by the Commonwealth. We also appreciate that our assertions, and those of numerous other commentators, contradict advice provided by a government-owned corporation.

Our detailed analysis has revealed that most of the claimed benefits of Snowy 2.0 are overstated or false. This conclusion has been reached after consultation and involvement of experts with extensive experience in hydro-electric schemes including Snowy Hydro, power system operations, the National Electricity Market, energy storage systems, renewable energy, demand response, economics and the environmental sciences.

If constructed, Snowy 2.0 would:

- lose nearly half the energy it stores, far more than other energy storages
- be powered by coal for the next decade or so, not renewable energy
- increase greenhouse gas emissions
- not have the energy storage capacity claimed and take 3+ months to recharge from empty
- not be required till 2029 (or at all, as there are other better alternatives)
- require major transmission upgrades and incur significant network losses due to its location
- be poorly located in terms of security of supply, as demonstrated by the recent fires
- be dispatched after competitors, due to their lower losses
- push electricity prices up, not down
- be uneconomic, costing far more than its estimate of $3.8 - $4.5 billion
- deliver market benefits less than half its cost
- leave a legacy of extensive permanent damage to Kosciuszko National Park

It is essential that the veracity of the benefits claimed by Snowy Hydro is subject to the most rigorous scrutiny. Our strong view is that the project does not comply with the core Ecologically Sustainable Development (ESD) principles of intergenerational equity, the conservation of biodiversity and ecological integrity. These ESD principle are never more important than when assessing a development proposal in a National Park - a place that past governments have set aside for the express purpose of biodiversity conservation and for the benefit of future generations.

We urge the NSW Government to seek independent assessments of the claimed community benefits of Snowy 2.0. As discussed at our meeting, NPA would be pleased to introduce you to some of the experts who have contributed to our analysis of the shortcomings of the project. Sharnie Connell will be in touch to organise an appropriate meeting time.

It would be tragic if Snowy 2.0 were approved on the basis of overstated claims that were never fully tested and later prove to be false.

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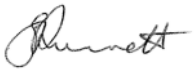
Yours sincerely,



Gary Dunnett
Executive Officer
National Parks Association of NSW
protecting nature through community action

Environmental Defenders Office

27 February 2020

Gary Dunnett
Executive Officer
National Parks Association of NSW

By email only: garyd@npansw.org.au

Dear Gary

Environmental Impact Assessment for Snowy Hydro 2.0

1. We refer to your request for advice on various aspects of the environmental impact assessment concerning the Snowy Hydro 2.0 proposal (**Project**), which is declared Critical State Significant Infrastructure (**CSSI**). Specifically, you have requested advice on:

    a. Whether there are any requirements to consider the cumulative impacts of the separate development applications comprising the Project; and

    b. Whether the proponent has a legal obligation to set out in the environmental impact statement (**EIS**) any alternatives to the Project (or any alternative locations or designs for the Project) that would result in less impact to Kosciusko National Park.

Summary of advice

2. On 7 March 2018, the Minister for Planning declared the Project to be CSSI under s 5.13 of the *Environmental Planning and Assessment Act 1979* (NSW) (**EP&A Act**) and cl 9 of Schedule 5 of the State Environmental Planning Policy (State and Regional Development) 2011.

3. As at the date of this advice, there appear to be four applications comprising the Project listed on the Major Projects website (plus two modification applications) in various stages of progress in the environmental impact assessment process.

4. The proponent is required to consider the cumulative environmental impacts of the Project by virtue of the following:

    a. the mandatory requirement to comply with the statutory criteria for the EIS (which require consideration of the cumulative impacts of the Project as part of the requirement to consider the principles of Ecologically Sustainable Development (**ESD**)) set out in the Environmental Planning and Assessment Regulation 2000 (NSW) (**EP&A Regulation**); and

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b. the mandatory requirement to comply with the Secretary of Planning's environmental assessment requirements (**SEARs**) for the Project (which specifically require consideration of the cumulative impacts of the Project).

5. Similarly, the proponent is required to set out in the EIS any alternatives to the Project that would result in less impact to Kosciusko National Park by virtue of the following:

a. the mandatory requirement to comply with the statutory criteria for the EIS set out in the EP&A Regulation (which specifically require consideration of any feasible alternatives for the Project); and

b. the mandatory requirement to comply with the SEARs (which also specifically require consideration of any feasible alternatives for the Project).

6. We note that if the proponent has not complied with these mandatory requirements, the Planning Secretary has the power to require the proponent to submit a revised EIS to address the SEARs.[1]

Requirements to consider cumulative environmental impacts

Requirement to justify infrastructure having regard to ESD principles

7. When an application for CSSI is made, the Secretary of Planning is to prepare the SEARs, which must require that an EIS be prepared on behalf of the proponent in the form prescribed by Schedule 2 of the EP&A Regulation.[2]

8. Clause 7 of Part 3, Schedule 2 of the EP&A Regulation specifies what is required to be included in the EIS. Specifically, the EIS must provide reasons justifying the carrying out of the CSSI in the manner proposed, having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development (**ESD**).

9. We further note that the Main Works SSI application is currently subject to the Assessment Bilateral Agreement between NSW and the Commonwealth. NSW has an obligation under that Agreement to ensure that it has regard to principles of ESD when assessing the Project.[3]

10. Specific principles of ESD are set out in cl 7 of Part 3, Schedule 2 of the EP&A Regulation. In order to allow for proper consideration of these principles, especially the precautionary principle, intergenerational equity and the conservation of biological diversity and ecological integrity, we consider the proponent would necessarily be required to include consideration of the cumulative environmental impacts of the Project in the EIS, especially in the context of this being a single Project split into a number of separate applications.

11. We also note that the Intergovernmental Agreement on the Environment (1992) to which NSW was and remains a party, requires NSW to give effect to the principles of ESD, including "the assessment of the regional cumulative impacts of a series of

[1] *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act), s 5.17(2).
[2] EP&A Act, s 5.16(2); EP&A Regulation, Schedule 2, Part 3, cl 5.
[3] NSW-Commonwealth Assessment Bilateral Agreement (26 February 2015), cl 7.5.

developments and not simply the consideration of individual development proposals in isolation."[4]

12. Further, we note that several decisions of the Land and Environment Court including *Kivi v Forestry Commission of NSW* (1982) 46 LGERA 38 and *Hastings Point Progress Association Inc v Tweed Shire Council* [2008] NSWLEC 180 have indicated that in assessing projects under the EP&A Act, cumulative impacts of development should be considered. These decisions have turned on requirements in the EP&A Act to consider impacts on the "environment".

Requirement to comply with the SEARs

13. In addition to the regulatory criteria for the content of an EIS, an assessment of cumulative impacts is also required by virtue of the proponent's mandatory requirement to comply with the SEARs. Clause 13 of Part 4, Schedule 2 of the EP&A Regulation provides that an EIS must comply with the SEARs.

14. There are four SEARs that have been issued for the applications for the four stages of the Project (Main Works SSI 9687, Exploratory Works SSI 9208, Segment Factory SSI 10034 and Transmission Connection SSI 9717). We note that each of the four SEARs explicitly refer to the mandatory requirement for the EIS to include an assessment of the cumulative impacts of the proposed infrastructure.

15. For example, in the SEARs dated 31 July 2019 for the infrastructure entitled, Main Works SSI 9687, the SEARs require a consideration of "any other existing, approved or proposed projects that could result in cumulative impacts with the project".[5] This clearly indicates that the EIS must include an assessment of the cumulative impacts of each stage of the Project, and the environmental impacts of the Project as a whole (including approved and proposed stages of the Project).

Requirements to assess feasible alternatives

Statutory requirements to provide an analysis of feasible alternatives

16. Clause 7(1)(c) of Part 3, Schedule 2 of the EP&A Regulation sets out the requirement for the EIS to include "an analysis of any feasible alternatives to the carrying out of the development, activity or infrastructure, having regard to its objectives, including the consequences of not carrying out the development, activity or infrastructure".

17. Each EIS should examine the other feasible alternatives to the proposed Project, including an examination of alternative pumped hydro schemes within the existing Snowy Scheme, in light of the expected significant environmental impacts of the proposed Project. Further, the EIS should include an analysis of feasible alternatives within the Project (e.g. alternative locations or designs) which would result in fewer impacts on Kosciuszko National Park.

[4] Intergovernmental Agreement on the Environment, Schedule 2, cl 3.2.
[5] Main Works SSI 9687, SEARs (31 July 2019), p 1.

Requirement to comply with the SEARs

18. As noted above, Clause 13 of Part 4, Schedule 2 of the EP&A Regulation requires the EIS to comply with the SEARs.

19. In the two sets of SEARs dated 31 July 2019 for the infrastructure entitled, Main Works SSI 9687 and Segment Factory SSI 10034, the Secretary has required an assessment of the alternatives to the Project that were considered. In the SEARs dated 4 February 2019 for the infrastructure entitled, Transmission Connection Project SSI 9717, the Secretary has required the assessment to include "why the proposed project is preferred over other alternatives, including detailed consideration of alternative options and routes (including other existing easements and connections to other transmission lines)".

Secretary's power to require a revised EIS

20. As noted above, compliance with the SEARs is a mandatory requirement under the EP&A Regulation. This is further reflected in the EP&A Act, which gives the Planning Secretary the power to require the proponent to submit a revised EIS to address the SEARs if they have not been complied with.[6]

If you wish to discuss this advice, please contact us on (02) 9262 6989.

Yours sincerely
EDO NSW

Rana Koroglu
Special Counsel

Ref: 1927056

[6] EP&A Act, s 5.17(2).

NATIONAL PARKS ASSOCIATION OF NSW
protecting nature through community action

The Hon Robert Stokes MP
Minister for Planning and Open Spaces
https://www.nsw.gov.au/your-government/ministers/minister-for-planning-and-public-spaces/

cc: The Hon Matt Kean MP, Minister for Energy and Environment, david.kitto@planning.nsw.gov.au; anthony.ko@planning.nsw.gov.au

2 March 2020

Dear Minister Stokes,

Snowy 2.0 lack of consideration of alternatives and cumulative impacts

The National Parks Association of NSW (NPA) wrote on 15 April 2019 requesting that you review a Department of Planning, Industry and Environment decision not to require Snowy Hydro to provide an assessment of feasible alternatives in the Environmental Impact Statement (EIS) for the Snowy 2.0 Exploratory Works.

The Department replied on your behalf on18 July 2019, noting NPA's concerns and stating that the *"the EIS for the Snowy 2.0 main works will be required to consider these issues in detail in accordance with the assessment requirements issued by the Department (i.e. SEARs)."* [Issues listed included *"the consideration of alternatives for Snowy 2.0, including the use of existing infrastructure within the Snowy Scheme"*].

NPA submitted a follow-up request in August 2019 for you to review the Department's decision to not require an assessment of feasible alternatives in the Exploratory Works EIS, but we have not received a response. We remain of the view that it is appropriate for you to respond.

When the Main Works EIS was released in September 2019 NPA was dismayed with the dismissive 'assessment' of alternatives, which goes nowhere near complying with the requirements referred to in the Department's correspondence of July.

Snowy Hydro's 'assessment' of feasible alternatives consists of just two paragraphs (page 1-13 in Part 1 of the EIS), a table and diagram, out of some 8,000 pages of exhibited documentation.

The 'assessment' is supposedly based on a 1991 internal report - a document that Snowy Hydro has refused to make available on the patently spurious grounds of being commercial-in-confidence. What possible commercial advantage could be gained by a competitor from seeing this out-of-date report? One would suspect that Snowy Hydro do not wish the report to be made public as it would reveal the complete lack of analysis to justify Snowy 2.0.

The Main Works EIS states that the report considered *"ten conventional hydro power alternatives and four pumped hydro alternatives"*. The lowest cost pumped hydro alternative, the Yarrangobilly Pumped Storage Scheme, was *"not considered economic at the time largely due to the comparative cost of gas turbines"*. It is noted that the Yarrangobilly Scheme was for a 990 MW station, just half the size of Snowy 2.0.

It is dismissive in the extreme of Snowy Hydro to try to justify Snowy 2.0 on a 30-year-old report that considered just four pumped storage alternatives, none of which included the 2,000 MW Snowy 2.0 project. There are many more pumped storage alternatives within the Snowy Scheme. NPA has identified several and there likely to be many more – see Appendix A of NPA's submission on the

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Main Works EIS for some examples. Obvious alternatives include a greater utilisation of Tumut 3, an existing pumped hydro facility within the Snowy Scheme which has barely been used to date.

Snowy Hydro has manifestly not complied with the SEARs nor Clause 7(1)(c) of Schedule 2 of the *Environmental Planning and Assessment Regulation* requiring *"an analysis of any feasible alternatives to the carrying out of the development, activity or infrastructure"*.

It is beyond belief that Snowy Hydro would consider the two paragraphs in the EIS as fulfilling the requirements of the SEARs and EP&A Regulation for an unprecedented multi $billion project in a National Park. The EIS fails to address the Department's advice that the Main Works EIS "*will be required to consider these issues in detail".* Not only does the 'assessment' not include all *"feasible alternatives"*, it does not provide a comparison of respective engineering, cost or, most relevantly, environmental impacts of the four alternatives in the 1991 report.

Compounding our concerns about alternatives is the inadequate assessment of cumulative impacts in the Main Works EIS. Our submission on the EIS details environmental values for which the failure to consider cumulative impacts of previous developments across Kosciusko National Park is particularly problematic.

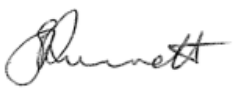
In our view, the failures to appropriately assess alternatives and cumulative impacts fundamentally compromises the principles of Environmentally Sustainable Development and thereby unreasonably constrains your capacity to make an informed decision on the environmental impacts of the Snowy 2.0 development. Snowy Hydro must address both issues in accordance with the SEARs and resubmit the Main Works EIS.

NPA sought advice from the Environmental Defenders Office on a proponent's obligations to assess alternatives and cumulative impacts under the *Environmental Planning and Assessment Act*. A copy of that advice is attached for your information.

If your office has any questions on these issues I can be contacted at garyd@npansw.org.au or on 9299 0000.

We understand that you have met with Snowy Hydro and given the standing of the NPA and the qualifications of those advising it of which you are aware, we would suggest that it is appropriate that we be given a similar opportunity to personally brief you on the many failings and overstated claims of Snowy 2.0.

Yours sincerely,



Gary Dunnett
Executive Officer
National Parks Association of NSW
protecting nature through community action

09 March 2020

Dear Minister Stokes,

Snowy 2.0 Claims Don't Stack Up and must be subject to a comprehensive independent review

The National Parks Association of NSW (NPA) opposes Snowy 2.0 on environmental grounds, as an infrastructure project of such immense scale is totally inappropriate in the fragile alpine environment of Kosciuszko National Park. As well as causing substantial permanent damage to the Park, the project does not stack up financially, technically or as the best energy storage option.

NPA released a second research paper on 26 February 2020, "Snowy 2.0 claims don't stack up". I hasten to add that this and the initial NPA Paper have been peer reviewed by a couple of dozen experts – ex-Snowy engineers, power systems operations engineers, renewable energy experts, National Electricity Market analysts, economists and environmentalists.

The paper reviews the (10) central claims for the Snowy 2.0 and finds that they are overstated and, in some cases, false.

The key findings of the latest Paper are that Snowy 2.0 will:

1. lose 40% of the energy it stores – more inefficient than other pumped hydro schemes and other energy storage options. It will lose 4 times more energy than batteries.
2. be a coal-powered storage well into the 2030's, not a renewable energy storage
3. incur 50 million tonnes of greenhouse gas emissions during construction and its first decade of operation (applying Snowy Hydro's pumping forecasts). By contrast, storage at renewable generator sites incurs zero GHG emissions
4. be almost idle until 2029 according to the latest AEMO forecasts
5. be in the worst location, requiring major transmission upgrades, incurring far greater network losses than other storage and be exposed to transmission constraints, as evidenced during the recent bushfires
6. run against the trend of a decentralised National Electricity Market
7. rarely have the claimed 350 GWh of storage capacity; and take 3+ months to recharge from empty
8. push electricity prices up, not down (according to Snowy Hydro's own modelling)
9. be uneconomic, costing far more than $3.8 - $4.5bn (updated from the original $2bn estimate). A $5.1bn contract for part of the works has been awarded
10. have market benefits less than half its cost

11. leave a legacy of permanent damage over 10,000 ha of Kosciuszko National Park, including:

- 14 million m3 of excavated spoil, some contaminated with naturally occurring asbestos and potentially-acid-forming rock, with two-thirds to be dumped in Snowy reservoirs
- four high voltage transmission circuits on twin towers with a 120 m easement for 10 kms through the Park
- over 100 kms of new or widened roads and tracks
- depressed water tables and stream flows above sections of the tunnel
- destruction of 1,000 ha of habitat for 14 threatened species
- spread of pest fish and diseases throughout the Snowy Scheme and downstream rivers, devastating the aquatic environment and alpine fishing; extinction of a critically endangered species
- infrastructure and landscape scars across 30km of the alps

It is now manifestly clear that Snowy 2.0 is not as it has been portrayed.

It is well time for the Commonwealth and NSW Governments to establish an independent expert Review Panel to rigorously assess Snowy 2.0 and alternative energy storage options. NPA is confident that such a Review would conclusively determine that the project is unviable, inferior to alternative storage options and that environmental approval should be refused.

It would be tragic if Snowy 2.0 was constructed on the premise of overstated claims that were never tested and later proven to be false. At stake are $billions of taxpayers' money, tens of millions of tonnes of greenhouse gas emissions and thousands of hectares of Kosciuszko National Park.

I am keen to personally brief you about our concerns and can be contacted on 02 9299 0000 or at president@npansw.org.au.

Yours faithfully,

Anne Dickson
President

Link to the claims paper
https://npansw.org/wp-content/uploads/2020/02/Snowy-2.0-claims-dont-stack-up.pdf.
Link to recent media Renew Economy 27th Feb 2020

NATIONAL PARKS ASSOCIATION OF NSW
protecting nature through community action

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20 March 2020

Snowy 2.0 Main Works - Preferred Infrastructure Report and Response to Submissions

Dear David,

The National Parks Association of NSW (NPA) appreciates the invitation from Department of Planning, Industry and Environment (DoPIE) to provide feedback on the Preferred Infrastructure Report (PIR) and Response to Submissions (RTS) prepared by Snowy Hydro and released on the Major Project website.

NPA notes that the PIR makes a number of changes to the proposal, including a claimed (but disputable) reduction in the disturbance area within Kosciuszko National Park (KNP). However, the scale and intensity of residual impacts remains unprecedented in a protected area context, involving the destruction of more than 600 hectares of threatened species habitat and probably driving an entire species, the Stocky Galaxias, to extinction. The area or Park that will be left permanently damaged will be of the order of 100 square kilometres.

The information provided in the PIR makes it clear that Snowy Hydro is simply unable or unwilling to mitigate a range of significant impacts including dumping 14 million cubic metres of spoil (some contaminated) in the Park and the transfer of aquatic pests and pathogens throughout and beyond the Snowy Scheme. NPA is particularly concerned that the PIR and RTS does not address the cumulative impacts of the proposal on KNP, the generation of excessive quantities of greenhouse gas emissions by the project or feasible alternatives.

We refer to our previous communications and particularly the two research Papers “Snowy 2.0 doesn’t stack up” and “Snowy 2.0 claims don’t stack up”, which provide conclusive evidence that the claimed benefits of Snowy 2.0 are overstated and in some cases false. The Papers and NPA’s Main Works EIS Submission also highlight the many better energy storage alternatives to Snowy 2.0 and its unprecedented and completely unacceptable environmental impacts on Kosciuszko National Park.

The detailed comments below includes analysis of the excessive commercial benefits Snowy Hydro derives from the use of KNP, including for the disposal of wastes that would otherwise attract fees in the vicinity of a billion dollars.

For these reasons and others as detailed below the NPA remains firmly of the view that the environmental impacts of the proposal are entirely inappropriate in a protected area and that the Minister for Planning should deny project approval.

We also note that the EIS for the Transmission Lines connecting Snowy 2.0 to the electricity grid has yet to be exhibited. As Snowy 2.0 cannot operate without these transmission circuits and they will also incur substantial environmental damage on KNP, it would be premature and inappropriate for consideration of the Main Works EIS in isolation of consideration of the Transmission Lines EIS. Both EISs must be considered concurrently (together with the Exploratory Works and Segment Factory EISs).

NPA obtained advice from the Environmental Defenders Office (EDO) confirming the need for the EIS to address feasible alternatives and cumulative impacts (advice was previously forwarded to the Department and Minister). Neither the EIS nor the PIR have adequately addressed these two fundamental requirements.

NPA, together with a wide cohort of experts (environmentalists, energy industry leaders, ex-Snowy engineers, NEM specialists, renewable energy experts, economists), are calling on the NSW and Commonwealth Governments to undertake a comprehensive review of Snowy 2.0 by independent experts. The multiple concerns over all aspects of Snowy 2.0 and its claimed benefits are overwhelming and need to be properly reviewed, something that has not been undertaken to date, before the project can be properly assessed for its environmental impact.

Our experts are continuing to analyse various facets of the Snowy 2.0 proposals and will be provide the department with further details as these come to light.

I am most willing to meet to discuss these issues and can be contacted at garyd@npansw.org.au or on 0432 757 059.

Yours sincerely,

Gary Dunnett
Executive Officer
National Parks Association of NSW
protecting nature through community action

Detailed comments

The Main Works EIS, as amended by the PIR, is seriously deficient in responding to the:

1. analysis of feasible alternatives
2. cumulative impacts of the proposal
3. rehabilitation strategy
4. changed environmental context as a result of the recent bushfires
5. overstated benefits to the National Electricity Market and community
6. dumping of excavated spoil, including hazardous materials, in KNP
7. transfer of prohibited pests, pathogens and weeds into currently unaffected waterways
8. likely extinction of the critically endangered Stocky Galaxias.
9. lack of detailed water balance information
10. lack of an appropriate assessment of greenhouse gas emissions
11. clear attempts to avoid appropriate offset payments for the environmental damage to be caused by the project
12. deferred development of mitigation strategies for critical impacts
13. misleading semantic changes to the definition of disturbance area

1. Analysis of feasible alternatives

Since the release of the Exploratory Works EIS in July 2018, NPA has continually raised the lack of analysis of feasible alternatives to Snowy 2.0. This lack of analysis runs contrary to the *Environmental Planning and Assessment Regulation, 2000* requiring:
"an analysis of any feasible alternatives to the carrying out of the development, activity or infrastructure"

NPA has written to the Minister on several occasions seeking review of the decision not to require Snowy Hydro to provide a comprehensive analysis of feasible alternatives in the Exploratory Works EIS. We expected this omission to be rectified in the Main Works EIS, especially in view of the Department's advice, dated 18 July 2019, stating that:
"the EIS for the Snowy 2.0 main works will be required to consider these issues in detail in accordance with the assessment requirements issued by the Department (i.e. SEARs)."
Issues listed included *"the consideration of alternatives for Snowy 2.0, including the use of existing infrastructure within the Snowy Scheme"*

However, Snowy Hydro's analysis of alternatives in the Main Works EIS consists of just two paragraphs, a table and diagram, out of some 8,000 pages of exhibited documentation.

The analysis relies on an internal report, issued in 1991, that Snowy Hydro has refused to make available on the patently spurious grounds of commercial-in-confidence. What possible advantage could be gained by a competitor from seeing this thirty-year old report, especially as no competitor would be permitted to build infrastructure in KNP?

The EIS states that the report considered *"ten conventional hydro power alternatives and four pumped hydro alternatives".* The lowest cost pumped hydro alternative, the Yarrangobilly Pumped Storage Scheme, was *"not considered economic at the time largely due to the comparative cost of gas turbines"*. It is noted that the Yarrangobilly Scheme was for a 990 MW station, half the size of Snowy 2.0.

The claimed analysis of alternatives considered just four pumped storage alternatives. Not only does it not include all *"feasible alternatives"*, it does not provide a comparison of engineering, cost or, most relevantly, environmental impacts of the four alternatives in the 1991 report.

NPA and its advising experts remain of the firm view that there are many feasible pumped storage alternatives within the existing Snowy Scheme that are potentially superior to Snowy 2.0, as described in Appendix A of our submission on the Main Works EIS.

NPA has separately forwarded advice from the Environmental Defenders Office (EDO) confirming the need for Snowy Hydro to provide an analysis of alternatives. Neither the EIS nor RTS fulfill the Department's commitment that the Main Works EIS *"will be required to consider these issues in detail … including the consideration of alternatives for Snowy 2.0, including the use of existing infrastructure within the Snowy Scheme"*.

2. Cumulative impacts

The original Snowy Scheme resulted in significant environmental damage to the alpine landscapes that are now gazetted as KNP. This includes roadworks, quarries, spoil dumps, construction sites, transmission lines, switchyards, transfer of fish species (including climbing galaxias) and the areas flooded, eroded and otherwise modified around the reservoirs. These works have significantly modified the alpine bioregion, especially the lower valley floor landforms that were transformed into reservoirs. Accordingly, it is essential that the assessment of the impacts of Snowy 2.0 evaluate the cumulative impacts of the project in respect to the original Scheme.

Snowy 2.0 will be utilising assets from the original Scheme and significantly altering their operations and environment, including:

- Operation of Tantangara Reservoir from a yearly water cycle to a daily/weekly cycle of rapidly fluctuating levels.
- Changed water characteristics in both Talbingo and Tantangara through water mixing.
- Potential degradation in water quality, and hence aquatic habitat, through seepage from the spoil dumped in both reservoirs. Most of the spoil is contaminated with naturally occurring asbestos and/or potentially acid forming rock.
- Substantial degradation in Tantangara's aquatic environment, through the transfer of pest fish, pathogens and weeds from Talbingo.
- Eucumbene Dam storage levels being significantly less, as water inflows into Tantangara (averaging 300 GL/year) will be transferred directly to Talbingo, bypassing Eucumbene.

The RTS fails to consider the cumulative impacts of Snowy 2.0 and its specific impacts on the original Snowy Scheme.

The assessment of cumulative impacts must also consider all stages in the current development proposal. NPA understands that planning legislation makes provision for staged development. However, a fundamental principle of environmental planning is that impact assessments must consider the total impact and the broadest possible context. NPA contends that the separation of assessment into at least six stages (so far) over two or more years is excessive and obscures the total impact of the project (possibly deliberately so). This conclusion is reinforced by Snowy Hydro's

repeated assertion that the transmission lines form a separate process and that the associated environmental impacts do not form part of the Snowy 2.0 proposal - a patently absurd argument.

The EIS and RTS make only passing references to cumulative impacts of the five EISs issued to date, with the major Transmission Lines EIS still to come. A holistic, comprehensive assessment of Snowy 2.0 and the cumulative impacts of the whole project is essential. EDO advice confirming the need for an analysis of cumulative impacts has been provided to the Department and Minister.

Most importantly, the Main Works EIS should not be considered in isolation of the Transmission Lines EIS. Snowy 2.0 cannot function without transmission connections to the grid and both components of the project are substantial developments in their own right.

The transmission lines involve four 330kV circuits on two side-by-side transmission towers for 10 kms with an easement swarth 120 m wide through largely pristine Park habitat. Also, there will be a network of vehicular tracks into and along the route for ongoing maintenance. As well as the destruction of habitat, the lines, towers and tracks will be a visual blight seen over a vast area of the Park, totally out of keeping with the natural landscape.

It would be premature to approve the Main Works EIS without considering the Transmission Lines, as it is inconceivable that the Transmission Lines EIS would be rejected should the Main Works EIS be approved.

The release of the Transmission Lines EIS seems to have struck a significant delay. When the timing of its release was discussed with Snowy Hydro executives on 18 April 2019, they stated that the Main Works EIS and the Transmission Lines EIS were expected to be exhibited concurrently in August 2019. NPA expressed support for such joint release as it was logical and necessary to consider the whole project (i.e. hydro and transmission components) at one time.

However, the Transmission Lines EIS wasn't released at the same time as the Main Works EIS (September 2019) and the RTS merely notes that the Transmission Lines EIS wasn't available at the time:
"The Transmission Connection Project is proposed by TransGrid. The EIS being prepared by TransGrid was not available at the time of preparation of the Snowy 2.0 Main Works EIS. However, as a key stakeholder, TransGrid has been consulted throughout the planning and delivery of Snowy 2.0."

Six months later the Transmission Lines EIS still hasn't been exhibited.

The RTS incorrectly claims that the cumulative impacts of the transmission lines are considered in the Main Works EIS (page 103):
"Although TransGrid as the proponent of the Transmission Connection Project has lodged a separate application seeking approval of those works, the EIS lodged by Snowy Hydro for Main Works considers the cumulative impacts of the Transmission Connection Project."

However, contrary to this claim the RTS repeatedly comments along the lines that (page 86):
"Suitable information on … the Transmission Connection Project was not available at the time, however Snowy Hydro has provided TransGrid with all relevant survey data to inform the cumulative assessment to be carried out for the Transmission Connection EIS."

One of the few references to the transmission lines in the RTS refers to spoil from tower excavations being dumped in Talbingo Reservoir but with no details.

The Minister's consideration of the Main Works EIS must be delayed till the Transmission Lines EIS is released and assessed in parallel. Otherwise the Minister is not in a position to consider the cumulative impacts of the entire project and any decision to approve the Main Works would be premature and not in accordance with the SEARs.

3. Rehabilitation strategy

The RTS asserts (page 101) that:
"the Snowy Mountains rehabilitation program operated for more than a decade from 2003, implemented by NPWS in partnership with Snowy Hydro. Snowy Hydro provided $32 million towards the program, which restored lush bushlands, carried out major earthworks, removed hazardous materials, and cultivated native plants with a 90 per cent survival rate.
Following the Snowy Mountains rehabilitation program, a better understanding and more successful methods for rehabilitation of alpine vegetation communities have been determined and rehabilitation improved over many years since the original Scheme was built. The Rehabilitation Strategy developed for Snowy 2.0 builds on this demonstrated experience to ensure that newly disturbed areas will be successfully revegetated and maintained in the long term."

NPA understands that the rehabilitation program was supposed to restore an initial group of approximately 400 sites but that the funding was not sufficient for this purpose. In addition, the only information which is in the public arena around the success of the rehabilitation works considered a small subset of the 400 sites[1]. Snowy Hydro is claiming success, and calling for confidence in their future capabilities, for a program of limited and unverified effectiveness.

It is notable that one of the uses of the proposed offset payment is to further rehabilitate damage from the original Scheme (see Section 11):
"conservation management actions to rehabilitate, restore and enhance altered catchments and habitat loss that has … arisen from past land use in the Snowy region, including mining, agricultural use and the development of the original Snowy scheme."

4. Changed environmental context as a result of the recent fires

The recent fires ravaged one third of Kosciuszko National Park, including most of the area encompassed by Snowy 2.0 (page 134):
"The fires in January 2020 burnt large areas of the Main Works project area, including Talbingo, Lobs Hole Ravine Road and Marica. In these areas, the fire was extensive with no areas left unburnt. ***As such, the fires have not resulted in any reconsideration of impacts*** *[emphasis added]."*

[1] "The environmental dividend from Snowy 2.0" July 3, 2018 Jamie Pittock
https://www.linkedin.com/pulse/environmental-dividend-from-snowy-20-jamie-pittock-phd

The suggestion that the fires do not require a re-evaluation of the biodiversity impacts is fundamentally flawed. On the contrary, the extensive fire damage warrants a fresh assessment including recalibrated approaches to impact mitigation.

Also, the above statement assumes the impacts of fire are only relevant to the habitat values and fauna/flora populations within the development footprint. This approach entirely misses the fact that the fires have significantly changed the conservation status and resilience of threatened species and communities across the alpine regions. What previously might have been (contestably) presented as the loss of a small portion of relatively robust populations, must now be considered from the perspective of species that have undergone major population and habitat loss. It is notable that the analysis by the Commonwealth's Threatened Species Recovery Hub of species at imminent risk of extinction in the wake of the fires includes the Broad toothed Rat, one of the species most affected by Snowy 2.0.

5. Overstated benefits to the National Energy Market and community

The RTS sums up the "*strategic need for the project"* on page 74:
"Snowy Hydro reaffirms its stated position in the EIS that Snowy 2.0 is critical to ensuring an orderly transition to a low carbon emissions economy, is in the public interest (including lowering energy costs for consumers), and should proceed."

NPA has previously introduced DoPIE to some of the members of the broad group of experts in power generation, the NEM, renewable energy and storage who have been assisting NPA in assessing these claims. The consensus amongst these experts is that, contrary to Snowy Hydro's claimed benefits (as summarised above):

- Snowy 2.0 is not *"critical to ensuring an orderly transition to a low carbon emissions economy".* Snowy 2.0 would provide energy storage, but so can many other storage projects. The NEM will not collapse if Snowy 2.0 is not constructed.
- How could Snowy 2.0 be *"in the public interest"* when its market benefits are less than its cost (see later) and it will permanently damage large areas of KNP?
- Snowy 2.0 will not *"lower energy costs for consumers"* according to Snowy Hydro's own modelling[2] (Fig 12). Snowy 2.0 will result in higher wholesale prices.
- Snowy 2.0 *"should NOT proceed"* as there are many better energy storage alternatives at far higher efficiency, lower (or zero) greenhouse gas emissions, lower cost and far less environmental damage (to a National Park.

The RTS repeats previous claims of Snowy 2.0 being a *"renewable energy project",* providing numerous benefits to the NEM:
"Snowy 2.0 will utilise otherwise unused low-cost generation (surplus coal and VRE) and provide dispatchable and firm capacity that can operate for days if required, with the effect that the NEM will operate more efficiently and with lower emissions. In the absence of this less VRE would be built and when powered by VRE, the project's carbon emissions are zero." (page 76)

Snowy 2.0 is not a *"renewable energy project"*. Snowy 2.0 will be a net load on the NEM, powered by coal-fired electricity well into the 2030's. Water is the 'medium' for energy storage, but it is coal-

[2] "Final Investment Decision Information – Market Modelling" Snowy Hydro January 2019 https://www.snowyhydro.com.au/our-scheme/snowy20/fid/

fired generators that will provide the electricity for pumping. For its first decade or so Snowy 2.0 will act as storage for coal-fired generation.

Snowy 2.0 will incur tens of millions of tonnes of greenhouse gas emissions during construction and operation. NPA estimates GHG emissions over the first 10 years of operation will total 40+ million tonnes, applying Snowy Hydro's forecast for pumping. Snowy 2.0 will incur far more emissions than other storages. For example, storages directly connected to renewable energy generators, including roof top solar cells, incur zero emissions. Also, demand response incurs zero emissions.

Even when Snowy 2.0 is powered entirely by renewable energy (sometime after 2040) it will still lose around 40% of the energy stored - ~25% in the pumping/generation cycle and ~10% in network losses (each-way).

Snowy 2.0's losses are more than other pumped hydro schemes due to its excessively long tunnel (the longest in the world) and distance from load centres (500km). Snowy 2.0's 40% loss is far more than other forms of storage - e.g. batteries lose 10%, demand response has zero losses.

The RTS is stretching credibility when it makes statements such as *"Snowy 2.0 will be necessary to quite literally 'keep the lights on'".* The same preposterous statement could be made for every large generator on the NEM.

The RTS makes other similarly preposterous statements to obviate potential environmental impact mitigation measures, such as installing fish barriers at the Talbingo intake:
"Any alterations or additions to the design of Snowy 2.0 that could reduce the reliability, availability or capacity of the station to pump or generate at any given time will reduce the value and function of Snowy 2.0 to the NEM and potentially affect energy system security."

Snowy 2.0's storage capacity is stated to be 350 GWh, capable of generating at full capacity (2,000MW) for 7 days. Such capacity will rarely be available:

- The active storage capacity of Tantangara Reservoir will be less that the claimed 240GL, due to sedimentation over the past 60 years, dumping of excavated spoil and the need to maintain a headspace to avoid spilling. The 350 GWh maximum energy capacity will be proportionately lower. The RTS is silent on this issue.
- Tantangara Reservoir will rarely be full. The average level will be about half (see Fig 6 in NPA Paper, taken from the AEMO ISP). Tantangara is usually emptied in mid-winter/early spring, prior to the snow melt, and has less than 50 GWh capacity for nearly 2 months. The RTS is silent on this issue.
- Tantangara Reservoir has 50% more capacity than Talbingo, so even if Talbingo were empty, only two-thirds of Tantangara's volume will fit – the remaining third (80GL) would be discharged to Blowering Reservoir where it is 'lost' to Snowy 2.0. The RTS is silent on this issue.
- But Talbingo Reservoir is usually kept close to full as it is the head storage for Tumut 3 pumped storage station. The RTS disputes this statement on page 77, but then contradicts itself in Appendix O (page 63) by indicating that the average level of Talbingo is *"just under full supply level"* (by 1.7m):
  "Talbingo Reservoir has a rated [Minimum Operating Level] MOL of 534.35 m AHD, an [Full Supply Level] FSL of 543.19 m AHD, an operating range of 8.84 m. The historic, long term average level for Talbingo Reservoir is 541.47 m AHD, which is just under the FSL."

- The 'closed system' capacity of Snowy 2.0 is 45 – 240 GWh, but at the lower end if the current operating regime of Talbingo is maintained. The RTS is silent on this issue.
- In a drought sequence Snowy 2.0 could be limited to its closed system capacity and in very wet years will be precluded from operating at all. The RTS is silent on this issue.

Most importantly, if Tantangara were ever emptied it would typically take three months or more to be recharged by pumping, due to limited economic opportunities to purchase cheap power for pumping and to the restricted replenishment flow rate into Talbingo from Eucumbene Dam. The RTS is also silent on this issue.

Snowy Hydro claim that Snowy 2.0 is needed today, but the latest AEMO forecast shows it will not be required till 2029, or at all, if there are other alternatives.

It is claimed that Snowy 2.0 is ideally located mid-way between Sydney and Melbourne. But the best location for storage on the NEM, to minimise network losses and constraints, is at a renewable generator or load centre, not 500km away. Snowy 2.0 requires $billions of transmission augmentation to enable the flow of electricity to its pumps and from its generators.

Snowy Hydro continue to assert that it is not responsible for the necessary transmission connections nor should it contribute towards the cost (page 79):
"The cost of updates to the transmission networks owned and operated by the Transmission Network Service Providers (TNSPs) cannot be included in the project's costs, as the transmission lines to be upgraded or built are part of the NEM's shared transmission network and are not owned or controlled by Snowy Hydro, nor for the sole benefit of Snowy Hydro or the project."

This spurious argument ignores the fact that the proposed transmission extensions have been routed and scheduled to accommodate Snowy 2.0. Even if Snowy Hydro is not required to contribute to the costs, those extra costs incurred specifically for Snowy 2.0 must be included in the evaluation of Snowy 2.0's financial merit, particularly when making comparisons with alternative storage projects.

DoPIE has indicated that the NSW Government is not concerned about Snowy 2.0's ever-increasing cost as that is a matter for the Commonwealth Government, as sole shareholder of Snowy Hydro. The original estimate of $2 billion is now approaching $10 billion in the view of many experts. Snowy Hydro maintains that the cost will be $3.8 - $4.5 billion even though noting that this excludes several major costs such as financing, hedging, operational spares, GST and transmission. Snowy Hydro have awarded a $5.1 billion contract, which already exceeds the estimated cost even though it is for only one component of the project.

NPA contends that the cost of the project is a relevant issue for the NSW Government's consideration of the Main Works, particularly when compared against the project's market benefit.

Snowy Hydro estimates the market benefit of Snowy 2.0 to be $4.4 - $6.8 billion (a figure that is considered by experts to be highly inflated). How could Snowy 2.0 be favourably considered by the NSW Government when its cost exceeds its benefit to the community?

Snowy Hydro contends that the claimed benefits 'justify' the environmental damage to Kosciuszko National Park. Even if the claimed benefits were accurate and not overstated or false, they would not justify the environmental damage to the Park.

6. Dumping of contaminated spoil in KNP

The proposals for dumping excavated spoil have continued to change. The Exploratory Works envisaged most spoil from the Main Works, other than that used for road works and civil construction, would be dumped in the 'dead storage zone' of Talbingo and Tantangara Reservoirs. The Main Works EIS then proposed most spoil would be dumped in the 'active storage area' of the two reservoirs, with the rest 'land-formed' at Lobs Hole.

The RTS now proposes that most of the spoil will be subject to 'geomorphic land forming' at various sites, primarily on land and some in the active storage of the reservoirs. A small amount from Marica (400,000 m3) is to be transported off-Park. Whether the spoil is dumped on land or in a reservoir, it is still within KNP and is unprecedented, representing a long-term threat to the ecological integrity of the Park. No National Park should be used as a waste dump.

The justification for not transporting all spoil off-Park are cost and traffic density. The NSW Government has stated that it is not concerned about the financial merits of Snowy 2.0 and therefore the cost of essential impact mitigations should not be a factor in the Minister's consideration. Traffic density is an issue for all aspects of the project and should likewise not be accepted as a barrier to mitigating environmental impact.

The latest estimate of spoil appears to be approximately 14 million cubic metres (bulked). This is an enormous quantity, that would fill two lines of B-double trucks from Sydney to Adelaide and back.

Significant quantities of spoil will be contaminated by naturally-occurring-asbestos (NOA) and potentially-acid-forming rock (PAF). It would appear that 6km of the headrace tunnel (i.e. over 20% of the 27km long tunnel) will contain NOA and most of the tunnel and other excavations will contain PAF rock.

Some millions of cubic metres of contaminated spoil are to be dumped in Talbingo and Tantangara Reservoirs. NPA is not aware of any excavated spoil being dumped in reservoirs during the construction of the original Scheme. To state the obvious, one usually doesn't deliberately dump anything in a reservoir.

The potential consequences of contaminated spoil being dumped in and adjacent to Talbingo and Tantangara Reservoirs has not been addressed. There seems to be a reasonable chance of leaching of that contaminated spoil impacting the aquatic environment and possibly causing fish kills. Such leaching will be exacerbated by the frequently fluctuating water levels due to the operation of the pumping/generation cycle. In the case of Tantangara the water levels can fluctuate by up to 5m a day and the shoreline will move hundreds of metres back and forth due to its relatively flat bathymetry.

NPA has become aware of a study that investigated periodic fish mortalities in the Tooma River below the dam[3]. Although limited funding precluded conclusive evidence of causation, the presence of a large spoil dump in an upstream tributary, resulting from the original Snowy project, was highly suggestive.

The EIS and PIR provide almost no information on the management of these contaminated wastes, other than the indicated shape of re-constructed landforms, referring instead to a 'Excavated Material Management Plan', 'Asbestos Management Plan' and 'Site-based Erosion and Sediment Control Plans' to be prepared post approval. The bland assurances that important measures will be worked out later are not appropriate given the scale of the disposal challenge and the long term potential for serious pollution and contamination of the landscape and waterways.

The RTS makes a rather nebulous statement about taking unsuitable material to an "appropriate licensed facility" (Appendix C, page 12), but provides no details:
"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). Depending on the classification of the material, a licensed waste transport company will be used to transport material, which is required to leave the project, to an appropriately licensed facility. Excavated material may be subject to treatment and application on site."

The RTS also mentions there are limited nearby waste facilities operated by the Snowy Monaro Regional Council (page 161). It proposes to dispose of asbestos material within the Tantangara adit.

NPA's position is that dumping spoil in a protected area, including reservoirs, is inappropriate in all circumstances, and even more so when that spoil is contaminated. The consequences of asbestos and acidic spoil dumped on Park land and in the reservoirs could be environmentally catastrophic, and should not be sanctioned without rigorous research.

7. Transfer of prohibited pests, pathogens and weeds throughout the Snowy Scheme and downstream

The Department of Primary Industries submission and research papers commissioned by Snowy Hydro conclusively detail the numerous devastating impacts of Snowy 2.0 on the aquatic environment in the reservoirs and downstream waterways, extending well beyond the Snowy Scheme.

Initially Snowy Hydro were dismissive of the possibility of pest fish, pathogens and weeds in Talbingo Reservoir being transferred to Tantangara Reservoir. However, following extensive research the Main Works EIS indicated it is 'likely' that such pests will be entrained and survive pumping up to Tantangara "*in the absence of additional controls"*. The PIR argues against any such additional controls, on the basis that such measures would incur excessive costs and have uncertain outcomes.

[3] "The Tooma River Project —Interdisciplinary probes into ill-defined and unpredictable contamination" December 2006 John Harris, Lee Bowling, Reuben Keller, Robert Keller, Jessica Kress, P.S. (Sam) Lake and D.C. (Bear) McPhail https://www.researchgate.net/publication/262973181_The_Tooma_River_Project_-_Interdisciplinary_Probes_into_Ill-defined_and_Unpredictable_Contamination

Instead, the PIR proposes actions to try to contain such pests within Tantangara Reservoir and mitigate the impacts.

One of the proposed mitigations is a barrier at the Tantangara dam wall, which *"will likely be the largest fine mesh screening system designed for fish exclusion in the world".* In other words, an untested mitigation, and one that will be subject to many opportunities for failure over the 100 year-lifetime of Snowy 2.0.

Even in the unlikely event that the barrier worked successfully for 100 years, it will be bypassed whenever Tantangara Dam spills into the Upper Murrumbidgee. NPA have been advised that Tantangara spilled in 1964 and 1974-75. Snowy Hydro contend that spilling is unlikely in future due to the fast drawdown capacity of Snowy 2.0, suggesting a 1:37,000,000 chance of a spill (page 40 of Appendix N). There are numerous situations that question this confidence:

- In future Tantangara will be operated at a much higher average level than in the past to maximise Snowy 2.0's generating capacity. In the past Tantangara levels have been quickly lowered after the snow melt by transferring water to Eucumbene (maximum rate of 2GL/day) to provide headspace for subsequent large rain inflows. Future higher operating levels will mean there is less margin to quickly react to wet weather events.
- In wet years the Tumut Scheme is bottled up and the hydro stations are precluded from operating to avoid exacerbating flooding of the Tumut River below Blowering Dam. At such times Snowy 2.0 would also be precluded from generating. In such wet years Tantangara is also likely to be full and spill.
- What guarantees are there that Snowy Hydro would run Snowy 2.0 to lower the level of Tantangara ahead of forecast wet weather, if the market price was low, or negative. Snowy Hydro would have competing considerations of possible low (negative) financial returns versus the risk of spilling. It may be in Snowy Hydro's commercial interest to allow Tantangara to spill. What measures can be taken to ensure that Snowy Hydro attempts to avoid spilling no matter the financial cost?
- Snowy 2.0 will not always be able generate at full capacity and draw down Tantangara levels, for example when generating units are out of service, AEMO backs off generation due to issues within the NEM, or there are transmission outages or constraints
- Climate change is predicting more extreme weather events, resulting in more severe wet weather than in the past and an increase risk of spilling.

Also, the barrier is unlikely to stop the transfer of pests and pathogens into Eucumbene Dam, especially when the tunnel is operating at its peak flow of 21 m^3/second – a rate equivalent to Sydney's water consumption. Once the pests are in Eucumbene, they will quickly migrate upstream and downstream, ensuring complete infestation throughout the Snowy Scheme and downstream into the Murrumbidgee, Snowy and Murray Rivers.

The proposed barriers, even if they were effective in stopping pest fish, are totally ineffective in relation to the Epizootic Haematopoietic Necrosis Virus (EHNV). The critically endangered Macquarie Perch is particularly sensitive to EHNV and all downstream populations are at risk once Redfin Perch, the primary host for the pathogen, become established in Tantangara.

The proposed EHNV monitoring program will not stop the spread of this virus: it will only detect and monitor its spread (after it is too late to stop it). The proposed EHNV mitigation plan has not been

detailed at this stage so there can be no clarity on what it might be nor on how effective it might be. NPA totally agrees with the submission of the Department of Primary Industries:
"A more rigorous and appropriate assessment of the current and potential extent of EHNV is clearly required for a project and potential impacts of this magnitude."

The transfer of these pest fish, pathogens and weeds form Tantangara is inevitable over the 100-year life of Snowy 2.0. For this reason Snowy Hydro has applied for a general exemption from the following provisions of the *NSW Biosecurity Act 2015 (NSW)* with respect to the operation of Snowy 2.0:

- *"the general biosecurity duty which applies in relation to biosecurity risks which arise from the potential transfer of Redfin Perch (Perca fluviatilis) (redfin), Climbing Galaxias (Galaxias brevipinnis), Eastern Gambusia (Gambusia holbrooki) and Epizootic haematopoietic necrosis virus (EHNV); and*
- *the mandatory measures which apply in relation to redfin and EHNV"*

As noted above, NPA is of the view that this application is likely to understate the potential spread and downstream impacts of the pests and disease into the headwaters of the major river systems in South-Eastern Australia. This would be environmental vandalism at a rarely seen scale.

A decision on Snowy Hydro's request for exemption from the provisions of the Biosecurity Act must be made before a decision is made on the EIS. Otherwise, any approval of the EIS would effectively pre-empt proper consideration of the exemption request.

Snowy Hydro are proposing to stock Tantangara with large trout based on the idea that *"large salmonoids are better able to avoid the impacts of competition or predation from any redfin perch in the reservoir, should they be transferred".*

If such stocking were successful it may satisfy some recreational fishers, but would not address the impact of redfin on other fish species nor the infection of all fish by EHNV (stocked large trout and redfin included). Also, once EHNV-infested redfin are in Tantangara, the pathogen will be more readily spread to other waterways via fishing gear. What will be the impact on the recreational fishing industry throughout KNP?

The EIS/RTS fails to comply with the SEARs' requirement to provide *"an assessment of the social impacts of the project on users of the Kosciuszko National Park, including recreational fishing …"*

The consequences of pest and pathogen transfer are devastating. What will be the penalty when this (inevitably) occurs?

8. Extinction of Stocky Galaxias

Predation by trout is recognised as one of the primary threats to the survival of the Stocky Galaxias. The additional stocking of trout would have the effect of perpetuating the removal of options to improve the security of Stocky Galaxias by re-introducing the critically endangered species to other streams in the Tantangara catchment, particularly Kiandra Creek. Stocky Galaxias have persisted despite recent bushfires and the presence of 20,000 feral horses in KNP.

The more immediate threat to the last remaining in situ population of Stocky Galaxias is competition from Climbing Galaxias introduced into Tantangara from Talbingo.

The proposed barrier across Tantangara Creek has no publicly available design and is untested in Australia. The single location will only aim to protect the sole remaining population of Stocky Galaxias and not future translocation sites, seriously hampering proposed recovery efforts.

The barrier only needs to fail once, for instance during a flood event, for Climbing Galaxias to access the upper creek and wipe out the Stocky Galaxias. The EIS and PIR provides a flawed assessment of risk that omits consideration of the consequences of failure, that is the outright extinction of a critically endangered species.

The lack of attention to the risk, though in NPA's view it is a certainty, of causing a species to become extinct is a major shortcoming of the EIS and PIR, one that in and of itself more than justifies the rejection of the project.

9. Groundwater and water balance

The PIR suggests the water table drawdown will be less than predicted in the EIS. Nevertheless, the impacts are still significant (as seen in Figure 4.6, page 124):

- *"The total inflow to excavations is expected to peak at 62 L/s (2 GL/year) in the final year of construction, and reducing to 45 L/s (1.4 GL/year) during operation"* (App I Part 1, page ES.3)
- Predicted steady state (long term) baseflow reduction of 1,151 ML/yr (Murrumbidgee 518 ML/yr, Lake Eucumbene 258 ML/yr and Upper Tumut 375 ML/yr)
- Tunnel inflows of 4,000 kL/day
- Gooandra Creek would change from having a perennial streamflow regime to being ephemeral with 'no flow' from 0% to 2%.
- The headwaters of the Eucumbene River could change from having a perennial streamflow regime to being ephemeral from 0% to 5-7%.

No doubt these impacts will detrimentally affect the landscape and habitat. Will the lowered water table reduce flows into the Snowy reservoirs (any water tracking along the tunnel will need to flow uphill to enter the reservoirs)? If so, how will Snowy Hydro compensate for this water lost to the downstream environment and water users of the Tumut/Murrumbidgee River system?

The RTS proposes no monitoring of downstream water quality (p122):
"Characterisation of existing water quality and flow regimes downstream of Tantangara and Talbingo reservoirs has not been undertaken on the basis that there is no material water quality impact predicted to these watercourses."

NPA questions the basis for this assumption, particularly when the EIS forecasted 16,000 tonnes of sediment being transported through Tumut 3 power station. Also, this will be the first time that spoil has been dumped in Snowy reservoirs, so there is no history to substantiate that monitoring is unnecessary. Further, the spoil is contaminated.

The EIS and PIR don't satisfy the SEAR requirements for:

- *"a detailed site water balance for the project, including the water take from each surface and ground water source;*
- *an assessment of the impacts of the project on:*
  - *the quantity and quality of the region's surface and ground water resources, including Yarrangobilly River, Wallaces Creek, and the Tantangara and Talbingo Reservoirs;*
  - *hydrological flows on site, including any potential flooding impacts;*
  - *key water features on site, including potential impacts on riparian land and the Tantangara and Talbingo Reservoirs;*
  - *water-related infrastructure, basic landholder rights and the entitlements of water users;*
- *a description of the likely changes to the hydrological regime of the existing water storages of the Snowy Hydro Scheme up to the authorised full supply level, and any associated biodiversity impacts"*

10. Greenhouse gas emissions

The SEARs requires *"an assessment of the particulate matter and greenhouse gas emissions of the project"*. The information on greenhouse gas emissions provided in Appendix V (Air Quality) of the EIS does not satisfy this requirement:

- There is only piecemeal information on selected emissions.
- Information is provided on an annual basis, without a total over the construction period.
- Those emissions that are described are understated (see Rusty Langdon paper previously provided).
- There is no information at all on the emissions from operating the pumped hydro station.
- No information is provided on cumulative emissions of the project, i.e. the Exploratory Works, Segment Factory.
- The Segment Factory EIS did not include all emissions from source materials.

NPA has estimated the CO2e emissions from construction to be at least 6 million tonnes, with emissions from the first 10 years of operation to be over 40 million tonnes (applying Snowy Hydro's pumping forecast). Such enormous GHG emissions is a highly pertinent issue, especially as alternative energy storage options incur significantly less or even zero emissions.

It is particularly relevant consideration for the EIS/RTS in light of the NSW Government's target of zero net emissions by 2050. Also, GHG emissions of over 5 million tonnes/year equate to an associated cost to the Australian economy of over $100 million per annum (at a conservative $20/tCO2e).

11. Offset payment and strategy

The Exploratory Works EIS included *"a total of 1,865 ecosystem credits and 2,060 species credits"* from *"the clearing of 95.2ha of native vegetation and impacts to 70.64ha of threatened species habitat for five species credit species"*. The offset payment was determined as a risible $10.5 million.

The Main Works EIS calculated a total of 76,218 offset credits. The PIR suggests that the modifications to the proposal has enabled the reduction of offsets to 12,927 ecosystem credits and 22,283 species credits, though NPA is not convinced of the validity of the revised figures (see Section 13).

Startlingly, Snowy Hydro provides a valuation on these offsets of just $36 million.

NPA calculates that, based on either the standard Biodiversity Conservation Trust rates or a proportionate escalation from the Exploratory Works EIS, an offset payment for the Main Works should be in the order of $100 million [35,210/3,925x$10.5m=$95m] rather than the proposed $36 million. Applying the EIS credits the offset payment would be in the order of $200 million [76,218/3,925x$10.5m=204m]. It would appear that the proponent is making a blatant attempt to use the EIS process to influence the commercial outcome of negotiations with the NSW Government.

Snowy Hydro proposes that the $36 million payment be made over 20 years, an average of less than $2m/year. In real terms the payment over the period 2025 to 2045 equates to less than $20 million in 2020 dollars (i.e. just half the payment for the Exploratory Works). How could such an amount in anyway represent an offset for the destruction of a minimum of 6 square kilometres of threatened species habitat let alone tipping a species into outright extinction?

The EIS and PIT provide no indication of other issues that require compensation including:

- Dumping 14 million cubic metres of spoil in the Park, some contaminated
- Dumping other waste in the Park
- Transfer of pest fish, pathogens and weeds throughout the Snowy Scheme and downstream rivers
- Introduction and spread of weeds from construction traffic and activities
- Reduced water flows into Snowy reservoirs from lowered groundwater levels
- Exclusive use of sections of the Park for up to 8 years
- Permanent loss of amenity over large areas of the Park from the blight of infrastructure and transmission lines

As an example of the order of compensation that should apply, NPA estimates it would cost about $0.7 billion to dump the spoil in a Snowy Monaro Regional Council facility, assuming of course there was a tip(s) with that capacity [14,000,000 m3 x 2 tonne/m3 x $25/tonne (crushed concrete fee) = $700,000,000]. Additionally, there would be the cost of transporting the spoil to the tip and an excess fee for contamination, bringing the total avoided cost for Snowy Hydro to well over of $1 billion.

Such an amount puts Snowy Hydro's paltry offer of $36 million over 20 years into perspective and exemplifies Snowy Hydro's dismissive attitude to its exclusive access to a KNP.

Any commercial landowner would seek recompense for such benefits being provided to a developer. The NSW Parks and Wildlife Service should be no different. In fact, additional compensation for dumping spoil is warranted as this is Kosciuszko National Park, not a common municipal tip.

Also, compensation should be applied for other commercial benefits, all of which are being assumed by Snowy Hydro to be provided at no cost.

Snowy Hydro should be treated in exactly the same way as any commercial enterprise, whether that be a competitor in the NEM or BHP or Adani. There is no intrinsic reason to provide Snowy Hydro with special privileges or subsidies because of its history or ownership. Snowy Hydro should be

treated no differently by the NSW Government than if it were privately owned, noting that the sale of Snowy Hydro is virtually certain at some point in the next 100 years.

Patently, Snowy 2.0 should not be approved. But if it were, the offset payment must be many orders of magnitude greater than that offered to fully compensate for destroyed habitat, permanent environmental damage and Snowy Hydro's avoided costs. Otherwise the existing subsidies provided to Snowy Hydro will be perpetuated, such as its Park Lease fee of just $750,000/year for the whole of the Snowy Scheme (less than the rental of the Sydney office).

The proposed "Offset Strategy" is summarised in page 6 of Appendix L:
"The conceptual framework outlined above provides a framework for delivering holistic ecosystem management for catchments in KNP, resulting in broader benefits to species and communities. Offsets arising from Snowy 2.0 Main Works will be used to undertake conservation management actions to rehabilitate, restore and enhance altered catchments and habitat loss that has occurred due to weeds, pests and degraded aquatic habitat including loss of riparian corridors. These impacts have arisen from past land use in the Snowy region, including mining, agricultural use and the development of the original Snowy scheme. Ninety percent of funding will be used to derive direct conservation outcomes for the species and communities being impacted."

It would appear that the proposed offset payment is to be directed to weed control, feral animal control, revegetation works and species-specific actions. These actions appear to have little relevance or relationship with the impacted habitats and species.

Also, the offset payment is to be applied to address remaining impacts of the original Snowy Scheme. Surely Snowy Hydro should be required to address such impacts anyway, independently of whether Snowy 2.0 proceeds or not. It is telling that there are still significant impacts needing attention from the original Snowy Scheme constructed 50-70 years ago! This is not a good precedent for a project as large and complex and environmentally damaging as Snowy 2.0.

The strategy totally fails to comply with the SEARs' requirement for:

> *"a strategy to offset the residual impacts of the project on these ecosystems, focussing on enhancing the biodiversity values of the Kosciuszko National Park in the medium to long term"*

12. Deferred development of mitigation strategies

The EIS and PIR defer provision of essential information about management and mitigation strategies to plans to be developed after approval of the EIS. The problem is that critical information about whether certain impacts can be effectively mitigated will not be available to the Minister at the time of decision on the EIS. This concern is exacerbated by the excessive number of deferred plans, which include:

- Aboriginal Heritage Management Plan
- Air Quality Management Plan
- Aquatic Habitat Management Plan to guide management of impacts to aquatic habitat
- Aquatic Habitat Management Plan
- Asbestos Management Plan
- Biodiversity Management Plan
- Blasting Management Plan

- Bushfire Emergency Management Plan
- Construction Noise and Vibration Management Plan
- Construction Traffic Management Plan
- Cultural Heritage Management Plan
- Erosion and Sediment Control Plans
- Excavated Rock Management Plan
- Management Plan to minimise impacts to known geodiversity sites and potential undocumented geodiversity sites
- Rehabilitation Management Plan
- Rehabilitation Management Plan for the new landforms at Tantangara Reservoir, Lobs Hole and Talbingo Reservoir.
- Site-based Erosion and Sediment Control Plans
- Social Impact Management and Monitoring Plan
- Threatened Species Monitoring Program to assess impacts arising from clearing
- Water Management Plan
- Weed, Pest and Pathogen Management Plan to minimise and manage the spread of weeds, pest fish and pathogens

13. Misleading semantic changes to the definition of disturbance area

The RTS introduces different terminology for the construction footprints and claims that the impact of the works has been reduced by 62%. It is obvious that the introduction of a Construction Envelope is little more than a semantic attempt to reduce the overall impact of the project. There is no fundamental change to the project nor its impact. Obvious issues concerning the claimed reduction in size of the Disturbance Area include:

- land around the accommodation blocks and other buildings, now designated as part of the Construction Envelope will still be impacted and should be retained as Disturbed Areas
- the 'islands' within Disturbance Areas, now shown as part of the Construction Envelope, will be impacted by workers etc.
- runoff from roads and tracks will not be contained within the Disturbance Area
- land associated with tracks, power lines, communication cables etc are not shown within the Disturbance Area (nor within the Construction Envelope)

Irrespective of the attempt to downplay the impact of the construction works, areas of KNP that are still not acknowledged as impacted by Snowy 2.0 through inclusion in the published disturbance area include:

- areas affected by groundwater reductions
- Talbingo and Tantangara Reservoirs – water mixing, pest fish, pathogen and weed transfers, more frequent and greater water level fluctuations, potential contamination from spoil
- downstream waterways – pest fish, pathogen and weed transfers, and potential contamination from spoil
- additional or widened roads and tracks
- underground cables
- transmission lines
- weed and rubbish spread from activities and road traffic
- areas from which the new works can be seen

NPA maintains its view that, once these more dispersed impacts are accounted, around 10,000 ha of the Park will be permanently damaged by Snowy 2.0. The visual blight extends much further as will

the impact of pest fish and pathogens. To suggest that *"the disturbance area is less than 0.1% of the KNP"* is just not credible and deliberately trivialises what is the largest, most destructive development proposal in an Australian National Park.

NATIONAL PARKS ASSOCIATION OF NSW
protecting nature through community action

PRESS RELEASE
26 March 2020

Expensive, damaging and unnecessary
Snowy 2.0 must be publicly reviewed before proceeding

30 eminent Australian energy, engineering, economic and environmental experts have called on the Prime Minister and NSW Premier to delay final approval of the Snowy 2.0 pumped storage project until there has been a comprehensive independent review.

In an Open Letter they contend *"It is now evident that Snowy 2.0 will cost many times its initial estimate, not deliver its claimed benefits and permanently damage Kosciuszko National Park to an unprecedented extent."*

"Snowy 2.0 is not as it has been publicly portrayed. There are many alternatives that are more efficient, cheaper, quicker to construct, and incur less emissions and environmental impacts."

Mr Dunnett, Executive Officer of the National Parks Association of NSW added *"it is unbelievable that the massive Snowy 2.0 project has not been subjected to independent scrutiny, even though it is proposed by a Commonwealth Government Corporation, where the Australian taxpayer bears the risk".*

"*Snowy Hydro haven't even complied with the Environmental Planning and Assessment Regulation 2000 requiring an analysis of feasible alternatives"* Mr Dunnett added.

With respect to the numerous environmental consequences Mr Dunnett referred to the transfer of pest fish, diseases and weeds around the Snowy Scheme and downstream rivers, devastating the aquatic environment and recreational fishing in the snowy region. *"Snowy Hydro have had to apply for an exemption from the NSW Biosecurity Act to circumvent such illegal actions."*

The Open Letter concludes that *"Snowy 2.0 should not proceed on the basis of overstated claims that have never been tested."*

"At stake are billions of dollars of Australian taxpayers' money, tens of millions of tonnes of greenhouse gas emissions and thousands of hectares of Kosciuszko National Park."

"We consider an independent review to be essential, so that Snowy 2.0's claims can be publicly and transparently tested."

Contact: Gary Dunnett, Executive Officer NPA 0432 757 059
Attach: Open Letter to Prime Minister and NSW Premier

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Open Letter to Prime Minister Scott Morrison and Premier Gladys Berejiklian
24 March 2020

The Hon Scott Morrison MP
Prime Minister
Parliament House
Canberra

The Hon Gladys Berejiklian MP
Premier of NSW
Parliament House
Sydney

Expensive, damaging and unnecessary
Snowy 2.0 must be publicly reviewed before proceeding

Dear Prime Minister Morrison and Premier Berejiklian,

We hesitate to divert your attention away from the unparalleled challenges facing our nation from the escalating coronavirus pandemic. But we are very concerned about the merits of the Snowy 2.0 pumped hydro storage project and the possibility of it proceeding without independently validated justification.

We appeal to you both to commission a comprehensive public review of Snowy 2.0 and alternative energy management options before the Commonwealth Government considers its final approval for the project and the NSW Government completes its assessment of the Environmental Impact Statement.

We request that the review be undertaken by the Productivity Commission, and/or Infrastructure Australia, and/or the Commonwealth Chief Scientist and NSW Chief Scientist & Engineer, and include independent experts of international standing.

When the Snowy 2.0 pumped hydro storage project was announced in March 2017, energy industry experts were sceptical about its merits. That scepticism has consolidated as information has emerged. It is now evident that Snowy 2.0 will cost many times its initial estimate, not deliver its claimed benefits and permanently damage Kosciuszko National Park to an unprecedented extent.

In particular, Snowy 2.0 will:

- lose around 40% of the remote source energy that is ultimately delivered to consumers after transmission and pumping/generation cycle losses are taken into account. Snowy 2.0's losses are more than other pumped storage schemes due to its distance between reservoirs (27km) being far longer than any scheme in the world, and its remoteness from load centres and source generators. Also, its losses are far greater than other energy storage options, such as batteries connected to rooftop solar panels (~10%) or controlled demand response (zero loss).
- require substantial transmission works to connect to the grid, costing billions of dollars. The best location for energy storage is at or near major load centres (e.g. Sydney or Melbourne), not 500km away, in order to minimise transmission upgrades, energy losses and constraints.
- store electricity from coal-fired power stations, not renewable generators, well into the 2030's.
- lead to more, not less, greenhouse gas emissions. Over 50 million tonnes of CO2e will be incurred during construction and the first 10 years of operation (applying Snowy 2.0's pumping projections). Such additional emissions counter NSW's net zero target and bring an associated cost to the Australian economy of over $100m per annum.
- be largely unused until 2030 – as confirmed by recent AEMO projections and evidenced by the historically low use of the pumped storage component of Tumut 3 station.
- rarely have the claimed 350GWh of storage capacity; taking 3+ months to recharge from empty.

- cost at least 500% more than its initial $2 billion estimate. A $5.1bn contract has been awarded for part of the project, with further costs to be added (other works, financing, transmission, contingencies etc). Snowy 2.0's increasing costs and scheduling (initially to be completed by 2021, now 2025) give little confidence of no further increases, particularly with the poor record for delivery of infrastructure projects in Australia.
- cost more than its market benefit of $4.4 - $6.8bn (as estimated by Snowy Hydro, though likely to be optimistic), bringing into doubt its financial viability and value to the community.
- increase, not decrease, average electricity prices (according to Snowy Hydro modelling).
- convert extensive areas of Kosciuszko National Park into construction sites (for 8 years), with permanent negative impacts over thousands of hectares of the Park and beyond, including:
  - 14 million cubic metres of excavated spoil dumped in the Park, on land and in Snowy 2.0's reservoirs – with some contaminated by naturally-occurring-asbestos and potentially-acid-forming rock
  - two double-circuit 330kV transmission lines, running 10km through the Park in a 120m-wide easement
  - depressed water tables and stream flows above sections of the tunnel
  - over 100km of new or upgraded roads and tracks
  - destruction of 1,000 hectares of habitat for 14 threatened species
  - spread of pest fish, diseases and weeds throughout the Snowy Scheme and downstream rivers, devastating the aquatic environment and recreational fishing, and probably driving an entire species, the Stocky Galaxias, to extinction. Snowy Hydro have applied for an exemption from the NSW Biosecurity Act to avoid prosecution for such illegal actions.
  - a legacy of infrastructure and landscape scars across 30km of the Australian Alps
  - compounding the recent bushfire damage to the National Park and countering its recovery

Snowy 2.0 is not as it has been publicly portrayed. There are many alternatives that are more efficient, cheaper, quicker to construct, and incur less emissions and environmental impacts – e.g. other pumped hydro, potentially even within the Snowy Scheme, batteries (especially longer duration and electric vehicles), controlled demand response, renewable hydrogen (within a decade or so).

Snowy 2.0 should not proceed on the basis of overstated claims that have never been tested. At stake are billions of dollars of Australian taxpayers' money, tens of millions of tonnes of greenhouse gas emissions and thousands of hectares of Kosciuszko National Park.

We consider an independent review to be essential, so that Snowy 2.0's claims can be publicly and transparently tested.

Yours sincerely,

Steve Blume MAIE, MACS, MAICD	President, Smart Energy Council; Director, Australian Institute of Energy; Treasurer, Global Solar Council
Robert Burns BE, MEngSc, MIEAust, MIEEE	former Senior Power System Operations Engineer, Electricity Commission of NSW, Pacific Power, Eraring Energy
Dan Cass BSc(Hons1)	Energy Policy and Regulatory Lead, The Australia Institute; Research Affiliate, University of Sydney Business School
John Dembecki BE(Hons1), ME, FIEAust	former System Control Engineer, Electricity Commission of NSW; Member, Snowy Mountains Council Operations Committee; Chair & General Manager, Energy Authority of NSW; Professorial Fellow, University of Sydney School of Electrical Engineering
Bruce Donald AM LLM(Harv)	Media and environment lawyer; former Partner, Allens; General Counsel ABC; Chair Environmental Defenders Office; Australian Heritage Commissioner
Gary Dunnett BA(Hons1)	Executive Officer, National Parks Association of NSW; former Regional Manager, NSW National Parks & Wildlife Service

Penelope Figgis AO BA(Hons1)	Vice Chair Oceania, IUCN World Commission on Protected Areas; former Board Member, Uluru-Kata Tjuta National Park, NSW Environmental Protection Authority, Australian Tourist Commission, Sydney Olympic Park Authority
Dr Sid French BE, PhD, MIEAust, NER	Structural engineer, major power and water infrastructure projects; former Director, Worley Ltd
Peter M Garlick BE, MEngSc	Managing Director, P M Garlick & Associates (power generation planning specialists); former Consultant Power Engineer, World Bank and Asian Development Bank; former Director, Queensland Generation Corporation
Peter Graham DipBus, PMD(Harv), MAICD	former Chief Executive Officer, Pacific Power; Chief Operating Officer, Fairfax Media; Chief Operating Officer, University of NSW
John Hancox	former Chief Executive Officer, Clyde Engineering Division, Clyde Industries Limited
Adj Ass Prof John Harris BVSc, PhD	Centre for Ecosystem Science, University of NSW; river ecology and fisheries science
Emeritus Prof Max Irvine BE, PhD, FIEAust, FIStructE, NER	former Head, School of Civil Engineering, University of NSW
Rusty Langdon BFA, M.Sustainability	Post-graduate student, Sustainability Assessment, University of Sydney
Ass Prof Mark Lintermans BSc(Hons), MSc	Institute for Applied Ecology, University of Canberra; former Chair, Australian Society for Fish Biology Threatened Fishes Committee
Emeritus Prof Ian Lowe AO FTSE, BSc, PhD, DSc	Science, Technology and Society, Griffith University; Adjunct Professor, Sunshine Coast University, Flinders University; former President, Australian Conservation Foundation
Dr Gavan McDonell DEng, PhD, MA, BE, FTSE, FIEAust	former Sole Commissioner, NSW Enquiry into Electricity Generation Planning; Senior Banker, European Bank for Reconstruction and Development; Senior Economic Consultant, National Electricity Market; Adjunct Professor, University of NSW
Ass Prof Dr Bruce Mountain ME, PhD	Director, Victoria Energy Policy Centre, Victoria University
Dr Hugh Outhred BSc, BE(Hons1), PhD, FAIE, Life Member IEEE	Managing Director, Ipen; former Professorial Visiting Fellow in Energy Systems, University of NSW
Nancy Pallin BA(Hons)	Director, Paddy Pallin Pty Ltd; Paddy Pallin Foundation
Rob Pallin	Chair, Paddy Pallin Pty Ltd; former Chair, Nature Conservation Council of NSW; former Member, NSW Environment Trust
Dr Bruce Robins BSc(Hons1), PhD	Director, ROBINSOLAR; former Head Project Development, BP Solar International; former Head Projects, Energy Authority of NSW
Jim Ryan BEng(Civil)	former Engineer, Snowy Mountains Hydro-electric Authority; Executive Engineer, Snowy Mountains Engineering Corporation
Hon Ass Prof Hugh Saddler BSc(Hons), PhD	Crawford School of Public Policy, Australian National University
Max Smith BE(Elec)	former General Manager Retail, Great Southern Energy
Prof Andrew Stock BE(Hons1), FIEAust, FAIE, GAICD	Councillor, Climate Council; Enterprise Professor, University of Melbourne; former Director, Clean Energy Finance Corporation; former Senior Executive, Origin Energy
Hon Ass Prof Don White BEng, FIChemE, CEng, AMICDA	Engineering, University of Sydney; Chair, Nature Conservation Council NSW; Member, NSW Environmental Trust; former Board Member, Environment Protection Authority of NSW
Dr George Wilkenfeld BArch(Hons), MPhil, PhD	Director, George Wilkenfeld & Associates Energy Policy Consultants
Ted Woodley BSc, BE(Hons1), FIEAust, FAIE, FIML, FAICD	former Managing Director, PowerNet, GasNet, EnergyAustralia, GrainCorp; former General Manager Power Systems, CLP (Hong Kong); Hon Treasurer, National Parks Association of NSW
Dr Graeme L Worboys AM BSc, MAppSci, PhD	(Honorary) Associate Professor, Fenner School, Australian National University; former Regional Manager (inc. Kosciuszko National Park), NSW National Parks and Wildlife Service; co-author, *Kosciuszko: A Great National Park*, Envirobook, 2020 (in press)

Open Letter
6 April 2020

The Hon Rob Stokes MP
Minister for Planning and Public Spaces

The Hon Matt Kean MP
Minister for Energy and Environment

Approving the Snowy 2.0 EIS would have unprecedented environmental ramifications

Dear Ministers,

We appeal to you to not approve the Environmental Impact Statement (EIS) for the Main Works of the Snowy 2.0 pumped storage project, located in Kosciuszko National Park (the Park).

Your decision is of profound importance. The consequences of approval would endure for many hundreds of years. This letter adds its voice to those 30 experts who last week signed an Open Letter to the Prime Minister and NSW Premier, copied to yourselves. That Letter called for a comprehensive public review of Snowy 2.0 and alternative energy management options before the Commonwealth Government considers its final approval for the project and the NSW Government completes its assessment of the EISs.

That Letter contends that Snowy 2.0 is not vital for the transition to renewable energy, would incur vast greenhouse gas emissions, not deliver its claimed benefits to the National Electricity Market, lose around 40% of energy cycled and permanently damage a large expanse of the Park. It was noted that there are many pumped hydro alternatives and other energy storage options that are more efficient and cheaper, and without such significant environment impacts.

In this letter we wish to highlight to you, as the relevant NSW Ministers, the environmental and protected area policy issues, the environmental ramifications of the project and the unparalleled precedents that approval would establish.

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Ministers, Kosciuszko National Park would never be the same if this project goes ahead - the precedents set and the permanently damaged alpine environment would be grave legacies for the current NSW Government.

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NATIONAL PARKS ASSOCIATION OF NSW
protecting nature through community action

Jim Betts
Secretary
Department of Planning, Industry and Environment
By email to: jim.betts@planning.nsw.gov.au

28 April 2020

Dear Mr Betts,

The National Parks Association of NSW (NPA) has serious concerns about the environmental impacts and claimed benefits of the Snowy 2.0 infrastructure development in Kosciuszko National Park. NPA has participated to the full in the formal planning process, making submissions on the Exploratory Works EIS, Main Works EISs and their amendments. We have met with Ministerial policy advisers and the DPIE Major Projects team.

While we have appreciated the opportunity to meet with your staff it has become increasingly apparent that they are operating within a framework that envisages that all developments can be rendered acceptable through appropriate conditions of approval. We are concerned that they cannot conceive of a recommendation for refusal of a Critical State Significant Infrastructure project.

This seriously undermines the confidence of NPA and the community in the fundamental integrity of the NSW planning system. Along with a growing number of experts in the energy, economics and environment fields, we have formed the view that the information provided to the Commonwealth and NSW Governments about the criticality of the project has been wildly overstated. Our analysis indicates that the claim that Snowy 2.0 is essential for the national transition to renewable energy is simply false. More appropriately sized, lower cost and better performing storage solutions abound.

Moreover, Snowy Hydro has consistently sought to understate the environmental impacts of the project, which range from an outright extinction event to the clearance of hundreds of hectares of threatened species habitat, the dumping of millions of tonnes of contaminated waste into a National Heritage Listed National Park and the transport of noxious species and virulent pathogens into the major rivers of south-east Australia. The disingenuous assertion that only a small proportion of Kosciuszko National Park will be affected stands in stark contrast to the reality that this is the largest development ever proposed in an Australian National Park.

NPA is concerned about a potential lack of objectivity in the assessment of the Snowy 2.0 proposal by DPIE. We have also contended for some time that the various EISs have not complied with the EPA Regulation nor the SEARs with respect to several aspects, particularly the assessment of feasible alternatives and cumulative impacts. EDO advice confirming these failings has been provided.

In that context, we ask for the opportunity to brief you, as departmental head, on the reasons why we believe the advice to the Minister should, not only contemplate, but recommend rejection of the Main Works EIS. I can be contacted at garyd@npansw.org.au or on 9299 0000.

Yours sincerely,

Gary Dunnett
Executive Officer
National Parks Association of NSW
protecting nature through community action

Open Letter
6 April 2020

The Hon Rob Stokes MP
Minister for Planning and Public Spaces

The Hon Matt Kean MP
Minister for Energy and Environment

Approving the Snowy 2.0 EIS would have unprecedented environmental ramifications

Dear Ministers,

We appeal to you to not approve the Environmental Impact Statement (EIS) for the Main Works of the Snowy 2.0 pumped storage project, located in Kosciuszko National Park (the Park).

Your decision is of profound importance. The consequences of approval would endure for many hundreds of years. This letter adds its voice to those 30 experts who last week signed an Open Letter to the Prime Minister and NSW Premier, copied to yourselves. That Letter called for a comprehensive public review of Snowy 2.0 and alternative energy management options before the Commonwealth Government considers its final approval for the project and the NSW Government completes its assessment of the EISs.

That Letter contends that Snowy 2.0 is not vital for the transition to renewable energy, would incur vast greenhouse gas emissions, not deliver its claimed benefits to the National Electricity Market, lose around 40% of energy cycled and permanently damage a large expanse of the Park. It was noted that there are many pumped hydro alternatives and other energy storage options that are more efficient and cheaper, and without such significant environment impacts.

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NATIONAL PARKS ASSOCIATION OF NSW
protecting nature through community action

The Hon Robert Stokes MP
Minister for Planning and Open Spaces

30 April 2020

Dear Minister,

Snowy 2.0 Main Works EIS

The National Parks Association of NSW (NPA) has been supported by many eminent environment, energy, hydro-engineering and economic experts in coming to the position that Snowy 2.0 is a profoundly flawed proposal that will inflict irreparable damage on Kosciuszko National Park, while delivering little, if any, benefit to Australia's transition to renewable energy. Our case is summarised in the two open letters NPA previously forwarded to you and your department, copies of which are attached.

NPA understands that a decision on the Main Works EIS is imminent, and the fact that Snowy 2.0 sits at the top of the Government's post-covid 19 economic stimulus package foreshadows the outcome. Nonetheless, as an organisation that has worked with successive NSW Governments over more than sixty years to establish, promote and celebrate this State's remarkable network of national parks and reserves, we entreat you not to make a premature decision.

We use the term 'premature' deliberately. The current assessment process has serious shortcomings, including the failure to adequately address alternatives and cumulative impacts, or to provide an integrated assessment of the entire project, including the transmission lines. Environmental Defenders Office advice confirming these failings has been provided to you and your Department.

Equally importantly, the fundamental context for the assessment has changed dramatically since the project was declared as Critical State Significant Infrastructure. Snowy 2.0 was pitched to former Prime Minister Turnbull as an electricity game changer, a project that would counteract the intermittency of renewable generators and cause negligible environmental impacts because the infrastructure would be underground.

The reality has fallen far short of this admirable concept. Rather than low environmental impact, Snowy 2.0 is without doubt the most damaging development ever proposed in any Australian National Park, let alone one with the irreplaceable values of Kosciuszko National Park. As if clearing hundreds of hectares of threatened species habitat, dumping 20 million tonnes of contaminated waste in the Park and spreading noxious pests and diseases into the headwaters of the Murrumbidgee, Snowy and Murray Rivers wasn't enough, the project will drive an entire species into extinction. We find it inconceivable that Mr Turnbull was aware of such dire environmental consequences, nor of the tens of millions of tonnes of greenhouse gas emissions that will be incurred by Snowy 2.0.

Snowy Hydro argues that the pathway to renewables hinges on Snowy 2.0, and these environmental sacrifices are therefore justified. However, the energy industry experts we have consulted, some of the most experienced and respected in Australia, have shown that the claimed benefits of Snowy 2.0 are overstated or false. The National Electricity Market (NEM) is already embracing alternative forms of energy storage that are lower cost, far more efficient and better aligned to the next generation of renewable generators. This week's announcement by AEMO that they are updating their Integrated System Plan forecast to reflect a market shift towards batteries and demand management and away from pumped hydro illustrates the point. Pumped hydro, especially the massive storage proposed by

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Snowy 2.0, is inexorably being pushed out of any role in the NEM. A far cry indeed from the claim that the future of renewables depends on Snowy 2.0.

NPA and our coalition of experts have been calling for an independent review of the Snowy 2.0 project for some time. We urge you to take the opportunity for measured reflection on the dramatically changed context since the project was conceived and its overstated benefits. This would be no step backwards, but rather the mark of a mature government using the most up to date information to secure a low emission future and create jobs for NSW.

A decision to approve the Main Works EIS would set appalling precedents for the future management of protected areas and create a terrible legacy for the current Government. Please don't devastate a national icon for the sake of infrastructure that has already been rendered irrelevant.

I would welcome the opportunity to discuss these matters. I can be contacted on 0418 256 700 or at G.Douglas@westernsydney.edu.au.

Yours sincerely,

Dr Grahame Douglas
President
National Parks Association of NSW
protecting nature through community action

Copy: The Hon Gladys Berejiklian MP, Premier of NSW
The Hon Matt Kean MP, Minister for Energy and Environment

Response to: Snowy 2.0 Main Works and Segment Factory EIS

Rusty Langdon, January 2019

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Snowy 2.0 CSSI Project Classification

On the 7th of March 2018, Anthony Roberts (Minister for Planning) made an order under the Environmental Planning and Assessment Act 1979 declaring 'Snowy 2.0 and Transmission Project' as Critical State Significant Infrastructure (CSSI) (NSW, 1979). Under the EPA Act in conjunction with NSW specific CSSI principles and guidelines, it is a requirement of the CSSI project proponent to report on environmental impacts via an Environmental Impact Statement (EIS). This report responds to two EIS documents (Snowy Hydro Limited, 2019a, 2019b) issued by the proponent of the CSSI classified 'Snowy 2.0 and Transmission Project', outlining where each EIS fails to report Greenhouse Gas (GHG) emissions comprehensively, transparently and cumulatively under the reporting requirements of a CSSI classified project.

Critical State Significant Infrastructure Reporting Requirements

A project classified as CSSI is required to adhere to the Planning Secretary's Environmental Assessment Requirements (SEARs). For the Snowy 2.0 and Transmissions Project, three SEARs documents have been issued; Exploratory Works SEARs; Main Works SEARS; and Segment Factory SEARs. The Snowy 2.0 Main Works (Department of Planning and Environment, 2019a) and Segment Factory (Department of Planning and Environment, 2019b) SEARs documents indicate that GHG emissions associated with both projects must be included in the EIS document. The SEARs reporting requirements are broken down into 'General Requirements' and 'Key Issues' (Department of Planning and Environment, 2015). The key issue identified by both SEARs documents is 'Air' and under this issue category there is an associated requirement to measure GHG emissions. The standard SEARs guidelines document includes no guidelines on how to quantify GHG emissions under the air quality performance outcome (Department of Planning and Environment, 2015), all guideline documents for air quality relate to the toxic impacts of air pollutants *(Image 1)*.

5. Key Issue Standard SEARs

Key Issue and Desired Performance Outcome	Requirement (specific assessment requirements in addition to the general requirement above)	Current Guidelines
5. Air Quality The project is designed, constructed and operated in a manner that minimises air quality impacts (including nuisance dust and odour) to minimise risks to human health and the environment to the greatest extent practicable.	1. The Proponent must undertake an air quality impact assessment (AQIA) for construction and operation of the project in accordance with the current guidelines. 2. The Proponent must ensure the AQIA also includes the following: (a) demonstrated ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations Act 1997* and the *Protection of the Environment Operations (Clean Air) Regulation (2010)*; and (b) a cumulative local and regional air quality impact assessment.	Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DEC, 2005) Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC, 2005) Technical Framework - Assessment and Management of Odour from Stationary Sources in NSW (DEC, 2006)

Image 1. Air quality: reporting requirements for CSSI EIS.

The GHG emissions reporting performance outcome is instead identified under key issue number sixteen, sustainability. The Infrastructure Sustainability Rating Tool can be used to quantify Scope 1, 2 and 3 emissions of any infrastructure project (Infrastructure Sustainability Council of Australia, 2018).

Key Issue and Desired Performance Outcome	Requirement (specific assessment requirements in addition to the general requirement above)	Current Guidelines
16. Sustainability The project reduces the NSW Government's operating costs and ensures the effective and efficient use of resources. Conservation of natural resources is maximised.	1. The Proponent must assess the sustainability of the project in accordance with the Infrastructure Sustainability Council of Australia (ISCA) *Infrastructure Sustainability Rating Tool* and recommend an appropriate target rating for the project. 2. The Proponent must assess the project against the current guidelines including targets and strategies to improve Government efficiency in use of water, energy and transport.	NSW Sustainable Design Guidelines Version 3.0 (TfNSW, 2013) Infrastructure Sustainability Rating Tool Scorecard relating to energy and carbon for large infrastructure projects, ISCA

Image 2. Sustainability: reporting requirements for CSSI EIS.

An inconsistency exists between the SEARs requirements issued to Snowy Hydro Limited for Snowy 2.0 and the guidelines for reporting under the general requirements. In the event that an inconsistency occurs, the SEARs document stipulates, "In the event of an inconsistency between any policy and/or guideline, the more stringent requirement will prevail to the extent of the inconsistency" (Department of Planning and Environment, 2015). This response to the Snowy 2.0 EIS documents considers the reporting guidelines for GHG emissions under the sustainability assessment requirements are more stringent than the absence of a guideline for GHG emissions reporting under air quality. Therefore, the NSW Sustainable Design Guidelines (NSWSDG's)

(Transport for NSW, 2014) should be used to inform the scope and method of GHG emissions reporting for the purposes of the Snowy 2.0 EIS. Additionally, the NSWSDG's, or an adapted version for a broader range of infrastructure projects, should be used for all large infrastructure projects to assess and compare the 'cumulative impacts' (Department of Planning and Environment, 2019a) as required by the SEARs document.

When quantifying the cumulative impacts of the project, GHG emissions should be considered cumulatively and comprehensively for all three projects associated with the Snowy 2.0 upgrade. GHG emissions should be considered based on the full life cycle of the project; including a transparent and comprehensive breakdown of GHG emissions for scope 1, 2 and 3 emissions categories. The NSWSDG's are in keeping with this requirement, whereby it is compulsory for road and tunnel projects to report a comprehensive 'footprint' of emissions for scope 1, 2 and 3 emissions categories if capital investment is greater than ten million dollars. As an example, SEARs for the M5 motorway upgrade (WestConnex) specified reporting to the NSWSDG's (Roads and Maritime Services, 2017) and as a result a comprehensive and transparent report of GHG emissions for the project were presented in the EIS. It is considered that Snowy 2.0, with capital works expenditure over ten million dollars, is not dissimilar to the M5 upgrade in relation to material infrastructure requirements; the major components of the Snowy 2.0 project can be classified as tunnel, ventilation and road infrastructure.

The NSWSDG's contain principles that underpin a broader vision for substantial GHG emissions reductions in NSW, where Paris Agreement commitments require a 26-28 per cent reduction in emissions by 2030 and net zero emissions by 2050, in order to keep global warming to well below 1.5 degrees. Australia is one of the highest per capita GHG emitters in the world (International Energy Agency, 2011). Without rigorous and transparent assessment of the full lifecycle of GHG emissions for all major infrastructure projects, the possibility of achieving this target and keeping global warming below 1.5 degrees is rapidly becoming out of reach.

CSSI Sustainability Reporting Requirements

Reporting of scope 1, 2 and 3 GHG emissions must be achieved transparently and comprehensively, using a 'footprint' method under the reporting requirements of the NSWSDG's. A footprint considers the supply chain impacts of all project elements (Williams, Kemp, Coello, Turner, & Wright, 2012). Based on these conditions, Snowy Hydro Ltd have failed in reporting on the following GHG emissions sources (Snowy Hydro Limited, 2019a, 2019b):

- Supply-chain emissions relating to (Scope 3)
    - Construction material, including but not limited to, concrete, steel, electrical cabling, ducting materials, transmission lines;
    - Machinery
    - Fly in – Fly out workers
    - Finance
    - Administration
    - Worker's accommodation facilities
    - Electricity consumption (only transmission losses have been calculated by Snowy Hydro Ltd)
- Scope 2
    - Electricity consumption for construction and operation phases (TBC),
- Comprehensive reporting of Scope 1
    - Land clearing related emissions (Emissions have not been recorded for all vegetation types),
    - Sewerage treatment onsite

Reporting all sources of GHG emissions comprehensively and transparently in the Snowy 2.0 Main Works and Segment Factory EIS's and in consideration with the cumulative impacts of the Exploratory Works and future transmission line upgrades will satisfy the following requirements of the SEARs, that:

"Information provided in the EIS must be sufficient to ensure that decision-makers, government regulators and government advisory agencies are able to understand and assess a project and its

impacts without seeking further information from the Proponent. It is intended that this approach will provide greater clarity and certainty regarding the impacts of a project and the effectiveness of the proposed mitigating measures in the EIS to reduce the level of post-approval investigation."

References:

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Integrating sustainability analysis into future infrastructure planning: a case study on Snowy 2.0.

Rusty Langdon, BFA (UNSW), M. Sustainability (USyd)

Introduction

The inadequate reporting of the sustainability impacts of state infrastructure projects by infrastructure proponents is the result of inconsistencies in New South Wales (NSW) environmental assessment reporting requirements and guidelines. Best practice quantification of sustainability related impacts could be achieved by streamlining best practice approaches across all areas of infrastructure planning. The streamlining of best practice approaches will minimise discrepancies in reporting outcomes and will strengthen the ability of decision makers to make informed decisions, leading to a sustainable future for NSW and Australia. This paper identifies where NSW infrastructure planning frameworks and guidelines are siloed in their approach to quantifying the key environmental, social and economic impacts of major infrastructure projects, using Snowy 2.0 as a case study. Ambiguity and inconsistency in reporting requirements has resulted in the inadequate quantification of the greenhouse gas (GHG) emissions impacts of the Snowy 2.0 hydroelectric storage project by Snowy Hydro Ltd.

Proponent led impact assessment issues and opportunities

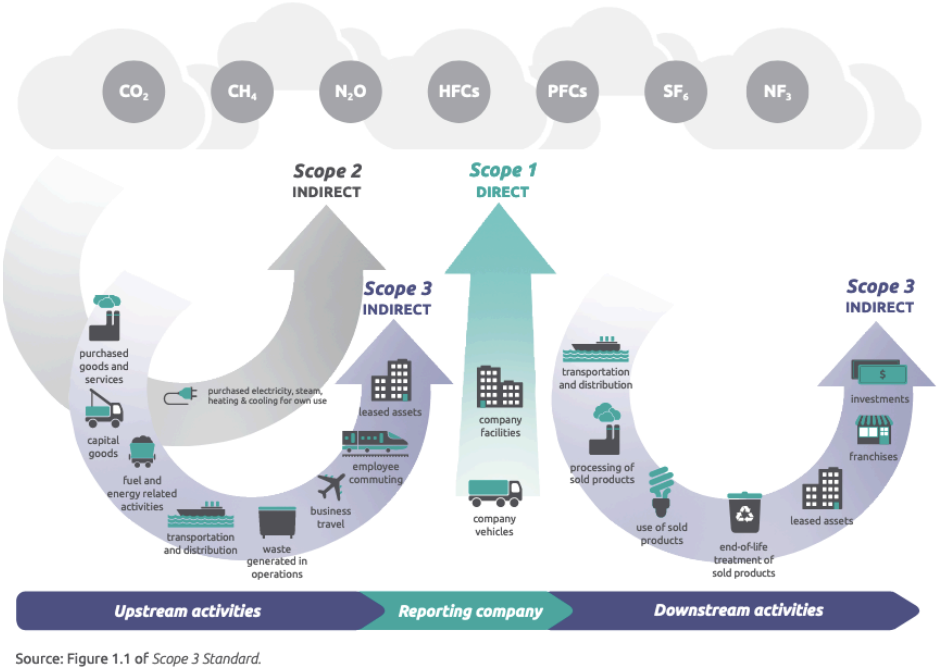
The opportunities for government agencies to reduce time in the assessment of major infrastructure projects by moving to a proponent led assessment process cannot be understated, however it is essential to ensure that these efficiency gains do not come at the expense of reduced environmental, social or economic outcomes. To ensure that best practice outcomes are achieved, rigorous assessment criteria must be maintained across all areas of state infrastructure development. Key deficiencies have been identified in the NSW Critical State Significant Infrastructure (CSSI) reporting requirements, especially in relation to the consideration of cumulative environmental, social and economic impacts. The Snowy 2.0 hydroelectric storage project is used as a case study to show where ambiguous CSSI environmental reporting requirements, combined with inadequate reporting from the proponent, have resulted in the

incomplete quantification of environmental impacts; GHG emissions have been used as an example.

Key Issues: Snowy 2.0

The Secretary's Environmental Assessment Requirements (SEARs) for the Snowy 2.0 Exploratory Works, Segment Factory and Main Works projects, provide no guidelines for the quantification of GHG emissions under the key issues category of 'Air Quality' (Department of Planning and Environment, 2019a, 2019b; Snowy Hydro Limited, 2018). The absence of GHG reporting guidelines under this key issue category (Department of Planning and Environment, 2015) has resulted in the inaccurate quantification of GHG emissions by the proponent.

Snowy Hydro Ltd uses the National Greenhouse Accounts Workbook for guidance on the quantification of GHG emissions (Department of Environment and Energy, 2018). This method is not a best practice approach to considering the GHG emissions of an infrastructure project. The NSW Sustainable Design Guidelines (Transport for NSW, 2014) correctly identifies best practice quantification of GHG emissions as comprehensively considering Scope 1, Scope 2 and Scope 3 emissions sources. *Figure 1* gives an overview of Scope 1, 2 and 3 emissions sources.



Source: Figure 1.1 of *Scope 3 Standard*.

Figure 1. Overview of Scope 1, 2 and 3 emissions sources (Greenhouse Gas Protocol).

Snowy Hydro Ltd have selectively identified some sources of Scope 3 GHG emissions in the Snowy 2.0 EIS documents, this approach omits a significant amount of GHG emissions embodied in the products and services that will be used to build Snowy 2.0. Best practice quantification of Scope 3 emissions considers all emissions sources in the supply chain of a project; this includes sources from extraction, processing and distribution of materials and related services being used for the project. Best practice reporting of all direct and indirect emissions sources is referred to as a footprint analysis. (Wiedmann T. & Minx J, 2008) define a footprint as "…a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product." Therefore, in the case of Snowy 2.0, a footprint report should identify direct and indirect emissions sources comprehensively, transparently and rigorously. Snowy Hydro Ltd have inadequately reported the footprint of the project by selectively reporting on direct and indirect GHG emissions sources. The GHG footprint of Snowy 2.0 should also consider and report estimated GHG emissions for the operation of the hydroelectric storage station, given that fossil fuel based electricity generation contributes a significant portion of energy to the NEM.

In addition to failing to meet best practice GHG reporting requirements, Snowy Hydro Ltd have not adequately satisfied the SEARs in reporting the cumulative impacts of the Snowy 2.0 project. A cumulative GHG emissions total for the Exploratory Works, Main Works, Segment Factory, Transmission Lines and Operational Stage of the project has not been provided by Snowy Hydro Ltd in the EIS documents. A comprehensive breakdown of Scope 1, 2 and 3 emissions, in addition to providing a cumulative total for all Snowy 2.0 construction and operational project components would satisfy this requirement.

An estimate on the total direct and indirect GHG emissions for the Snowy 2.0 construction works is provided in *Table 1*, this estimate is calculated using the input output analysis method, similar to that used in the GHG Protocol project based calculation tool (GHG Protocol). A figure of $5.1 billion has been used based on a recently signed construction contract for Snowy 2.0 (IC, 2020); the emissions intensity of the 'non-building construction' sector has been considered as this sector category covers tunnels, pipelines and electricity distribution projects (Australian Bureau of

Statistics, 1993). Calculations of operational GHG emissions have not been considered in this estimate.

Reported GHG emissions for Snowy 2.0

	Included Scope 1 and 2	Included Scope 3	Total GHG emissions
Snowy 2.0 EIS documents	• Fuel • Electricity • Explosives • Vegetation clearing	• Fuel • Electricity (transmission losses only)	**2,700,000 Tonnes CO_2e**
Best practice GHG reporting	Those included in the Snowy 2.0 EIS + • Onsite sewerage treatment (emissions unknown for this calculation)	Materials and services (examples): • Concrete • Steel • Chemicals • Supply chain transport • Supply chain electricity use • Administration • Fly in/Fly out travel • Machinery/ plant equipment manufacture • Onsite accommodation infrastructure • Road infrastructure • Substations • Transmission Lines + All supply chain emissions sources.	**6,000,000 Tonnes CO_2e** Estimation based on emissions intensity of .733kt/$m for the 'non-building construction' industry which includes tunnel, pipeline and electricity distribution construction projects (Australian Bureau of Statistics, 1993), at a project cost of $5.1 billion.

Table 1. Comparison of GHG emissions reported in Snowy 2.0 EIS and best practice GHG reporting.

Assessment of the significance of impacts.

An assessment of impacts should be considered in the context of national commitments to the Paris Agreement (keeping global warming below 1.5 degrees) and in the context of NSW aspirational goals for 'net zero' emissions by 2050. Assessment of impacts should also consider the impact on local and national carbon sinks due to recent wildfires and the cumulative impacts of the project on severe drought conditions in the state and nationally. To effectively consider the significance of the GHG impacts of the project, the total project emissions should be considered in the context of state and national emissions, rather than an annual average figure (as reported in the EIS documents). Reporting total project emissions comprehensively and transparently will give decision makers the essential information needed to benchmark the project against other alternative infrastructure options. This is particularly important in the context of Snowy 2.0 where an understanding of the total GHG footprint should be considered against other potential energy storage options including batteries, alternative pumped hydroelectric projects and power to gas storage (Mostert, Ostrander, Bringezu, & Kneiske, 2018). Snowy Hydro Ltd dually fail to comprehensively and transparently assess the significance the cumulative impacts of the project and identify alternatives to the proposal, as required by the SEARs.

Recommendations for Snowy 2.0

A request should be made to Snowy Hydro Ltd for a more thorough and transparent GHG emissions assessment of the Snowy 2.0 project, using best practice sustainability analysis methods (tools identified below). Comprehensive consideration of Scope 1, 2 and 3 GHG emissions sources, including quantification of total direct and indirect emissions for all construction elements of the project should be reported, this will enable effective consideration of the significance of impacts. A transparent and itemised breakdown of the scope of consideration in the GHG emissions assessment should be provided. If any emissions sources are excluded from the scope of consideration, quantification of these emissions should be provided along with a robust justification for exclusion in the final calculation. The significance of GHG impacts should be considered in the context of state and national emissions reduction targets.

Recommendations on streamlining best practice impact assessment

Integrating best practice sustainability assessment tools into the EIS reporting process can be easily achieved. A number of tools are available for the quantification and assessment of the sustainability related impacts of infrastructure projects, including but not limited to: the GHG protocol's calculation tools and the Infrastructure Sustainable Council of Australia's IS Rating Tool. A number of Australian universities have developed industry leading research tools that can quantify the GHG, water, employment, economic, land use and energy related footprints of infrastructure projects: AusIELab (Integrated Sustainability Analysis Team - University of Sydney) and AusLCI (University of NSW). Integrating a triple bottom line (environmental, social and economic) approach to EIS reporting and assessment is an opportunity for policy and decision makers to achieve a thorough understanding of resource use impacts; benchmark project impacts against other infrastructure opportunities; and enable world-leading infrastructure planning for a sustainable future.

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SNOWY 2.0
CLAIMS DON'T STACK UP

The battery that loses 40% of its energy
- $billions down the drain

NATIONAL PARKS ASSOCIATION OF NSW
protecting nature through community action

This Paper, prepared by the National Parks Association of NSW, contends that the claimed benefits for Snowy 2.0 do not stack up

This Paper, focussing on the claimed benefits of Snowy 2.0, follows on from a previous NPA Paper 'Snowy 2.0 doesn't stack up', published on 15 October 2019 (https://npansw.org/wp-content/uploads/2019/10/191014-Snowy-2.0-doesnt-stack-up-FINAL.pdf

26 February 2020

All information contained within this Paper has been prepared by the National Parks Association of NSW from available public sources. NPA has endeavoured to ensure that all assertions are factually correct in the absence of key information including the Business Case and financial data.

National Parks Association of NSW is a non-profit organisation that seeks to protect, connect and restore the integrity and diversity of natural systems in NSW

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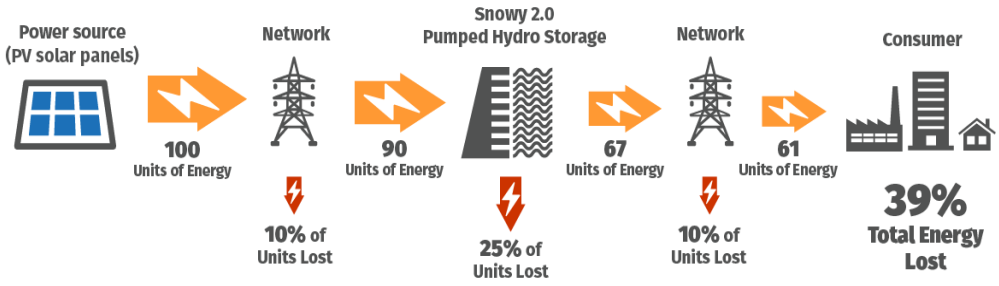
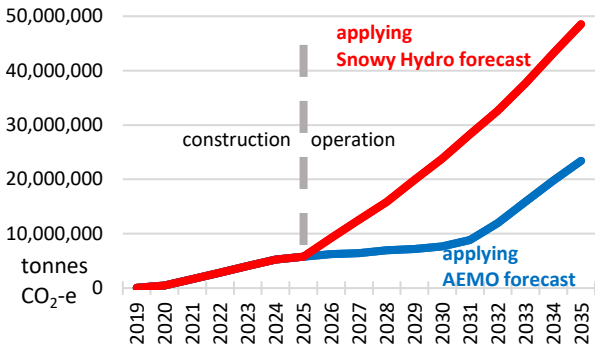
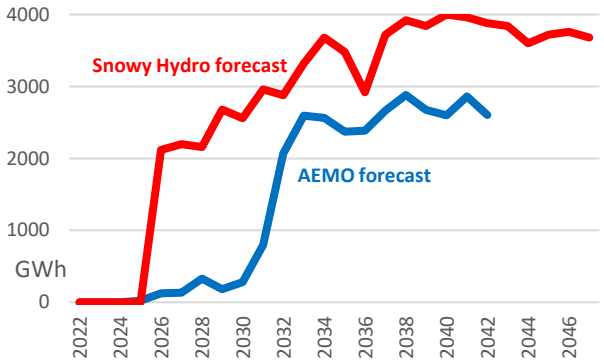
A DIAGRAMATIC SNAPSHOT



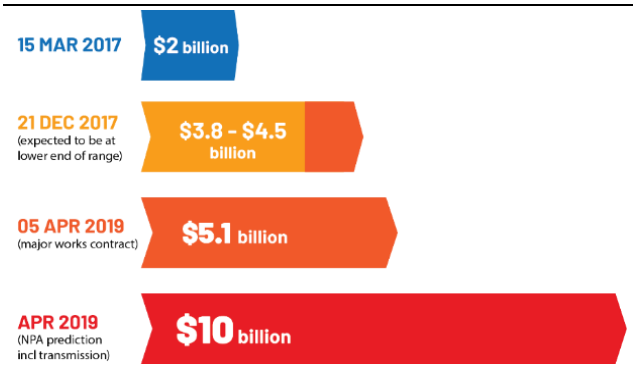
Snowy 2.0 loses 40% of energy stored – far more than other storage options (Fig. 3)



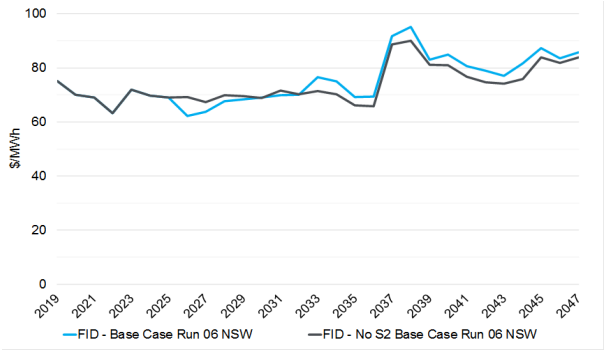
50Mt of CO_2-e emissions by 2035 (Fig. 5)



Overstated SH generation forecast (Fig. 11)



Ever-increasing capital cost (Fig. 15)



Snowy 2.0 pushes electricity prices up (Fig. 19)

Snowy Hydro earth-moving equipment turning Kosciuszko National Park into a massive construction site (January 2020).

A third of the Park has recently been burnt. Now is a critical time for nurturing and recovery, not inflicting further human-induced damage over thousands of hectares.

SUMMARY

The Snowy 2.0 pumped hydro-electric storage project has been promoted as the best option for providing energy storage for the National Electricity Market (NEM). Neither at the time of its announcement (15 March 2017[1]) nor over the ensuing 3 years has there been an independent, expert assessment of the project and its claimed benefits, nor of alternative energy storage options.

NPA issued an earlier Paper, 'Snowy 2.0 doesn't stack up'[2], addressing the lack of an overall plan, premature approval, ever-escalating cost, massive environmental impact, overstated benefits and lack of consideration of alternatives. This latest Paper focusses on the claimed benefits.

Australia's environmental planning process is underpinned by the principle of Ecologically Sustainable Development[3] (ESD), requiring *"the effective integration of economic, environmental, social and equity considerations in decision-making processes"*. The benefits of a project must outweigh its costs:

- with respect to environmental costs, the Environmental Impact Statements (EISs) for Snowy 2.0 describe the devastating and unprecedented damage that would be inflicted on the irreplaceable alpine ecosystems and species of Kosciuszko National Park
- on the other side of the ESD ledger, this Paper concludes that the claimed benefits are overstated, in several instances false, and well short of outweighing the costs

It is well time for the Commonwealth and NSW Governments to establish an independent expert Review Panel to rigorously assess Snowy 2.0 and alternative energy storage options. NPA is confident that such a Review would conclusively determine that the project is unviable, inferior to alternative energy storage options and that environmental approval should be refused.

The claimed benefits of Snowy 2.0

Snowy Hydro Ltd 'justifies' Snowy 2.0 on the basis of ten key benefits[4]:

1. *"Snowy 2.0 provides low emission on-demand energy and will underpin the continued decarbonisation of the economy"*
2. *"Snowy 2.0 provides deep storages to allow more flexibility to respond to seasonal variability when compared to other VRE and batteries"*
3. *"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. This is because Snowy 2.0's pumping capabilities work in a 'closed' system - water is recycled between the two dams so the same water can be used to generate power more than once, making the most of available water"*
4. *"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)"*

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[1] "Securing Australia's Energy Future with Snowy Mountains 2.0". Press Release by Prime Minister Malcolm Turnbull, 16 March 2017 https://www.malcolmturnbull.com.au/media/securing-australias-energy-future-with-snowy-mountains-2.0

[2] "Snowy 2.0 doesn't stack up" NPA 15 October 2019 https://npansw.org/wp-content/uploads/2019/10/191014-Snowy-2.0-doesnt-stack-up-FINAL.pdf

[3] "What is ecologically sustainable development?" NSW EDO https://www.edonsw.org.au/hys_what_is_ecologically_sustainable_development

[4] The key benefits have been stated in various ways in Snowy 2.0 documents. The first six claims are direct quotes from the most recent EIS (Exploratory Works Modification 2).

5. *"Snowy 2.0 will improve the overall efficiency of the National Electricity Market (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"*
6. *"Snowy 2.0 has a 100-year design life and will generate power for the generations to come"*
7. *"Snowy 2.0 is ideally located between the two major load centres - Sydney and Melbourne"*
8. *"Snowy 2.0 will provide energy storage at least cost"*
9. *"Snowy 2.0 will reduce electricity prices"*
10. *"Snowy 2.0 has market benefits of $4.4 - $6.8 billion, being more than its cost"*

NPA contends that each of the ten claimed benefits are overstated or false

Our reasons for reaching this conclusion are summarised below. A more detailed evaluation of each claim is provided later in the Paper.

1. Provides low emission energy and underpins decarbonisation?

To state the fundamental though often overlooked fact, pumped hydro is a net consumer of energy. Snowy 2.0 will not be a net *'provider'* or generator of energy. Before being able to generate energy, Snowy 2.0 must first pump water uphill, consuming considerably more energy from external generators than later provided.

Snowy 2.0 will consume 40% of the energy it recycles after accounting for losses in pumping/ generation (~25%) and transmission/distribution (~10% each way) - akin to investing at an interest rate of minus 40%. The losses incurred by Snowy 2.0 are higher than other pumped hydro schemes, due to its very long tunnel between reservoirs, and are far higher than other forms of storage. For example, batteries located at consumer premises with roof-top solar PV cells, incur a cyclic loss of less than 10% - one-quarter that of Snowy 2.0.

For at least the next decade or so most of Snowy 2.0's pumping electricity will be supplied by fossil fuel generators. Perversely, Snowy 2.0 will result in an increase, not decrease, in both fossil fuel generation and greenhouse gas (GHG) emissions, and potentially extend the life of coal-fired generators. During this period Snowy 2.0 will effectively be a coal-powered storage, despite water turning the turbines – it will be providing high emission energy, not *'low emission energy'.*

NPA estimates that Snowy 2.0 will incur over 6 million tonnes of CO_2-equivalents for its construction, plus up to 5 million tonnes per year for operations, totalling 50 million tonnes by 2035. To put these figures in context, 1 million tonnes of CO_2-e is equivalent to the annual emissions of 440,000 vehicles. By contrast, energy storage connected to solar/wind farms or consumer's premises with solar cells incurs zero GHG emissions from operations, as it collects renewable energy directly.

It is somewhat of a stretch to claim that Snowy 2.0 *'provides low emission energy and underpins decarbonisation'*. Snowy 2.0 will be a coal-powered storage for a decade or so, incurring tens of millions of tonnes of greenhouse gas emissions, and will always lose 40% of energy stored.

2. Provides deep storages?

Snowy 2.0 does provide relatively *'deep storages'*. But NPA contends that these storages and associated generation capability would rarely be called upon in full, certainly not for the next two decades. Snowy 2.0's Feasibility Study states that *"in any given year prior to 2040, the Project will be operated at full capacity [i.e. 2,000 MW] for less than 87 hours/year".*

It is anticipated that Snowy 2.0's usual operation would be to pump and generate over a few hours

on some days, extending beyond that only occasionally. It is unlikely that Snowy 2.0's *'deep storages'* would provide significant additional practical value or commercial return compared to a smaller storage capacity.

Also, it is noted that the active storage volume of Tantangara Reservoir, on which the claimed 350 GWh of energy capacity is derived (240 GL in 1960), will be about 10% less due to sedimentation, dumping excavated spoil and operating headspace.

3. Seasonal storage and closed system capacity?

It seems problematic that Snowy 2.0 would be operated as a seasonal storage. But even if the claimed capacity of Snowy 2.0 (350 GWh) were transferred from one season to another, this equals just 0.8% of the quarterly NEM demand (45,000 GWh).

Snowy 2.0 is not really a *'closed system'* as claimed, as it needs to be integrated within the existing Tumut Scheme. Talbingo Reservoir (Snowy 2.0's lower reservoir) is normally kept full to provide maximum capacity as the head reservoir for Tumut 3 pumped hydro station. Also, Talbingo has only two-thirds the active storage volume of Tantangara Reservoir (160 GL versus 240 GL). Put simply, Tantangara's water won't fit in Talbingo. The excess would be 'lost' downstream from Snowy 2.0 into Blowering Dam and not be able to be recycled.

Snowy 2.0's *'closed system capacity'*, based on the *'water recycled between the two dams so the same water can be used to generate power more than once'*, is between about 45 and 230 GWh, depending on the operating regime of Talbingo Reservoir. If Talbingo continues to be kept full, the closed system capacity is toward the lower end of the range – i.e. 45 GWh, equating to 23 hours (1 day) generation at 2,000 MW.

4. 7 days storage?

Snowy 2.0 could run for 7 days at 2,000 MW, provided Tantangara Reservoir started full and space was available in downstream storages. However, projections show Tantangara being only half full on average (i.e. 175 GWh capacity), with minimal storage during mid-winter/early-spring.

Snowy 2.0 could be limited to its closed system capacity during extended droughts and to zero in wet years when water discharges to Blowering are prevented to minimise downstream flooding. Also, Snowy 2.0's output will be constrained when the transmission capacity is limited, for example during bushfires, heatwaves and major storms, as recently experienced.

Most significantly, it would typically take three months or more to recharge Tantangara by pumping, due the restricted replenishment flow rate into Talbingo from Eucumbene Dam and limitations in economic opportunities to purchase cheap power for pumping. In reality, generating 350 GWh, if it ever occurred, would be a 'once-a-season-shot'. Recharging would require 470 GWh of pumping energy, incurring a cyclic loss of 120 GWh (plus transmission losses of a further 80 GWh).

5. Improve efficiency of NEM?

Like any energy storage, Snowy 2.0 would pump (store) when electricity prices are cheap and generate when prices are high. What distinguishes Snowy 2.0 is its large losses, which actually decrease, not improve, the efficiency of the NEM.

If Snowy 2.0 is commissioned in 2024/25 as scheduled and provides all new pumped hydro generation till 2029, rather than any contributions from Tumut 3 and Shoalhaven pumped hydro stations, it would constitute only 0.1% rising to 0.5% of the NEM demand over that period.

6. *100-year life, generating for future generations?*

Snowy 2.0 should have a 100-year life, but will it *'generate power for future generations'*?

Contrary to Snowy Hydro statements that Snowy 2.0 is needed today, it cannot be justified till the 1,800 MW Tumut 3 pumped hydro station is operating at full capacity. Over the past decade Tumut 3 has pumped on average for only 280 hours/year (i.e. 3% of the year).

Snowy 2.0 is modelled and presented as a stand-alone facility, rather than as an integrated component of the existing Snowy Scheme, and it is inappropriately assumed that Snowy 2.0 will displace Tumut 3 pumped hydro station. As well as 'competition' from Tumut 3 and other far more efficient energy storages, Snowy 2.0 needs to sell electricity at nearly twice the pumping purchase price just to cover its losses.

NPA contends that the modelling of Snowy 2.0 substantially overstates its use, a view supported by the recently published AEMO Integrated System Plan (ISP), which indicated that Snowy 2.0 (or its equivalent) is not required till 2029 and will generate minimal energy till the next decade. Expert analysts predict that Snowy 2.0 will rarely be economic to run.

Snowy 2.0 stands against the trend away from large power stations towards a decentralised NEM of multiple generation sources and storages, particularly at consumer premises.

Who can foresee what technological advances will evolve over the coming decades that could render Snowy 2.0 totally redundant well before its 100-year life, especially with its large losses and distance from major loads?

7. *Ideally located?*

Contrary to Snowy Hydro's assertion, Snowy 2.0 is in the worst possible location.

The best location for storage, to minimise network losses and constraints, is at a renewable generator or load centre. Snowy 2.0 is many 100's kms away from both the sources of pumping energy and the major load centres of Sydney and Melbourne. The recent bushfires have clearly demonstrated the risk of transmission constraints for the Snowy Scheme.

The grid will require augmentation costing $billions to transmit 2,000 MW to and from Snowy 2.0, as it will constitute the largest single load ever to be added and the largest generator for 35 years.

Most importantly, Snowy 2.0 is in the worst possible location from an environmental perspective, incurring permanent damage over large areas of Kosciuszko National Park.

8. *Least-cost energy storage?*

Snowy Hydro has not analysed alternative energy storage options, as would be expected for a multi-billion-dollar project by a Government Corporation and as is required by the *Environmental Planning and Assessment Regulation 2000*. Snowy Hydro has failed to demonstrate that Snowy 2.0 *'will provide energy storage at least cost'.*

The initial $2 billion cost estimate of Snowy 2.0 doubled to $3.8 to $4.5 billion (Feasibility Study) and rose again with the awarding of a $5.1 billion contract. Snowy Hydro continue to assert that the cost will not exceed $4.5 billion (even though that figure excludes certain costs such as financing). NPA estimates the full project cost, including transmission, will reach $10 billion. Irrespective of whether Snowy 2.0 is required to contribute to the infrastructure needed to transmit 2,000 MW to and from Snowy 2.0, that cost is ultimately borne by electricity consumers and hence an appropriate portion

should be regarded as attributable to the Snowy 2.0 project when assessing its merits.

Compared to typical new pumped hydro schemes, Snowy 2.0 is five times the cost for power generation and a similar cost for energy capacity. By way of comparison, Snowy 2.0 is seven times the cost/kW of the 100 MW Tesla battery in Hornsdale, South Australia.

If Snowy 2.0 is not needed till 2029 this will significantly impact the financial projections and viability. Finally, there should be no need for the $1.38 billion taxpayer-funded equity injection/ subsidy for a project that is supposedly economic, especially as any subsidy provides an unfair advantage against competitors in the NEM.

9. Reduce electricity prices?

Snowy 2.0 will push prices up, not down.

According to a Snowy Hydro Report, Snowy 2.0 will lower NSW spot prices for only 3 of the 22 years from 2026 to 2047. Prices are predicted to be similar from 2028 to 2033, but higher for every year thereafter. Also, this analysis does not include the cost impact of additional transmission attributable to Snowy 2.0, which will ultimately be passed on to consumers.

10. Market benefit of $4.4 - $6.8 billion, being more than its cost?

The estimated market benefit of Snowy 2.0 is $4.3 - $6.6 billion, not $4.4 - $6.8 billion. Snowy Hydro have improperly claimed a higher benefit range that includes construction of Snowy 3.0 and raising Tantangara Dam, neither of which are part of the Snowy 2.0 project.

Analysts have questioned the assumptions in the report. The latest AEMO forecast will mean either Snowy 2.0 will be idle for its first 5 years or it will cannibalise Tumut 3. Either way, Snowy 2.0 will not generate the previously estimated net revenues in its first years of operation, reducing both its financial viability and market benefit.

Even applying Snowy Hydro's own estimates, a market benefit of $4.3 - 6.6 billion is approximately equal to the cost of the project ($5.1+ billion, excluding transmission). If NPA's $10 billion cost estimate is correct and the market benefit of Snowy 2.0 is inflated, the project will cost at least twice its market benefit.

A comprehensive, independent review of Snowy 2.0 is essential and well overdue

NPA fully supports renewable energy and the need for energy storage, but not Snowy 2.0. If constructed, Snowy 2.0 would:

i) lose 40% of the energy it stores, far more than other energy storages
ii) be powered by coal for the next decade or so, not renewable energy
iii) incur millions of tonnes of greenhouse gas emissions during construction and operation
iv) not have the energy storage capacity claimed; and take 3+ months to recharge from empty
v) not be required till 2029 (or at all, as there are other better alternatives)
vi) need major transmission upgrades and incur sizeable network losses due to its remote location
vii) be dispatched after competitors, due to their lower losses and greater flexibility
viii) push electricity prices up, not down
ix) be uneconomic, costing far more than its estimate of $3.8 - $4.5 billion
x) deliver market benefits less than half its cost

xi) leave a legacy of extensive permanent damage to Kosciuszko National Park

Such concerns have been expressed by industry experts ever since Snowy 2.0 was announced. As information has been revealed over the ensuing 3 years, the serious shortcomings of Snowy 2.0 have become more evident and alarming.

It is now manifestly clear that Snowy 2.0 is not as it has been portrayed.

Snowy Hydro has not produced a wholistic, comprehensive assessment of Snowy 2.0 or an evaluation of alternatives. Information has been eked out over a two-year, multi-stage EIS process. The Exploratory Works EIS was released in July 2018 with two subsequent modifications in June and October 2019, the Segment Factory EIS was released in September 2019, the Main Works EIS was released in September 2019, and the Transmission Line EIS has yet to be released.

Snowy 2.0 has not been subjected to comprehensive and periodic check-point reviews by independent expert engineering, power systems, economic or environmental analysts. This is standard practice for $multi-billion projects, particularly for a Government Corporation where it is the Australian community that bears the risks.

It is well time to pause and undertake a comprehensive, independent review.

Snowy Hydro will no doubt object, citing construction delays and increased costs. Such objections must not dissuade the Commonwealth and State Governments from their obligations to ensure the project stacks up. Snowy Hydro would have been aware of the risk of commencing construction and procuring equipment well before releasing details of the project and exhibiting the EISs for the Main Works and Transmission Lines.

There is no need to hastily proceed with Snowy 2.0 on the pretext it is urgently required and is the only option for energy storage. There is ample time to properly consider alternatives, of which there are many, and develop a long-term plan of action before Snowy 2.0 or alternate storage is required (2029). It will be far better in the long run to properly assess Snowy 2.0 now (for the first time), focus on better storage alternatives, avoid wasting $billions and avert millions of tonnes of GHG emissions than to continue because of sunk costs.

Finally, and most importantly, aside from the compelling operational, GHG and economic concerns, there is the spectre of Snowy 2.0 permanently damaging thousands of hectares of Kosciuszko National Park. It would be tragic if Snowy 2.0 were approved on the basis of overstated claims that were never tested and later proven to be false.

Recommendation

It is recommended that:

"The Commonwealth and NSW governments, in collaboration with the Commonwealth Chief Scientist, the NSW Chief Scientist & Engineer and appropriate industry experts, undertake a comprehensive review of Snowy 2.0 and alternative energy storage schemes"

DETAILED RESPONSE TO THE TEN CLAIMED BENEFITS OF SNOWY 2.0

1. *"Snowy 2.0 provides low emission on-demand energy and will underpin the continued decarbonisation of the economy"*

1.1. Snowy 2.0 pumped storage is a net load, not a net generator

A fundamental though often overlooked fact is that all energy storage schemes are not net generators of energy, but net consumers of energy. Whilst Snowy 2.0 will provide *'on-demand energy'*, to be able to generate that energy it needs to have first consumed considerably more energy to pump water up to Tantangara Reservoir. This is unlike hydro power stations that simply generate electricity as water flows downhill.

Snowy 2.0 adds to the load of the NEM, and proportionately more than other energy storage schemes due to its excessive losses, as outlined below.

1.2. Snowy 2.0 loses 25% in the pumping/generation cycle

The performance of pumped-storage schemes is expressed by the 'round-trip efficiency' (RTE)[5] of the pumping/generation cycle:

> *"For the purposes of the [Snowy 2.0 Feasibility] Study, round-trip efficiency has been defined as:*
> *RTE = (energy gained during generation)/ (energy required for pumping)*
>
> *The hydraulic head losses from the waterway conduit were combined with the losses due to plant efficiencies (e.g. generator efficiency of 98.5%) to calculate the energy gained during generation and the energy required for pumping. These are combined in the above equation to obtain the round-trip efficiency.*
>
> *The base case achieves the round-trip efficiency target at 1,000 MW output with a value of 75.5%, which is estimated to marginally decrease to 74.5% at end of the design life. At full design capacity (2,000 MW), a round-trip efficiency of 67% is obtained at minimum gross head; this may drop over the design life of the Facilities to 63%."*

The subsequent Final Investment Decision (FID) Valuation Business Case[6] assumes *"An RTE range from 72% to 78% for pumped-hydro that is a function of electro-mechanical and hydraulic efficiency".* The actual RTE range of the plant to be installed is unknown, though a Snowy Hydro executive recently stated[7] that the loss would be *"about 25 per cent; worst case".*

Experts have questioned whether Snowy 2.0's RTE will actually be as high as 75%, particularly as it should be at the lower end of the range for typical pumped hydro stations of 70-80%[8] largely due to high friction losses from water flows through such long tunnels (Section 8.10) and the use of reversible, rather than separate, turbines for pumping and generation modes.

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[5] "Snowy 2.0 Feasibility Study Facilities Report V2 09" December 2017 https://www.snowyhydro.com.au/our-scheme/snowy20/snowy-2-0-feasibility-study/

[6] "Snowy Hydro FID Reports" December 2018 https://www.snowyhydro.com.au/our-scheme/snowy20/fid/)

[7] "Senate Estimates Environment and Energy page 43" 21 October 2019 https://www.aph.gov.au/Parliamentary_Business/Hansard/Estimates_Transcript_Schedule

[8] "A Brief Appraisal of the Potential of Pumped Storage in NSW" MS Phillips, WL Peirson and RJ Cox June 2013 https://www.nccarf.edu.au/settlements-infrastructure/sites/www.nccarf.edu.au.settlements-infrastructure/files/Discussion%20Paper%20Z%20Final.pdf
"Pumped-storage hydroelectricity" https://en.wikipedia.org/wiki/Pumped-storage_hydroelectricity

For simplicity and to avoid any criticism of bias this Paper adopts the Snowy Hydro RTE estimate of 75%, noting that the actual efficiency varies over the operating range of the generators/pumps and will decline over time.

Applying a RTE of 75% means that for every 100 units of electricity used to pump water up to Tantangara Reservoir, only 75 units will be generated when that water flows back down through the turbine generators to Talbingo Reservoir – i.e. 25 units are consumed/ lost in the cycle.

Every hour that Snowy 2.0 generates will require approximately 1.3 hours of pumping (at the same capacity) to replenish the water used [100/75=1.33].

1.3. Network losses bring the total loss to 40%

As well as having a 'round-trip' loss of approximately 25% within the pumping/ generation cycle, there are also losses in transmitting electricity to and from Snowy 2.0, plus further losses within the distribution system, typically 10% each-way[9]:

> *"As electricity flows through the transmission and distribution networks, energy is lost due to electrical resistance and the heating of conductors. The losses are equivalent to approximately 10% of the total electricity transported between power stations and market customers".*

Snowy 2.0's actual network losses (each-way) may well vary from that average figure of 10% and Snowy Hydro should provide such an estimate.

The total loss of Snowy 2.0 pumped storage operation on an overall system basis will be approximately 40% [100-100x0.9x0.75x0.9=39]. See Figure 2 for more detail. For every unit of electricity produced elsewhere and sent to Snowy 2.0 for pumping, only 60% will be delivered to the consumer - akin to investing at an interest rate of minus 40%.

Putting it the other way around, 170 units of electricity is required for Snowy 2.0 to provide 100 units to a consumer.

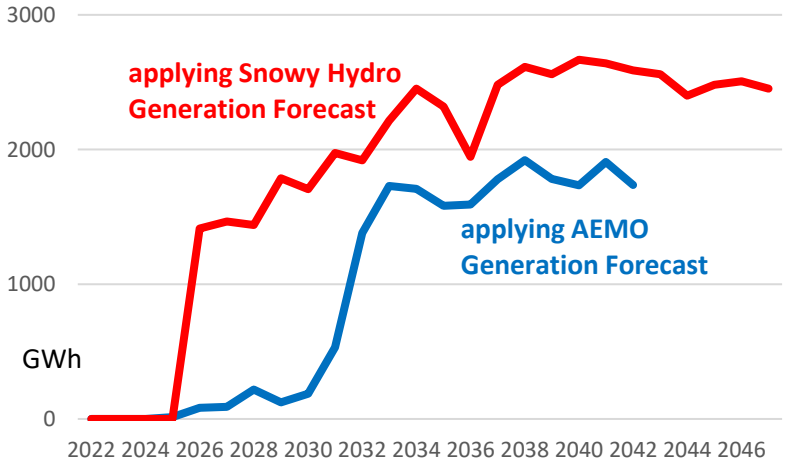

Figure 1 – Forecast Snowy 2.0 annual losses

[9] "Loss Factors and Regional Boundaries". Australian Energy Market Operator https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Loss-factor-and-regional-boundaries

Snowy 2.0's 40% loss applies irrespective of the source of pumping energy, whether from renewable or fossil fuel generators, and it applies forever – in fact the loss gets larger as the plant ages.

The amount of energy lost will vary depending on the usage of Snowy 2.0. Figure 1 shows losses of some thousands of GWh per year, based on the generation level forecast by Snowy Hydro and by AEMO (see Section 6.10).

1.4. Snowy 2.0 loses four times more energy than RTPV and batteries

Snowy 2.0's losses, as well as being higher than typical pumped hydro schemes (Section 1.2), are also considerably higher than other forms of storage.

For example, the latest batteries are over 90% efficient, with further improvements in efficiency, cost and capacity anticipated. And they can be located at load centres, thereby avoiding both transmission and distribution network losses when there are renewable generators nearby, such as roof-top photovoltaics (RTPV) on consumer premises.

Figure 2 provides an indicative comparison of the overall losses of Snowy 2.0 compared to batteries. The total energy loss on an overall system basis of Snowy 2.0 is twice that of large stand-alone batteries connected to the grid near a load centre (18%) and four times that of batteries at consumer premises with RTPV (9%).

Energy Storage	Source of stored energy	Network loss from source	Storage loss	Network loss to load	Overall loss
Snowy 2.0	RTPV	10%	25%	10%	39%
Snowy 2.0	Solar/Wind Farm or coal-fired power station	5%	25%	10%	36%
Battery connected to Solar/Wind farm	Solar/Wind Farm	0%	9%	10%	18%
Battery on grid adjacent to load centre	Solar/Wind Farm or RTPV	5%	9%	5%	18%
Battery at consumer premises with RTPV	RTPV	0%	9%	0%	9%

Overall loss (%) = 100 – (100-Network loss from source) x (100-Storage loss) x (100-Network loss to load)
RTPV = Roof Top Photo Voltaic (power)

Figure 2 - Indicative losses of Snowy 2.0 compared to batteries (NPA)

Batteries linked to RTPV have other advantages, including:

- reduced need for additional transmission
- reduced need for additional distribution, though control systems will need augmentation to provide for two-way flows
- enhanced reliability, through a distributed network of small generators and storage rather than a concentration of large power stations and storages – "more (smaller) eggs in the basket"
- incremental scalability, rather than large amounts at one time (e.g. 2,000 MW)

- faster installation – months versus years for pumped hydro
- consumers will become more self-sufficient and in control of their electricity usage
- financial benefits to consumers in avoiding high peak prices

In coming years battery costs are expected to markedly reduce, and efficiency and capacity to further improve, boosting their competitiveness with pumped hydro.

The difference between Snowy 2.0 storage losses and RTPV at consumer premises is more starkly illustrated in Figure 3.

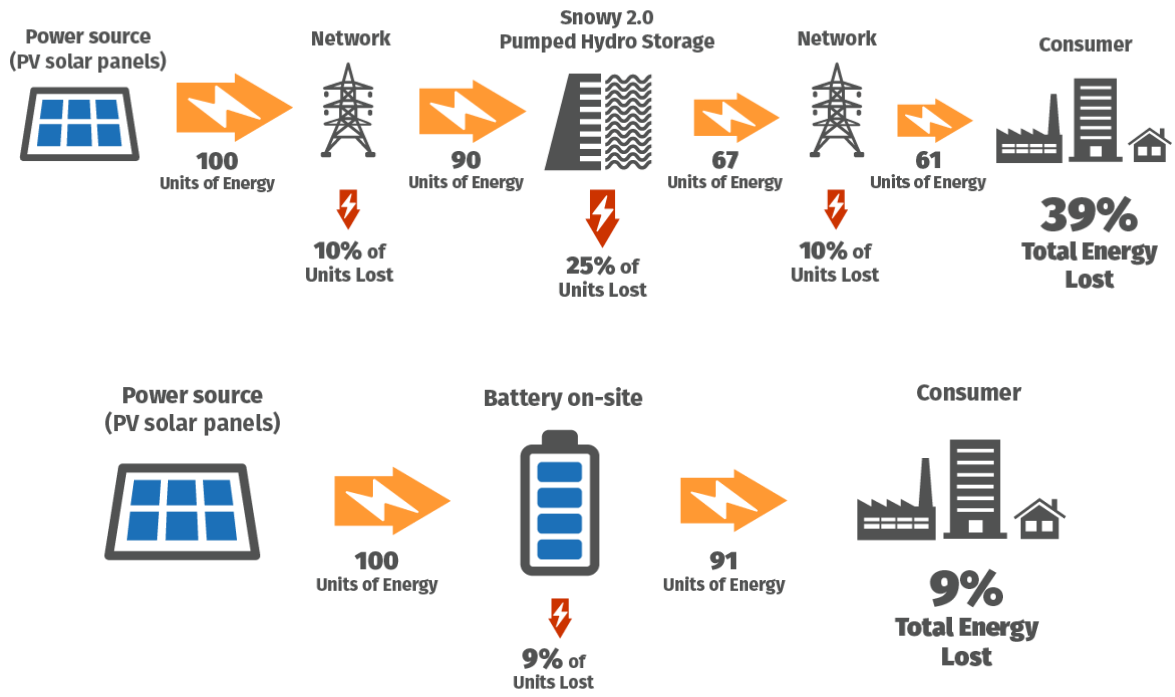

Figure 3 - Snowy 2.0 losses compared to batteries with RTPV at consumer premises (NPA)

A promising future development will be the rise in electric vehicles, as EV batteries provide a ready-made home storage option at almost no additional cost. Whenever the EV is plugged in it can both store energy, when cheap, and potentially provide energy to the premises, when expensive. EV storage capacities of typically 50 kWh are many times that of residential batteries and could power a home for several days. Though the impact of additional cycling on battery life may limit usage.

Another form of "storing" energy is shifting consumption (like water heating) into periods of high RTPV output. The associated load reduction in low RTPV periods is equivalent to increasing off-site generation at those times. Shifting consumption incurs minimal losses and cost.

No doubt energy storage will be provided by a variety of methods. The crucial point is that Snowy 2.0 has very large losses and hence would be amongst the last storage to be utilised (Section 6.13).

1.5. Snowy 2.0 will be a fossil fuel storage for the next decade or so

A further fundamental though often overlooked fact is that whilst water is the 'medium' for storing and generating energy, it is the energy used for pumping that water uphill that actually powers the storage process.

For the next decade or so, Snowy 2.0 pumping energy will come almost exclusively from coal, not renewable energy. And it's not 'unused coal' as stated by Snowy Hydro[10], it is additional coal to that which would otherwise be used.

As Snowy 2.0 pumping requires more generation than would otherwise be the case, pumping effectively triggers the dispatch, or greater production, of the marginal (highest priced) generator in the dispatch order to provide that energy. Fossil fuel generators have non-zero production costs and so will almost always be higher up the dispatch order than zero marginal cost renewable generators.

Thus, whenever any fossil fuel generator (coal, gas or diesel) is producing above its minimum generation level at the same time that Snowy 2.0 is pumping, Snowy 2.0 is using fossil fuel production, not renewable energy.

Some might suggest that one should consider the average emission intensity to determine the greenhouse gases associated with Snowy 2.0 pumping. But, as explained in a Victoria Energy Policy Centre article[11], Snowy 2.0 does not avoid average emissions when not pumping, it avoids marginal emissions:

> *"Leaving all other factors unchanged, it is the marginal change in emissions that determines the emissions when Snowy 2.0 pumps. The question to ask yourself is this: which generator would be turned down if Snowy 2.0 did not buy electricity to pump water uphill?"*

The expected daily operation of Snowy 2.0 during its initial years is illustrated in Figure 4 (from the Main Works EIS):

- pumping occurs from around 2 am to 5 am – *"when demand is low, water is pumped into the upper reservoir using cheaper energy and stored"*
- generation occurs from around 5 pm to 8 pm – *"when demand is high, water is released from the upper reservoir, generating energy"*

It would have been more correct to state that pumped hydro stations pump when electricity is cheap and generate when the price is high, rather than referring to the level of demand as the determinant.

Electricity in the early hours of the morning is currently supplied mainly from coal-fired base load plant. This pattern is expected to change with pumping during daylight hours becoming more common. But coal-fired plant will invariably be the marginal generator at such times of pumping till the mid-late 2030's when most coal-fired generators will have been retired.

Figure 4 corrects previous depictions of Snowy 2.0 operations from 2024-25 (straight after commissioning) of pumping during daylight hours and generating at night (see NPA Paper).

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[10] *"Snowy 2.0 would utilise otherwise unused low-cost generation (unused coal and VRE) and provide dispatchable and firm capacity … there is very significant coal-fired generation capacity out to 2047"*. Snowy 2.0 Segment Factory EIS Vol 1, September 2019

[11] "Snowy 2.0 will reduce greenhouse gas emissions in Australia: truth or lie?" Assoc Professor Bruce Mountain, Director Victoria Energy Policy Centre. December 2019 https://www.vepc.org.au/post/will-snowy-hydro-2-0-reduce-greenhouse-gas-emissions-in-australia-truth-or-lie

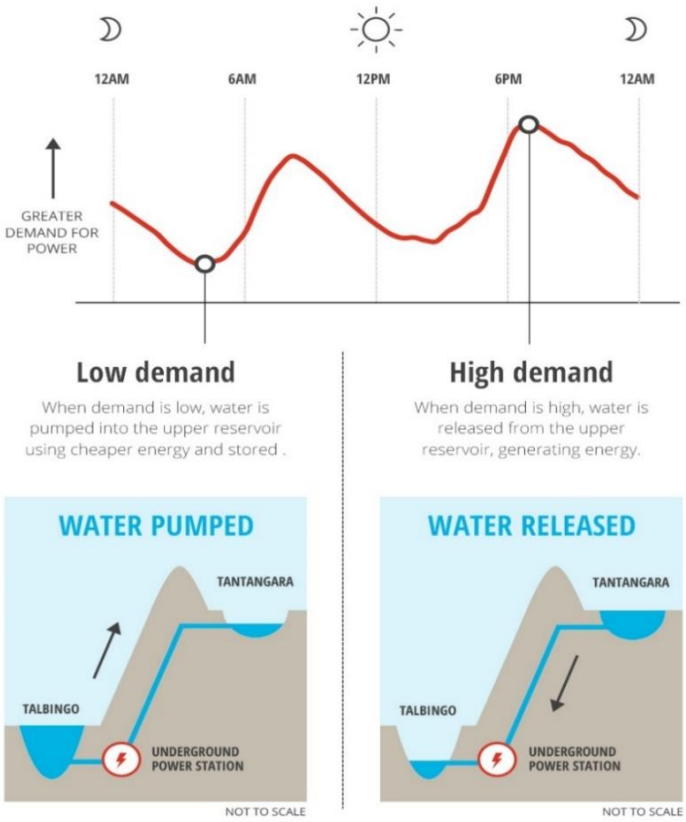

Figure 4 - Daily demand profile and Snowy 2.0 operation (Snowy 2.0 Main Works EIS)

So, for the next decade or so Snowy 2.0 will not "*provide low emission energy*", as claimed – just the opposite. Snowy 2.0 will effectively be a coal-powered storage, despite water turning the turbines. Perversely this will result in an increase in fossil fuel generation and greenhouse gas emissions and potentially will extend the life of coal-fired generators.

It is only after all coal-fired generation has been retired that Snowy 2.0 could claim to be using renewable energy as its source of energy for pumping and being a zero-emission storage. Though there may be occasional periods when the marginal generator is gas-fired and Snowy 2.0 still stores fossil fuel energy.

1.6. Snowy 2.0 incurs enormous emissions, more than any other energy storage

Snowy 2.0 is a massive project requiring substantial energy and materials in its construction. Most of the energy involved is derived from fossil fuels (coal, gas, petroleum), resulting in greenhouse gas (GHG) emissions from:

- diesel for the temporary power station at Lobs Hole
- electricity to power three tunnel boring machines and other services
- transportation of materials and plant
- lining the 10 m diameter, 27 km long tunnel with concrete/steel
- equipment and materials
- construction of roads, transmission lines, structures etc

The GHG emissions for the construction phase of Snowy 2.0 have been partially addressed in each of the five EISs to date (the Transmission Line EIS is yet to be released). However, differing methodologies have been applied and, in many instances, only annual figures provided. There are

no detailed calculations, nor a total GHG emission figure, as of course there should be. Independent analysis[12] has estimated the GHG emissions included in the Snowy 2.0 EIS's (to date) to total about 2.7 million tonnes of CO_2-equivalents.

However, that analysis also revealed numerous components missing in this assessment, including the concrete and steel lining of the tunnel, lining of the power station cavern and manufacture of equipment, such as the tunnel boring machines, earth-moving plant, mechanical and electrical equipment, including transmission lines. The analysis estimates the GHG emissions from construction of Snowy 2.0 to be at least 6 million tonnes of CO_2-e.

Snowy Hydro has not provided an assessment of Snowy 2.0's operational GHG emissions. Such emissions will be substantial due to the use of coal-fired power for pumping in its initial years of operation, plus network losses.

NPA estimates Snowy 2.0's annual emissions to be about 4 million tonnes of CO_2-e in 2030 rising to over 5 million tonnes in 2035, based on Snowy Hydro's estimated pumping loads (Section 6.10) and an 'emission factor' for NSW black coal-fired power stations of 910 kg/MWh[13].

This brings the total emissions from Snowy 2.0's construction and first decade of operation to be of the order of 50 million tonnes (Figure 5).

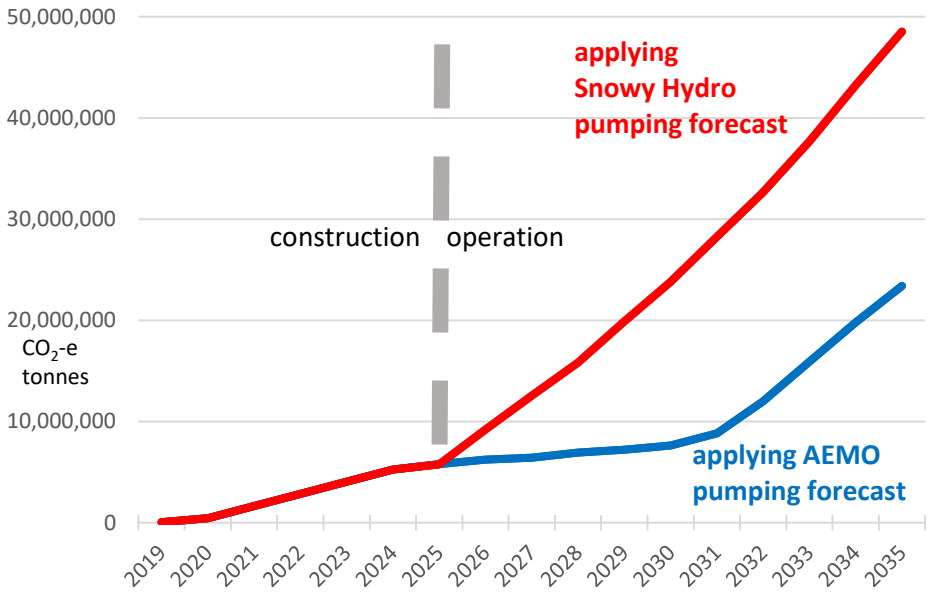

Figure 5 – Snowy 2.0 cumulative greenhouse gas emissions (NPA)

The emissions are less if AEMO's lower estimates for pumping are applied (Section 6.9), but still total over 20 million tonnes from construction and the first 10 years of operation.

To put these figures in context, 1 million tonnes of CO_2-e is equivalent to the annual emission of

[12] "Integrating sustainability analysis into future infrastructure planning: a case study on Snowy 2.0" February 2020 Rusty Langdon (yet to be published)

[13] "Scenarios, inputs, assumptions, methodologies and guidelines – 2019 Input and Assumptions workbook v1.3" AEMO 12 December 2019 https://www.aemo.com.au/consultations/current-and-closed-consultations/2020-planning-and-forecasting-consultation-on-scenarios-inputs-and-assumptions
Average 'Emission Factor' (Column X) of Bayswater (912.64), Eraring (910.14), Mount Piper (908.52) and Vales Point B (908.31) is 909.9 kg/MWh

440,000 vehicles[14]. (It will be even more vehicles in future years as car emissions improve).

In stark contrast, energy storage connected to solar/wind farms or consumer's solar cells or wind turbines (i.e. 'behind-the-meter') incur zero GHG emissions from operation, as such storages collect renewable energy directly.

Not until Snowy 2.0 only stores renewable energy will it attain zero GHG emissions and *'provide low emission energy',* then becoming equivalent to other energy storages directly connected to renewable generators.

Even then Snowy 2.0 will still lose 40% of the energy stored.

[14] "Carbon Dioxide Emissions Intensity for New Australian Light Vehicles 2018" National Transport Commission. https://www.ntc.gov.au/sites/default/files/assets/files/Carbon%20dioxide%20emissions%20intensity%20for%20new%20Australian%20light%20vehicles%202018.pdf
"Survey of Motor Vehicle Use, Australia, 12 months ended 30 June 2018" Australian Bureau of Statistics https://www.abs.gov.au/ausstats/abs@.nsf/mf/9208.0
New passenger vehicles emit an average of 2.28 tonnes of CO_2 per year (12,600 kms/year @ 181 g/km)
1Mt CO_2 = 1,000,000/2.28 = 438,000 vehicles

2. *"Snowy 2.0 provides deep storages to allow more flexibility to respond to seasonal variability when compared to other VRE and batteries"*

The Main Works EIS and most other Snowy 2.0 documents state that:

> *"Snowy 2.0 will increase the generation capacity of the Snowy Scheme by almost 50%, providing an additional 2,000 megawatts generating capacity, and making approximately 350,000 megawatt hours (175 hours of energy storage) available to the National Electricity Market."*

Snowy 2.0 does have relatively *'deep storages'* but …

2.1. Snowy 2.0 is unlikely to generate 2,000 MW for 175 hours, at least for 20 years

No information or analysis has been provided on how often a situation might arise in the NEM where Snowy 2.0 would be called upon to generate continuously at 2,000 MW for 175 hours (7 days).

Energy experts contend that it is a capability that would probably never be called upon to deliver in full, certainly not for a few decades and then rarely, if ever. It is anticipated that Snowy 2.0's usual operation would be to pump and generate over a few hours on some days, extending beyond that only occasionally.

Further evidence of the limited generation expectations of Snowy 2.0 is provided in the Feasibility Study modelling[15] *"which shows that in any given year prior to 2040, the Project will be operated at full capacity for less than 87 hours per year"*.

Whilst Snowy 2.0 might have a nominal energy reserve of up to 350 GWh, it would rarely if ever be called upon, or would it be economic, to operate for any more than some hours at a time, rather than for days or a week.

2.2. An indicative scenario in 20 years

AEMO has recently published its 'Draft 2020 Integrated System Plan (ISP)[16]', which includes a chart showing the energy stored in Tantangara over the course of 2039-40 (Figure 51 of the Appendices). Suffice it to say that a forecast 20 years into the future can only be indicative, but the chart (Figure 6) foresees an annual sequence of:

- minimal levels during winter and into early spring (awaiting snow melt inflows)
- a rapid increase in spring due to snow melt
- a short period of significant generation in November, though this could be any time over

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[15] "*A key consideration for the power waterway diameter selection was the average permissible velocity in a concrete lined tunnel (generally accepted to be 6m/s). Prolonged operation at such high velocities may lead to a deterioration by scouring of the power waterway's concrete surfaces due to high local turbulence at surface irregularities. This analysis consequentially must be matched to the independent market expert's modelling of the Project's operation profile, which shows that in any given year prior to 2040, the Project will be operated at full capacity for less than 87 hours per year. At this stage of the Project's due diligence efforts, this is deemed acceptable."* Snowy 2.0 Feasibility Study (page 16 of Summary) https://www.snowyhydro.com.au/our-scheme/snowy20/about-snowy-2-0-2/

[16] "Draft 2020 Integrated System Plan" AEMO 12 December 2019 https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Integrated-System-Plan/2019-Integrated-System-Plan

summer, need not be as rapid or may not occur at all

- a recharging during summer and retention of high levels through autumn
- a rapid drawdown in early winter, though this could be anytime and need not be rapid

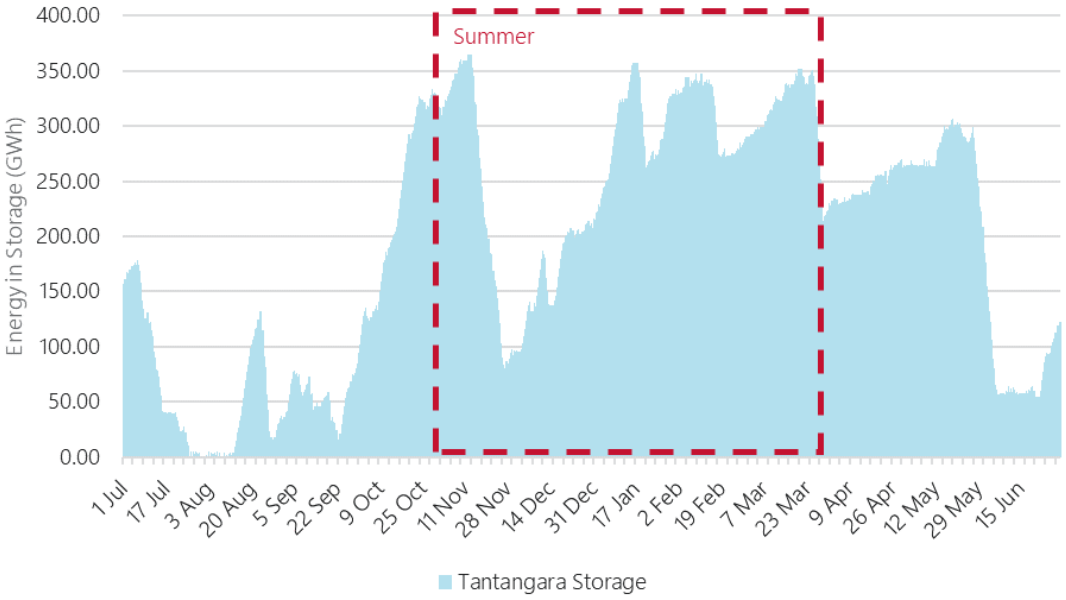

Figure 6 – Forecast Tantangara stored energy level in 2040 (AEMO ISP)

The chart illustrates Tantangara's 'deep storage', but also the overstated claims concerning its storage capacity covered in this Paper:

- the nominal 350 GWh capacity is rarely available (Section 4.1):
  - the full 350 GWh is available for only a couple of weeks a year
  - capacity is under 50 GWh for nearly 2 months
  - zero capacity for a couple of weeks in mid-winter/early-spring
- average capacity of about 175 GWh (i.e. half 350 GWh)
- few if any periods of sustained generation at 2,000 MW (Section 2.1)
- one sustained pumping cycle annually rather than regular or seasonal cycling (Section 3.1)
- taking 6 weeks (Dec-Jan) to recharge 250 GWh by pumping (Section 4.5)

The chart also brings into question the claims that Snowy 2.0 will assist the NEM for periods in winter when there is minimal solar and wind generation. This the very time when Tantangara levels are minimal to provide headspace for the spring snow-melt inflows.

The chart also brings into question the claims that Snowy 2.0 will pump during the spring when prices are projected to be cheap. This is the time when pumping will be restricted due to snow-melt inflows.

2.3. If Snowy 2.0's full capacity is rarely if ever used, it provides less value than claimed

It may seem advantageous to have excess storage capacity, just in case it might be needed. But if that full capacity is rarely if ever used it has limited practical or commercial value. Also, a smaller, less 'deep', scheme could make an equivalent contribution to the NEM at a lower financial and/or environmental cost.

For any pumped storage scheme to be cost-effective, water needs to be recycled reasonably frequently, with each cycle producing a profit. Capacity that is rarely used cannot support the justification for a project, no matter how appealing/comforting the claim may appear to be.

It is unlikely that Snowy 2.0 would provide significant additional practical value or gain additional commercial return from having 350 GWh of storage compared to a smaller storage capacity.

2.4. Tantangara Reservoir does not have 240 GL of active storage

The claimed 350 GWh capacity is based on the upper reservoir, Tantangara, being at close to full supply level. Of course, the deliverable energy capacity is less whenever Tantangara is not full and is zero when Tantangara is at minimum operating level.

The active storage volume of Tantangara was surveyed as 240 GL when the dam was completed in 1960. However, the active storage volume for Snowy 2.0 operations would be approximately 10% less (215 GL) than this notional volume due to:

- sedimentation over the ensuing 60 years (~9 GL)
- dumping of excavated tunnel spoil (~3 GL)
- the need to maintain an operating headspace to avoid spilling from unexpected flood events (~12 GL)

If the claimed 350 GWh energy storage capacity is based on 240 GL, a reduced storage volume would result in ~10% less energy capacity than the claimed 350 GWh.

This is a moot point if the full 350 GWh is never called upon. But for a project costing many $billions the current volumes of Tantangara and Talbingo Reservoirs should have been surveyed and further reductions in storage volumes from sedimentation estimated over the 100-year life of Snowy 2.0.

This is particularly important in the case of Tantangara Reservoir due to the accelerated sedimentation from feral horses trampling the catchment and the slumping of its banks from more frequent and rapid movements in water levels when Snowy 2.0 is generating and pumping.

2.5. Snowy 2.0 does not qualify as a Variable Renewable Energy generator

The wording of the claimed benefit implies that Snowy 2.0 is an *'other variable renewable energy generator'*. Possibly the word 'other' was an inadvertent insertion, but if not, it is questionable that Snowy 2.0 qualifies as a *'renewable energy generator'.*

Snowy 2.0 produces electricity by water flow and to that extent uses a renewable resource. Also, generation using Tantangara inflows could be classified as renewable generation, though Snowy 2.0 merely replaces such generation currently carried out by Tumut 1 & 2 power stations (see Section 6.7).

However, Snowy 2.0 generation from water that is pumped uphill by fossil fuel energy is not renewable or *'low emission'* generation.

Even when Snowy 2.0 pumps are powered only by renewable energy, Snowy 2.0 is not a net *'provider'* or generator and so can hardly be classified as a *'renewable energy generator'.*

3. *"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. This is because Snowy 2.0's pumping capabilities work in a 'closed' system - water is recycled between the two dams so the same water can be used to generate power more than once, making the most of available water"*

3.1. Snowy 2.0 'seasonal storage' is negligible in the NEM

It may be a pedantic point, but rather than Snowy 2.0 operating as a 'seasonal storage' (i.e. quarterly), Figure 6 indicates a six-month cycle.

Nevertheless, it is questionable if Snowy Hydro would operate Snowy 2.0 in a seasonal sense, holding back generation (and pumping) at certain times of the year in the expectation that higher (or cheaper) prices will prevail at some future time. It is more likely that the opportunity would be taken to generate whenever prices were high enough and pump whenever prices were cheap enough rather than foregoing such an opportunity in the hope of a better financial return later.

Even if 350 GWh was transferred from one season to another, this is too small to make a meaningful difference to supply and demand across seasons. The quarterly NEM demand is around 45,000 GWh, so Snowy 2.0's 350 GWh constitutes just 0.8% of the NEM demand on a quarterly basis or 0.2% on an annual basis.

AEMO forecast Snowy 2.0 to generate 970 GWh in 2030 rising to 2,600 GWh in 2040 (Figure 11), constituting 0.5% and 1.4%, respectively, of the current NEM demand (Figure 7).

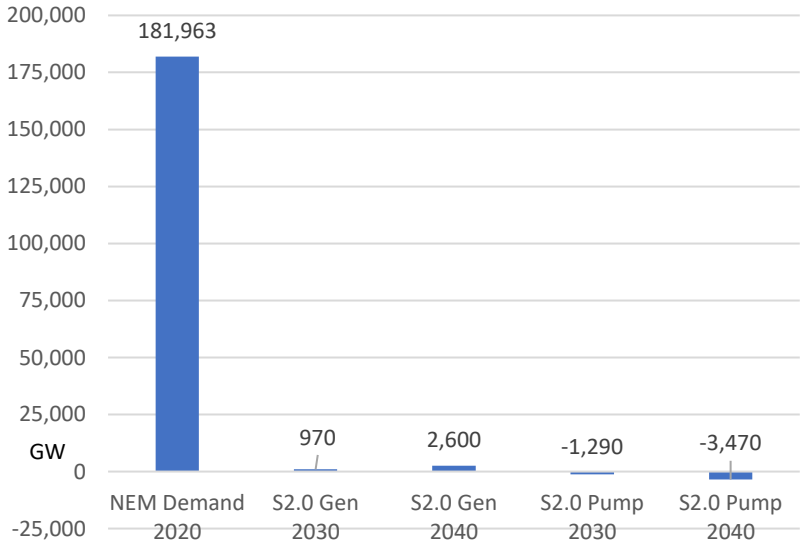

Figure 7 - NEM demand compared to Snowy 2.0 generation/pumping in 2030 & 2040

The energy generated by Snowy 2.0 incurs a commensurate pumping demand on the NEM of 1.3 times that output – 1,290 GWh in 2030 rising to 3,470 GWh in 2040.

3.2. Snowy 2.0 is not a closed system

Snowy 2.0 is portrayed as a 'green battery' cycling water between its upper and lower reservoirs in a closed system, capable of generating 2,000 MW for 7 days straight (350 GWh) and then quickly recharging ready for another 7 days of generation.

Contrary to the above claim, Snowy 2.0 is not really a *'closed system'* with exclusive use of its two reservoirs (see Figure 8).

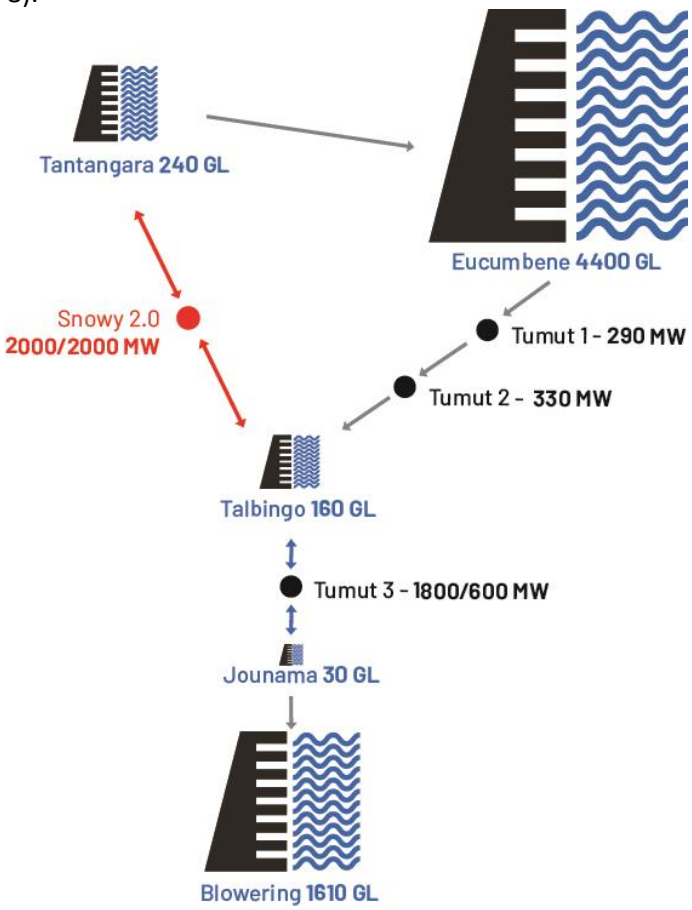

Figure 8 - Schematic of Tumut Scheme with Snowy 2.0 (NPA)

Snowy 2.0 would need to be integrated within the Tumut Scheme (Tumut 1, Tumut 2 & Tumut 3 power stations). In particular, Snowy 2.0 does not have exclusive use of Talbingo, which is the lower reservoir of Tumut 2 hydro power station and the upper reservoir of Tumut 3 pumped hydro station.

3.3. Snowy 2.0's 'closed system capacity' is 45 - 240 GWh, but at the lower end

The 'closed system' energy storage capacity of a pumped storage scheme is based on the fixed volume of water that can be recycled between the two reservoirs – i.e. determined by the volume of the smaller reservoir[17].

Snowy 2.0's smaller reservoir, Talbingo, has only two-thirds the active storage capacity of Tantangara (160 GL versus 240 GL nominal). One-third of the water in Tantangara will not fit in

[17] "ROAM report on Pumped Storage modelling for AEMO 100% Renewables project" 24 September 2012 http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.434.9204&rep=rep1&type=pdf

Talbingo. Hence, the theoretical closed-system capacity of Snowy 2.0, ignoring Tumut 3 and its use of Talbingo, is two-thirds of 350 GWh – i.e. 240 GWh.

However, levels in Talbingo Reservoir are kept as high as possible to optimise the operation of the Tumut 3 pumped hydro station. The higher the level of Talbingo the greater is the amount of energy stored and the higher is the efficiency of Tumut 3 generation. As stated in the Main Works EIS:

> *"Water levels [in Talbingo] are typically maintained at the dam crest level for around six months of the year and lower water levels tend to occur in late winter or spring, although this pattern shifts from year to year."*

Historically, the spare capacity in the Tumut 3/Talbingo/Jounama system has been approximately equal to the capacity of Jounama Pondage (30 GL).

If the current operating regime were maintained, with spare capacity in Talbingo/Jounama of about 30 GL, then only 30 GL of Tantangara water can be cycled back and forth to Talbingo. This equates to a recyclable closed system energy storage capacity of about 45 GWh [30/240x350=44]. Any generation beyond 45 GWh would result in water being discharged to Blowering at which point it is 'lost' to Snowy 2.0 and cannot be recycled (up to 210 GL (87%) of Tantangara water is 'lost').

Applying the definition provided in Claimed Benefit 3, the *'closed system capacity'* of Snowy 2.0, as determined by the *'water recycled between the two dams so the same water can be used to generate power more than once, making the most of available water',* is between 45 and 240 GWh, depending on the operating regime for Talbingo. This equates to operation at 2,000 MW for 23 to 120 hours (1 to 5 days).

It is likely that Talbingo would continue to be kept reasonably full to maximise the capacity of Tumut 3, pushing the closed system capacity of Snowy 2.0 toward the lower end of the range.

3.4. In drought years Snowy 2.0 could be limited to its closed system capacity

In the event of a lengthy drought when water releases downstream of the Snowy Scheme are restricted, minimal make-up water would be available from Eucumbene to Talbingo. Snowy 2.0 could be restricted to only the water that could be recycled as a closed system.

As an aside, it is unclear how Snowy 2.0 provides an *'insurance against drought risk'*.

3.5. In wet years Snowy 2.0's energy capacity could be zero

In very wet years when Blowering is full, generation by the Tumut stations is restricted to Tumut River inflows only, to minimise flooding of the River below Blowering. In such circumstances Snowy 2.0 could not discharge into Talbingo, as its water does not constitute Tumut River inflows.

Hence Snowy 2.0 may be prevented from generating at all. It is unlikely that Snowy 2.0 could pump either as it is likely that Tantangara would also be subject to high inflows and in danger of spilling.

4. *"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)"*

4.1. Snowy 2.0 could only run "for seven days" if Tantangara started full, which is not often

Snowy 2.0's claimed 350 GWh maximum energy capacity is based on Tantangara Reservoir being full and space being available in downstream storages. The deliverable energy capacity is less when Tantangara is not full and zero when Tantangara is at minimum level.

As shown in Figure 6, AEMO expects Tantangara to be full for only a couple of weeks a year. On average it is expected to be about half full (i.e. 175 GWh capacity), with minimal volume during late winter/ early spring.

Also, the maximum energy capacity needs to be confirmed against the actual ~10% lower storage volume of Tantangara (Section 2.4). Nevertheless, this Paper assumes the claimed 350 GWh maximum capacity from a full Tantangara Reservoir is correct.

4.2. If Snowy 2.0 ran "for seven days continuously", most water would be 'lost'

Despite a 'closed system' recyclable capacity of only 45 - 230 GWh (Section 3.3), Snowy 2.0 could generate 350 GWh (2,000 MW for 7 days), if all six generators were available, Tantangara stated full and there was space available in downstream storages. However, doing so would result in as much as 210 GL of Tantangara's 240 GL being discharged into Blowering, lost to Snowy 2.0 and not able to be recycled.

The lost water would need to be replenished from Eucumbene via Tumut 1 & 2 stations for pumping back up to Tantangara. This should not be an issue unless the annual allocation of water to Blowering of 1,040 GL had been delivered (though it would take months – see Section 4.5). Also, discharging from Tantangara, via Snowy 2.0, into Blowering would not normally be an issue from an operational perspective, due to Blowering's large capacity (1600 GL).

4.3. In drought and wet years Snowy 2.0 could not run "for seven days continuously"

However, as noted in Sections 3.4 & 3.5, in a drought sequence Snowy 2.0 could be limited to its closed system capacity and in very wet years could be precluded from operating at all.

4.4. Snowy 2.0 generation is restricted when there are transmission constraints

It doesn't happen often, but occasionally the transmission capacity between the Snowy Scheme and Sydney/ Melbourne is constrained or even out of service. Snowy 2.0 is vulnerable to transmission constraints due to its distance from generation sources and load centres. Usually such occurrences are a result of major weather events, such as heatwaves, fires, high winds, storms and floods. It is usual for such events to occur at the very times when electricity supply is even more essential.

For example, bushfires on 4 January 2020 resulted in the shutdown of Upper Tumut and Lower

Tumut Switching Stations and the loss of connection between NSW and Victoria[18&19] The NSW Energy Minister urged the public to cut their power consumption at the very time the state was experiencing scorching temperatures and high electricity demand, driven by air-conditioning. Wholesale electricity prices peaked at the $14,700/MWh market price cap for over two hours.

It is most unfortunate when at such crucial times, Snowy 2.0's generation (and pumping) capability is constrained or not deliverable at all. By contrast, storage located at load centres is unaffected by transmission constraints.

4.5. If run to 'empty' Snowy 2.0 would take many months to be recharged

A major constraint on Snowy 2.0's pumping/generating cycling is that whenever Tantangara Reservoir is emptied it will take many months to refill.

Theoretically Tantangara could be refilled in about 10 days of continuous 24 hour/day pumping at 2,000 MW (allowing for the 25% RTE loss factor). However, this would not be possible as there would be insufficient water in Talbingo, being two-thirds the capacity of Tantangara. Also, it would not make economic sense to generate at Tumut 1 & 2 to refill Talbingo at the same time as Snowy 2.0 was pumping, thus limiting make-up water from Tumut 1 & 2 to non-pumping periods.

Usually it would not be economic to run Snowy 2.0 pumps for more than 5-8 hours/day (i.e. when the spot price is 'cheap'). It could well be less hours/day or a lower rate, as if Tantangara were emptied it is likely to be during a period when wholesale prices were high due to stresses within the NEM that triggered extended Snowy 2.0 generation in the first place.

To run a plausible best-case scenario, if Snowy 2.0 pumped for say 6 hours/day at 2,000 MW, it would take about 40 days to fill Tantangara [350,000/6x2000/0.75=39], at about 6 GL/day. Coincidentally, 5 GL/day is about the maximum rate at which water can be transferred from Eucumbene to Talbingo via Tumut 1 and Tumut 2 generating for 12 hours/day, which is likely to be the maximum daily period for economical generation. So, 40 days is the minimum time it would take to refill Tantangara, ignoring any direct inflows to Tantangara and minimising a net drawdown of Talbingo.

This best-case scenario assumes no generation by Snowy 2.0 during that 40-day period. But it is likely to be profitable to run Snowy 2.0's generators for some of those days, especially if the NEM remained under stress and prices were high. Any Snowy 2.0 generation depletes the water pumped back to Tantangara and requires pumping for 1.3 times that period at the same MW rate to replenish the water used.

Also, unavailability or breakdown of the Snowy 2.0 pumps or the Tumut 1 or Tumut 2 generators would extend the time to refill Tantangara.

In summary, it would take many months (3+) to fill Tantangara and *'recharge'* Snowy 2.0's full capacity. If Tantangara were ever emptied it would be a once-a-season shot.

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[18] "Fires cut power link between NSW and Vic" Australian Financial Review 4 January 2020 https://www.afr.com/companies/energy/nsw-at-risk-of-blackouts-as-fires-cut-power-link-with-vic-20200104-p53ov4

[19] "More details on the bushfire-driven extremes in the NSW Region of the NEM on Saturday 4th January" WattClarity 5 January 2020 http://www.wattclarity.com.au/articles/2020/01/more-about-4jan2020/

4.6. Snowy 2.0 requires 470 GWh of pumping energy to completely re-fill

If ever Tantangara needed to be completely re-filled it would consume 470 GWh of pumping energy, incurring a cyclic loss of 120 GWh (plus transmission losses of a further 80 GWh).

5. *"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"*

5.1. This claim can be applied to all forms of energy storage, but less so for Snowy 2.0

All forms of energy storage (pumped hydro, batteries, hydrogen[20] etc) store cheap energy for generating at peak times. The stored energy is not 'excess energy', it is merely energy determined by the storage operator as being cheap enough to purchase with the intention of making a profit when sold later at a higher price.

Doing so flattens the load curve and assists the NEM to that extent.

The storage operator makes no choice of pumping based on one form of electricity production over another: for example, purchasing renewable energy versus fossil fuel energy.

Snowy 2.0 is no different to any other energy storage in this regard. The key issues are the efficiency and cost effectiveness of a specific energy storage. On both counts Snowy 2.0 is inferior to alternatives.

5.2. Snowy 2.0 would only make a relatively small contribution to the NEM

The National Electricity Market[21] has a generating capacity of 54,000 MW and supplies 180,000 GWh/year.

Snowy 2.0 generation would add to the NEM:

- 2,000 MW (4%), but usually for only a few hours a day at most
- up to 350 GWh capacity, subject to the limitations detailed in Sections 3 & 4
- the AEMO ISP forecast indicates that Snowy 2.0 (or other new pumped hydro) is not required till 2029 (Section 6.9).
    - even if Snowy 2.0 provided all such additional pumped hydro generation, rather than any contributions from Tumut 3, Shoalhaven or other new pumped hydro, it would constitute only 0.1% in 2025, rising to 0.5% in 2030 and 1.4% in 2040 of the annual NEM demand (see Figure 7)

5.3. On the other hand, Snowy 2.0 would be a net load on the NEM

Snowy 2.0 pumping would add to the NEM a load of:

- 2,000 MW
- 1.3 times the GWh generated, plus associated transmission losses

[20] "Australia's National Hydrogen Strategy" COAG Energy Council November 2019 https://www.industry.gov.au/data-and-publications/australias-national-hydrogen-strategy

[21] "National Electricity Market" AEMO https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM

6. *"Snowy 2.0 has a 100-year design life and will generate power for the generations to come"*

6.1. Snowy 2.0 should have a 100-year life, but will it operate for generations to come?

Who can foresee the future beyond a decade or so and what technological advances may evolve with improved and new forms of energy storage or energy production that could render Snowy 2.0 redundant well before its 100-year life, especially with its poor efficiency and distance from major load centres?

6.2. Snowy 2.0 is additional to existing plant, forestalling its full utilisation

Market and physical co-ordination with existing Snowy Hydro plant would impose constraints on how Snowy 2.0 operates and limit its potential financial return.

The current capacity of Snowy Hydro is 4,100 MW, with generation of 4,000 - 5,000 GWh annually. Current plant has substantial capability to load-shift over minutes to months due to the flexibility in releasing water to the major storages (Blowering and Hume) for both the Tumut and Murray Schemes.

Snowy 2.0 would be additional to this existing capability. Whenever it is economic for Snowy Hydro to generate, Snowy 2.0 would not necessarily be the first of Snowy Hydro's 9 power stations to be dispatched, especially as the other power stations need to fulfil water licence requirements for downstream use. Nor would it necessarily be the first of Snowy Hydro's pumping stations to be dispatched (Tumut 3 and Jindabyne), due to its higher losses (Section 6.6).

The extent to which Snowy 2.0 would actually be utilised on top of Snowy Hydro's existing capability is a key issue, not just Snowy 2.0's capability in isolation. There are limited references to such operating constraints/ considerations in the documentation. In fact, the modelling[22] assumes, incorrectly in our view, that Snowy 2.0 will operate independently of the existing Snowy Hydro plant (dubbed Snowy 1.0):

> *"The modelling assumed that Snowy 1.0 operates independently to Snowy 2.0 (although in practice they share Talbingo and there is a relationship)."*

From a financial assessment perspective, Snowy 2.0 should be the last to be dispatched, as all other Snowy Hydro power stations are existing (and largely depreciated).

6.3. Snowy 2.0 is not required today, as recently claimed

At a Senate Estimates hearing on 21 October 2019, the Managing Director of Snowy Hydro stated that Snowy 2.0 is required today, citing the NEM situation on the previous Friday as an example:

> *"As my colleague just said, Snowy 2 is required today. With a swing of 9,000 megawatts, and Snowy 2.0 is 2,000 megawatts, we're underdone already. As the market operator has pointed out, with the transition that's going on in the marketplace, the investment in renewables, you're going to need many more 2.0s."*

[22] "Modelling Snowy 2.0 in the NEM" Marsden Jacob Associates 3 December 2018 https://www.snowyhydro.com.au/wp-content/uploads/2018/12/MJA-NEM-Study-Public-Report-3Dec2018.pdf

Dr Mountain, Director Victoria Energy Policy Centre, disputed that claim[23] and Snowy Hydro's 'evidence' based on the operation of the NEM on the previous Friday:

> *"Specifically, on that day Snowy Hydro generated 4207 MWh in total. This is just 0.83% of the NEM's total generation for the day.*
>
> *And how much did the Tumut 3 pumped-hydro station pump or generate on that day? Well, it pumped nothing, and it generated 1 MWh (0.000199%) of NEM production for the day). So, on a day that Snowy Hydro argues emphatically proves the need for a massive augmentation of pumped hydro, in point we find no such need at all.*
>
> *To the contrary existing capacity lies barely used, as has long been the case."*

Snowy 2.0 is not needed today, contrary to Snowy Hydro's claim.

6.4. Snowy 2.0 is not needed until Tumut 3 is running near full capacity

Tumut 3, a similarly sized pumped hydro station (1,800 MW generation, 600 MW pumping) to Snowy 2.0, has been significantly underutilised over its 50-year life. During 7 of the 17 years from 2002 to 2018 pumping occurred on less than 10 days per year - in 2013 Tumut 3 didn't pump at all[24].

Over the past decade Tumut 3 pumps have been in service for an average of only 280 hours/year[25] (Figure 9) or 3% of the year [280/8760=0.03].

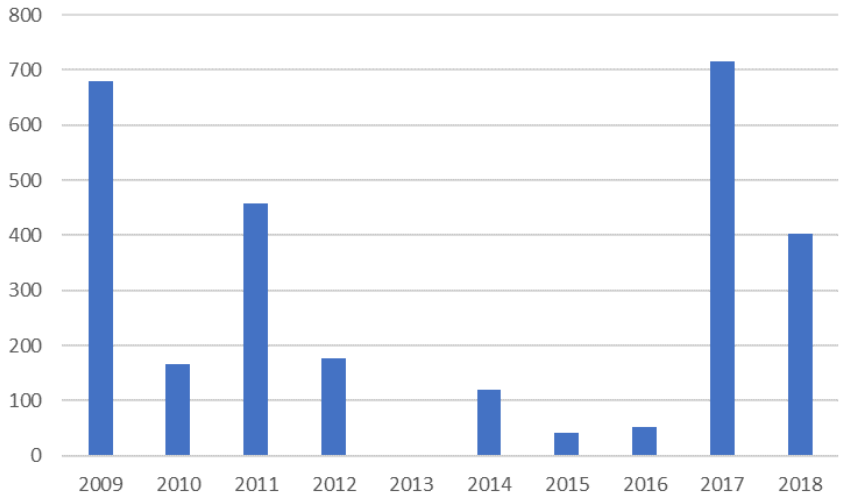

Figure 9 – Hours/year when Tumut 3 pumps were in service (WattClarity)

Snowy 2.0 cannot be justified until Tumut 3 is near full capacity, otherwise it would be supplanting/ cannibalising an existing, depreciated asset.

6.5. Modelling (inappropriately) assumes Snowy 2.0 displaces Tumut 3 pumped hydro

Snowy 2.0 modelling assumes pumping nearly 3,000 GWh/year from 2026, rising to 5,500 GWh/year by 2038 and thereafter (Figure 10 – Section 12.5[22]). Analysts have questioned these assumptions as

[23] "Snowy 2.0: Who will be held to account for this giant folly?" https://www.vepc.org.au/post/snowy-2-0-who-will-be-held-to-account-for-this-giant-folly

[24] "Does Snowy Hydro 2.0 Stack Up?" IES. 28 April 2017 http://iesys.com/assets/news/attachments/Insider-028.pdf

[25] "Generator Report Card 2018". WattClarity. 31 May 2019 http://www.wattclarity.com.au/other-resources/detailed-analysis-and-reports/generator-report-card-2018/

being highly optimistic, especially as they would involve pumping at 2,000 MW for an average of 4 hours for every day of the year in 2026, increasing to 7.5 hours/day in 2034 (or twice those daily hours at 1,000 MW). The recent AEMO ISP forecast has considerably lower projections (Figure 11).

Also, the modelling inappropriately assumes Snowy 2.0 displaces Tumut 3, rendering its existing pumps almost superfluous for another 20 years. Tumut 3 pumping is assumed to be almost zero from 2019 to 2026, increasing to just 300 GWh/year in 2034 (only 6% of Snowy 2.0 pumping).

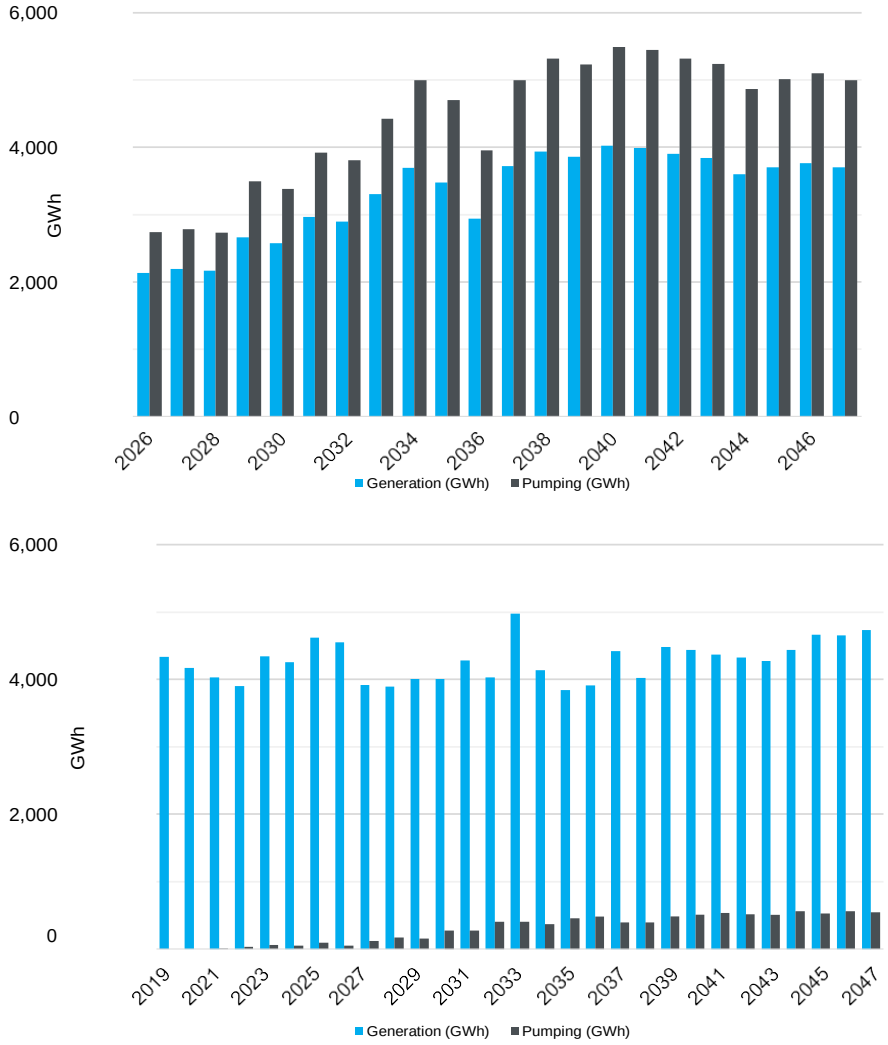

Figure 10 – Generation/Pumping Snowy 2.0 (top): current Snowy Scheme (bottom) (MJA)

6.6. Snowy 2.0 may cannibalise Tumut 3, even though it is less efficient

If Snowy 2.0 is constructed, will it be dispatched ahead of Tumut 3?

Snowy 2.0 is likely to be less efficient than Tumut 3 due the design of the turbines and very long tunnels (Section 8.10).

Snowy 2.0's reversible turbines cover both pumping and generation modes, whereas Tumut 3's separate turbines for pumping and generation are inherently more efficient. Tumut 3 does have a dewatered generator casing when pumping (and vice versa) so there are extra windage and friction losses, though minor. Also, Tumut 3 has large compressed air systems requiring considerable maintenance and refurbishment/replacement. On the other hand, Tumut 3 has virtually zero

pipeline friction losses (500 metres between reservoirs versus Snowy 2.0's 27 kilometres), whereas Snowy 2.0's very long tunnels would incur head losses of the order of 3% for both pumping and generation.

As well as having higher losses, Snowy 2.0's pumps are considerably larger than Tumut 3 (340 MW versus 200 MW) and hence less flexible in terms of bidding and dispatch.

Overall, it would appear that Tumut 3 is more efficient than Snowy 2.0. However, the part-load flexibility of the Snowy 2.0 asynchronous units may see them dispatched first.

Of course, if Snowy 2.0 is dispatched first it will effectively cannibalise the use of Tumut 3, other than in exceptional circumstances when the full capacity of both stations (3,800 MW) is dispatched.

6.7. Snowy 2.0 will supplant 30% of Tumut 1 & 2 generation, for little gain

Annual inflows into Tantangara Reservoir are currently diverted to Eucumbene Dam and thence through Tumut 1 & 2 power stations into Talbingo Reservoir. Diversions average 300 GL/year[26], constituting about 30% of the water currently turbined through Tumut 1.

In future Snowy 2.0 would turbine those natural inflows into Tantangara, supplanting Tumut 1 & 2. Due to the slightly higher head of Snowy 2.0 compared to Tumut 1 & 2, a marginal increase in energy production from those inflows will result, estimated to be about 25 GWh/year.

6.8. Snowy 2.0 may curtail up to 2,517 MW from existing Tumut generators

During an extended period of generation by Snowy 2.0, the operation of the three existing Tumut power stations may have to be curtailed if discharging into Blowering is to be limited or avoided:

- Tumut 3 (1,800 MW) would not pump whilst Snowy 2.0 is generating. Hence its generation would be limited to the spare capacity in Jounama
- operation of Tumut 1 (330 MW) and Tumut 2 power station (287 MW) may also have to be curtailed to stop water discharging from Tumut 2 into Talbingo Reservoir and limiting the space for Tantangara water

As the combined output of the three Tumut power stations is 2,517 MW, any curtailment must be offset against the 2,000 MW generation capacity of Snowy 2.0.

6.9. Snowy 2.0, or alternative pumped hydro, not needed till the late 2020's

AEMO's recent ISP provides forecasts till 2042. Snowy 2.0 has been incorporated in the forecasts as it was deemed to be a committed project (by Snowy Hydro and the Commonwealth Government).

AEMO's analysis considers the sensitivity of a four-year delay to Snowy 2.0's scheduled commissioning year of 2024-25. It concludes that such a delay would have no material impact on system costs, provided HumeLink is delivered on time in 2024-25 (Section 5.3.1 of the Appendices[27]):

> *"While Snowy 2.0 is a committed project, prudent planning must consider the impact to the power system if the project was not delivered on time with the current commissioning schedule.*

[26] "Snowy Hydro response to incorrect claims" November 2019 https://www.snowyhydro.com.au/our-scheme/snowy20/faqs20-2/

[27] "Draft 2020 Integrated System Plan Appendices" AEMO 12 December 2019 https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/ISP/2019/Draft-2020-ISP-Appendices.pdf

AEMO has conducted a sensitivity with a four-year delay to the project to investigate the impact on the forecast costs, benefits, and resource mix of the NEM. The transmission required to unlock the project – the HumeLink transmission project – will be delivered independently to Snowy 2.0, and in this sensitivity is not delayed with the storage project.

Under all candidate development paths, AEMO's sensitivity analysis forecasts that the power system is relatively resilient to such a delay, with no material impact to the overall system costs. This assessment is on the premise that the transmission projects that form part of the candidate development path (and HumeLink in particular) are delivered on schedule, providing the necessary resilience in the event of Snowy 2.0 delay."

A caveat is added that the assessment is not at a level consistent with the Electricity Statement of Opportunities, nor has it been determined whether the level of reliability would satisfy the NSW Energy Security Target[28]. AEMO concludes that from 2029 onwards *"Snowy 2.0 additional dispatchable capacity would be essential for the NEM in the longer term".*

Figure 11 shows the AEMO forecast of Snowy 2.0 generation for the Central Optimal Development Path scenario. AEMO predicts minimal generation till 2030, rising to 2,600 GWh in 2033 and then stabilising at around 2,800 GWh/year thereafter.

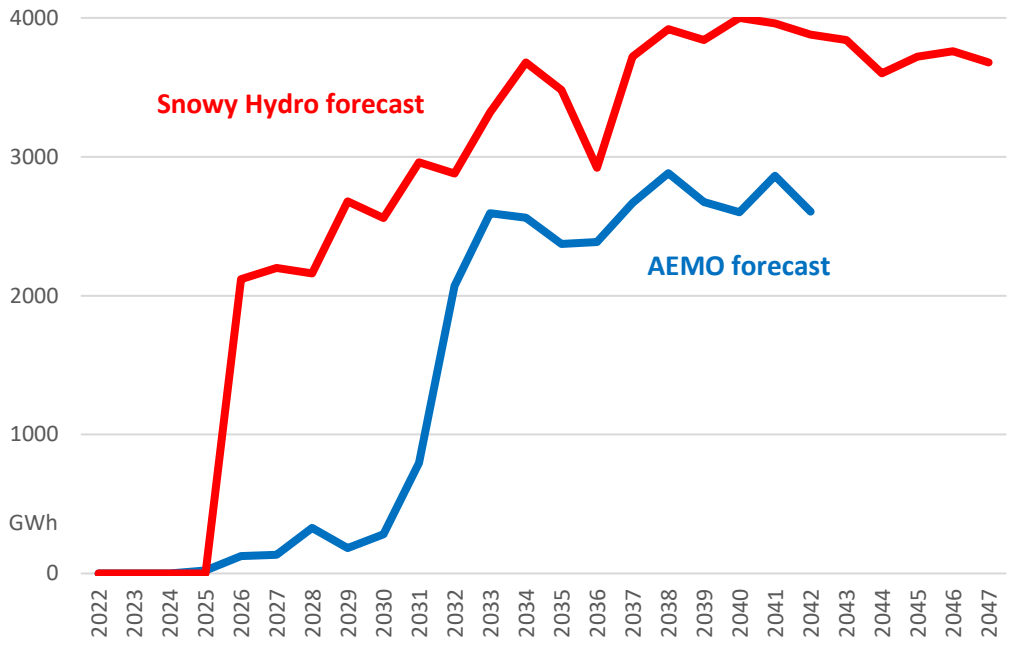

Figure 11 – Forecast Snowy 2.0 annual generation

As with all forecasts caution is necessary, but suffice it to say this forecast indicates that the need for additional pumped hydro generation in NSW can be provided by spare capacity in Tumut 3 and Shoalhaven stations till about 2030, consistent with the sensitivity analysis showing no material impact from a 4-year delay in Snowy 2.0.

Moreover, AEMO's forecast of generation from all forms of storage, excluding behind-the-meter storage, is less than 1000 GWh/year prior to 2031.

New pumped hydro, whether from Snowy 2.0 or alternatives, is not required till about 2029.

[28] "NSW Electricity Strategy" 22 November 2019 https://energy.nsw.gov.au/government-and-regulation/electricity-strategy

6.10. Snowy Hydro's forecasts seem highly optimistic

Figure 11 also shows Snowy Hydro forecasts for Snowy 2.0 generation, illustrating a significant difference to AEMO's forecast.

Snowy Hydro's forecast is for Snowy 2.0 to immediately generate over 2,000 GWh/year at its commissioning in 2025 and steadily increasing to 4,000 GWh/year from 2038 onwards.

AEMO's forecasts indicate a 5 to 6-year delay in the ramping up of Snowy 2.0 generation and then a maximum output level of 75% of Snowy Hydro's forecasts.

If the modelling assumptions for Snowy 2.0 are overstated, as would seem to be the case, not only is the usage of Snowy 2.0 overstated, but its estimated financial returns and economic viability would also be significantly overstated. There would be minimal revenues from storage for the first 6 years of operation, rising to only three-quarters of the forecast maximum revenues (see Section 8.6).

6.11. Increasingly, large solar and wind generators are coming with storage

Most new solar and wind farms have storage on site, usually in the form of batteries. Also, some existing renewable generators are adding battery storage.

The owners can see the commercial advantage of limiting exposure to the whims of the market and being able to take advantage of opportunities. Also, storage at the generator enables spreading the period over which energy can be injected into the network, reducing network losses and improving the marginal loss factor for the generator, thus improving average price received and profitability.

Local storage also avoids commercial dependence on a third-party storage provider, such as Snowy Hydro.

6.12. Snowy 2.0 runs against the trend of a decentralised NEM

The overall trend of electricity supply is away from large power stations and storages towards a dispersed system of multiple generation sources and storages, particularly at consumer premises (e.g. roof top solar cells with battery storage).

This trend leads to greater efficiency, minimal network losses, less expenditure on network additions and shields consumers from system outages and faults. It also provides for gradual additions to the NEM rather than lumpy additions like Snowy 2.0.

6.13. Would Snowy 2.0 *'generate power for the generations to come'?*

Whilst Snowy 2.0 would provide useful energy storage capability, would it actually run? Major factors mitigating against its use include:

- no need for new pumped hydro in NSW till about 2029 (Section 6.9)
    - not needed till Tumut 3 was near capacity (Section 6.4)
- very inefficient compared to other energy storage (Section 1.4:
    - larger network losses due to the longer distance both from generators supplying pumping energy and to load centres (Section 7.1)
    - total round-trip losses of 40%, far higher than other storage (Section 1.4)

    - larger losses that Tumut 3 (Section 6.6)
    - Snowy 2.0 will be near the bottom of the merit order dispatch list
- decreasing opportunities to buy and sell electricity:
    - need to sell electricity at twice the pumping purchase price to just cover losses
    - decreasing opportunities to cycle, due to a predicted decline in average electricity price spreads to less than 2:1[29]:
        - 2025: $85/MWh (off-peak $50/MWh, peak $135/MWh) – i.e. 2.7:1
        - 2030: $30/MWh (off-peak $75/MWh, peak $105/MWh) – i.e. 1.4:1

Expert analysts predict that Snowy 2.0 will rarely be economic to run.

[29] "Snowy 2.0's revenue streams" Snowy Hydro https://www.snowyhydro.com.au/our-scheme/snowy20/snowy-2-0-feasibility-study/revenuestreams/

7. *"Snowy 2.0 is ideally located between the two major load centres - Sydney and Melbourne"*

7.1. Snowy 2.0's location results in significant network losses

The Main Works EIS states:

> *"the project is located between the two largest load centres in the NEM (Sydney and Melbourne) and in proximity to renewable energy zones in south western NSW and north western Victoria."*

However, Snowy 2.0 is located 500 kilometres or so from both the:

- major load centres, primarily Sydney and Melbourne, and
- major generation centres, currently the Hunter Valley and Latrobe Valley, and future large solar and wind farms across NSW/VIC (Figure 12). NSW's first renewable energy zone in the Central West of the state (3,000 MW) is even further away

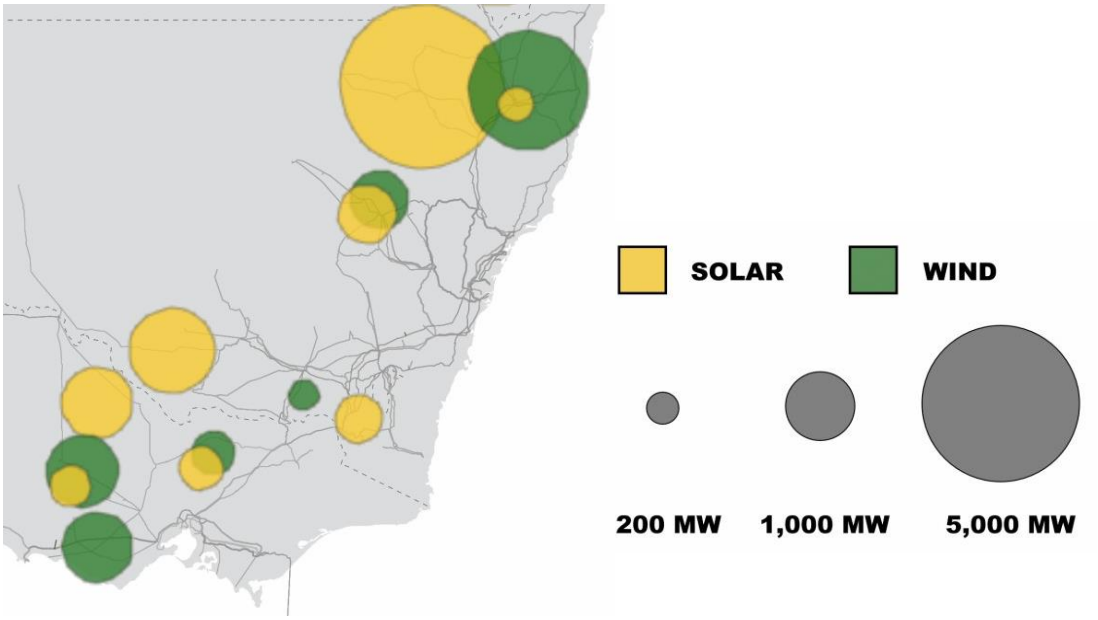

Figure 12 - Forecast new solar and wind farms 2040 (AEMO ISP Central Scenario)

In order to minimise network transmission losses and constraints, the best locations for energy storage are at a renewable generator station or a load centre.

For example, a battery co-located with a solar/wind farm or situated nearby (say at a local hub) incurs no network losses for storage, just the one-way transmission/distribution losses for supply to the load (Section 1.4). A further advantage is that generated energy can be stored and then injected into the network at a lower rate over a longer period than without the battery. This will reduce losses because the dominant series component of network losses is a function of the square of the energy flow rate. This reduction in network losses would partly compensate for the battery cyclic losses.

Also, no network losses at all are incurred when storage is adjacent to both a renewable generator and a load, as is the case with batteries co-located with RTPV on consumer premises (residential, commercial or industrial).

Snowy 2.0, being 100's of kms away from renewable generators and 500 kms away from each of the

major load centres, is a significant disadvantage, rather than a benefit as claimed.

7.2. Snowy 2.0 requires major, costly grid upgrades

The national electricity grid will require substantial augmentation to transmit 2,000 MW to and from Snowy 2.0, as it will constitute the largest single load ever to be added and the largest generator for 35 years.

In June 2019 Transgrid issued a Project Specification Consultation Report[30] providing 12 options for reinforcing the NSW grid north from Snowy 2.0 to Sydney by an additional 2,000 MW to 3,100 MW, ranging in cost from $0.8 to $1.9 billion. Information on grid reinforcements south from Snowy to Melbourne are yet to come.

The Report lists four needs underpinning the proposed investment, with Snowy 2.0 being the first:

i) *"The committed expansion of generation and storage capacity in the Snowy Mountains ('Snowy 2.0')*

ii) *The strength of the renewable energy resources in southern NSW and western VIC*

iii) *The limitations on the existing NSW transmission network that would limit northwards flows from the Snowy Mountains to the major NSW load centres*

iv) *AEMO's ISP analysis that identified transmission augmentation of the shared network between the Snowy Mountains and Sydney as part of the optimal network development plan that would deliver net market benefits as dispatchable generation in NSW retires."*

Two new 500 kV circuits from Maragle to Bannaby (just north of Goulburn), one via Wagga, constitute Option 3C (Figure 13), providing an additional 2500 MW firm capacity at an indicative capital cost of $1.35 billion. Option 4C extends those two new 500 kV lines from Bannaby to Sydney, providing firm capacity of 3100 MW at an indicative cost of $1.9 billion.

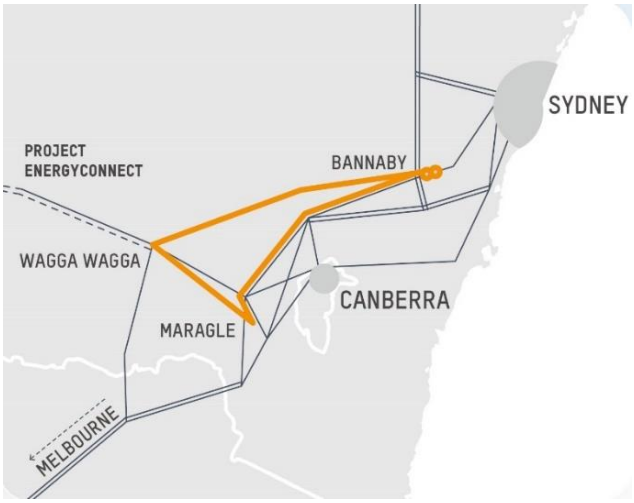

Figure 13 – Transmission extensions from Snowy 2.0 to Sydney (Transgrid PSC Option 3C)

These indicative costs do not include the lines from Snowy 2.0 to Maragle or further required

[30] "Project Specification Consultation Report: Reinforcing the New South Wales Southern Shared Network to increase transfer capacity to the state's demand centres" Transgrid 25 June 2019 https://www.transgrid.com.au/what-we-do/projects/regulatory-investment-tests/Documents/TransGrid%20PSCR_Reinforcing%20NSW%20Southern%20Shared%20Network.pdf

strengthening of the network from Wagga to Victoria to accommodate Snowy 2.0. AEMO are yet to finalise the ISP, so it will be some time before the additional circuits are finalised and the cost determined. But it would appear that the total cost of transmission augmentations to both provide for Snowy 2.0 and strengthen the grid will be well over $2 billion.

Figure 14, taken from the AEMO ISP, shows the proposed grid extensions in Southeast Australia. The extension from Snowy 2.0 north is called 'HumeLink' and described as *"the transmission required to unlock the project"*.

Figure 14 – Optimal Development Plan (AEMO ISP)

Whilst HumeLink will also strengthen the grid and provide other wider benefits, Snowy 2.0 is a prime reason for its construction, route and timing.

It is noted that the AER has just approved[31] the EnergyConnect project between Wagga and South Australia, reducing the wider benefits that would be derived from reinforcing the grid to connect Snowy 2.0.

7.3. Transmission capacity risk

Snowy 2.0's distance from Sydney and Melbourne and its location within a remote, natural area exposes it to the risk of insufficient transmission capacity to provide the full capability of Snowy 2.0 generation in addition to the existing Snowy Scheme output.

As noted in Section 4.4, transmission constraints occur occasionally. Complete disconnection of Snowy 2.0 from the grid is also a possibility, particularly the transmission lines from Snowy 2.0 through Kosciuszko National Park. Snowy Hydro's Managing Director echoed those risks when he

[31] "AER approves South Australia – NSW interconnector regulatory investment test" 24 January 2020 https://www.aer.gov.au/news-release/aer-approves-south-australia-–-nsw-interconnector-regulatory-investment-test

recently warned[32]:

> *"rising bushfire risk along the east coast has spurred the need for critical electricity transmission lines to be built connecting Victoria and NSW, but through the west of the states in non-forested areas that are less prone to fires"*

The location of Snowy 2.0 is a disadvantage, especially compared to multiple distributed energy storages within load centres, which are unaffected by network constraints and outages.

7.4. Kosciuszko National Park is the worst possible location

This Paper is focussed on the claimed benefits of Snowy 2.0, skirting the fact that Snowy 2.0 is located within Kosciuszko National Park. Never has a commercial development of anything like the size and impact of Snowy 2.0 been proposed in a NSW National Park. 'Biodiversity offset payments' from the damage are mooted to be of the order of $250 million – an unprecedented amount, reflecting the scale of destruction.

The major environmental impacts of Snowy 2.0, outlined in the Main Works EIS and highlighted in NPA's EIS submission[33], include:

Area of impact on Kosciuszko National Park

- the 'project area' (as defined by Snowy Hydro) covers 250,000 ha covers one-third of Kosciuszko National Park (twice the area of Greater Sydney; bigger than the ACT)
- physical disturbance to 1,680 ha, with a total loss of 1,053 ha of native vegetation including 992 ha of habitat for 14 threatened species
- permanent broader impact to 10,000 ha (100 square kms) of the Park through new or expanded roads and tracks, altered aquatic environments in the two reservoirs, depressed water tables and stream flows, transmission lines, spread of pest species (even beyond Snowy 2.0 and the Snowy Scheme)

Excavated spoil

- 14,000,000 cubic metres of excavated rock dumped in the Park (enough to cover a football field to a height of 3 kilometres)
- approximately half having naturally occurring asbestos and/or being potentially acid forming
- unbelievably, 8,000,000 m^3 to be dumped in Talbingo and Tantangara Reservoirs, decreasing their storage capacities
- 6,000,000 m^3 dumped on Park land (minor amount for roadworks and structures)

Major construction works and infrastructure

- major infrastructure at Tantangara, Marica, Lobs Hole and Talbingo
- involving land clearing and reforming, 3 accommodation camps (over 2,000 workers), rock dumps, electricity substations, works areas and permanent infrastructure
- over 100 km of new, widened or upgraded tracks and roads
- a major two-lane sealed road down the precipitous mountainside to Lobs Hole, requiring extensive cutting and land-reforming

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[32] "Fire sparks Snowy Hydro call to link NSW, Victoria power" Australian Business Review 9 January 2020 https://www.theaustralian.com.au/business/fire-sparks-call-to-link-nsw-victoria-power/news-story/4543f7131e74e960691182020c73c609

[33] "NPA Submission to Snowy 2.0 Main Works EIS" 6 November 2019 https://www.planningportal.nsw.gov.au/major-projects/submission/580546

Transmission lines

- two side-by-side high voltage transmission lines traversing 10 km of the Park
- associated access tracks
- easement swathe 120 metres wide

Depressed water table above the 27 km tunnel

- in some sections by over 50 m
- up to 2 km either side of the tunnel
- drying up streams and bogs, killing off habitat and native species (some threatened)
- reducing inflows to Snowy reservoirs and downstream rivers

Spread of pests, weeds and pathogens

- pests spread throughout the Snowy Scheme and downstream
- transporting pest fish, including Redfin Perch (a Class 1 Noxious Fish), Eastern Gambusia and Wild Goldfish (and fish diseases), from Talbingo up to Tantangara Reservoir (pest-free) and the Murrumbidgee catchment, and thence throughout the Snowy Scheme and downstream rivers
- almost inevitable extinction of a critically endangered fish (Stocky Galaxias)

Tantangara Reservoir

- fluctuations in the water level of Tantangara Reservoir of up to 5 metres a day, resulting in shoreline movements of hundreds of metres, dramatically affecting the aquatic ecology and public amenity:
- when empty Tantangara will be a puddle surrounded by an extensive mud/dirt shoreline over 2,000 ha
- the reservoir will become nothing more than a holding tank and an eyesore

Visual blight

- transmission lines, roads and tracks, infrastructure and landscape scars seen from over tens of thousands of hectares

This recent photo shows earth-moving equipment after razing and compacting a few hectares at Lobs Hole on the banks of the Yarrangobilly River – a further 1,680 ha to go. A third of Kosciuszko National Park has been burnt by fires. Now is a critical time for nurturing the Park, not inflicting further human-induced damage.

8. "Snowy 2.0 will provide energy storage at least cost"

8.1. No analysis of alternatives

Since the announcement of Snowy 2.0 only the Tantangara/Talbingo 2,000 MW project has been promoted. There has not been an analysis of alternative projects. By contrast, the Battery of the Nation project in Tasmania is proceeding down the usual, and to be expected, transparent pathway of progressively publishing reports on options, preliminary assessments, selecting the best options, submitting EISs etc.

Snowy Hydro has not provided any analysis of alternative energy storage options to demonstrate that Snowy 2.0 *'will provide energy storage at least cost'.*

Other alternatives clearly exist. Snowy Hydro has alluded to Snowy 3.0 and 4.0 and a further 6000 MW of pumped hydro within the Snowy Scheme. The earlier NPA Paper lists several alternative pumped hydro schemes within the Snowy Scheme.

In December 2018 the NSW Government published a "NSW Pumped Hydro Roadmap"[34]:

> *"The NSW Government has worked with the Australian National University (ANU) to uncover opportunities for pumped hydro across the State. This analysis found an incredible 20,000 reservoirs in the natural landscape that could be used as storages for pumped hydro energy. These could be paired-up in different ways to create 98,000 potential off-river pumped hydro sites—representing over 50 terawatts (TW) of firm generation capacity. In 2018, AEMO has projected that NSW will need investment in 9,000 MW of utility-scale energy storage by 2040, which is less than 1 per cent of the opportunities mapped".*

No doubt most of these options will not be viable, but some are likely to be commercially and environmentally suitable.

The NSW Government has established a $75 million Emerging Energy Program *"to support the development of innovative, large-scale electricity and storage projects in NSW."* Grants were recently awarded[35] for 10 pre-investment studies, representing 2,150 MW of on-demand electricity for projects covering compressed air storage, batteries and pumped hydro. Also, 21 projects were shortlisted for 700 megawatts of pumped hydro, gas, biogas, solar thermal, virtual power plants and batteries.

There is no need to hastily proceed with Snowy 2.0 on the pretext it is urgently required and is the only option for energy storage.

Alternatives potentially entail less construction, cost and risk, are more modular and manageable, have significantly less (or negligible) environmental impact and only require minor transmission upgrades.

Snowy Hydro should have analysed all feasible alternatives in detail and demonstrated why *'Snowy 2.0 will provide energy storage at least cost'*, including an environmental comparison. It is well past the time that should be done, especially with the growing scepticism of the fundamentals of the

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[34] "NSW Pumped Hydro Roadmap". December 2018 https://energy.nsw.gov.au/media/1546/download

[35] "NSW Government delivering an affordable, reliable and clean energy future" Minister for Energy 30 September 2019 https://energy.nsw.gov.au/nsw-government-delivering-affordable-reliable-and-clean-energy-future and https://energy.nsw.gov.au/renewables/clean-energy-initiatives/emerging-energy-program

project.

Calls for a comprehensive review of Snowy 2.0 have been made by many stakeholders, the most recent being the NSW Nature Conservation Council[36].

8.2. No analysis of alternatives, as required by the EPA Regulation

No analysis of alternatives to Snowy 2.0 was included in the Exploratory Works EIS and only cursory comments were provided in the Main Works EIS. This is despite Clause 7(1)(c) of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*[37] requiring *"an analysis of any feasible alternatives to the carrying out of the development, activity or infrastructure".*

8.3. The Snowy 2.0 project will cost approximately $10 billion

The cost of Snowy 2.0 has increased 500% since its announcement (Figure 15):

- $2 billion - original estimate (15 March 2017)
- $3.8 - $4.5 billion (expected to be at lower end) - Feasibility Study (21 December 2019)
  - but excluding "*Land and development costs; Foreign exchange fluctuations or hedging costs; Funding or financing costs; Snowy Hydro Project Management and operational ramp-up costs; Validation of project uncertainty in association with risk profile; Operational spares; and GST"* and transmission
- $5.1 billion - for a single contract (5 April 2019)
- $4.6 billion - Main Works EIS estimate (26 September 2019)
  - again excluding "*exploratory works, segment factory, SHL, advisors, funding, approvals, GST, land acquisition and escalation costs"* and transmission

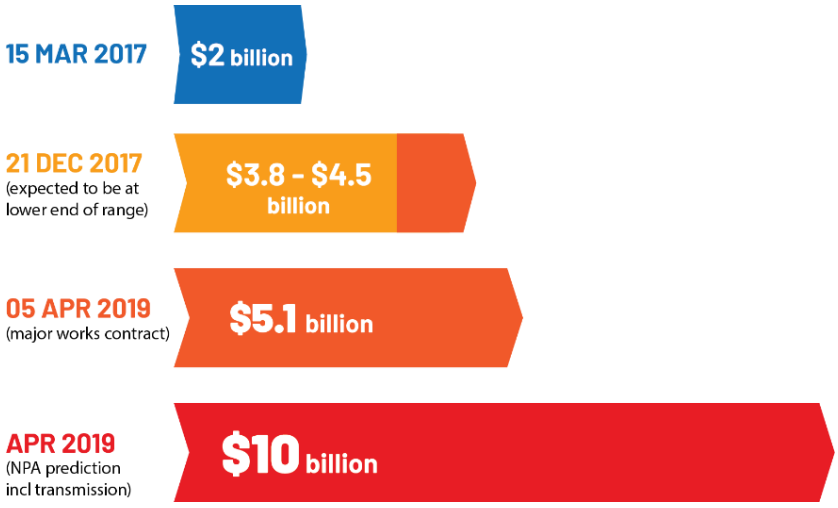

Figure 15 - Ever-increasing capital cost estimate (NPA)

[36] "Nature Conservation Council Annual Conference Motion 2019/3" 2 November 2019
"That the Nature Conservation Council of NSW call for Snowy 2.0 to be halted pending:
a) the outcome of a full environmental impact assessment that includes the transmission impacts; and
b) an independent review of the claimed benefits and costs relative to feasible alternative energy storage solutions."

[37] "Environmental Planning and Assessment Regulation 2000"
https://www.legislation.nsw.gov.au/#/view/regulation/2000/557

Unbelievably, Snowy Hydro continue to assert that the cost of Snowy 2.0 will be no more than $3.8 - $4.5 billion, despite overwhelming evidence to the contrary:

> *"We reject any claims that there have been cost over-runs on this project. Our projected capital cost remains within the 2017 Feasibility Study cost of $3.8 billion to $4.5 billion."*

NPA estimates the total cost of the hydro component of the project to be approximately $8 billion. When transmission is included the total cost of the project rises to approximately $10 billion, five times the original estimate.

8.4. The cost of transmission should be included in an assessment of Snowy 2.0

As noted in Section 7.2, whilst HumeLink and other ISP extensions will strengthen the grid and provide other wider benefits, Snowy 2.0 is a prime reason for their construction, timing and routing. Without Snowy 2.0, the ISP proposals would be less extensive and not as urgent.

Snowy Hydro states[26]:

> *"Snowy Hydro has been clear from the outset that transmission augmentation is required to support Snowy 2.0, and we support HumeLink and KerangLink, but they are not - and cannot be - our projects and accordingly cannot be factored into Snowy 2.0's capital cost."*

In accordance with established electricity industry capital contributions policies, Snowy 2.0 should pay an equitable proportion of these extensions, especially as it will gain double the benefit from being both a generator and a load. Snowy Hydro has made no allowance for the cost of electricity transmission in its Business Case, other than the 10 km of lines through Kosciuszko National Park, which constitute just 1.5% of the 630 km of new lines to the north alone.

Irrespective of whether Snowy 2.0 is required to contribute to the remaining 98.5% of transmission, that cost is ultimately borne by electricity consumers and hence an appropriate portion should be regarded as attributable to the Snowy 2.0 project when assessing its merits.

For the purpose of this Paper, NPA has attributed $2 billion as Snowy 2.0's share of the transmission augmentation costs.

8.5. Large, complex infrastructure projects rarely come in on budget

It does not bode well that both the estimated completion time and cost have blown out by over 200% and 500% respectively in just 3 years, and before the major works are underway. Invariably, overruns also occur during the construction of large, complex infrastructure projects.

8.6. Snowy 2.0 appears to be financially unviable

The NPA Paper questions the economic viability of Snowy 2.0, citing interest payments on an $8 - $10 billion loan of $460 - $570 million per annum, more than double the annual profit of the whole of Snowy Hydro ($210 million).

Snowy Hydro has projected the value of Snowy 2.0 to be $7.7 billion[38], though expert analysts have disagreed with the underlying assumptions, most notably the forecast operations (see Sections 6.9 and 6.10).

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[38] "Snowy 2.0 FID - S08 Valuation and Selected Business Case" December 2018 https://www.snowyhydro.com.au/our-scheme/snowy20/fid/

The Snowy 2.0 valuation is derived from projected revenues from six 'products' (Figure 16):

1. *"Storage - the ability to purchase energy at low prices, store as potential energy, and sell the energy when supply-demand is constrained*
2. *Traditional capacity - the ability to sell and defend $300 cap products*
3. *Renewable firming - the ability to match intermittent solar or wind (supply) with a load (demand)*
4. *Retail diversification - being able to improve the alignment of peak capacity with peak demand*
5. *System security - increased capacity to participate in the five-minute Frequency Control Ancillary Services market*
6. *Drought and real option value - increased capacity to operate without requiring water from inflows"*

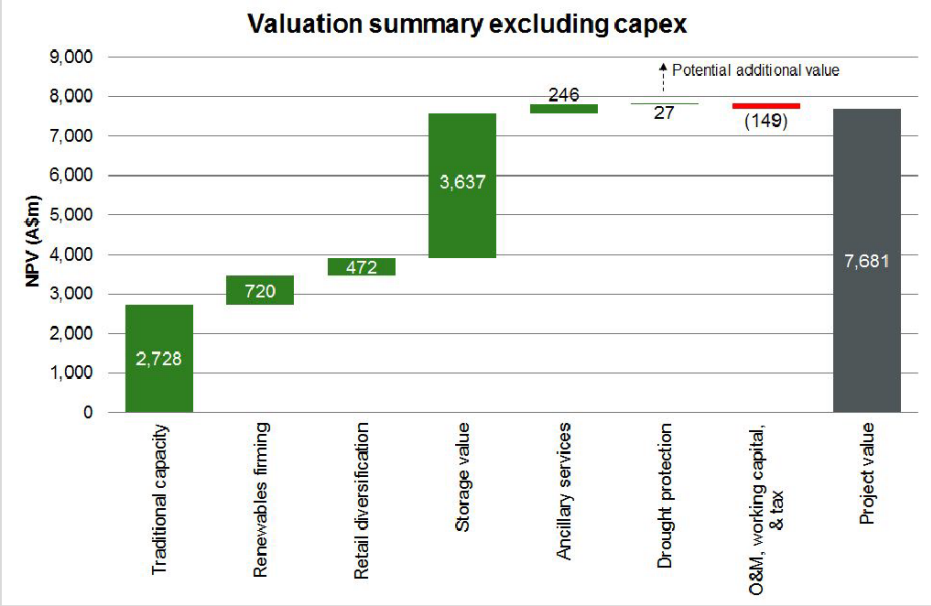


Figure 16 – Snowy 2.0 valuation summary (Snowy Hydro)

Snowy 2.0's revenue is projected to come primarily from storage (47%), traditional energy (35%) and renewable firming (9%).

Assoc Professor Bruce Mountain, Director Victorian Energy Policy Centre, has calculated the present value of Snowy 2.0 revenues, using Snowy Hydro's own figures, to be $1.7 billion[39], not $7.7 billion.

8.7. A 5-year delay in the need for Snowy 2.0 has a substantial financial impact

As noted in Section 6.9 and Figure 11, AEMO's scenario analysis indicates that Snowy 2.0 is not required for its initial five years, resulting in minimal revenue from storage and revenue reductions in other products. Total revenue during those years is likely to be less than half Snowy 2.0 projections, resulting in a substantial decrease in the projected value and financial viability.

AEMO also forecasts maximum generation of only three-quarters the level predicted by Snowy Hydro.

[39] "Snowy 2.0: Who will be held to account for this giant folly?" https://www.vepc.org.au/post/snowy-2-0-who-will-be-held-to-account-for-this-giant-folly

Snowy Hydro should release its financial analysis and demonstrate how Snowy 2.0 could service its debt and still make a profit, especially in light of it not being needed for 5 years after commissioning.

8.8. Taxpayers providing a $1.38 billion subsidy

When first announced, Snowy 2.0 was to be fully funded by Snowy Hydro, without any taxpayer support. However, the Commonwealth's approval of the Business Case included an announcement that taxpayers would contribute up to $1.38 billion to the project.

There are conflicting statements by the Government and Snowy Hydro on the purpose of the $1.38 billion subsidy/ equity injection. But there should be no need for a taxpayer-funded subsidy for a project that is supposedly economic, especially as any subsidy provides an unfair advantage against competitors in the NEM.

8.9. Snowy 2.0 has not been demonstrated to be the least-cost energy storage option

No comprehensive information is provided on the costs of Snowy 2.0 compared to other pumped hydro schemes.

Researchers from the Australian National University estimated[40] the capital cost for new off-river pumped hydro stations at roughly $800/kW (power) and $70/kWh (energy). It is noted that estimates for new pumped hydro stations include the construction of reservoirs, whereas Snowy 2.0 would use existing reservoirs.

By comparison, the cost of Snowy 2.0 (excluding transmission) is of the order of:

- $4,000/kW ($8bn/2,000 MW) – 5 times the typical cost
- $25/kWh ($8bn/350 GWh) – one-third the typical cost

However, Snowy 2.0 will rarely if ever be required to supply its maximum capacity (Section 2.1). Also, the actual practical recyclable storage capacity of Snowy 2.0 is far less than the claimed 350 GWh (see Sections 3 & 4) and it would usually cycle a considerably lesser amount of energy. Applying these two adjustments would increase the Snowy 2.0 energy cost per GWh to a similar or even higher cost per GWh than typical new pumped hydro stations.

Also, by comparison, the three most promising pumped hydro schemes in Hydro Tasmania's "Battery of the Nation"[41] have an estimated cost of $1,700/kW (with two of those schemes having the additional cost of a new upper reservoir).

It is noted that the Main Works EIS includes a chart on lithium-ion battery costs, predicting a fall from $2,000/kW in 2019 to $1,000/kW in 2040. These estimates appear high compared to the Hornsdale battery in South Australia (Tesla 100 MW/ 129 MWh lithium battery), built in 2017 in less than 3 months for a reputed US$50 million. Hornsdale's cost is $750/kW – just 15% the cost per kW of Snowy 2.0 (incl transmission), though it can't match the energy storage capacity of pumped hydro. Simplistically, $10 billion would provide 130 Hornsdale batteries (13,000 MW/ 17 GWh),

[40] "100% Renewable Electricity in Australia" Blakers, Lu, Stocks 15 August 2017 https://doi.org/10.1016/j.energy.2017.05.168

[41] "Battery of the Nation – Pumped Hydro Energy Storage Projects Prefeasibility Studies Summary Report" Hydro Tasmania August 2019 https://www.hydro.com.au/docs/default-source/clean-energy/battery-of-the-nation/botn-phes---prefeasibility-studies-summary-report-aug19.pdf?sfvrsn=2b089a28_2

though no doubt more batteries could be negotiated for such a large deal.

The Hornsdale battery is ideally co-located with a 315 MW wind farm, thereby incurring no network losses as well as having 300% less cyclic losses than pumped hydro (Section 1.4).

8.10. The advantage of two existing reservoirs is more than offset by their distance apart

The availability of two existing large reservoirs, at a major head differential, would appear to be the reason for choosing the Tantangara/Talbingo option for Snowy 2.0. However, that advantage is more than offset by the extraordinarily long interconnecting tunnel, resulting in an enormous cost, the need to dispose of massive quantities of spoil and high water-friction losses.

NPA can find no pumped storage scheme in the world with a distance between reservoirs of anywhere near 27 kilometres. Most schemes have their reservoirs within a couple of kilometres apart, as shown in Figure 17 for the world's largest schemes[42]; the distance for Tumut 3 is 500 metres.

Rank	Pumped Storage Scheme	Generation Capacity (MW)	Distance between Upper & Lower Reservoirs (km)
1	Bath County USA	3,030	2
2	Huizhou China	2,448	4
3	Guangdong China	2,400	2.5
4	Ludington USA	2,172	0.3
5	Okutataragi Japan	1,932	2.5
6	Tianhuangping China	1,836	0.5
7	Tumut-3 Australia	1,800	0.5
[5]	Snowy 2.0 Australia	2,000	27

Figure 17 – Distance between reservoirs of the world's largest pumped storage schemes

Hydro engineers have a "rule of thumb"[43] that for a pumped storage project to be economic, the length of the interconnecting tunnel/pipeline should ideally be less than four times the hydraulic head:

> *"The ratio of horizontal distance to vertical distance (H/V Ratio) should be less than 10 and preferably less than 4 to minimise friction losses, minimise conduit costs and avoid the inclusion of a surge tank"*

Snowy 2.0 has a H/V Ratio of 40. This is ten times the rule-of-thumb, though some allowance is appropriate to take account of the fact that Snowy 2.0 does not require new reservoirs.

[42] Data sourced from Wikipedia https://en.wikipedia.org/wiki/Pumped-storage_hydroelectricity
[43] "A Brief Appraisal of the Potential of Pumped Storage in NSW" MS Phillips, WL Peirson and RJ Cox June 2013 https://www.nccarf.edu.au/settlements-infrastructure/sites/www.nccarf.edu.au.settlements-infrastructure/files/Discussion%20Paper%20Z%20Final.pdf

Figure 18 lists the H/V Ratios for Australian and USA pumped storage schemes[44], showing most have H/V Ratios of 4 or less. Tumut 3 and Wivenhoe have H/V Ratios of 3 and 4, respectively. Only two schemes exceed 10.

Pumped Storage Scheme	Pumping Capacity (MW)	H/V Ratio
Bear Swamp	540	3
Muddy Run	855	3
Senaca	380	3
Tumut 3	600	3
Wivenhoe	500	4
Blenheim Gilboa	1,030	4
Cabin Creek	280	4
Ludington	1,888	4
Raccoon Mountain	1,370	4
Yards Creek	350	5
Jocassee	628	6
Bath Country	2,100	8
Northfield	1,000	9
Taum Sauk	350	9
Fairfields	512	13
Helms	1,200	13
Snowy 2.0	2,000	40

Schemes shaded yellow are in Australia. All others are in the USA.

Figure 18 – H/V Ratios of pumped hydro storage schemes

It is noted that Snowy 2.0 will have the second largest pumping capacity of all pumped hydro stations in the USA and Australia.

[44] "Technical Analysis of Pumped Storage and Integration with Wind Power in the Pacific Northwest" prepared for U.S. Army Corps of Engineers by MWH August 2009 https://www.hydro.org/wp-content/uploads/2017/08/PS-Wind-Integration-Final-Report-without-Exhibits-MWH-3.pdf

9. "Snowy 2.0 will reduce electricity prices"

9.1. Snowy 2.0 will increase electricity prices

Snowy Hydro and the Commonwealth Government claim that Snowy 2.0 will lower electricity prices. For example, the Minister for Energy and Emissions Reduction stated on 19 October 2019 that:

> *"[Snowy 2.0] will bring down electricity prices, reduce volatility to prices and put downward pressure on electricity bills for all of us while keeping the lights on".*

No evidence has been provided to justify this claim.

On the contrary, the Snowy Hydro FID Market Modelling Report[45] predicts that Snowy 2.0 will push NSW spot prices higher. No predictions are included for Victorian or South Australian prices.

Figure 19 (copied from the Snowy Hydro Report) shows NSW electricity spot prices from 2026 to 2047, with and without Snowy 2.0 (blue and black lines, respectively).

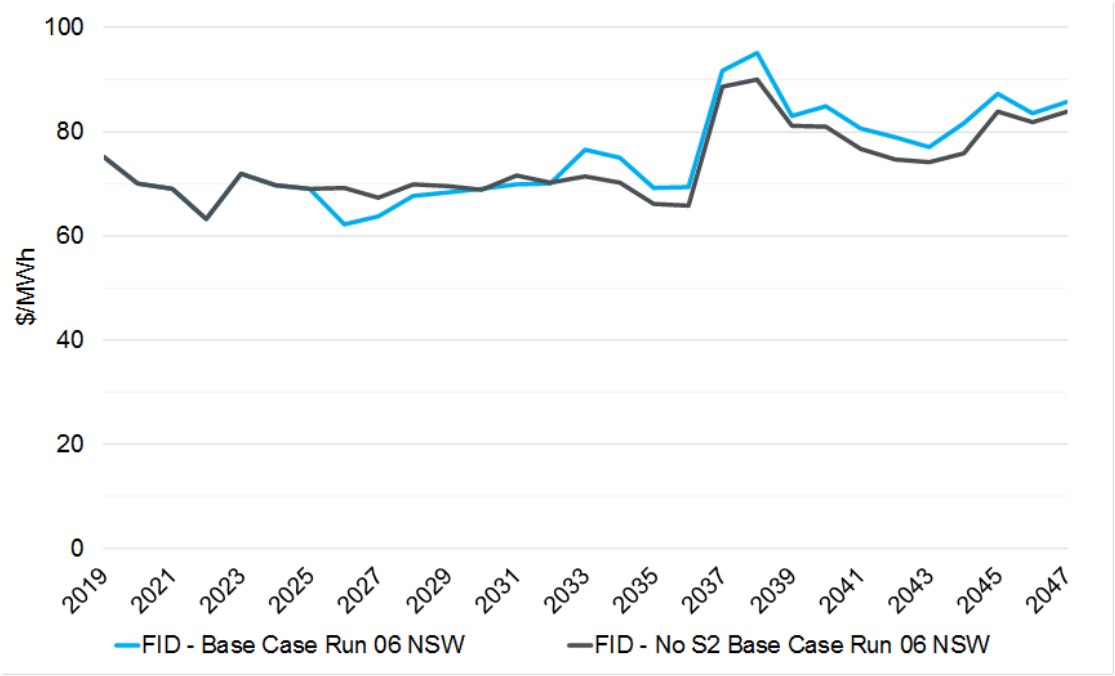


Figure 19 - NSW spot prices with and without Snowy 2.0 (Snowy Hydro Fig 12[45])

The Snowy 2.0 FID Scenario Analysis Report states (Section 4.2.3[46]):

> *"Snowy 2.0 results in a reduction of spot prices until the early 2030s reflecting an excess of capacity. After this Snowy 2.0 results in slightly higher spot prices. This reflects more variability due to a higher level of VRE, reduced gas plant, reduced coal plant minimum generation levels during low price periods, and higher demand due to pumping."*

Remarkably, prices are only predicted to be lower with Snowy 2.0 for 3 of the projected 22 years. Prices are similar from 2028 to 2033, but higher for every year thereafter to 2047 and seemingly

[45] "Final Investment Decision Information – Market Modelling" Snowy Hydro January 2019 https://www.snowyhydro.com.au/our-scheme/snowy20/fid/

[46] "Snowy 2.0 FID - S09 Scenario Analysis" December 2018 https://www.snowyhydro.com.au/our-scheme/snowy20/fid/

beyond.

One could surmise that, whilst Snowy 2.0 generation would place downward pressure on peak prices, Snowy 2.0 pumping would place upward pressure on off-peak prices. As pumping occurs for 1.3 times the period for generation, the net impact of Snowy 2.0 would be an increase in average spot prices.

9.2. Additional transmission will push electricity prices further up

The Snowy Hydro Reports do not include the cost impact of the additional transmission needed for Snowy 2.0.

This additional cost (Section 8.4) will add to the overall impact of Snowy 2.0 pushing electricity prices up.

10. "Snowy 2.0 has market benefits of $4.4 - $6.8 billion, being more than its cost"

10.1. Incorrect market benefit

Snowy Hydro and Minister Taylor[47] claim the market benefit of Snowy 2.0 to be $4.4 - $6.8 billion:

> *"We strongly reject any argument that Snowy 2.0 is not in the national interests. It has demonstrable economic and consumer benefits that have been independently valued at $4.4 to $6.8 billion."*

That valuation comes from a report prepared for by Marsden Jacob Associates (MJA)[48]:

> *"Snowy 2.0 would provide market benefits that reflect a reduction in capital and operating costs (including fuel costs) that would otherwise be needed for the production of wholesale electricity and maintaining supply reliability in the NEM."*

The table in the MJA report summarising the estimated market benefits (copied as Figure 20) has two sets of results - 'Excluding Optionality' and 'Option for further development'.

The option for further development assumes construction of Snowy 3.0, involving a duplication of Snowy 2.0 and increasing the height of Tantangara Dam. MJA estimate the extra capacity of Tantangara would provide a piggy-backing benefit for Snowy 2.0 of an estimated $150 million. The MJA Report gave *"a conservative estimate of a 25% probability that Snowy 3.0 would be developed"*.

Table ES1 Market Benefits and Snowy 2.0 Revenues Present Value $M

Scenario	Market Benefits		
	Excluding Optionality	Option for further development	Total
LRET+VRET	4,272 to 4,738	150	4,423 to 4,889
LT Commitment	6,140 to 6,643	150	6,291 to 6,793

Source: Marsden Jacob, 2017.

Figure 20 – NEM market benefits (MJA Table ES1)

Most improperly Snowy Hydro have referenced the higher market benefit based on the further development option.

Based on the MJA Report the market benefits of Snowy 2.0 are estimated to be $4.3 - $6.6 billion, not $4.4 - $6.8 billion as claimed.

10.2. Overly optimistic assumptions

Several expert analysts have questioned the optimistic assumptions of the MJA Report and consider its market benefits, which have been calculated over 50 years, to be highly inflated (see NPA Paper).

For example, the MJA Report assumes a rather optimistic usage of Snowy 2.0:

> *"Snowy 2.0 would operate in response to market needs. This would involve periods of operation*

[47] Snowy 2.0" ABCTV 7:30 Report 14 October 2019 https://www.youtube.com/watch?v=NfKJS-C3nQ8
[48] "NEM outlook and Snowy 2.0". Report prepared for Snowy Hydro Limited by Marsden Jacob Associates, 4 January 2018 https://arena.gov.au/assets/2018/02/National-Electricity-Market-outlook-Snowy-2.0.pdf

where Snowy 2.0 was:

- *operating in a repeatable way each day such as generating 8 hours/day and pumping for 10.5 hours/day. Roughly a repeating operating pattern each day will likely be the most common mode of operation*
- *operating at high output for continuous days in a row. Such operation may be associated with low wind condition across the east coast of Australia and generator outages*
- *high levels of continuous pumping for continuous days. Such operation may be associated with high wind condition across the east coast of Australia and low demand."*

AEMO's forecasts for Snowy 2.0 operation are considerably lower that the MJA assumptions (Sections 6.9 and 6.10). Applying the AEMO forecasts would result in a considerably lower estimate of Snowy 2.0 market benefits.

10.3. Snowy 2.0's cost is greater than its market benefit

More relevantly, Snowy 2.0's (overstated) market benefit of $4.3 - $6.6 billion is similar to its (understated) cost of $3.8 - $4.5 billion, when excluded costs are added (and ignoring transmission costs).

If NPA's estimate of a $10 billion cost for the total project is correct and MJA's estimated market benefit of Snowy 2.0 is inflated, the total project will cost at least twice its market benefit.

SNOWY 2.0 DOESN'T STACK UP

NATIONAL PARKS ASSOCIATION OF NSW
protecting nature through community action

Irreparable damage to the precious alpine landscapes of Kosciuszko National Park is reason enough to reject Snowy 2.0, let alone untenable costs, inappropriate taxpayer subsidisation, dubious renewable energy claims and complete lack of transparency.

Snowy Hydro has failed to demonstrate that Snowy 2.0 is the best option for the nation's electricity storage needs. **SNOWY 2.0 JUST DOESN'T STACK UP.**

ENVIRONMENTALLY DESTRUCTIVE

DAMAGING IMPACTS ON KOSCIUSZKO NATIONAL PARK. It is totally inappropriate for construction works of such magnitude and environmental impact to be permitted within one of the most significant natural landscapes in Australia, with its delicate alpine and sub- alpine environments. Snowy 2.0 will permanently impact 10,000 ha of Kosciuszko National Park.

LAND CLEARING. Impacts include clearing a 10 km-long, 120 m-wide easement swarth through Kosciuszko National Park for two side-by-side 330 kV transmission lines; building and upgrading 100 km of roads and tracks; and clearing 400 ha at Lob's Hole along an 8 km stretch of the Yarrangobilly River for an accommodation camp, construction site and rock dump.

DUMPING EXCAVATED ROCK IN RESERVOIRS. 14,000,000 cubic metres of excavated rock, some with naturally occurring asbestos and/or acidic, will be dumped in the Park - enough to cover a football field to a height of 3 km. Unbelievably, 8,000,000 m3 will be dumped in Talbingo and Tantangara Reservoirs.

INVASIVE SPECIES PROLIFERATION. Pest species (including Redfin Perch, a voracious predator and Class 1 Noxious Fish), will be transported from Talbingo up to Tantangara Reservoir and thence throughout the Snowy Scheme and downstream rivers.

PREMATURE APPROVAL. The project has been approved and construction has commenced before the EIS's for the Main Works and transmission lines have been assessed, totally disregarding the environmental assessment process.

UNECONOMIC

FLAWED BUSINESS CASE. Six weeks after the Business Case was approved by the Government, the cost estimate (of $3.8) was eclipsed by the first major contract to be signed (at $5.1 billion).

COSTS SOAR. The final cost, including transmission lines, could be as high as $10 billion – i.e. 500% higher than the original estimate of $2 billion! This staggering amount exceeds the value of the whole of Snowy Hydro ($7.8 billion).

ECONOMICALLY UNVIABLE. Snowy 2.0 could not cover the interest on its debt, let alone make a profit. The economics simply don't stack up.

SUBSIDY. Taxpayers shouldn't have to provide Snowy 2.0 with a $1.38 billion subsidy.

ELECTRICITY COST REDUCTIONS? No information is provided to support the claim that Snowy 2.0 will reduce electricity prices.

OVERLY OPTIMISTIC TIMING. The estimated construction time has more than doubled since Snowy 2.0 was first announced, from 2021 to 2027.

MINIMAL PAYMENT FOR USE OF KOSCIUSZKO. Snowy 2.0 proposes to only make minimal payments for use of Kosciuszko National Park during construction and operation – another inappropriate subsidy and unfair advantage compared to Snowy 2.0's competitors!

SNOWY 2.0 DOESN'T STACK UP

NATIONAL PARKS ASSOCIATION OF NSW
protecting nature through community action

RENEWABLE ENERGY?

COAL-FIRED GENERATION. Snowy 2.0 is being promoted as a 'green battery' for renewable energy. Yet, for at least the next decade or so, most of Snowy 2.0's pumping electricity will come from coal-fired generators. Perversely, this will result in increased emissions.

NET LOSSES (40%). Snowy 2.0 will consume more energy than it generates. For every 100 units of electricity used to pump water up to Tantangara Reservoir, only around 70 units of electricity will be retrieved when the water flows back down through the turbine generators to Talbingo Reservoir.

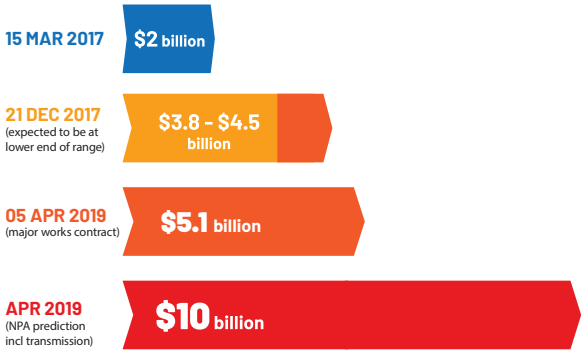
As well as having a 'round-trip' loss of 30% within the pumping / power cycle, there are also losses in transmitting electricity to and from Snowy 2.0 of typically 5% each way. So, for every 100 units of electricity purchased by Snowy 2.0, it will deliver only about 60 units.

LACK OF TRANSPARENCY

NO PUBLIC SCRUTINY OF THE BUSINESS CASE. Snowy Hydro is a Commonwealth Government Corporation. All Australians bear the liabilities of this risky project, including a $1.38 billion taxpayer subsidy. Electricity consumers and taxpayers need to know whether the project is financially viable and the claimed benefits are deliverable. Snowy Hydro has not released its Business Case or any financial information.

FLAWED PROCESS. The staged approach to the financial and environmental assessment, along with the limited release of information, means that neither the Government nor the public can comprehensively assess the entire project. The transmission lines EIS has yet to be released.

LACK OF RIGOROUS REVIEW. The Government's review of Snowy 2.0's Business Case was based primarily on advice from Snowy Hydro. The Government needs expert advice, independent of Snowy Hydro, on the environmental, economic and engineering impacts of the project.



Ever–increasing Capital Cost Estimates

BETTER ALTERNATIVES

IS SNOWY 2.0 THE BEST OPTION? Snowy Hydro has focused totally on the 'Snowy 2.0' project. No information has been provided on why Snowy 2.0 is the best option. Alternative pumped storage options exist – even Snowy Hydro has made references to the future use of other sites. Alarmingly, no substantive analysis of alternatives was included in the EIS, despite a legal requirement to do so.

There are alternatives involving less construction, cost, risk, transmission and environmental impact.

BROADER ALTERNATIVES NOT REVIEWED. Many other pumped storage opportunities have been identified in NSW, with a combined capacity considerably greater than Snowy 2.0. Before committing to Snowy 2.0 and providing a $1.38 billion subsidy, it was incumbent on the Government to review all storage options, including other pumped hydro, batteries and demand response.

There is no need to cut corners on the pretext that Snowy 2.0 is the only option for electricity storage and must be urgently constructed.

SNOWY 2.0 MUST BE STOPPED

Recent revelations on the cost and environmental damage of Snowy 2.0 confirm it just doesn't stack up. The Commonwealth Government should revoke approval of the Business Case, due to its significantly underestimated costs and overstated benefits to the Australian public. And the NSW Minister for Planning should refuse approval for the EIS due to the overwhelming damage to Kosciuszko National Park.

FULL PAPER. This summary outlines key issues from an NPA Paper on the Snowy 2.0 Business Case.

NPA is not opposed to pumped storage schemes. There is no question that additional electricity storage capacity is needed as renewable generation expands. However, this doesn't mean that pumped storage schemes require any less scrutiny than other large-scale construction projects, especially when located in one of the most precious and delicate parts of our nation.

NPA contends that the case for Snowy 2.0 doesn't stack up. It will trash Kosciuszko National Park, is totally uneconomic, is not a 'green battery' and will not deliver its claimed benefits. There are many better alternatives.

Snowy 2.0 is the wrong project in the wrong place!

NPA has endeavoured to ensure that all assertions are factually correct in the absence of key information including the Business Case.

Appendix F – Expert Advice

- Landform Review prepared by Golder Associates Pty Ltd, dated 18 May 2020
- Water Quality Review prepared by Water Research Laboratory, UNSW Sydney, report dated 4 October 2019 and letter dated 2 April 2020
- Groundwater Review prepared by Hydro Algorithmics, dated 20 March 2020
- Review of the Biodiversity Offset Strategy prepared by WSP Australia dated 15 May 2020

REPORT

Snowy Hydro Preferred Infrastructure Report Assessment

Landform design component review

Submitted to:

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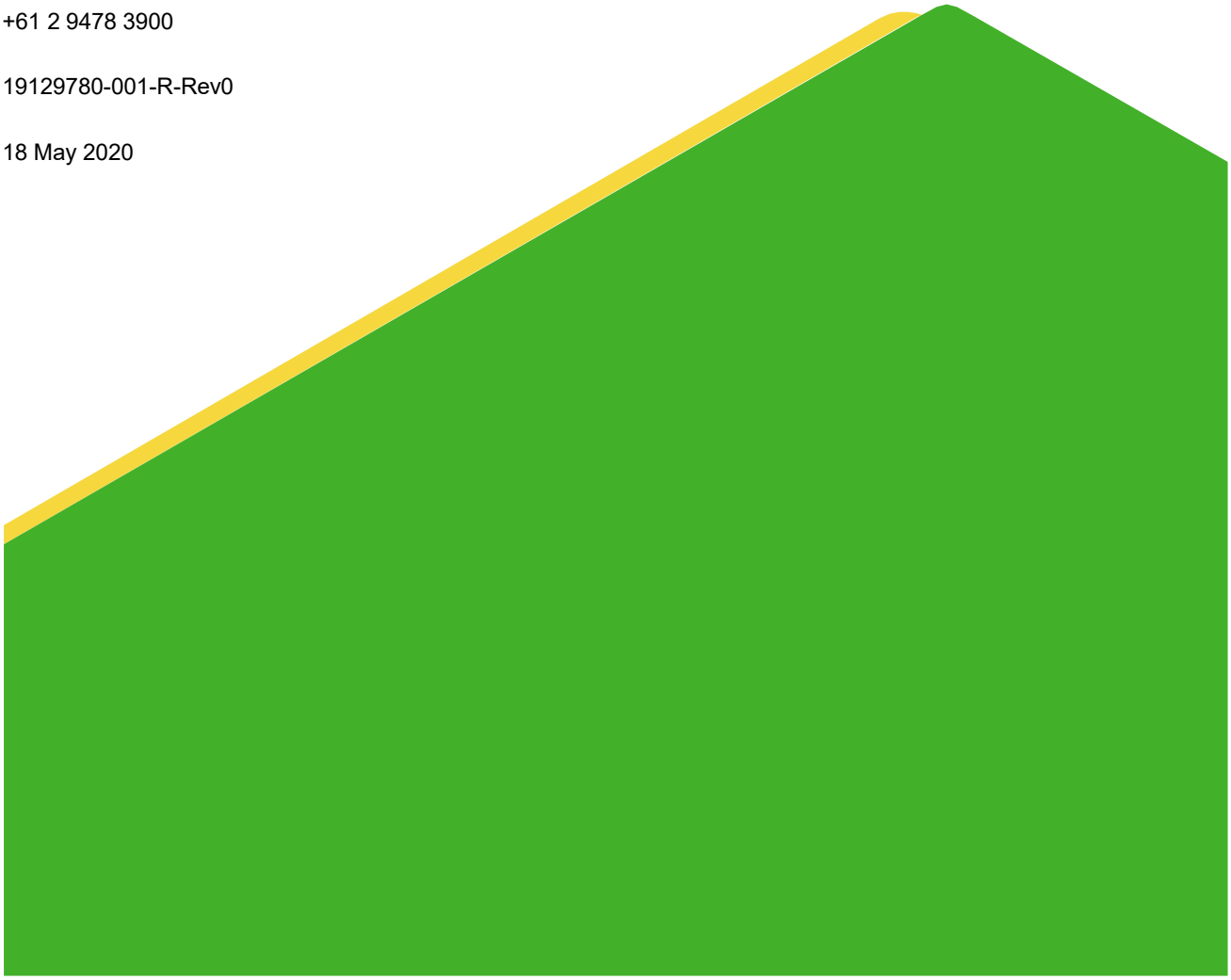
18 May 2020



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NSW Department of Planning, Industry and Environment

Golder Associates

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1.0 INTRODUCTION

The Department of Planning and Environment (Department) appointed Golder Associates Pty Ltd (Golder) in September 2019 to provide independent expert advice over Snowy Hydro's proposed excavated rock disposal strategy for the Snowy 2.0 project, and in particular, the landforms that would be created.

The Golder team has significant experience in geomorphic landform design within New South Wales dating back to 2012, predominantly on mine waste rock landform rehabilitation in and around the Hunter Valley.

The Snowy 2.0 project is predominantly a tunnelling project and the tunnels will generate significant volumes of excavated rock. While some of the excavated rock can be used for essential infrastructure such as construction pads needed to build tunnelling equipment and access roads, a significant volume would require permanent disposal.

The initial concept for the excavated rock was to dispose of it into the Talbingo and Tantangara reservoirs using barges to transport the material to the deepest parts of the reservoir, where it would be tipped and allowed to settle to the floor of the reservoir. While disposal below water would reduce the impact of the project on the land within the Kosciuszko National Park (KNP) it was found to result in significant impacts on the water quality of the reservoir, primarily high suspended solids associated with the fine material produced by the Tunnel Boring Machine (TBM).

To address government department concerns about these impacts, Snowy Hydro investigated a range of alternatives for both above and below water rock placement.

Golder reviewed several of these alternatives at the concept stage and provided advice to the department. This advice was critical of the proposed landforms in each of the alternatives, particularly from a long-term erosional stability perspective, but also in terms of the likely impact on the KNP.

In response to this criticism, Snowy Hydro commissioned Prof José Martin Duque from Spain to develop the preferred alternatives further and to refine the design of the preferred landforms, given that he has experience in the design of geomorphologically based landforms.

This work led to significant changes to the excavated rock disposal strategy for the Snowy 2.0 project, which were outlined in the Preferred Infrastructure Report (PIR) for the project. Primarily, there has been a move away from filling in valleys to forming new ridge lines on the edges of the reservoirs where there is limited upslope catchment. Other changes have resulted from more detailed project planning and refinement.

Key changes include the following:

- The volumes of estimated excavated material have reduced.
- Initial estimates of the surplus excavated rock material from the tunnelling operations was well above 10 million m^3 - this has reduced to 7.4 million m^3 largely because of refinement of the compaction density estimates and tunnelling planning. Note that this volume is for the excavated material measured after excavation and placement into the landform.
- The landform locations have been refined.
- The PIR has a combination of above and below Full Supply Level (FSL) landforms located on the edge of the reservoirs using normal earthworks equipment, with most of the material below FSL being Drill and Blast (D&B) material, that is, the coarser material, as well as one valley in-fill landform.
- The scheduling of access and material generated by the various tunnelling methodologies has resulted in some constraints.

- The key issue is that access to the Talbingo area and the rate of generation of D&B material will limit the disposal of excavated rock at Talbingo initially. The D&B material is the preferred material for placement below reservoir FSL due to its lower fines content. This scheduling limitation has meant that GF01 (located at Lobs Hole), the main valley in-fill landform, has had to be retained, resulting in the revised emplacement areas as shown in **Figure 3.7** of the PIR report, reproduced here as Figure 1 for ease of reference.

  It is worth noting , however, that the largest volume of material of surplus material (81 per cent) is proposed to be placed into the edge of reservoir landforms at Talbingo and Tantangara reservoirs, with the 'all to land' option (GF01) accommodating most of the remainder (nearly 14 per cent). The remaining balance is proposed to be accommodated in the so-called Rock Forest, located outside of the KNP.

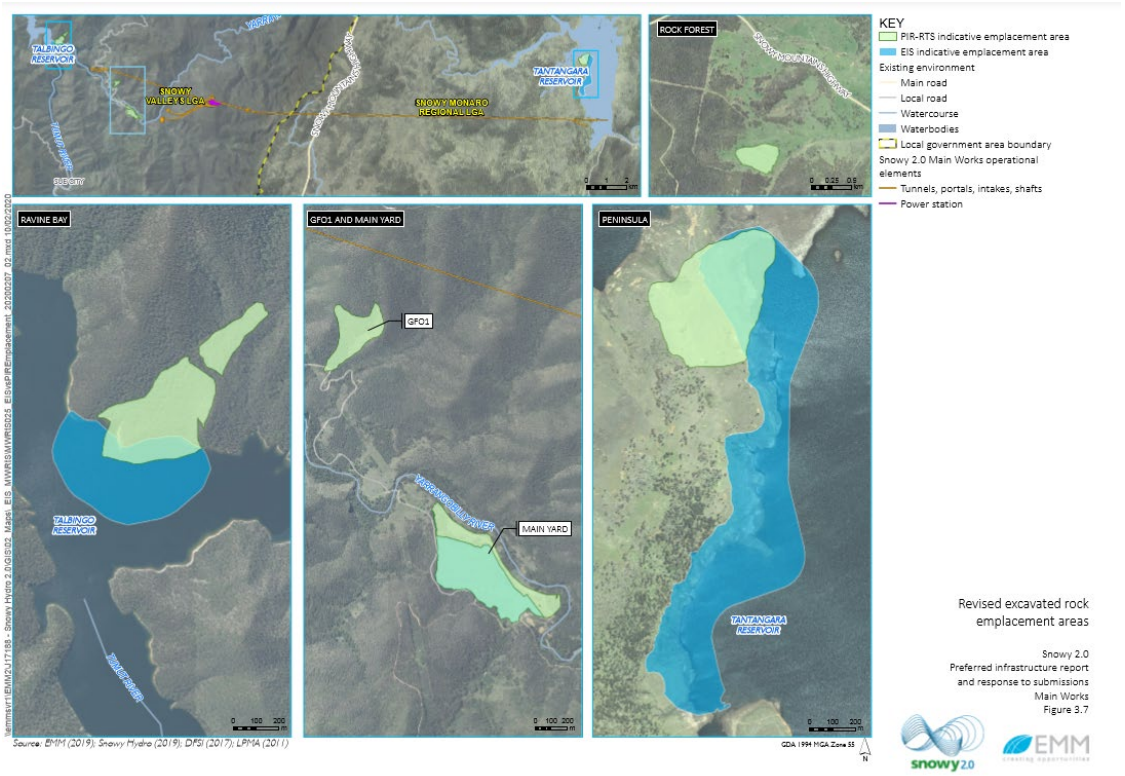

Figure 1 – Location of revised rock emplacement areas

Golder has reviewed the proposed excavated rock landforms in the PIR, which includes a high-level description of each of the landforms to a level appropriate for environmental evaluation, including three dimensional modelling and production of visual outputs of the landforms, noting that further refinement of these landforms will occur during the detailed design of the project if it proceeds.

This review has concluded that the changes made by Snowy Hydro are a significant improvement on the original proposal and would significantly reduce the environmental impacts associated with the disposal of the excavated rock generated by the project.

It has also concluded that the proposed landforms are feasible and can be delivered with a high degree of confidence.

Nonetheless, Golder identified several risks that would need to be carefully managed during the delivery of the project, and addressed in the final design of the landforms, including:

- An assessment of the availability, suitability, and erodibility of the topsoil to be used.
- Confirmation around sediment controls, including the space requirements for sediment dams and traps.
- Where applicable, refinement of the landform slopes at the water's edge, between the Minimum Operating Level (MOL) and Full Supply Level (FSL), the conceptual designs having these at angle of repose.
- Refinement of the possible creek diversion at Talbingo, including the erosional stability of the diversion and downstream section. Note that, in our view, the potential diversion is an important feature for Talbingo.
- Confirmation of the water management at GF01, including the upstream catchment during construction and the size of rock armouring required to confirm it is of a practical and reasonable size.

Golder sought additional information from Snowy Hydro on the above issues, and a response was received from them addressing most of these issues.

After reviewing this additional information, it is apparent that:

- The issues around topsoil and the creek diversion at Talbingo is only likely to be resolved by soil sampling and testing during the next phase of the Snowy 2.0 project, should it proceed.
- Sediment controls and optimisation of slopes at the water's edge are outstanding issues that will need to be managed during the detailed design phase.
- The rock size required for GF01 is practical and reasonable. The proposed upstream construction water management supplied by Snowy Hydro for GF01 is (in our view) not an optimal solution for the KNP. There are alternative options that have been discussed with Snowy Hydro for them to consider further.

Golder has subsequently given the Department advice on the landform specific conditions to be applied to the project including the design objectives for the landforms, and ensuring the residual risks are dealt with in the final design. The Department has incorporated these recommendations into the project conditions. Our understanding is that the final agreed designs will be signed off by the Department before any deposition may occur.

This report:

- Identifies why the initial landform designs were considered high risk for some areas (Section 2.0)
- Documents the concepts, limitations and opportunities associated with the current design approach (Section 3.0)
- Assesses the proposed landforms for the Snowy 2.0 project and identifies the residual risks to be addressed during the detailed design of the project (Section 4.0)
- Indicates a likely way forward (Section 5.0).

2.0 INITIAL LANDFORM DESIGN COMMENTS

The initial landforms proposed focussed on valley infill opportunities in and around the Snowy 2.0 project area. It was conceptualised that these valleys would be filled by diverting runoff from upstream of the excavated rock area around the infill area, with the diversions being permanent features in the landscape, and the residual valley then shaped, filled, and rehabilitated.

An example of one of these designs is shown in Figure 2, including the existing valley pre-construction and the proposed valley post-construction.

Figure 2 – Proposed Lick Hole Excavated rock emplacement location

While from the above visuals the approach may appear quite reasonable, there are several critical elements to the required design that were considered high risk (and in some cases impractical) which can perhaps be more clearly seen in a 3D image of one of the valley in-fill options in Figure 3 showing the potential footprint of the feature overlain on to the natural terrain in grey.

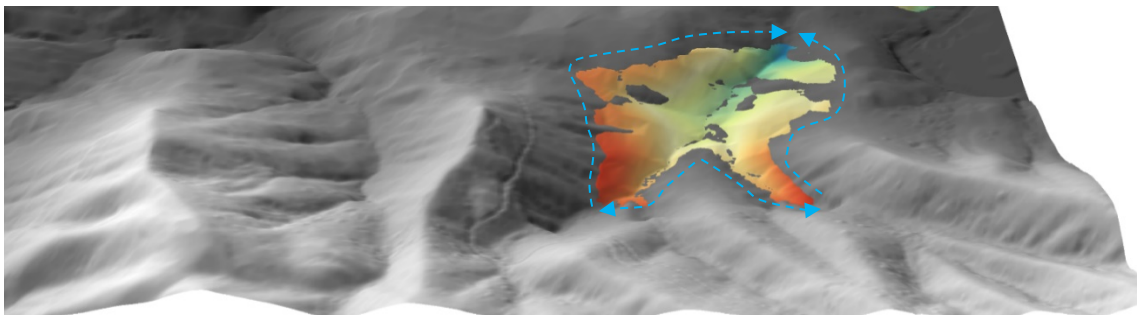

Figure 3 – Illustration of challenges associated with valley in-fills

The issues raised as potential concerns included the following:

- The diversions would need to collect the upstream flows, and then run on the sides of the steep slopes of the valley. The side slopes of the natural ground vary, but in many instances are steeper than 18 degrees or 1V:3H. Cutting stable long-term channels into these valley sides is not always practical and could necessitate deep cuts back into the mountain side.
- The upstream catchments are relatively large in extent, and the slopes are hydraulically steep. Consequently, the diversions will represent a challenging transition from the natural creek, with changes in the type of flow (from supercritical or “shooting” flow to sub-critical flow) as the grade flattens, as well as flow direction. Due to space constraints within the valley, none of these changes will be gradual, and conceptually could require an engineered feature such as a plunge pool or similar to ensure the transition (including the likely hydraulic jump associated with the change from supercritical to sub-critical flow) is managed.

- While there could be options to form an engineered transition either upstream of the infill or on the excavated rock material, the space constraints and the likelihood of settlement of the excavated rock makes this a high-risk option in our view, complicated by the expected high velocities.
- Further downstream, the gradient of the diversion around the excavated rock landfill changes, this time steepening from a flat gradient to a steep gradient as the diverted water is brought around the sides of the excavated rock emplacement back to the lower levels below the feature. These steep sections have the potential for erosion and may also require an energy dissipator at the bottom of the valley.

All the above indicated the likelihood that high levels of engineering would be required, residual risks would be significant, and a high possibility that ongoing maintenance would be required. These potential outcomes were considered not consistent with the requirements for a landform in the KNP.

The issue of upslope run-on was a consistent issue for the landforms being considered, particularly for the in-fill valleys, but also for the edge of dam designs for Talbingo and Tantangara, the original conceptual layout for Talbingo being shown in Figure 4

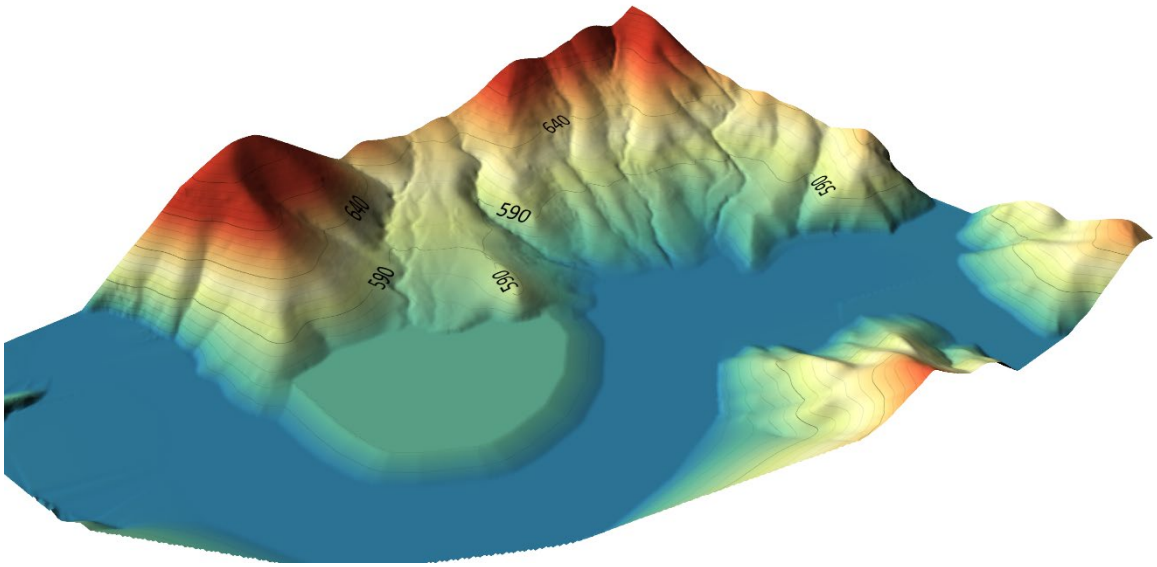

Figure 4 – Proposed Talbingo excavated rock emplacement location

While the location of the Talbingo landform again looked reasonable, on review it was noted that it is located below relatively steep natural catchments with high velocity flows transitioning from natural ground on to the excavated rock, and then into the Talbingo Reservoir. Potentially this detail results in either the need for hydraulic structures, or an armoured channel, potentially with a significant size of rock in a lined channel, or some combination of these measures.

The above issues resulted in a change in the design approach as set out below.

3.0 CURRENT DESIGN APPROACH USED BY THE PROJECT

Landform design methodologies tend to fall into three distinct categories. In broad terms, these are:

- **Empirical type design approaches**, using historically proven stable slopes or designs. These can be found in many mining environments, such as the use of traditional 17-degree linear slopes in the mining industry, often combined with engineering interventions such as contour banks and/or drop structures.

  In our view, the use of empirical design methods is not best practice, primarily because the long term sustainability of these linear designs with engineering interventions is at best uncertain, and in some instances (and particularly on dispersive soils) likely to be unsustainable without significant ongoing maintenance.

- **Analogue methods**, typically using the characteristics of relevant stable natural landforms in the local environment and applying these characteristics to the design of new landforms of similar materials. The reasoning for this approach seems very logical – stable landforms have evolved over long periods of time, and by understanding what makes natural landforms stable and emulating these characteristics, we have a reasonable chance of designing and constructing landforms that can last well into the future. Since most natural landforms in NSW are shaped by water erosion, managing the drainage of water in a safe and sustainable manner is a key requirement for long term stability.

  Examples of this approach are found in publications by Swatsky and Beersing, or the Geofluv™ methodology developed by Bugosh. The Geofluv™ method has commercially available software (Natural Regrade®) in support of the design of non-linear landforms with drainage density that can be used to emulate natural landforms. Importantly, the Geofluv™ method is intended to utilise alluvial analogues, that is, landforms formed by the deposition and subsequent erosion of transported soils such as are typically found along meandering river systems. These landforms theoretically do not require rock armouring, being stabilised in nature by vegetation only without significant rock or bedrock.

- **Erosional based methods** that focus on the soils to be used. These methods involve a combination of laboratory testing, sometimes including large scale flume test, and computer modelling. At the simplest level, the approach may rely on methods such as the Revised Universal Soil Loss Equation (RUSLE) to assess whether a soil will be stable on the proposed landform.

  More commonly on larger projects in Australia, two-dimensional analysis such as that used in the Water Erosion Prediction Project (WEPP) model is combined with more complex three-dimensional Landform Evolution Models (LEMs) such as Siberia or CAESAR. There is a substantive list of LEMs used globally; Siberia seems to be most widely used for landform analysis in Australia, whereas CAESAR is more widely used in North America.

While we now have experience in Australia with the Geofluv™ methodology dating back to 2012, the approach has almost always been integrated with site specific soils data and erodibility assessments based on methods used in LEM models or incorporating LEM modelling. This design approach incorporating the duality of methodologies has been developed in response to both some of the more problematic and erodible soils present in Australia, as well as the space constraints for many of the landforms on the East Coast, particularly in NSW.

While this methodology is not the only one that could be considered, there are several reasons for adopting this approach for the Snowy 2.0 project:

- Numerous drainage lines and steep slopes occur in the general area of each of the proposed landforms. This makes it unlikely that any new landform can be designed without accounting for concentration of flow, either from run-on to the landforms, or in managing the erosional risk of the landform itself. The use of a geomorphic design approach utilising the Natural Regrade® software or a similar design approach facilitates this, although it is preferable to limit run-on as much as is practical.
- The steepness of the terrain and the significant volumes of overburden to be managed makes it unlikely that a design based on an alluvial analogue can be accommodated in this environment. Since the use of alluvial analogues is a key requirement for using the Geofluv™ approach, this limitation means that a LEM will be required to assess the short and long-term stability of any designed landform.

It was consequently suggested to Snowy Hydro that a geomorphic approach with a high level of focus on surface water management was critical to the success of the Snowy 2.0 project, and Prof Jose Martin Duque and his team were appointed by Snowy Hydro to undertake most of the conceptual design work.

Prof Duque has worked extensively with the Geofluv™ methodology, and recently he worked with Prof. Greg Hancock at the University of Newcastle on a project integrating the Geofluv™ methodology with Siberia erosion modelling.

A unique feature of the Snowy 2.0 project compared to most other sites is both the steepness of the general terrain and the very high drainage density. Most of the valley in-fill sites considered by Prof Duque and his team during the conceptual work were vulnerable to this combination of steep drainage lines with reasonable catchment sizes resulting in potentially high velocity water flows and risks of scour and erosion (refer some of the sites evaluated in Figure 5).

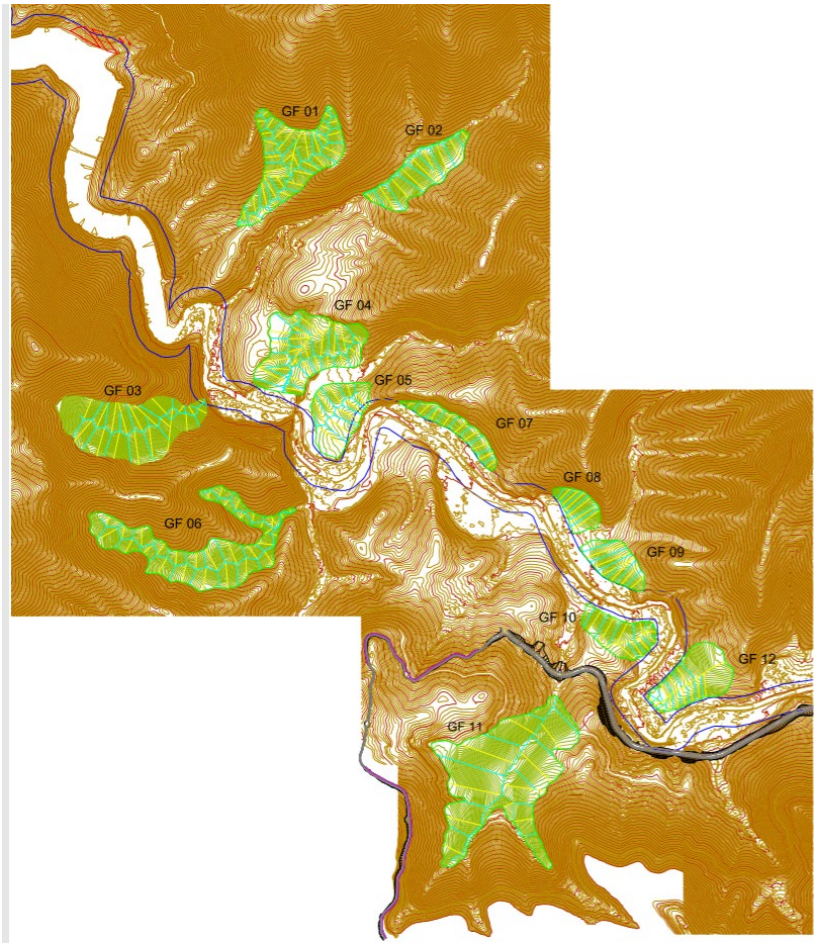

Figure 5 – Some of the valley in-fill sites evaluated during the study

As a result, there was a need to move away from valley in-filling as far as is practical to extending ridge lines to form new landforms with limited upstream catchment. The areas most suited to this design approach were at Talbingo and Tantangara, and it was initially hoped that these features would be able to accommodate all the surplus excavated rock. However, as indicated previously, scheduling issues and access challenges to get to the Ravine Bay at Talbingo meant that an additional landform had to be considered for the surplus material, being a valley infill at GF01 (Lobs Hole), as discussed in more detail below.

It is important to conclude this section of the report by noting that there are other methodologies that could be considered for the detailed design phase. For example, there are methods that go straight from a WEPP analysis to the use of LEMs without developing drainage density. There are also some practitioners in this field who dispute the long-term validity of the current LEM models.

However, our experience in NSW has given us confidence that the approach currently being used by Snowy Hydro is at the leading edge of design work in this field, particularly for a highly sensitive environment such as KNP. We believe that communities will increasingly require constructed landforms to be visually sympathetic with the natural environment and have a high level of environmental variability in both habitat and ecosystems, in addition to being safe and stable. We are confident a geomorphic approach allows one to achieve these goals.

In addition, the use of LEMs to predict long-term erosional impacts has been widely accepted as the most reasonable and scientifically justifiable approach for current technology, being used on iconic projects such as the Ranger Uranium Mine, where long term erosional stability is a critical outcome as for the Snowy 2.0 project.

The following section sets out the current landforms proposed in the PIR and our assessment of the areas of residual risk associated with data gaps, uncertainties, and construction level details still to be addressed.

4.0 REVIEW OF THE CURRENTLY PROPOSED LANDFORMS

An assessment of each of the proposed landforms is set out below.

4.1 Talbingo Reservoir

The layout of the proposed landform at Talbingo Reservoir is shown in Figure 3.13 of the PIR, reproduced here in Figure *6* for ease of reference with some points of interest flagged.

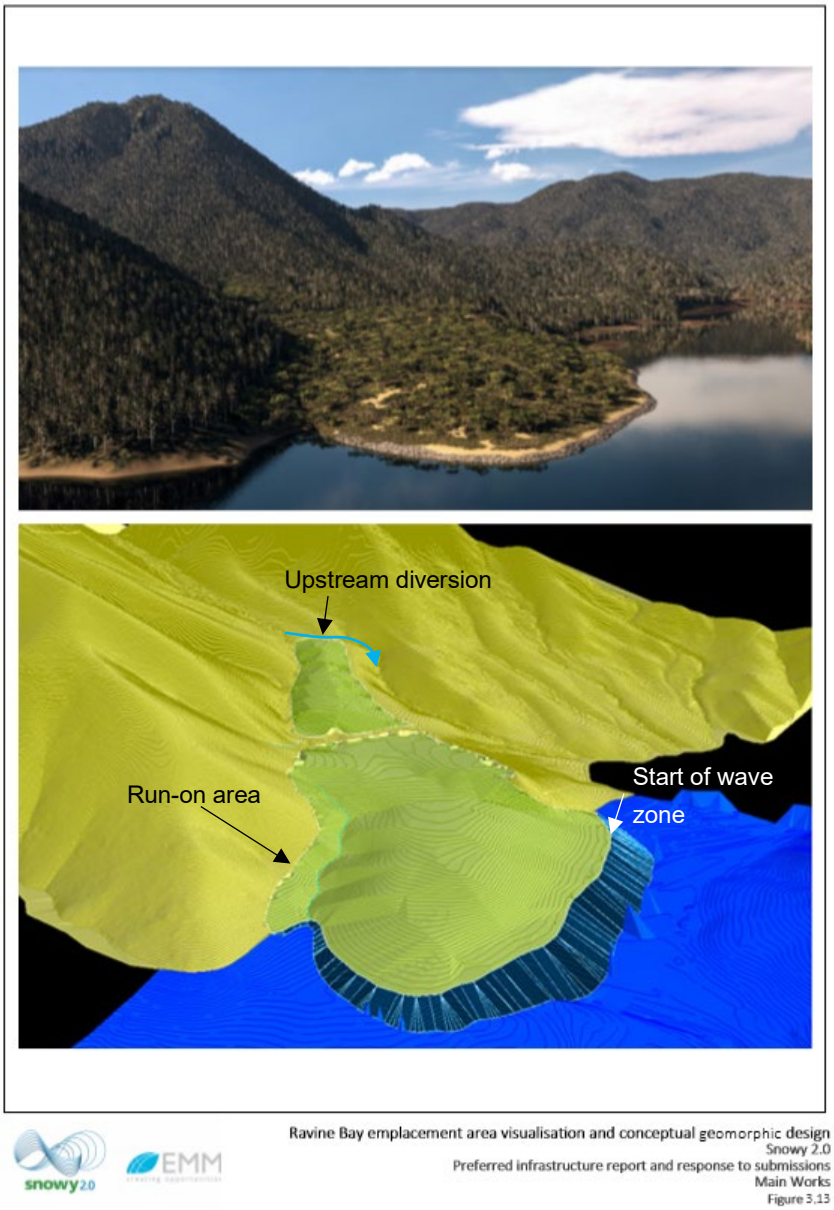

Figure 6 – Talbingo Reservoir Ravine Bay emplacement area

The current features and requirements for this emplacement are summarised in Table 1. This table is not intended as a complete and exhaustive list of the features and issues to be managed, but rather an initial high level assessment.

Note that in the comments we have inidicated items that we believe require clarification prior to approval (indicated in bold).

Table 1 - Features and requirements for Talbingo Reservoir Ravine Bay emplacement (refer Figure 6)

Overview	Aspect	Description	Comment
Description	Type of design	Edge of reservoir constructed on D&B pad tipped into the reservoir.	TBM material located above the D&B platform. D&B likely to be end tipped into water.
Water management	Upstream water management	Proposed diversion of upstream flows into the adjacent drainage line. However, see notes on RFI below the table which does not appear to show the diversion.	Geotechnical investigation into the diversion and adequacy of adjacent drainage line for increased flow still to be established. **An initial high-level assessment of how the diversion will change peak flows and velocities in the adjacent drainage line it will feed into should be undertaken (CR).** **If no diversion is proposed, then there is significant run-on over the final landform and a high-level assessment of this detail in terms of initial rock sizing, velocities and stream power is required (CR).**
	Residual run-on to be managed	With the diversion there is run-on from the northern side only. Without the diversion, there is a significant upstream catchment to be managed	Area of erosion risk still to be quantified. With diversion, only limited erosional risk and can potentially be excluded with only a small loss of volume in the overall landform if this needs to be adjusted. Without diversion, potentially significant residual risk (noted in previous item).
	Drainage Density	Some swales or sub-catchments on landform at conceptual level	Detailed design can optimise the extent and need for swales. Some smoothing likely – overall geometry is favourable to limit flow concentration.

Overview	Aspect	Description	Comment
Constructability	Construction sediment loading	Discussed, but not detailed yet. Upstream diversion (if constructed) will limit direct flow on to the surface, but runoff from the feature will need to be managed.	May require sediment control on transition from upper surface to sub-aqueous, potentially with a bench or similar feature to allow sediment collection.
	Construction access	Currently proposed from the area to the east, but significant cut required. Still being optimised.	Possibility of access from across the other side has been discussed to reduce additional excavation required. If implemented may impact on D&B volumes for pad construction below FSL.
	Initial shaping of natural ground.	No initial planning on this yet	Initial access and pads for vehicle management still to be refined. May need some cut into existing surface to form initial access, turning areas etc. Options for stockpiling of topsoil (if any available) to be considered.
	Progressive rehabilitation	Conceptual planning but no detail yet.	Ideally landforms will be built to final line and level as quickly as practical to allow for progressive rehabilitation to limit visual and dust impacts. This will probably require construction from the northern end of the feature.
	Slopes and benching	Our understanding is that overall slopes are typically flatter than 14deg or 1V:4H for initial designs, which should allow for ease of construction.	Possible need for and management of any steeper slopes to be addressed at detailed design phase. Conceptual level planning around temporary benches to be formed has been discussed but not detailed yet.
	Safety around water	Dozers will be reshaping final landform towards water. “Protective zone” may be needed to limit risk of entering water.	While initial D&B pad will be formed by end tipping and dozing material into water, the greater risk appears to be the final shaping of the sloped landform with dozers operating towards the water’s edge. May need a bench or similar protective zone with a barrier to manage this risk.

Overview	Aspect	Description	Comment
Erosional stability	Nature of final surface	No detail yet on topsoil availability (volumes) and erodibility of material.	Soils tested to date appear to have a high clay content and not ideally suited to slopes. There may be an option to utilise topsoil material from transmission line construction which could have a reasonable gravel content. It is likely that some rocky material will be required on the outer surfaces. **A high-level topsoil balance is required together with a subjective assessment by a technical specialist (preferably with some initial sampling) to indicate the nature of available material (CR).**
	Revegetating final surface	No detail yet on revegetation strategy.	Key to revegetation is the management of topsoil including limiting stockpiling and preserving the integrity of topsoil. This requires careful planning around the timing of stripping and availability of surfaces to place directly, areas for stockpiling on the final surface etc. To be addressed at detailed design.
	Long term stability	Not assessed yet. Use of appropriate software referred to in the documentation.	Envisage that Siberia modelling or similar will be required – this in turn will need materials characterisation. As indicated above it is likely that some rocky material will be required on the outer surfaces.
	Drainage lines on feature	Some drainage lines potentially requiring rocky armouring.	Long term sustainability of drainage lines is a key issue. These include the need to manage the rock sizing, rock grading, underlying materials and a range of other issues. The management of this component of the design will need more consideration once the nature, size and type of rock being generated by the D&B can be assessed.

Overview	Aspect	Description	Comment
	Wave action	Provision of rock armouring on areas subject to wave action.	Discussed in meetings, detailed design still to be undertaken, but slopes and rock sizing important for this section of the design. **We do have concerns about the material to be placed at angle of repose above the Minimum Operating Level (MOL) - see notes below this table (CR).**
Final land use	Habitat and ecological aspects	Geomorphic designs offer opportunity for variable habitat on slope aspects, areas of water concentration.	To be addressed at detailed design.
	Recreational use	Our understanding is that most of this area would just be rehabilitated without recreational use.	To be addressed at detailed design.

**Note that the above review excludes geotechnical stability, although Snowy Hydro have undertaken some work on this aspect.

CR = Clarification Required

It should be noted that a Response to the Request For Information (RFI) was issued in March 2020. There are a few issues raised in the updated details (refer Figure 7) compared to those shown in Figure 6 that require clarification.

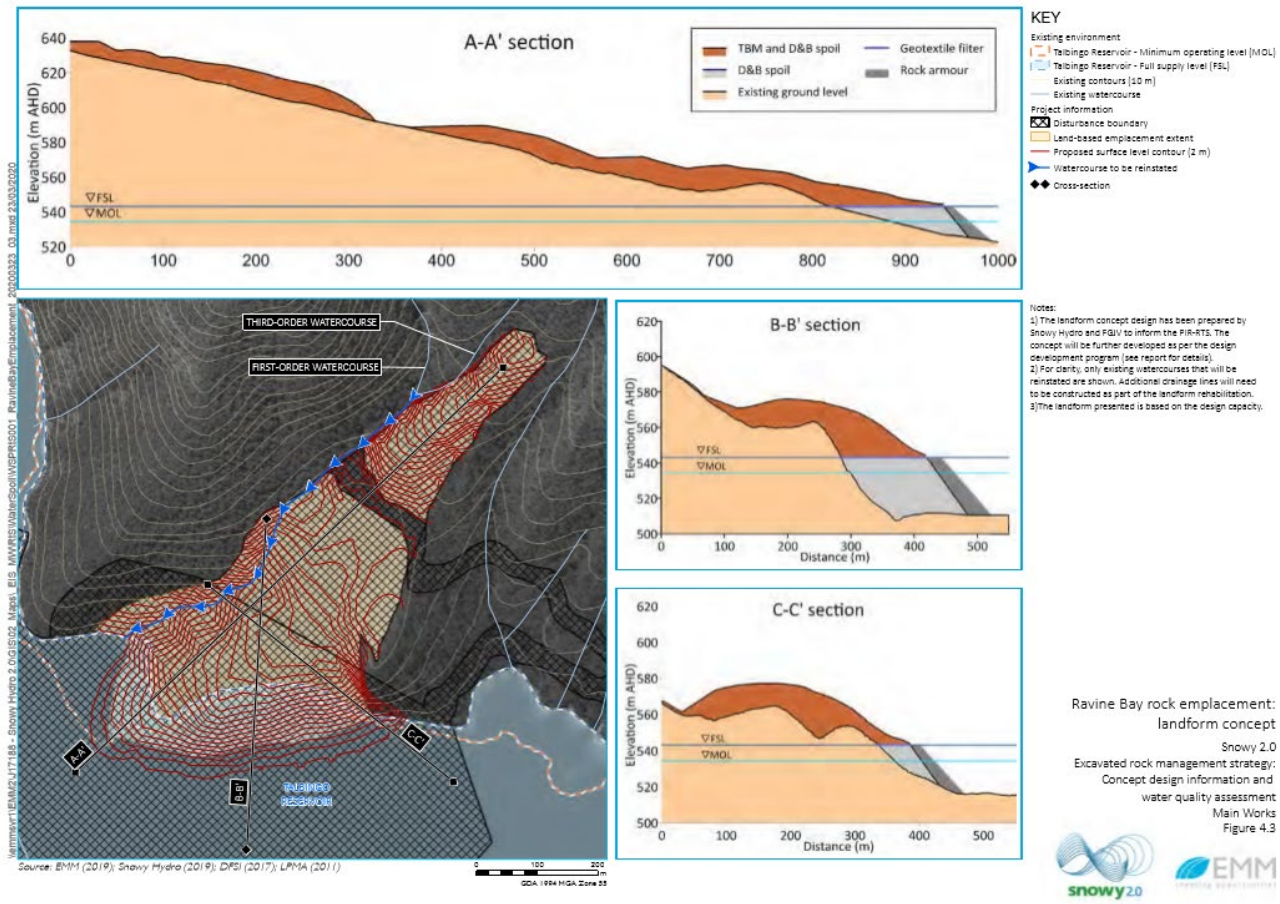

Figure 7 – Ravine Bay in RFI document

The issues noted are:

- The upstream diversion is not shown in the RFI. This needs to be clarified by Snowy Hydro primarily:
  - Avoiding run-on can significantly reduce the erosional risk to the emplacement, and we would just need to understand the reasoning if this has been changed.
  - Whether the required rock armouring on this section of the emplacement without the upstream diversion is reasonable and practical - there are limits to the velocity and rock size that can be easily accommodated, both in terms of the final landform appearance and the long-term sustainability. Most rock lined channels on geomorphic landforms in NSW would require a mean rock size of the order of 600mm or less, more often around 300mm to 400mm. While this is indicative only, there are potential challenges if the required rock size becomes excessive.
- Our understanding is that the formation of the pad below the FSL will require end tipping, which means the material will be tipped at angle of repose as can be seen in Figure 7. However, there is no guarantee that this slope will be long term stable, even with rock tipped over the edge to form protection against wave action, particularly under conditions of rapid drawdown and repeated cycles of filling and lowering. We also believe that between the MOL and FSL, a zone that will be frequently exposed and accessible, the slope should be flattened preferably to 1V:3H which would allow proper placement of the rip rap layer, be safer for anyone who access the area and also reduce the impacts of wave action.

We would expect that there will be times that this edge between FSL and MOL will be accessible to equipment since the reservoir is not always at FSL, and that it should be practical to flatten a significant proportion of the exposed edge using excavators where necessary and through reasonable management of the reservoir operating levels.
We also envisage that a 'sacrificial zone' should be considered for the material that must be left at angle of repose so that if there are localised areas of sloughing of the underlying surface this does not extend up into the area above the MOL.

In summary, key issues that we believe need clarification at Talbingo for the current phase of the Snowy 2.0 project are:

- Confirm whether the diversion will be constructed or not.
  - If not, assess the required characteristics of the rock armouring required along the main drainage line to confirm this option is practical and can be engineered to blend in with the environment.
  - Otherwise, provide a high-level assessment as to whether the adjacent drainage line can sustain the additional catchment without significant erosional risk.
- Provide a high-level assessment of the availability and nature of the topsoil to be used. This can be used to assess whether mitigation measures will be required to manage material that may be subject to higher erosion rates if placed into the landform, and how any shortfall might be managed.
- Confirm if the edge of the landform between MOL and FSL can be flattened and not left at angle of repose.

4.2 GF01 Valley in-fill landform at Lobs Hole

The layout of the proposed landform at GF01 is shown in Figure 3.13 of the PIR, reproduced here in Figure 8 for ease of reference with some points of interest flagged.

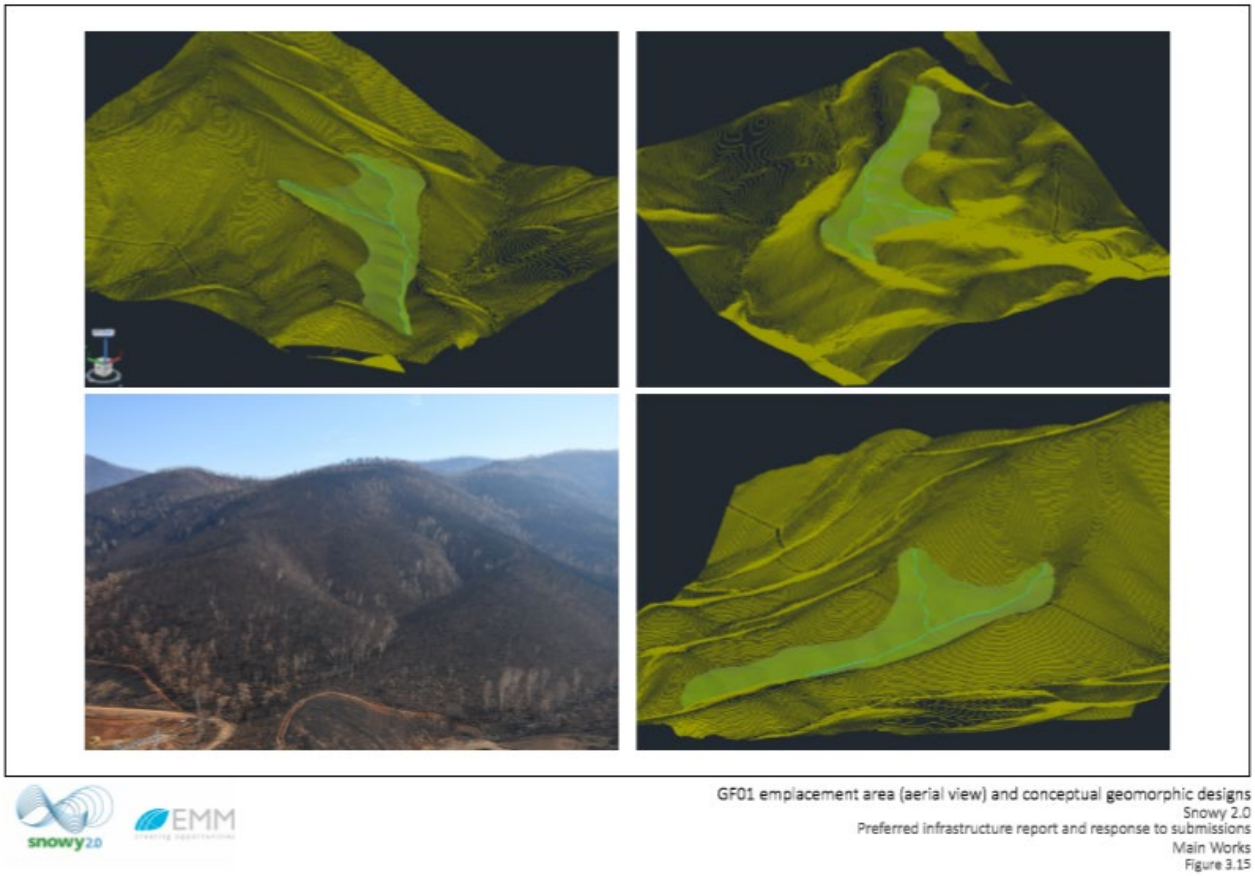

Figure 8 – GF01 Valley In-fill

The current features and requirements for this emplacement are summarised in Table 2. It is important to note that Prof Duque assessed a significant number of valley in-fill options, and GF01 was the preferred outcome due to the limited run-on extents from upslopes and favourable volume / disturbance footprint relationship. Nevertheless, there are still upstream catchments that shed on to this landform.

Table 2 - Features and requirements for GF01 (refer Figure 8)

Overview	Aspect	Description	Comment
Description	Type of design	Valley in-fill primarily (our understanding) using D&B material.	Preferred site of all the valley in-fill assessed.
Water management	Upstream water management	Temporary management of water during construction and then shedding of runoff on to the final landform.	Although we do not see this as an insurmountable challenge, the management of water during construction is nevertheless potentially challenging with an element of residual risk. **We recommend that a high-level review of the interim staging of the landform and how the upstream water will be managed should be provided (CR).**
	Residual run-on to be managed	There is run-on from the upslope areas.	Although the landform fills a significant proportion of the valley, there are residual erosional risks to be managed. It is not certain yet that these will be stable once vegetated, and rock cladding of certain areas may be required.
	Drainage Density	Matches the main drainage lines of the existing valley	Largely driven by the existing topography.
Constructability	Construction sediment loading	Discussed, but not detailed yet.	May require sediment control in the form of a sediment dam downstream of the feature. There are space constraints when considering access, and **a high-level assessment of the required sediment dam size and a review of how and where it might be accommodated is recommended to make sure this can be constructed (CR).** Likely that stormwater management from above the benches being placed will be challenging with some risk of washout and erosion.
	Construction access	No initial planning on this yet.	Likely to require access up the drainage line, or close to this area, to have manageable slopes.
	Initial shaping of natural ground.	No initial planning on this yet	Apart from construction roads and clearing, probably not much initial shaping required. However, blending of edges of landfill to the natural surface will need planning.

Overview	Aspect	Description	Comment
	Progressive rehabilitation	No detail yet.	Unlikely that much progressive rehabilitation will be possible due to limited space at the lower end of the feature, assuming construction from the bottom up.
	Slopes and benching	28% of the landform is steeper than 11.3deg (1V:5H), but only 2% at or steeper than 18deg (1V:3H).	This landform should be relatively easy to shape and rehabilitate. Conceptual level planning around temporary benches to be formed has been discussed but not detailed yet, and planning on vehicle access on the final landform required.
	Safety around steep slopes	Dozers will be reshaping final landform with some steep slopes.	Typically, certain agricultural type equipment would not be allowed access on to slopes steeper than 14deg, and these areas may need to be highlighted for separate management.
Erosional stability	Nature of final surface	No detail yet on topsoil availability (volumes) and erodibility of material.	As for Talbingo, soils tested to date appear to have a high clay content and not ideally suited to slopes. There may be an option to utilise topsoil material from transmission line construction which could have a reasonable gravel content. It is likely that some rocky material will be required on the outer surfaces. **A high-level topsoil balance is required together with a subjective assessment by a technical specialist (preferably with some initial sampling) to indicate the nature of available material (CR).**
	Revegetating final surface	No detail yet on revegetation strategy.	As for Talbingo, key to revegetation is the management of topsoil including limiting stockpiling and preserving the integrity of topsoil. This requires careful planning around the timing of stripping and availability of surfaces to place directly, areas for stockpiling on the final surface etc. The management of topsoil can be addressed at detailed design.
	Long term stability	Not assessed yet. Use of appropriate software referred to in the documentation.	Envisage that Siberia modelling or similar will be required – this in turn will need materials characterisation. As indicated above it is likely that some rocky material will be required on the outer surfaces.

Overview	Aspect	Description	Comment
	Drainage lines on feature	Some drainage lines potentially requiring rocky armouring.	Long term sustainability of drainage lines is a key issue, particularly for this landform. A high-level assessment of this detail in terms of initial rock sizing, velocities and stream power is required – this information was supplied by Snowy Hydro and the rock size is considered appropriate. As before issues such as the rock grading, underlying materials and a range of other issues need to be considered.
Final land use	Habitat and ecological aspects	Largely re-instating similar to the current land use.	To be addressed at detailed design, but our understanding is that this will be largely as per the existing landscape.

**Note that the above review excludes geotechnical stability, although Snowy Hydro have undertaken some work on this aspect.

CR = Clarification Required

In summary, key issues that we believe need clarification for G01 for the current phase of the Snowy 2.0 project are:

- Provide a high-level assessment of the availability and nature of the topsoil to be used.
- Provide more detail on the management of runoff from the upstream catchment during construction, including one or two stage plans showing a conceptual layout to allow an assessment of the residual risks.
- Undertake an initial sediment dam sizing (if one is to be used) and assess the practicality of a dam while still maintaining access to the area. Alternative options could also be considered.

4.3 Tantangara Reservoir

The layout of the proposed landform at Talbingo Reservoir is shown in Figure 3.22 of the PIR, reproduced here in Figure 9 for ease of reference with some points of interest flagged.

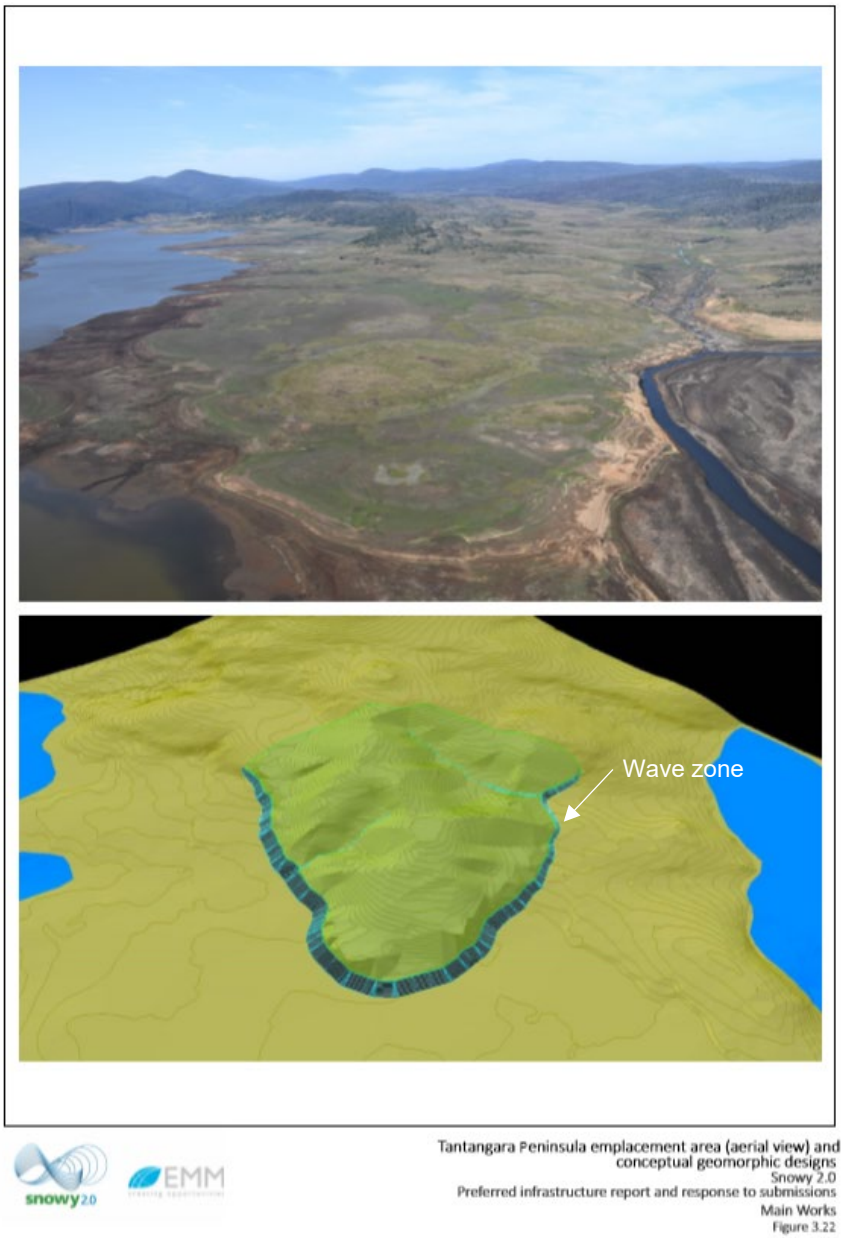

Figure 9 – Talbingo Reservoir Ravine Bay emplacement area

The current features and requirements for this emplacement are summarised in Table 3. This table is not intended as a complete and exhaustive list of the features and issues to be managed, but rather an initial high level assessment.

An important feature of the Tantangara design is that, although the toe of the emplacement area is below the FSL in many areas, it is expected that this can be managed and most of the construction can be undertaken under dry conditions.

Table 3 – Features and requirements for Tantangara Reservoir (refer Figure 9)

Overview	Aspect	Description	Comment
Description	Type of design	Edge of reservoir constructed on D&B pad formed largely on dry ground.	TBM material located above the D&B platform. D&B likely to be placed when reservoir levels are below the toe of the dump.
Water management	Upstream water management	Little to no upstream water management required.	Ideal situation for new landform.
	Residual run-on to be managed	No notable areas of run-on other than perhaps a bit on the edge.	Ideal situation for a new landform.
	Drainage Density	Some drainage has been provided at conceptual level	Initial concept can be refined, but overall looks favourable.
Constructability	Construction sediment loading	Primarily managing sediment off rehabilitated surfaces only.	Probably will be able to manage sediment loading on the toe with temporary features as and when required.
	Construction access	Access to the area along existing roads for much of the route.	None.
	Initial shaping of natural ground.	Plenty of space to shape and provide access.	Options for managing any material to be stripped to be considered if not suitable for use as topsoil or stockpiling of material suitable as topsoil.
	Progressive rehabilitation	Conceptual planning but no detail yet.	If constructed from the south, should be able to build to full height and rehabilitate progressively, but will need evaluation of the scheduling of materials to assess this.
	Slopes and benching	Overall slopes typically flatter than 25% or 1V:4H for initial designs, which should allow for ease of construction.	Possible need for and management of any steeper slopes to be addressed at detailed design phase.

Overview	Aspect	Description	Comment
	Safety around water	Dozers will be reshaping final landform but expected to be dry during construction.	Manage this risk by considering reservoir fluctuations.
Erosional stability	Nature of final surface	No detail yet on topsoil availability (volumes) and erodibility of material.	As for other landforms, soils tested to date appear to have a high clay content and not ideally suited to slopes, including probably material on the current footprint of Tantangara which is a flat area. There may be an option to utilise topsoil material from transmission line construction which could have a reasonable gravel content. **As for the other emplacements a high-level topsoil balance is required (CR).**
	Revegetating final surface	No detail yet on revegetation strategy.	Space management of topsoil should be relatively easy here - to be addressed at detailed design.
	Long term stability	Not assessed yet. Use of appropriate software referred to in the documentation.	Envisage that Siberia modelling or similar will be required – this in turn will need materials characterisation.
	Drainage lines on feature	Some drainage lines potentially requiring rocky armouring.	The extent to which the drainage lines on the feature may require rock armouring has still to be confirmed, but the risks for this feature are considered low if properly designed.
	Wave action	Provision of rock armouring on areas subject to wave action.	Discussed in meetings, detailed design still to be undertaken, but slopes and rock sizing important for this section of the design. **We do have concerns about the material to be placed at angle of repose above the Minimum Operating Level (MOL) - see notes below this table (CR).**
Final land use	Habitat and ecological aspects	Geomorphic designs offer opportunity for variable habitat on slope aspects, areas of water concentration.	To be addressed at detailed design.

Overview	Aspect	Description	Comment
	Recreational use	Our understanding is that this area could be required for recreational use which may impact on the design of the wave zone.	To be addressed at detailed design.

**Note that the above review excludes geotechnical stability, although Snowy Hydro have undertaken some work on this aspect.

CR = Clarification Required

The information for Tantangara provided in the RFI are shown in Figure 10.

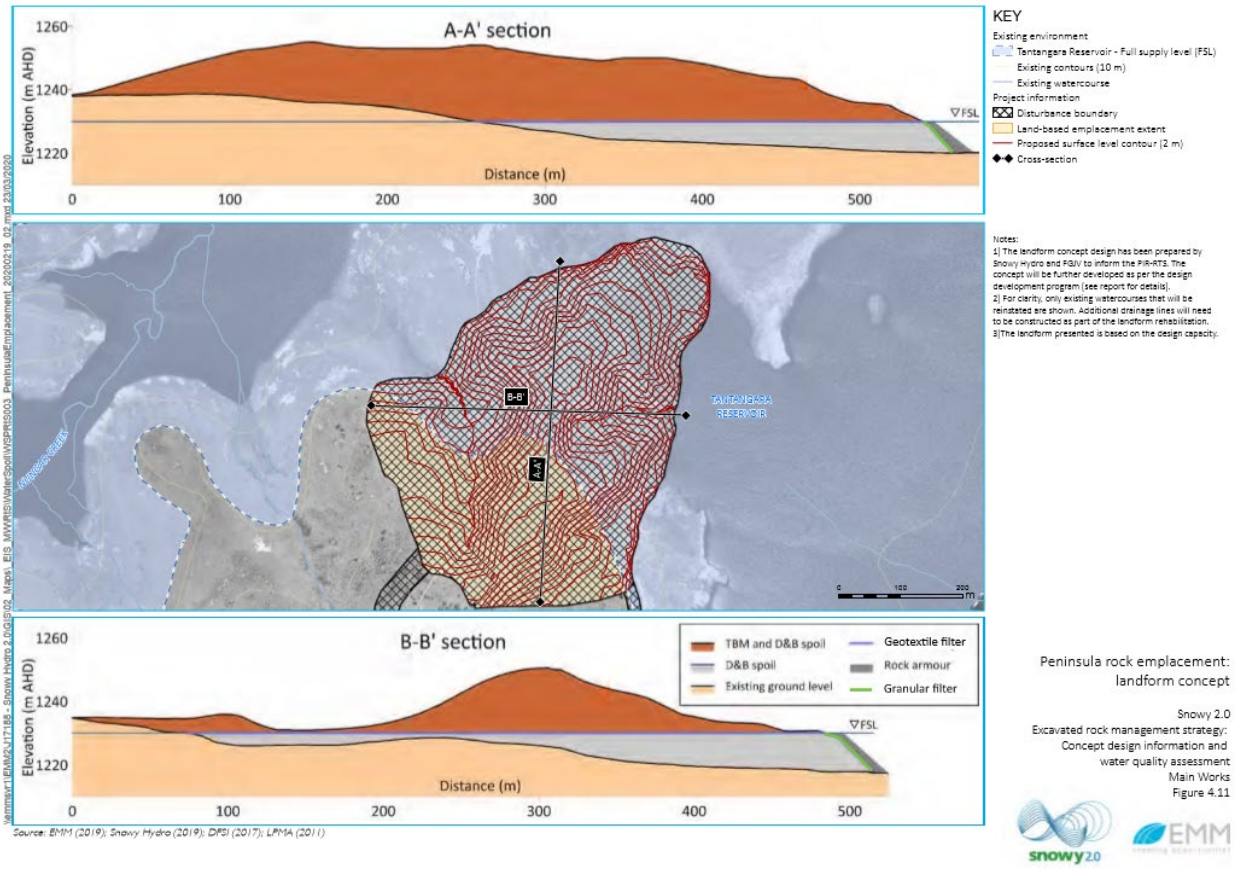

Figure 10 – Tantangara as in RFI

As for Talbingo, the cross section indicates the material below FSL will be at angle of response. Our understanding from discussions is that this landform will be constructed above the operating water level most of the time, and that the edge below FSL will be often visible and accessible. We believe that flattening the outer slopes to something more reasonable such as 1V:3H should be easily achievable, will allow more robust construction of the rock armouring and be a more stable long-term outcome. This flattening will also improve the visual amenity and safe access on to the landform.

We would suggest, however, that for areas that may be more exposed to recreational use or even just to break the length of relatively inaccessible edges, a far flatter slope should be considered in some areas, potentially of the order of 1V:7H and incorporating gravels / sands and smaller rocks so as to allow a boat to be pulled out of the water.

In summary, key issues that we believe need clarification for Tantangara for the current phase of the Snowy 2.0 project are:

- Provide a high-level assessment of the availability and nature of the topsoil to be used.
- Confirm if the edge of the landform between MOL and FSL can be flattened and not left at angle of repose, and whether this flattening can be substantial in some areas to break the length of difficult to access landform.

4.4 Rock Forest

The layout of the proposed landform at the Rock Forest is shown in Figure 4.8 and Figure 4.9 of the RFI of March 2020, reproduced here in **Figure 11** and **Figure 12** for ease of reference.

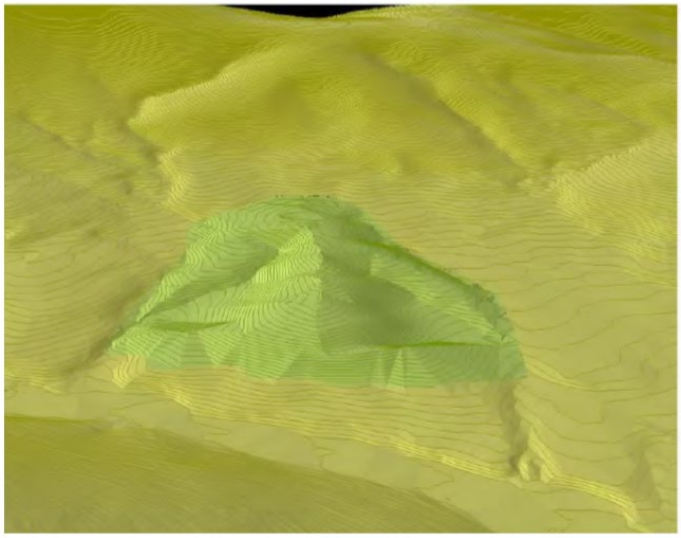

Figure 11 – Rock Forest emplacement area visualisation

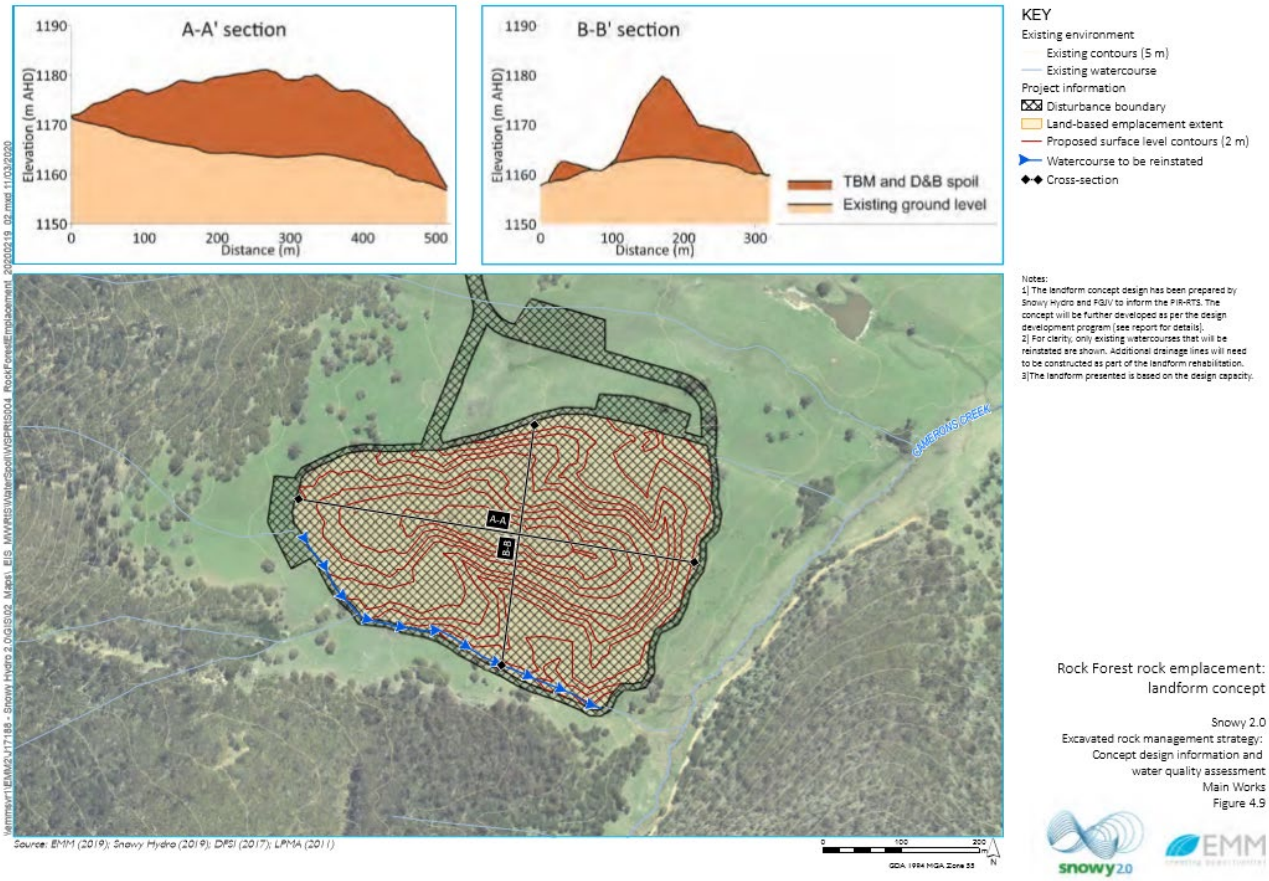

Figure 12 – Rock Forest emplacement area

The current features and requirements for this emplacement are summarised in Table 4.

Table 4 - Features and requirements for Rock Forest emplacement (refer Figure 12)

Overview	Aspect	Description	Comment
Description	Type of design	Above ground construction	D&B material
Water management	Upstream water management	Proposed diversion of upstream flows into the adjacent drainage line and then to Camerons Creek.	Geotechnical investigation into the diversion and adequacy of adjacent drainage line for increased flow still to be established.
	Residual run-on to be managed	No run-on.	None
	Drainage Density	Some swales or sub-catchments on landform at conceptual level	Design sheds runoff to the north and south
Constructability	Construction sediment loading	Discussed, but not detailed yet.	The emplacement area is up against the creek to the south. Main drainage lines on the landform may need sediment control included in the design i.e. outside of the creek, but this appears to be achievable. Some space will need to be left between the creek and the emplacement to allow for sediment fencing etc.
	Construction access	Currently proposed from the area to the north.	None
	Initial shaping of natural ground.	No initial planning on this yet	Options for stockpiling of topsoil (if any available) to be considered.
	Progressive rehabilitation	Conceptual planning but no detail yet.	Ideally landforms will be built to final line and level as quickly as practical to allow for progressive rehabilitation to limit visual and dust impacts. Should be space to achieve this.
	Slopes and benching	Slopes appear to be reasonable – review extent of slopes steeper than 1V:4H and 1V:3H during detailed design.	Possible need for and management of any steeper slopes to be addressed at detailed design phase. Conceptual level planning around temporary benches to be formed has been discussed but not detailed yet.

Overview	Aspect	Description	Comment
Erosional stability	Nature of final surface	No detail yet on topsoil availability (volumes) and erodibility of material.	Expectation that there will be topsoil within the base of the feature that could be utilised. **As for the other emplacements a high-level topsoil balance is required to assess if the material within the footprint is suitable for use on this feature (CR).**
	Revegetating final surface	No detail yet on revegetation strategy.	To be addressed at detailed design.
	Long term stability	Not assessed yet. Use of appropriate software referred to in the documentation.	Envisage that Siberia modelling or similar will be required – this in turn will need materials characterisation.
	Drainage lines on feature	Some drainage lines potentially requiring rocky armouring.	As for other features, long term sustainability of drainage lines is a key issue. Unlikely to be based on alluvial analogue and rock armouring is likely to be required.
	Impact of flooding	Provision of rock armouring on areas subject flooding from Camerons Creek if applicable.	Indicated to be above the flood prone land, but uncertain if outside the 1 per cent Annual Exceedance Probability (AEP) flood line. **To confirm if flood lines have been established and that the feature is outside of the 1% AEP or other appropriate flood line (CR).**
Final land use	Habitat and ecological aspects	Geomorphic designs offer opportunity for variable habitat on slope aspects, areas of water concentration.	To be addressed at detailed design.
	Recreational use	Our understanding is that most of this area would just be rehabilitated without recreational use.	To be addressed at detailed design.

**Note that the above review excludes geotechnical stability, although Snowy Hydro have undertaken some work on this aspect.

CR = Clarification Required

In summary, key issues that we believe need clarification for Rock Forest for the current phase of the Snowy 2.0 project are:

- Provide a high-level assessment of the availability and nature of the topsoil to be used.
- Confirm if the 1% AEP flood line has been determined and if the feature is outside of that flood line.

4.5 Main Yard

Main Yard is the area to be used for infrastructure, including laydown areas, workshops, sheds, machinery, offices and other project related infrastructure. The layout of the proposed final landform at Main Yard is shown in Figure 4.6 and Figure 4.7 of the PIR, reproduced here in Figure 13 and Figure 14 for ease of reference.

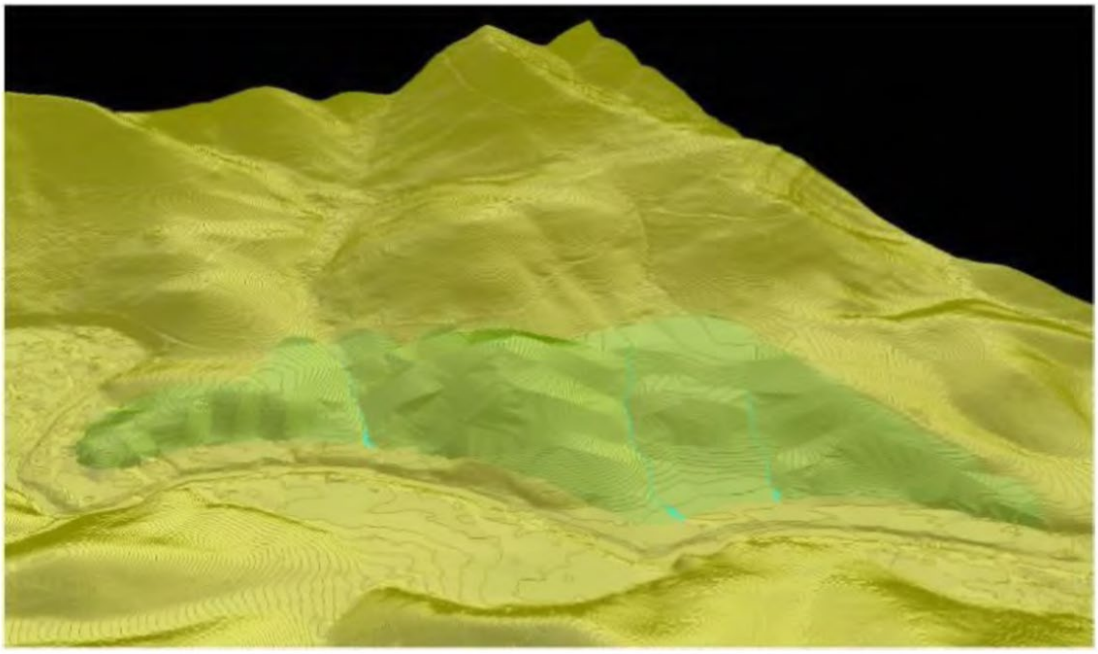

Figure 13 – Main Yard final landform visualisation

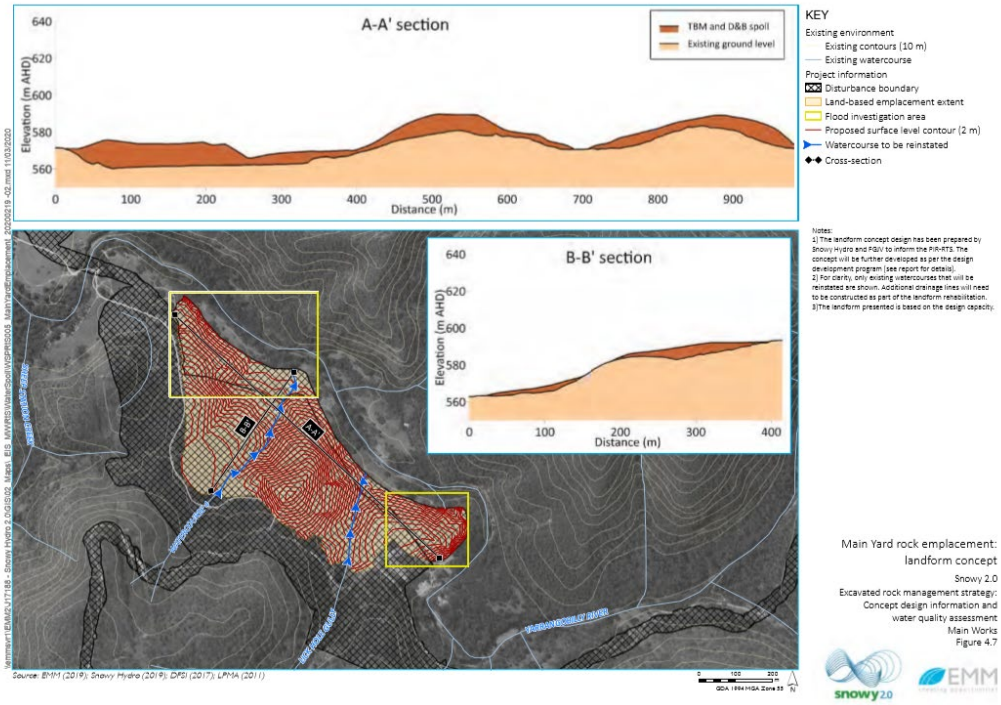

Figure 14 – Main Yard final landform

The current features and requirements for this emplacement are summarised in Table 5.

Table 5 - Features and requirements for Main Yard (refer Figure 13)

Overview	Aspect	Description	Comment
Description	Type of design	Valley in-fill primarily using D&B material initially, with TBM placed in the final rehabilitation process.	Our understanding is that Pads will initially be formed next to the drainage lines, with the drainage lines incorporated into the final profile.
Water management	Upstream water management	The final landform will have run-on from three main drainage lines.	It is not clear how the catchments will be managed prior to final shaping and whether the construction pads will extend across the drainage lines or be located between them.
	Residual run-on to be managed	There is run-on from the upslope areas in addition to the creek lines.	Areas with run-on occurring on to the final surface need to be assessed to determine if they are stable once vegetated, and what interim and long-term management measures may be required to ensure erosional stability.
	Drainage Density	Matches the main drainage lines of the existing valley	Largely driven by the existing topography.
Constructability	Construction sediment loading	Discussed, but not detailed yet.	With exposure to watercourses on 3 sides, each of the construction pad areas will need sediment control. This could take the form of localised sediment dams, but the proximity of the Yarrangobilly River may constrain the site in terms of the location of the 1% AEP flood event or alternatively motivated flood event. **We suggest a high-level assessment of the required sediment dam size and a review of how and where these might be accommodated is recommended to make sure this can be constructed (CR).**
	Construction access	Assess roads set out for the site from the north-west, west and south-east.	None

Overview	Aspect	Description	Comment
	Initial shaping of natural ground.	No initial planning on this yet	Issues around pre-stripping the area and possible topsoil stockpiling will need to be addressed early in the design.
	Progressive rehabilitation	Final shaping only done on completion of the Snowy 2.0 project.	None.
	Slopes and benching	Not presented, but likely to be some steep areas to be managed	This landform may have some steep slopes requiring special consideration but can be addressed at detailed design.
	Safety around steep slopes	Dozers will be reshaping final landform with some steep slopes.	Typically, certain agricultural type equipment would not be allowed access on to slopes steeper than 14deg, and these areas may need to be highlighted for separate management.
Erosional stability	Nature of final surface	No detail yet on topsoil availability (volumes) and erodibility of material.	Would expect that there could be some topsoil within the base of the landform that could be utilised, but the storage of the topsoil for the duration of the Snowy 2.0 project is potentially challenging as it will reduce the value of the topsoil. **As for the other emplacements a high-level topsoil balance is required to assess if the material within the footprint is suitable for use on this feature and what other strategies could be used (CR).**
	Revegetating final surface	No detail yet on revegetation strategy.	As for other features, key to revegetation is the management of topsoil – while we consider this a key issue, it can be addressed at detailed design provided there is enough material overall for the revegetation of the landforms.
	Long term stability	Not assessed yet. Use of appropriate software referred to in the documentation.	Envisage that Siberia modelling or similar will be required – this in turn will need materials characterisation.

Overview	Aspect	Description	Comment
	Drainage lines on feature	Some drainage lines potentially requiring rocky armouring.	Long term sustainability of drainage lines is a key issue, particularly for this landform. **A high-level assessment of this detail in terms of initial rock sizing, velocities and stream power is required (CR).**
	Impact of flooding	Landform will be designed to be stable during 'rare' Yarrangobilly River flood event.	Uncertain where the dump toe is relative to frequent flood events although the feature is set back from the creek channel in most areas. **During the construction phase (prior to reshaping) there may be a risk of frequent inundation of the shaped pads. Need a high-level review to assess the likely frequency of inundation and potential impact if not already assessed (CR).**
Final land use	Habitat and ecological aspects	Largely re-instating similar to the current land use.	To be addressed at detailed design, but our understanding is that this will be largely as per the existing landscape.

**Note that the above review excludes geotechnical stability, although Snowy Hydro have undertaken some work on this aspect.

CR = Clarification Required

In summary, key issues that we believe need clarification for Main Yard for the current phase of the Snowy 2.0 project are:

- Undertake a conceptual sediment control plan to confirm if there is space to manage the risk to the creek lines.
- Confirm the required parameters to armour the emplacement along the final landform drainage lines.
- Provide a high-level assessment of the availability and nature of the topsoil to be used.
- Provide an initial high-level indication of the frequency of flooding of the landform during the construction phase.

5.0 LIKELY WAY FORWARD

As indicated previously, there are a number of different methods or approaches that could be considered to finalise the landform design work for the Snowy 2.0 project, and section below is not intended to be prescriptive, but rather to provide an indication of how we would see the following work packages to be undertaken specifically for the landform design:

Initial Work

- Soils assessment (inputs)

  Identify likely material to be used on the outer surface of each feature (topsoil or other proposed soils).

  Obtain a first indication of likely erodibility of the material. Typically, this would require a soil scientist to indicate dispersivity, determine the Particle Size Distribution, and preferably undertake a WEPP analysis which is a 2D assessment of erosion risk. This would generate an indication of what combination of slope angle and height will be stable both without and with vegetation.

- Landform assessment

  Where non-alluvial analogues are designed (i.e. overall gradients steeper than what is stable on natural alluvial landforms in the local area) a combination of runoff tracking and GIS analysis can be used to predict whether the landform will be stable with or without armouring, preferably with armouring only required in the drainage lines.

  This phase of the work needs to consider aspects such as the potential delays in establishing vegetation associated with drought or other factors.

- Constructability

  Geomorphic landforms that are steeply sloped are generally formed by constructing temporary benches which are then dozed down to form the final landform. For the Snowy 2.0 project these will need to be generated together with a staged development plan to assess how the upstream water will be managed, whether you need a downstream sediment dam, and what sort of spillway size / wall size will be required, possible haul routes to access the top of the feature during construction.

  Other aspects such as topsoil storage, short term access and long-term access for weed control and bush fire management may also need to be considered at this point in the Snowy 2.0 project.

Detailed design

The design process would then proceed on several fronts including:

- Landform design

  The design would be refined using design software (Civil 3D, Natural Regrade / Carlson Civils or other suitable software), with runoff tracking and GIS based erosion risk assessments guiding the design.

- Hydrological modelling

  Software such as XP-RAFTS or similar would be used to obtain more detailed hydrological outputs on the landform. Natural Regrade uses a very simplistic Rational Method analysis, and more detailed hydrology is needed to optimize the rock lining required etc.

- Soils and erosion risk updates

  Obtaining “bulk” samples of the material to be used on the outer surface and testing its erodibility using flume tests. If the program allows, then this bulk soil testing should be done prior to the conceptual design progressing too far, which will facilitate a more accurate design process. However, adjustments can normally also be made at the detailed design phase.

  From the flume testing results the final landform can then be modelled using a LEM such as SIBERIA, CAESAR or something similar. This modelling would output the expected performance of the landforms in the long term, typically taken as 500 to 1000years.

  The key value of this work is then to be able to adjust the design to address any areas of weakness as well as demonstrating sustainability.

- Design outputs.

  The final design would then have:

  - The benches required prior to reshaping to the final landform surface.
  - The final landform surfaces.
  - Designation of areas requiring rock lining in the drainage channels, and (if needed) the extent of rock armouring on the slopes.
  - Potentially visual outputs using the final designed surface.

It is worth noting that the use of rock lining as an option for a long-term sustainable landform is something that can be challenged. Alluvial landforms get into a balance between erosion and deposition, but on natural landforms where there is rock in the drainage lines there is typically a source of rock from upslope that continually feeds into the drainage lines replacing rocky material that may get washed out.

While the use of engineered rock is a common practice, it may be worth including an assessment of whether we can increase the long term durability of the rocky lined drains by emulating natural systems in providing additional rock on the upper sections of the drainage line so that

this material can wash downslope with time to limit any loss of rocky material. We also envisage that trees and other vegetation can help to make the rocky drainage lines more stable in the long term, since most design methods ignore the potential benefits of vegetation on rocky linings.

In conclusion, it is important to note that the landform design is just one part of the puzzle. Getting the topsoil management and then developing the correct revegetation strategy and having the right strategy to prevent erosion of soil before the vegetation is established is equally if not more important for the overall long-term stability of the landforms.

6.0 CONCLUSION

The conceptual work has progressed significantly since the original concepts of September 2019. We believe that, for the most part, the designs have progressed sufficiently to provide confidence that the proposed landforms can be constructed to produce an environmentally acceptable outcome, provided that the following issues can be clarified as part of the current phase of work:

For all areas

- Provide a high-level assessment of the availability and nature of the topsoil to be used. This can be used to assess whether mitigation measures will be required to manage material that may be subject to higher erosion rates if placed into the landform, and how any shortfall might be managed.
- Confirm adequate space has been incorporated in the conceptual designs for the required sediment controls, not at a micro level, but at a broad planning level.

For Talbingo and Tantangara

- Confirm if the edge of the landform between MOL and FSL can be flattened and not left at angle of repose and (particularly at Tantangara) whether this flattening can be substantial to break the length of difficult to access shoreline.

For Talbingo

- Confirm whether the diversion will be constructed or not.
  - If not, assess the required characteristics of the rock armouring required along the main drainage line to confirm this option is practical and can be engineered to blend in with the environment.
  - Otherwise, provide a high-level assessment as to whether the adjacent drainage line can sustain the additional catchment without significant erosional risk.

For Rock Forest and Main Yard

- Provide an indication of the likely frequency of inundation by flood waters from the downstream creek (Camerons Creek and Yarrangobilly respectively) and indicate what the residual risks might be during construction and in the long term (if any).

For GF01, and Main Yard

- Provide initial concepts for the management of runoff from the upstream catchments during construction, to allow an assessment of the residual risks.
- Provide more detail for these two sites in terms of sediment controls, especially any proposed sediment dams and how they might be incorporated into the sites.

Signature Page

Golder Associates Pty Ltd

Chris Waygood
Principal Mine Closure

Andre Kemp
Principal Engineer and Closure Consultant

CW/AK/ds

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https://golderassociates.sharepoint.com/sites/123521/project files/6 deliverables/19129780-001-r-rev0 pir landformassessment.docx

golder.com

04 October 2019

WRL Ref: WRL 2019055 BMM L20191004

Mr Anthony Ko
Department of Planning, Industry and Environment
Level 30
320 Pitt Street
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By Email: anthony.ko@planning.nsw.gov.au

UNSW SYDNEY

Water Research Laboratory

Dear Anthony,

Expert Review - Snowy 2.0 Environmental Impact Statement Water Quality Predictions in Talbingo and Tantangara Reservoirs

1. Introduction

I have undertaken an expert review of sections of the "Snowy 2.0 Main Works - Environmental Impact Statement" as dated 13th September 2019 (version v1 Final). As instructed, my review has concentrated on water quality issues pertaining to the placement of excavated materials into the Talbingo and Tantangara Reservoirs.

My key findings are:-

- Tunnel Boring Machine (TBM) excavation will produce significant amounts of fine sediment particles, some of which will become suspended sediment in the Talbingo Reservoir when placed at Ravine Bay. Numerical modelling has been used to predict the fate, transport and persistence of the resulting turbidity elevated above environmental limits. This numerical modelling cannot be considered calibrated or validated against data and sensitivity testing of model parameters has not been presented in the EIS. Turbidity may be higher than predicted.

- The EIS suggests that the elevated turbidity will have an environmental impact but does not discuss mitigation options other than the inclusion of silt curtains. No site specific trigger value (SSTV) is proposed for turbidity however predicted values in the reservoir will be significantly above ANZEC guidelines. A "hybrid placement" method which significantly reduces turbidity in Talbingo Reservoir is presented in Appendix L but not included in any mitigation options nor discussed in the main report.

- The EIS assumes that the turbidity will return to background levels within six months of construction being completed and the ecology impact assessment states that it is likely that ecology would recover quickly once construction is ceased. However, sensitivity testing of modelling assumptions has not been presented. The persistence of elevated turbidity will be highly depended on sediment settling rates, ongoing resuspension of materials from the bed (including from operational flows) and possible leaching of fine sediments from the placement areas. The persistence of elevated turbidity may be longer than predicted.

- Suspended sediment exported from the reservoirs has a potential to impact downstream waterways. Numerical modelling has been used to predict the amount of sediment exported from the reservoirs without any presentation of how sensitive this prediction is to model parameters.

- Aluminium release from fine sediments was considered as a potential environmental impact. Laboratory testing concluded that the rate of aluminium release increased as particle size decreased. Laboratory testing only considered 75 µm particles whereas TBM sediment particles were reported as being down to 4 µm. As such, there is a potential for the aluminium released into the reservoirs to be greater than predicted.

2. Numerical Modelling

The numerical modelling of the predicted suspended sediment and turbidity within Talbingo Reservoir was reported primarily in Appendix L "Excavated Rock Placement Assessment", Annexure G "ERP Modelling – Construction".

The approach to the numerical modelling can be considered best practice. That is to say the type of model, the hydrodynamic and sediment processes included, the boundary conditions applied and the parameterisation of processes are all acceptable. However, values must be assigned to numerical modelling parameters and model predictions are dependent upon those values selected. Best practice numerical modelling involves collection of sufficient data over a range of processes to use part of the dataset for calibration of model parameters and the remaining data for verification of how well the model can reproduce the observations. This has not been done in this study.

The modelling report presents predictions from 2017 and compares these against observations in 2018. This is neither calibration nor verification of the model accuracy but rather only an indication that the model is generally predicting seasonal trends.

The modelling should cover the period of 2018 so that a direct comparison with 2018 data can be made. This point is already made in the modelling report. *"Due to available project time frames, a direct comparison to the field data is yet to occur. Validation or recalibration to these recent high-quality data sets is recommended to further increase confidence in model predictions."* (Section 4.1.2 of Appendix J, Annexure G).

In the absence of model calibration and verification, the results of sensitivity testing must be presented to consider the variability of predictions. That is to say, multiple scenarios must be run with a range of model parameters in order to assess the range of predictions, the amount of uncertainty and the source of that uncertainty. This has not been presented in this EIS. As such, the predictions of elevated turbidity within the Talbingo Reservoir cannot be assessed for uncertainty.

The modelling report includes internal review comments from two reviewers (Attachments E and F) of the Annexure G of Appendix L. Both reviewers requested sensitivity testing of parameters.

The key modelling parameters that I believe to have the greatest impact on turbidity in this study are discussed in the following Sections 2.1, 2.2 and 2.3 of this letter.

2.1 Turbulent Diffusion

The selection of turbulent diffusion parameters affect how fast the turbidity plume spreads through the reservoir, separate from how fast it is advected by currents. In a reservoir where currents are small, the turbulent diffusion parameters are particularly important. Selecting low diffusion values will result in higher concentrations over a smaller area whereas selecting high diffusion values will increase the area over which the plume mixes and therefore lower resulting concentrations. Default values were adopted (response to internal reviewers comment at Attachment F, Point 11) as they provided stable stratification profiles, however I believe that this stability would be influenced mainly by vertical turbulent diffusion. Scenario results with both higher and lower values of horizontal turbulent diffusion should be considered to assess the lateral dispersion in the reservoir.

2.2 Settling Velocity

The smaller the settling velocity parameter used in model, the longer particles will persist in the water column. Laboratory testing measured settling rates for site specific particles as small as 4 µm (Appendix L Figure 4.8). The measurement of settling velocities is to be commended.

However, the measured settling velocities were between 5 and 10 times slower than the "Stokes Law" settling velocities used in the scenarios. The modelling report suggests that column tests may have artificially slow, inhibited settling velocities, however the reasoning is not justified or referenced.

Modelling with a settling velocity five times slower will roughly equate to five times greater suspended sediment concentrations, which has major implications for the predictions provided in the EIS.

Internal reviewers raised this concern (Annexure G of Appendix L Attachment F Item 26) and requested whether sensitivity testing had been undertaken. The response was that "*Observed settling velocities are likely to be affected by laboratory conditions (i.e. hindered settling etc.). Sensitivity runs could be conducted, though given settling velocities are so low and finer fractions are not settling out, it is unlikely to make a significant difference to the study findings.*" As mentioned previously, the potential hindered settling in laboratory testing has not been justified. Further, settling is occurring in the model scenarios (as evidenced by the return to ambient conditions after construction is complete) and hence the reasoning for not running sensitivity testing on settling velocities is also not justified.

2.3 Source Term of Suspended Sediments

Table 6.5 of Appendix L Annexure G states the assumption that 60% of total clay particles and 45% of total fine particles will enter the water column during placement at Ravine Bay. These values are stated as "*provided by RHDHV based on experience with ERP activities*". This particular placement method into freshwater is not common so further justification of these adopted values is required. Suspended sediment concentration, bed deposition and mass of sediment leaving the reservoir would all increase if source rates were higher than assumed.

Sensitivity testing should be undertaken and presented.

3. Other Factors

3.1 Operational modelling and persistence of elevated turbidity

No modelling of sedimentation during construction was undertaken for Tantangara Reservoir presumably because all placement is to dry areas.

Modelling of operational conditions (including water transferring between reservoirs) predict peak bed shear values in each reservoir which are high enough to resuspend settled materials. Indeed, in the conclusion of the operational modelling report (Appendix L, Annexure H, Section 7) states *"In Talbingo Reservoir, both fine settled material from the construction phase and existing reservoir sediments located within 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 during commissioning of Snowy 2.0. In Tantangara Reservoir, existing reservoir sediments located within the intake approach channel and areas directly offshore and adjacent would be expected to be disturbed by generation and pumping flows."*

The persistence of elevated turbidity has been presented as approximately six months after construction is complete however this timeframe does not consider the longer term re-suspension and re-working of fine bed sediments arising from the construction phase. In Appendix M2 "Aquatic Ecology Assessment", elevated turbidity is partially justified by reasoning that the affected areas are small and that rapid recovery would occur after all construction works have been completed (Section 6.2.2.4).

The recovery time may be longer and has not been considered in modelling scenarios.

3.2 Export of Sediment from the Reservoirs

The total export of sediment from the reservoirs will be directly related to the suspended sediment concentrations. As such, any uncertainty in suspended sediments will also result in uncertainty in downstream impacts.

3.3 Aluminium Release

The rate of aluminium release from excavated materials increases significantly with decreasing particle size (page 37 of Appendix L). The majority of laboratory testing was undertaken with particles of 75 µm whereas suspended sediment will comprise materials down to 4 µm. CSIRO recommend "*testing of the longer-term release of substances from the clay to fine silt sized (<2 µm to 6.3 µm) excavated rock materials that are predicted to remain suspended within the reservoir water for periods of many months*". This has not been undertaken.

As aluminium levels are already predicted to be above guideline values, understanding the release rates from finer particles is crucial.

4. Summary

Suspended sediment concentrations, turbidity and aluminium concentrations are all predicted to be above the guideline values. The uncertainty in model predictions has not been presented and suspended sediment concentrations could be higher depending if actual parameter values differ from those adopted.

Mitigation options for managing higher turbidity have not been presented in the main EIS. A "hybrid placement" method which significantly reduces turbidity is discussed in Appendix L but not considered elsewhere as an alternative or mitigation option.

The time for reservoir recovery may be longer than predicted by modelling scenarios due to both slower particle settling and the re-working of bed sediments during operation.

Please contact me for any clarification or further information.

Yours sincerely,

Brett Miller
Principal Engineer – Hydraulics and Modelling
MIEAust, CPEng

02 April 2020

WRL Ref: WRL 2019055 BMM L20200402

Water Research Laboratory

Ms Nicole Brewer
Department of Planning, Industry and Environment
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By Email: nicole.brewer@planning.nsw.gov.au

Dear Nicole,

Expert Review - Snowy 2.0 Environmental Impact Statement Water Quality Predictions in Talbingo and Tantangara Reservoirs

I (Brett Miller) was engaged by the Department of Planning, Industry and Environment (DPIE) as an expert in water quality modelling studies, to provide expert review of sections of the "Snowy 2.0 Main Works - Environmental Impact Statement" as dated 13th September 2019 (version v1 Final). My review concentrated on water quality issues pertaining to the placement of excavated materials into the Talbingo and Tantangara Reservoirs.

I attended meetings with DPIE and the proponent in the lead up to the EIS submission. I provided my independent findings in a letter report of the 4th October 2019. All of my concerns were related to the lack of certainty of the settling rate and behaviour of the fine sediment particles in each reservoir.

I was subsequently provided with two further documents:

- "Snowy 2.0 Main Works – Preferred Infrastructure Report and Response to Submissions", February 2020
- "Snowy 2.0 Main Works – Preferred Infrastructure Report – Response to Request", 24th March 2020.

The contractor's preferred rock placement strategy no longer involves placement of fine materials from tunnel boring machine (TDM) excavation below the full storage level (FSL) of each reservoir. Only larger diameter sediment particles resulting from Drill and Blast (D&B) are to be placed below FSL. The settling rate and behaviour of these larger particles are much more certain than the fine particles. They will settle to the bed faster, be less influenced by stratification and have less likelihood of resuspension. Predicted turbidity and suspended sediment concentrations are now within acceptable ranges.

As such, the concerns that I raised on the 4th October 2019 have been addressed.

I recommend that a real time monitoring system be established to measure turbidity in the reservoirs during key phases of the material placement to ensure that turbidity remains within predicted ranges. Further, monitoring of water quality and turbidity should be undertaken at the predicted leachate points for a suitable duration no less than 12 months after construction is complete.

Please contact me for any clarification or further information.

Yours sincerely,

Brett Miller
Principal Engineer – Hydraulics and Modelling
MIEAust, CPEng

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DATE: 15 May 2020

TO: David Kitto
Executive Director Special Projects
Planning and Assessment
Department of Planning, Industry and Environment
Level 30, 320 Pitt Street
Sydney NSW 2001

FROM: Dr Noel Merrick

RE: Snowy 2.0 Main Works – Groundwater Expert Review

YOUR REF: Email 1 November 2019

OUR REF: HA2020/4

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1. Introduction

This review is provided in response to an email request of 1 November 2019 from the NSW Department of Planning, Industry and Environment [DPIE] for an expert review of the water assessment and associated groundwater modelling undertaken by EMM for the Snowy 2.0 Main Works project [the Project], on behalf of Snowy Hydro Limited.

The review has been conducted solely by Dr Noel Merrick in accordance with best practice.

The Project is predominantly located within Kosciuszko National Park and includes the development of underground tunnels to link the existing Tantangara and Talbingo Reservoirs, a new underground power station, and connection to TransGrid's electricity transmission system.

2. Background

DPIE initially required the independent expert to provide advice on the approach and results of the groundwater modelling for the project, and mitigation options, as documented in Appendix J Water Assessment of the *Snowy 2.0 Main Works Environmental Impact Statement* [EIS] (EMM, September 2019).

Advice was provided through the following mechanisms:

A. Teleconference on 6 November 2019 with DPIE, Snowy Hydro and EMM.
B. Phone discussion with EMM modeller on 25 November 2019.
C. Email comments on 14 January 2020 on a memo from EMM to Snowy Hydro (dated 19 December 2019).
D. Teleconference on 29 January 2020 with EMM and Snowy Hydro.

The initial desktop review of the Modelling Report in the EIS concluded that, while the modelling was conducted competently, the assumptions were far too conservative for the ability of the geological formations to pass water to the tunnel under practical construction and operational activities.

Of the 201 submissions on the EIS during the public exhibition period, only 5% supported the Project and another 22% provided comments only; 73% of submissions were opposed to the Project.

The major groundwater-related issues raised by objectors were:

- Water table drawdown in excess of 50m in the Gooandra Volcanics (at equilibrium).
- Water table drawdown about 0.5m at 3km either side of the tunnel in the Gooandra Volcanics (at equilibrium).
- Drying up of creeks, streams, bogs and fens.
- Disruption of the groundwater systems by tunneling.

These issues are largely a consequence of the overly-conservative assumptions adopted in the EIS, which have been made more realistic in remodelling presented in the *Preferred Infrastructure Report and Response to Submissions* since the public exhibition period. The cited prediction of excessive drawdown in the EIS was the result of an assumption of unlined and unmitigated tunnels that would receive an uncontrolled peak inflow of about 160 Litres/second (L/s) during construction in the most permeable part of the route, the Gooandra Volcanics Fractured Zone (with high hydraulic conductivity of 0.01 m/day in horizontal and vertical directions[1]), settling back to about 85 L/s during operation. Averaged predicted rates were about 5.3 L/s/km and 2.8 L/s/km, respectively. While grouting will be done in practice, where more intense fracture swarms are encountered, there is no way to anticipate their precise location in advance in a model, other than stochastically.

The EMM memo of 19 December 2019 (Advice item B) tabled for discussion a modelling approach that assumed tunnel inflows would be controlled to more realistic rates. Four scenarios were proposed for low, medium and high capped inflows, and for the maximum inflow considered "safe" at the tunnelling face. Instead of allowing the uncertain permeability values of the intersected lithologies to determine inflow rates, four alternative inflow rates were imposed as direct extraction of water as tunnelling progressed. These rates were allowed to reduce automatically to align with the amount of dewatering required to keep the tunnel dry during construction.

[1] The sensitivity analysis in Figure 3.21 showed no change in calibration performance for hydraulic conductivity 100 times lower.

Subsequently, in February 2020, EMM prepared a *Preferred Infrastructure Report and Response to Submissions* [PIR-RTS] including a revised Water Modelling report (Appendix I) which has the following report structure, focusing on groundwater:

Executive Summary
1. Introduction
2. Surface Water
3. Groundwater
    - 3.1 Groundwater modelling overview
    - 3.2 Model design
    - 3.3 Calibration and sensitivity analysis
    - 3.4 Predictive scenario modelling
    - 3.5 Summary, model limitations and recommendations
4. References

Electronic model files have not been examined by the reviewer.

3. Revised Modelling

The PIR-RTS report has new sections explaining the standard engineering practices of excavation sequencing, pre-grouting, post-grouting and segmental lining, illustrated by Figures 3.24 to 3.26 in Appendix I, each of which would minimise the rate and duration of high water inflows to the tunnel. Excavation sequencing and segmental lining are included in the revised model, but no mitigation by means of pre-grouting or post-grouting has been included, given the inability to know in advance where grouting might be required during the construction and operational phases.

The rates assumed for the four inflow scenarios were stipulated by Snowy Hydro based on the experience of the drilling contractor in similar geological contexts. The PIR-RTS report regards the “medium inflow” scenario as the base case for detailed reporting of modelling results. This scenario assumes the following maximum inflow rates:

- 1 L/s at the excavation face (15m length; about 1 day duration).
- 5 L/s/km during construction.
- 4 L/s/km during operation.

The main outcomes of the additional scenario simulations, as documented in the PIR-RTS report, are:

- Water table drawdown of about 5m in the Gooandra Volcanics (at equilibrium) between the Eucumbene River and Gooandra Creek where the Snowy Mountains Highway crosses the tunnel route.
- Water table drawdown about 0.5m at 2km either side of the tunnel in the Gooandra Volcanics (at equilibrium).
- Reduction in baseflow to Gooandra Creek by about 6%, probably causing the creek

to change from perennial to ephemeral streamflow.

- Reduction in baseflow to Eucumbene River by about 1%, probably causing the creek to change from perennial to ephemeral streamflow.
- Long-term reduction in total baseflow by about 3 ML/day, compared to long-term tunnel inflow of about 4 ML/day.
- Negligible impact on bogs or fens as they are expected to be perched systems independent of the regional water table.
- Minor effect on tunnel inflows of about 5% for wet and dry climates.
- Inconsequential disruption of the groundwater systems by tunnelling, as they are not significant water resources.

Although a groundwater monitoring network has only recently been established, with records dating from September 2017 across a full set of seasons, over 25,000 measurements of transient groundwater levels were available for model calibration at 106 sites. Hydraulic conductivity estimates were controlled by a wide range of *in situ* aquifer testing methods (Table 3.3). Calibration was aided by consistency checks for baseflow estimates with a loosely coupled surface water model.

Overall calibration performance is about 33 mRMS and 3.6 %RMS for steady-state simulation, similar to about 36 mRMS and 3.9 %RMS for transient simulation. This level of model calibration performance is acceptable. Localised performance is best in the surficial model layer, being about 1.5 %RMS, suggesting reliable predictive power at environmental receptors. Scattergrams (Figures 3.13 and 3.14) display acceptable agreement across the full topographic range.

Based on the modelling undertaken for the EIS, a separate peer review is included in the PIR-RTS report:

- HydroGeoLogic Pty Ltd, 2019, *Snowy 2.0 Modelling Peer Review*. Prepared for EMM Consulting, 28 August 2019, 11p.

This review covered both groundwater and surface water models, and the method of coupling the two, and was conducted progressively during model development. The main findings were:

- The modelling is consistent with best practice.
- Calibration to available groundwater levels and baseflow estimates is acceptable.
- The models are suitable for simulation of scenarios to estimate drawdown and catchment water balance impacts.
- Conservative (over-estimated) settings have been adopted, “noting engineering treatments can be applied during construction”.

4. Conclusion

This reviewer concurs with the findings of the peer review conducted by HydroGeoLogic (2019), in particular that the model is *fit for purpose* where the purpose is estimation of drawdown and baseflow impacts through scenario simulations. There is no doubt that the modelling has been done competently in accordance with best practice.

While the revised modelling in the PIR-RTS report has reduced the degree of conservatism adopted in the EIS report, the model still remains conservative in prediction of environmental impacts by not including pre-grouting or post-grouting in the model scenarios. However, excavation scheduling is optimised for the purpose of minimising the duration of high inflows, and segmental lining of the tunnel is included, as proposed in the EIS. The grouting options, while sure to be implemented in practice, cannot readily be included in a model without advance knowledge of where intensely fractured zones might occur.

The impacts that were the main concerns raised by objectors on groundwater matters, while remaining to some degree, have been considerably reduced in severity.

5. Recommendations

It should be noted that the groundwater model has been developed in the absence of a long record of groundwater system behaviour, and sparse information on regional transmissive and storage properties of intercepted lithologies. For this reason, ongoing monitoring of groundwater levels along the route and streamflow monitoring of relevant streams are crucial for assessment of actual environmental impacts during construction and operational phases.

Midway during the construction phase, the groundwater model should be recalibrated against the updated groundwater level and streamflow records.

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noel.merrick@hydroalgorithmics.com

DATE: 15 May 2020

TO: David Kitto
Executive Director Special Projects
Planning and Assessment
Department of Planning, Industry and Environment
Level 30, 320 Pitt Street
Sydney NSW 2001

FROM: Dr Noel Merrick

RE: Snowy 2.0 Main Works – Groundwater Management Conditions

YOUR REF: Email 14 May 2020

OUR REF: HA2020/5

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1. Introduction

The email from Anthony Ko on 14 May 2020, on behalf of the NSW Department of Planning, Industry and Environment [DPIE], requested comment or suggested changes on draft conditions of the groundwater component of the approval for the Snowy 2.0 Main Works project [the Project].

The Project is predominantly located within Kosciuszko National Park and includes the development of underground tunnels to link the existing Tantangara and Talbingo Reservoirs, a new underground power station, and connection to TransGrid's electricity transmission system.

2. Draft Conditions

2.1 Water Management Requirements

30. The Proponent must:

(a) maximise the recycling and reuse of water on site;

(b) maximise the diversion of clean water runoff around the disturbance areas;

(c) minimise the flow rates and velocities of any clean water runoff diversions to adjoining watercourses;

(d) minimise the flooding impacts of the development;

(e) minimise groundwater take from the Gooandra Volcanics and Kellys Plain Volcanics using pre and post grouting of the tunnel, to minimise the loss of streams flows in the waterways above these geological formations, including Gooandra Creek and the headwaters of the Eucumbene River;

(f) minimise erosion and the generation and dispersion of sediment using suitable controls in accordance with the relevant requirements in the *Managing Urban Stormwater: Soils and Construction* guidance series;

(g) design all instream works, particularly the inlet and outlet works, to minimise scour and erosion;

(h) unless approved, avoid carrying out of any development within 50 metres of any watercourse;

(i) carry out all instream works or development within 50 metres of any watercourse generally in accordance with the requirements in the *Guidelines for Controlled Activities on Waterfront Land;*

(j) treat all wastewater and surplus process water prior to discharging it at the approved discharge points at the Talbingo Reservoir or Tantangara Reservoir;

(k) reduce the number of diffuser points for low charge discharges to the Talbingo Reservoir or Tantangara Reservoir;

(l) not discharge any surplus process water to the stormwater basins on site;

(m) minimise the surface water quality impacts of the development, including:

- the development carried out in the vicinity of waterways, particularly the Talbingo Reservoir, Tantangara Reservoir and Yarrangobilly River;
- all instream works, including dredging, channel excavations, underwater blasting, barge infrastructure, fish barriers and screens, culverts and bridges, and service crossings;
- the temporary and permanent spoil emplacement areas;
- development at the Marica, Plateau and Rock Forest sites; and
- road works;
- the operation of the power station and associated infrastructure, including the operation of the inlets and outlets to minimise sediment disturbance risks and the dewatering of the tailrace tunnel;

(n) minimise the risk of spills or leaks on site, and clean up any spills or leaks as quickly as possible;

(o) minimise the groundwater quality impacts of the development, particularly through the design of the temporary and permanent spoil emplacement areas and all water storages on site;

(p) store chemicals and hydrocarbon products in bunded areas in accordance with the relevant Australian Standards.

2.2 Water Management Plan

31. Prior to the commencement of construction, the Proponent must prepare a Water Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:

(a) be prepared by a suitably qualified and experienced person in consultation with the EPA, NPWS, the Water Group and NSW DPI;

(b) include a Site Water Balance for the development with a program to review and update this water balance each calendar year;

(c) include a Surface Water Management Plan, containing detailed plans for the Talbingo Reservoir, Lobs Hole, Marica, Plateau, Tantangara Reservoir, and Rock Forest sites, with:

· detailed baseline data on surface water flows and quality in the watercourses that could be affected by the development, and a program to augment this baseline data over time;

· detailed criteria for assessing the surface water impacts of the development (flows, quality and flooding), including criteria for triggering remedial action (if necessary);

· a description of the measures that would be implemented to minimise the surface water impacts of the development and comply with the relevant water management requirements in conditions 4, 6 and 30 above, including specific plans covering:

- the temporary or permanent emplacement of spoil;

- dredging, channel extraction and underwater blasting in the Talbingo Reservoir and Tantangara Reservoir;

- operation of the discharge points;

- the design of the inlets and outlets; and

- dewatering of the tailrace tunnel during operations;

· identify the key risks to the successful implementation of these measures, and describe the contingency measures that would be implemented to address these risks;

· a program to monitor and publicly report on the surface water impacts of the development;

(d) include a Groundwater Management Plan with:

· detailed baseline data on groundwater levels, yield and quality on the aquifers that could be affected by the development, and a program to augment this baseline data over time;

· a program to validate and calibrate the groundwater model for the development as new information is collected;

· detailed criteria for assessing the groundwater impacts of the development, including criteria for triggering remedial action (if necessary);

· a description of the measures that would be implemented to comply with the water management requirements in condition 30 above;

· a program to monitor and publicly report on:

- groundwater inflows to the tunnel;
- water take from the groundwater bores;
- the impacts of the development on:
  - o regional and local (including alluvial) aquifers;
  - o base flow to surface water sources.

32. The Proponent must implement the approved Water Management Plan for the development.

3. Assessment

I have examined the conditions relevant to groundwater matters, namely 30(e), 30(o) and 31(d).

I find them all adequate apart from:

- At the first dot point in 31(d), change the preposition "on" to "of" preceding "the aquifers".
- For the second item in the last dot point of 31(d), expand the condition to read: "water take from the groundwater bores and connected water sources".

Our ref: LTR-ECO SNOWY

By email
David.Kitto@planning.nsw.gov.au

15 May 2020

David Kitto
Executive Director,
Special Projects
Department of Planning, Industry and Environment

Dear David

The Department of Planning, Industry and Environment (Department) required the services of a biodiversity specialist to provide independent expert advice regarding the Biodiversity Offset Strategy (BOS) (EMM, 2020) for the Snowy 2.0 Main Works project (project), proposed by Snowy Hydro Limited (Snowy Hydro).

The following provides a summary of an independent technical review of the revised BOS (EMM 2020), principally focused on the quantification and approach to the proposed conservation management and offset outcomes. In addition, a final recommendation of offset liability is provided.

INTRODUCTION

The Snowy 2.0 Main Works project is a Critical State Significant Infrastructure (CSSI) uniquely situated within the biologically significant Alpine bioregion of the Snowy Mountains. It is almost entirely positioned within Kosciusko National Park (KNP). The project includes the development of underground tunnels to link the existing Tantangara and Talbingo Reservoirs, a new underground power station and connection to TransGrid's electricity transmission system.

An Environmental Impact Statement (EIS) for the project was prepared and publicly exhibited. This included a Biodiversity Development Assessment Report (BDAR) (EMM 2019) that outlined the residual impacts on approximately 1,053 ha of native vegetation and habitat.

The initial BOS (EMM 2019) provided a high-level commitment to offset residual impacts within the KNP, in accordance with the Secretary's Environmental Assessment Requirements (SEARs), which required "*a strategy to offset the residual impacts of the project on these ecosystems, focussing on enhancing the biodiversity values of the Kosciuszko National Park in the medium to long term*." The initial BOS however provided limited detail on the quantification of any direct offset outcomes.

Following submissions from government, community and key stakeholders on the EIS and initial BOS (EMM 2019), Snowy Hydro significantly revised the Main Works impacts. The initial impact on 1,053 ha was significantly reduced through avoidance to 425 ha of native vegetation and habitat (EMM 2020).

A revised BOS (EMM 2020) was also prepared that further quantified the approach to offsets for residual project impacts by proposing a payment of $**36M** (comprising $22M for broad ecosystem

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management and $14M for targeted species actions) to NPWS for the management and conservation of biodiversity within KNP.

METHODOLOGY OF THE REVIEW

The technical review of the revised BOS incorporated the following approach and methods;

1. Extensive consultation with key stakeholders including; NSW National Parks and Wildlife Service (NPWS) representing KNP, the Department including biodiversity specialists from NSW Biodiversity Conservation Division (BCD), threatened species experts and Snowy Hydro.

   The reviews recommendations on the BOS management actions and offset liability were also subject to three rounds of comments and consultation with the above stakeholders.

2. A desktop review and analysis of management actions and conditions with KNP using the appropriate and available literature, including;

- key threats as documented in Bionet and the Threatened Biodiversity Data Collection (TBDC)
- Saving our Species (SoS) management actions for each species
- relevant species management and recovery plans
- Kosciuszko National Park Plan of Management 2006 (KNP PoM,) (DEC 2006)
- The project BDAR, technical documentation (EMM 2020) and BOS (EMM 2019 and 2020)
- disturbance data on horse impacts in the Alps (Robertson et al 2015)
- Caring for our Australian Alps Catchments (Worboys and Good 2011), including condition mapping
- horse and deer abundance and disturbance mapping (KNP 2016)
- broad scale vegetation mapping
- existing ecology reports, topographic maps and aerial photographs

3. Validating proposed rates and conservation management actions against;

- existing conservation management standards
- previous expert experience for CSSI and SSI BOS and conservation management actions
- government advice for conservation management under the BCT and BAM
- NSW Biodiversity Assessment Methodology (BAM) (OEH 2016)
- State and Commonwealth offset policy and guidelines
- relevant KNP biodiversity and management documentation

SUMMARY OF THE REVISED BOS

The ongoing development of the project design, siting and infrastructure layout has prioritised the hierarchical principals of avoidance and minimising impacts to biodiversity within this sensitive environment.

The residual project impacts associated with the 'Main Works' direct clearing of 425 ha of vegetation and habitat, will affect both terrestrial and aquatic ecosystems.

These project impacts have been comprehensively assessed and quantified in accordance with the NSW BAM (OEH 2016), DPI policy (FM Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The assessment of the biodiversity for the project was based on field data collected prior to the 20219/2020 bushfires.

The revised BOS (EMM 2020) provides a high-level assessment of the broad biodiversity offset objectives with some reference to the literature for key management requirements within KNP (eg. Worboys and Good (2011) and KNP PoM (DEC 2006).

The key approach of the BOS is to provide payment to NPWS for the management of biodiversity within KNP, including the species and communities to be impacted by the project. The approach is generally consistent with the previous recommendations of the independent expert on the initial BOS (EMM 2019) and consultation with NPWS, the Department and BCD.

This approach reflects the SEARs requirement for a '*a strategy to offset the residual impacts of the project on these ecosystems, focussing on enhancing the biodiversity values of the Kosciuszko National Park in the medium to long term*.' and acknowledges the unique setting of the project and limitations in the current NSW biodiversity offset scheme in providing the best conservation outcomes for biodiversity generally restricted to the existing reserve estate of KNP.

To ensure the quantum of the proposed offset meets the equivalent required offset liability under the BAM, the revised BOS has determined a hypothetical biodiversity stewardship agreement (BSA) within the KNP of 4,383 ha. The size of this BSA is reasonably equivalent to the area of habitat required to generate and meet the 'like for like' ecosystem credit requirements of the project under BAM.

The BSA has incorporated three classes of condition for each broad vegetation formation. This classification was based on field verified mapping and existing site value data collected throughout the projects locality as part of the EIS, prior to the 2019/2020 bushfires. The revised BOS proposed ecosystem offset liability reflects the costing of the targeted biodiversity management actions across the BSA for up to 20 years.

The revised BOS also provides for species-specific management actions for seven individual species and the threatened ecological community (TEC) Alpine Sphagnum Bogs and Associated Fens. The majority of the proposed species-specific management actions are associated with survey, monitoring and research.

RECOMMENDATIONS ON THE OFFSET LIABILITY

The detailed review of the proposed $36M offset contribution within the revised BOS (EMM 2020) focused on the adequacy of the proposed management actions, rates/costs attributed to each action and the data used to quantify the scale of the proposed approach.

The approach presented in the revised BOS (EMM 2020) was considered reasonable for quantifying the proposed offset against the ecosystem credit liability of the project. The review however, found several of the management actions were considered inadequately costed or not representative of the vegetation condition requirements to deliver and provide for the conservation outcomes within KNP over appropriate time scales.

This review also considered the proposed offset inadequately provided direct conservation outcomes for all threatened species impacted by the project.

Furthermore, the revised BOS doesn't adequately demonstrate how the proposed management actions will meet the direct offset requirements for each significantly impacted Commonwealth species and in particular, '*provide a measurable conservation gain for an impacted protected matter*' in accordance with the EPBC Act Environmental Offsets Policy (DSEWPaC 2012).

A summary of key areas of difference and recommendations of this review are provided in the following sections;

REQUIREMENT FOR MANAGEMENT BEYOND 20 YEARS

Offsets under the NSW BAM are required to provide in perpetuity outcomes. This acknowledges that impacts are generally permanent and for the offset to achieve the required benefits, an in-perpetuity outcome is required. Similarly, the establishment of an alternative offset approach establishing BSAs off-park would also require in perpetuity management costing.

There is also both State and Commonwealth policy guidance and substantial precedence of state significant projects requiring in perpetuity or '*long term'* offsets beyond 20 years.

Under the EPBC Act Environmental Offsets Policy (DSEWPaC 2012) there is also a requirement for the benefits to be secured for the duration of the impact. Therefore, for a permanent impact it's difficult to envisage many situations where ongoing in perpetuity management or maintenance wouldn't be needed. Given the impacts of the project and proposed offset outcomes are within KNP, a reasonable assumption can be made that by limiting the proposed management actions to 20 years, the project is transferring its liability beyond 20 years back on NPWS.

In assessing the applicability of the proposed 20 year limit to management, it is important to consider the direct impacts of the project will be relatively immediate rather than staged. The proposed offsets however, will rely on gradual direct management actions for species and ecosystems that will take time before the benefits are achieved.

While offset requirements should be typically targeted at in perpetuity, it is acknowledged a portion of project's impacts are associated with temporary disturbance areas subject to additional requirements for rehabilitation to biodiversity. The rehabilitation of these areas to pre-disturbance or better condition is likely to take significantly longer than 20 years, with ecosystem restoration likely to require at least 20-40 years to be substantially trending towards benchmark values. For many of the species impacted, the rehabilitation is unlikely to ever replace the loss of known species habitat.

Therefore, to achieve direct 'long term' outcomes from the proposed management actions it is strongly recommended the proposed offsets liability incorporate management actions beyond the 20 year limit. Recognising the significant contribution of management actions proposed within the initial 20 years, it is recommended that ongoing maintenance for a limited number of proposed management actions beyond the 20 years is required. This includes;

- feral animal control (shooting)
- feral predator control (baiting)
- feral herbivore control (poisoning/gassing)
- weed control (general).
- weed control along the banks of the Yarrangobilly River, particularly blackberry

To balance and recognise the project's temporary disturbance and the rehabilitation of a proportion of the impacts on ecosystems, the recommended ongoing costs have been limited to a 30 year program (equivalent to 40 years at 50% the application rate from years 20-40). This timeframe is also likely to align with the proposed rehabilitation of the temporary disturbance areas substantially trending towards self-sufficiency.

CHANGES TO THE PROPOSED AREA OF WEED MANAGEMENT ZONES

The revised BOS proposed weed management across the broad vegetation associations at different rates of application for each of the three vegetation conditions classes; low, poor and good. Low condition vegetation had the highest weed management requirements and was determined to be 3% of the total vegetation association area, poor condition was also 3% of the total vegetation association area and the remaining 94% was in good condition with only limited weed management requirements.

While the classification of three different vegetation management conditions within the revised BOS is supported, the review considered the percentage areas applied to the extent of low and poor vegetation condition and subsequent weed management requirements underestimated.

The review examined average site value condition scores, described presence of High Threat Weeds (HTW), exotic weed cover for every vegetation condition class and descriptions provided within the BDAR (EMM 2020). Additionally, this data was further considered against analysis from the broader KNP, including;

- disturbance data on horse impacts in the Alps (Robertson et al 2015) and edge effects of combined KNP roads
- disturbance and condition mapping within KNP from high horse and deer abundance areas (KNP 2006)
- moderate condition catchment mapping from Worboys & Good (2011)

Based on the above, the following revised percentage breakdown of vegetation management condition is recommended to more accurately reflect the requirements of weed management across the broader KNP;

- low 5%
- poor 15%
- good 80%

ADMINISTRATION, IMPLEMENTATION AND EQUIPMENT COSTS

The revised BOS provides a range of significant actions with need for equipment, administration and implementation costs, including substantial governance and reporting. These however, are not incorporated into the offset liability. It is recommended that the following additional costs be provided for;

- additional KNP staff for the implementation of the offset
- equipment including, monitoring cameras, office storage and fencing maintenance

These costs are considered additional to the Snowy Hydro currently funded KNP positions under the lease agreement.

SUMMARY OF RECOMMENDED ECOSYSTEM OFFSET LIABILITY

It is recommended the project offset liability for ecosystem management within KNP be increased from the $22M in the revised BOS to approximately $45M. A summary of each recommended management action liability is provided below in Table 1. A detailed breakdown of the recommended management cost is provided in Attachment A.

Table 1 Summary of Recommended Ecosystem Offset Liability

ECOSYSTEM MANAGEMENT ACTION	COSTS
Pest and feral animal control	18,372,585
Weed control	21,744,518
Revegetation /planting	378,000
Administration/equipment	5,324,625

TOTAL ECOSYSTEM LIABILITY	**45,819,728**

RECOMMENDATION FOR DIRECT OFFSETS FOR ALL CANDIDATE SPECIES/TEC

The revised BOS provides specific offset actions for seven of the more substantially impacted species, however, only limited justification for the absence of proposed offset outcomes for the remaining candidate species directly impacted by the project.

To ensure the project will deliver direct offset outcomes in accordance with State and Commonwealth policy requirements, an offset liability is recommended for all affected candidate species.

It is acknowledged that not all species are impacted by the project to the same extent and as such a recommended tiered approach was adopted to provide species specific offsets within the BOS, incorporating the following two options;

- payment to KNP of the equivalent BOPC species credit liability in accordance with BAM
- payment to KNP for the costs associated with the implementation of species specific management actions

Following consultation with NPWS, BCD and a review of individual species/TEC management plans developed by species experts, direct species management actions are recommended and costed for eight species substantially impacted by the project.

The recommended species management actions were guided by the following general principals;

- where possible actions should preferentially target outcomes for each species within KNP
- actions should be guided by existing species recovery planning and species expert recommendations
- avoid duplication of broader pest and weed management actions proposed and costed under the ecosystem offset liability
- considered EPBC Act Environmental Offsets Policy (DSEWPaC 2012) requirements for 'direct' actions
- provide long term benefits and outcomes
- be proportionate to the project impacts
- for species identified as 'priority affected species/TEC' in the Commonwealth guidance following the 2019-20 bushfires (DAWE 2020), consider additional bushfire recovery management requirements and actions within areas unaffected by the 2019-2020 bushfire.
- implementation of the management actions should be monitored and reported.

In addition to the individual costed management actions for the eight species/TEC and to ensure direct offsets outcomes are provided for all candidate species impacted by the project, the BOPC credit liability is recommended to determine the offset liability payment for a further ten species with relatively minor project impacts and/or considered unlikely to benefit from direct on ground management actions within KNP.

SUMMARY OF RECOMMENDED SPECIES OFFSET LIABILITY

It is recommended the species offset liability be increased from the $14M in the revised BOS to approximately $28M. The recommended species offset liability will provide direct benefits and outcomes for all 18 species affected by the project. A summary of the final species/TEC offset liability is provided below in Table 2. A detailed breakdown of the recommended management cost is provided in Attachment A.

Table 2 Summary of recommended species offset liability

METHOD	RULE SET	SPECIES	OFFSET COST
Equivalent BOPC credit liability payment to KNP[1].	— relatively small direct project impact and/or — on ground actions not achievable and/or — management actions disproportionately costlier than BOPC offset liability and/or — on ground actions, limited application for targeted species	*Caladenia montana*	6,693
		Calotis glandulosa	57,453
		Max Muellers Burr Daisy	14,370
		Slender Greenhood	92,505
		Gang Gang Cockatoo	63,306
		Raleigh Sedge	4,373
		Leafy Anchor Plant	13,685
		Glycine latrobeana	57,453
		White-bellied Sea Eagle	154,629
		Southern Myotis	92,506
Sub Total			**556,974**
Species/TEC specific targeted management actions	— species considered to be substantially impacted by the project and/or — BOPC offset liability disproportionate to project impacts and/or — priority bushfire affected species and/or — species requiring offsets under the EPBC Act Environmental Offsets Policy (DSEWPaC 2012)	Eastern Pygmy-possum	1,521,890
		Smoky Mouse	11,530,000
		Alpine Bogs and Fens TEC	1,399,200
		Alpine She-oak Skink	2,600,000
		Alpine Tree Frog	4,400,000
		Booroolong Frog	4,614,800
		Broad Toothed Rat	1,290,000
	— on ground actions considered proportionate to the BOPC offset liability	Kiandra Leek Orchid	65,000
Sub Total			**27,420,890**
TOTAL SPECIES/TEC LIABILITY			**27,977,864**

Notes 1. Offset liability current of the BOPC 28/2/2020

CONCLUSION

KNP is one of the most complex conservation reserves in Australia, having unique glacial landscapes and a rare and unusual assemblage of plants and animals, several which are found nowhere else in the world.

Given these key factors a strategic BOS is required that both directly targets the project requirements, to provide strategic conservation outcomes for KNP and considers State and Commonwealth legislation and policy guidance.

The revised BOS provides an approach to delivering the offset liability for the project through the contribution of funds for direct conservation management actions within KNP. To quantify the extent of the funded management actions, the BOS combines direct species specific actions with a modified approach to establishing and managing biodiversity generally consistent with a BSA.

The approach within the revised BOS to quantifying the size of the proposed BSA management area is considered appropriately based on site specific data, accurately reflecting the likely condition and management areas within KNP, prior to the 2019/2020 bushfires.

This review however found substantial shortfalls in the proposed timeframes, areas and rates of application for specific management actions and a lack of appropriately funded administration. It is recommended the estimated ecosystem liability contribution of the BOS be revised from $22M to $**45,819,728.**

This review also recommends the provision of direct offset outcomes for all 18-threatened species/TEC. These should be proportionate to the project impacts and incorporate a tiered approach consistent with the BOPC liability under the BAM, or for those species/TEC substantially impacted by the project, costed targeted management actions. It is recommended the estimated species/TEC liability be revised from $14M to $**27,977,864.**

This recommendation provides a framework tailored to directly contribute to the ongoing and future management of KNP, while providing species specific offset outcomes for the residual biodiversity impacts of the project.

By providing funding for direct on ground actions for Commonwealth listed species, the recommended offset outcomes will '*provide a measurable conservation gain for an impacted protected matter'* in accordance with the EPBC Act Environmental Offsets Policy (DSEWPaC 2012).

This revised total offset liability of **$73,797,592** provides an opportunity for a significant long lasting contribution to the conservation management of biodiversity and threatened species within KNP. It has been developed in direct consultation with key stakeholders; the Department, NPWS and BCD species experts.

Yours sincerely

Alex Cockerill
Ecology National Team Executive

Encl: Attachment A Management costing

ATTACHMENT A – DETAILED BREAKDOWN OF FINAL RECOMMENDED MANAGEMENT COSTS

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No.	Offset type	Management group	Management category	Management type	Management Action	Costs (excl GST)
ECOSYSTEM LIABILITY						
1	Ecosystem	Montane dry sclerophyll forests	Feral animal control	Direct	Feral animal control (shooting).	**$1,396,875**
2	Ecosystem / species		Feral predator control	Direct	Feral predator control (baiting).	**$178,800**
3	Ecosystem		Feral herbivore control	Direct	Feral herbivore control (poisoning/gassing).	**$1,396,875**
4	Ecosystem		Weed control	Direct	Weed control (primary).	**$167,625**
5	Ecosystem		Weed control	Direct	Weed control (secondary).	**$125,719**
6	Ecosystem		Weed control	Direct	Weed control (secondary).	**$377,156**
7	Ecosystem		Weed control	Direct	Weed control (general).	**$3,017,250**
8	Ecosystem	Subalpine grasslands and bogs	Feral herbivore control	Direct	Feral herbivore control (aerial shooting).	**$880,425**
9	Ecosystem		Feral animal control	Direct	Feral animal control (shooting).	**$1,539,375**
10	Ecosystem / species		Feral predator control	Direct	Feral predator control (baiting).	**$197,040**

11	Ecosystem		Feral herbivore control	Direct	Feral herbivore control (poisoning/gassing).	**$1,539,375**
12	Ecosystem		Weed control	Direct	Weed control (primary).	**$184,725**
13	Ecosystem		Weed control	Direct	Weed control (secondary).	**$138,544**
14	Ecosystem		Weed control	Direct	Weed control (secondary).	**$415,631**
15	Ecosystem		Weed control	Direct	Weed control (general).	**$3,325,050**
16	Ecosystem		Weed control	Direct	Weed control (aerial spraying)	**$43,718**
17	Ecosystem	Subalpine woodlands	Feral animal control	Direct	Feral animal control (shooting).	**$2,165,625**
18	Ecosystem / species		Feral predator control	Direct	Feral predator control (baiting). undertaken every two years for 20 years.	**$277,200**
19	Ecosystem		Feral herbivore control	Direct	Feral herbivore control (poisoning/gassing).	**$2,165,625**
20	Ecosystem		Weed control	Direct	Weed control (primary).	**$259,875**
21	Ecosystem		Weed control	Direct	Weed control (secondary).	**$194,906**
22	Ecosystem		Weed control	Direct	Weed control (secondary).	**$584,719**
23	Ecosystem		Weed control	Direct	Weed control (general).	**$4,677,750**
24	Ecosystem		Revegetation	Direct	Revegetation of degraded Snow Gum Woodland Revegetation of Snow Gum Woodland (PCT	**$378,000**

					644) degraded through repeated fire events.	
25	Ecosystem	Subalpine tall forests	Feral animal control	Direct	Feral animal control (shooting).	**$3,118,125**
26	Ecosystem / species		Feral predator control	Direct	Feral predator control (baiting).	**$399,120**
27	Ecosystem		Feral herbivore control	Direct	Feral herbivore control (poisoning/gassing).	**$3,118,125**
28	Ecosystem		Weed control	Direct	Weed control (primary).	**$374,175**
29	Ecosystem		Weed control	Direct	Weed control (secondary).	**$280,631**
30	Ecosystem		Weed control	Direct	Weed control (secondary)	**$841,894**
31	Ecosystem		Weed control	Direct	Weed control (general).	**$6,735,150**
SPECIES LIABILITY						
32a	Species	Eastern Pygmy-possum	Species - Eastern Pygmy-possum	Direct	Construction and distribution of nesting logs for Eastern Pygmy-possum in burnt habitats	$521,890
32b	Species		Species - Eastern Pygmy-possum	Indirect - Research	Detailed survey and monitoring program	$1,000,000
Total - Eastern Pygmy-possum						**$1,521,890**
33a	Species	Smoky Mouse	Species - Smoky Mouse	Direct	Placement of hollow-bearing logs, sourced locally from clearing works, into burnt habitat to provide refuge habitat and nesting habitat for Smoky Mouse. Placement of logs to focus on key habitat	$850,000

					areas identified during biodiversity surveys for Snowy 2.0, including gullies and adjacent to unburnt or low intensity burnt areas.	
33b	Species		Species - Smoky Mouse	Direct	Implementation of target specific soft jaw trapping programs for feral cat & fox	$400,000
33c	Species		Species - Smoky Mouse	Direct	Comprehensive regional assessment	$1,240,000
33d	Species		Species - Smoky Mouse	Direct	Establish breeding program	$2,300,000
33e	Species		Species - Smoky Mouse	Indirect - Research	Surveys and capture of breeding stock	$100,000
33f	Species	0	Species - Smoky Mouse	Direct	Reintroduction program including predator control	$900,000
33g	Species		Species - Smoky Mouse	Indirect - Research	Monitoring program	$1,000,000
33h	Species		Species - Smoky Mouse	Direct	Fire management	$40,000
33i	Species		Species - Smoky Mouse	Direct	Management of yet undetected population(s) in KNP, most likely to the north in the Bogong Range	$1,000,000
33j	Species		Species - Smoky Mouse	Direct	Road underpasses x 10	$500,000
Total Smoky Mouse						**$11,530,000**
34a	Species	Alpine Bogs and Fens	Species - Alpine bogs and fens and grasslands	Direct	Fencing of key habitat for Alpine Bogs and Fens in the Gulf Plain area, creating a feral Horse exclusion area. Exclusion fencing of 346 ha,	$399,200
34b	Species	Alpine Bogs and Fens	Species - Alpine bogs and fens	Direct	Feral herbivore control and exclusion fencing at key sites for *PCT*	$1,000,000

					637 including survey to identify key sites for protection.	
Total Alpine Bogs and Fens						**$1,399,200**
35a	Species	Alpine She-oak Skink	Species - Alpine She-oak Skink	Direct	Implementation of target specific soft jaw trapping programs for feral cat & fox	$600,000
35b	Species		Species - Alpine She-oak Skink	Direct	Annual weed control of grassland invasive species in known habitats	$200,000
35c	Species		Species - Alpine She-oak Skink	Direct	Contribution to Feral Herbivore management programs (aerial shooting pig/deer, ground control for rabbits) in known habitats	$500,000
35d	Species		Species - Alpine She-oak Skink	Indirect - Research	Population monitoring across the species range with a focus on Northern KNP	$1,000,000
35e	Species		Species - Alpine She-oak Skink	Direct	Genetic rescue program – link with Zoo's Victoria captive breeding population program for this species.	$300,000
Total - Alpine She-oak Skink						**$2,600,000**
36b	Species	Alpine Tree Frog	Species - Alpine Tree Frog	Direct	Fencing of key habitat for key populations in Nungar Creek, Tantangara Creek/Murrumbidgee River and the Eucmbene River to prevent access to breeding habitat by feral Horses.	$1,960,000

36c	Species		Species - Alpine Tree Frog	Indirect - Research	Implementation of a broad monitoring program looking at habitat characteristics, fecundity and breeding success in managed and unmanaged sites, in combination with local microclimate variables, particularly moisture, to better understand the impacts of feral Horses, as well as the impacts of climate change on populations and identify potential climate change refugia.	$1,540,000
36d	Species		Species - Alpine Tree Frog	Direct	Carry out 20 year blackberry control program at Micalong Swamp	$400,000
36e	Species		Species - Alpine Tree Frog	Direct	Research into Chytrid management	$500,000
Total - Alpine Tree Frog						**$4,400,000**
37a	Species	Booroolong Frog	Species - Booroolong Frog	Indirect - Research	Establishment of a monitoring program for the Booroolong, including baseline surveys across two sites on the Yarrangobilly River to determine occupancy of breeding habitat by males, including testing of the population for Chytrid fungus.	$1,420,000
37b	Species		Species - Booroolong Frog	Direct	Weed control along the banks of the Yarrangobilly River, particularly Blackberry, using appropriate control methods.	$1,800,000
37c	Species		Species - Booroolong Frog	Direct	As above - years 10-20	$1,394,800
Total - Booroolong Frog						**$4,614,800**
38a	Species	Broad Toothed Rat	Species - Broad Toothed Rat	Direct	Implementation of target specific soft jaw trapping programs for feral cat & fox	$600,000

38b	Species		Species - Broad Toothed Rat	Indirect - Research	Annual species & habitat monitoring	$300,000
38c	Species		Species - Broad Toothed Rat	Direct	Under road culvert crossings to link habitat.	$300,000
38d	Species		Species - Broad Toothed Rat	Direct	Genetic rescue program – developing genetic markers in scats to improve population monitoring across the species range in Kosciuszko NP.	$90,000
Total - Broad Toothed Rat						**$1,290,000**
39a	Species	Kiandra Leek Orchid	Species - Kiandra Leek Orchid	Direct	Seed collection and storage	$10,000
39b	Species		Species - Kiandra Leek Orchid	Indirect - Research	Determine propagation requirements - research on germination and growth requirements	$25,000
39c	Species		Species - Kiandra Leek Orchid	Indirect - Research	Survey throughout KNP over three growing seasons	$30,000
Total Kiandra Leek Orchid						**$65,000**
40	Species	**Total - Caladenia montana**	Total - Caladenia montana	Direct	Payment based on credits liability for the BOPC	**$6,693**
41	Species	**Total - Calotis glandulosa**	Total - Calotis glandulosa	Direct	Payment based on credits liability for the BOPC	**$57,453**
42	Species	**Total Max Muellers Burr Daisy**	Total Max Muellers Burr Daisy	Direct	Payment based on credits liability for the BOPC	**$14,370**
43	Species	**Total - Slender Greenhood**	Total - Slender Greenhood	Direct	Payment based on credits liability for the BOPC	**$92,505**
44	Species	**Total Gang Gang Cockatoo**	Total Gang Gang Cockatoo	Direct	Payment based on credits liability for the BOPC	**$63,306**

45	Species	**Total - Raleigh Sedge**	Total - Raleigh Sedge	Direct	Payment based on credits liability for the BOPC	**$4,373**
46	Species	**Total - Leafy Anchor Plant**	Total - Leafy Anchor Plant	Direct	Payment based on credits liability for the BOPC	**$13,685**
47	Species	**Total - Glycine latrobeana**	Total - Glycine latrobeana	Direct	Payment based on credits liability for the BOPC	**$57,453**
48	Species	**Total White-bellied Sea Eagle**	Total White-bellied Sea Eagle	Direct	Payment based on credits liability for the BOPC	**$154,629**
49	Species	**Total Southern Myotis**	Total Southern Myotis	Direct	Payment based on credits liability for the BOPC	**$92,506**
					Ecosystem offsets	**$40,495,103**
					Species offsets	**$27,977,864**
					On-costs (staff; admin; equipment, office and sheds etc)	**$5,324,625**
					Total	**$73,797,592**

Appendix G – Recommended Instrument of Approval

Appendix H – Community Views

The table below includes a summary of how the key issues raised by the community were taken into consideration.

Issue	Consideration
Development within KNP • inconsistent with objectives to protect national parks • impact on aesthetics, visitor experience and tourism	• Even with careful design, the project would adversely affect parts of the back country of the KNP during construction with native vegetation and threatened species habitat cleared, certain recreation areas closed to the public, and traffic, dust and noise impacts on areas of the KNP. • On completion of the project, the majority of the infrastructure would be underground except for permanent water intakes and buildings on Talbingo and Tantangara reservoir and smaller surface elements at Lobs Hole and Marica. • The impacts of the project can be reduced to an acceptable level with conditions requiring Snowy to minimise disturbance and rehabilitate those areas to a high standard leaving a small operational footprint, implement a visual mitigation plan and offset biodiversity impacts through payment to NPWS to enhance the biodiversity values of the KNP. *Conditions* • Rehabilitate disturbed areas to fully restore native vegetation and threatened species habitat and provide enhanced recreational facilities at Lobs Hole and Tantangara reservoir. • Offset the biodiversity impacts of native vegetation clearing through payment of $73.8 million to NPWS to implement conservation actions throughout KNP. • Prepare a visual mitigation plan to blend the infrastructure as much as possible with the landscape. • Develop a digital application for users of KNP to enhance their knowledge and enjoyment of the park.
Biodiversity • scale of disturbance • impacts on threatened species • adequacy of offsets	• The project has been designed to minimise impact with 425 ha of native vegetation to be removed, with 388 ha being inside KNP and including areas of habitat for threatened species. • There is one listed threatened ecological community, the Alpine Sphagnum Bogs and Fens within the disturbance footprint, with 1.03 ha proposed to be cleared. • The impacts of the project can be reduced to an acceptable level with conditions requiring Snowy to minimise disturbance and rehabilitate those areas to a high standard leaving a small operational footprint, offset biodiversity impacts through payment to NPWS to deliver major conservation benefits for key threatened species and communities. *Conditions* • Pay the NPWS up to $73.8 million to carry out conservation actions in other parts of KNP to offset the residual biodiversity impacts of the project (on top of the $8.5 million already paid to NPWS for the exploratory works). • Undertake ecological rehabilitation to a high standard in accordance with objectives to restore vegetation composition, structure and ecosystem function of disturbed areas within set time frames. • Prepare and implement mitigation measures in accordance with a Rehabilitation Management Plan and a Biodiversity Management Plan.
Biosecurity • transfer of pests and viruses between reservoirs and downstream • impacts on threatened fish • impacts on recreational fishing	• During operation there is potential for movement of pest fish and disease from the Talbingo Reservoir to Tantangara Reservoir and potentially further downstream. • Snowy has proposed to install large fish screens to prevent the spread of pest fish and disease downstream of Tantangara Reservoir, and install a fish barrier on Tantangara Creek and restock trout in Tantangara Reservoir and Lake Eucumbene if there are impacts on recreational fishing. • The potential impacts can be further reduced by conditions requiring Snowy Hydro to develop and implement captive breeding programs, establish a restocking program for the trout fishery, prepare a detailed Biosecurity Management Plan and minimise the impacts of the project on other threatened fish species and their habitat within the disturbance area. *Conditions*

Issue	Consideration
	• Develop a detailed captive breeding program for the Macquarie Perch and Stocky Galaxias, involving the spending of $5 million over 5 years during construction to establish self-sustaining, insurance populations of these species in the surrounding region. • Review this program and develop a trigger, action, response plan for the expansion of this program over time, if necessary. • Prepare and implement a detailed Biosecurity Management Plan for the project to minimise the development-related biosecurity risks of the project. • Minimise the impacts of the project on other threatened fish species and their habitat within the disturbance area. • Develop a Recreational Fishing Plan, which includes a program involving the spending of $5 million over 5 years during construction to develop the capability to restock, and to restock the Tantangara Reservoir and Lake Eucumbene with trout.
Recreation • closure of Tantangara Road • impacts on recreational fishing, horse camps and tourism operators • reduced water quality	• There will be short term impacts on recreational users during construction and potential for long term impacts on recreational fishing. • The potential for impacts on recreational fishing can be reduced through a detailed Recreational Fishing Management Plan including restocking trout in Tantangara Reservoir and Lake Eucumbene if there are impacts on recreational fishing and conditions requiring Snowy Hydro to reinstate public access and enhance recreational facilities following construction. *Conditions* • Pay NPWS $1,995,000 to offset recreational impacts on the KNP. • Reinstate public access to Tantangara Road after it is upgraded. • Enhance recreational facilities at Lobs Hole and Tantangara following completion of construction. • Prepare a recreational fishing management plan, including payment of $5 million to develop capability for restocking Tantangara reservoir and Lake Eucumbene with trout.
Spoil Disposal • water quality impacts • management of potential asbestos and acidic contaminants	• Following extensive consultation with agencies and through options evaluation, Snowy Hydro substantially revised the strategy to address the water quality concerns, ensuring only coarse materials would be placed within the reservoirs and fine materials above the full supply level. • The potential impacts from spoil emplacement can be further reduced by testing, classifying and managing all spoil in accordance with strict requirements and minimising disposal into reservoirs, implementing special procedures to manage any reactive or contaminated spoil, and developing detailed plans for all spoil disposal in the KNP to ensure any landforms created are natural, free-draining, complement the existing landscape and are returned to woodland. *Conditions* • Test, classify and manage excavated material including procedures for contaminated material. • Maximise reuse of material. • Minimising any spoil disposal to the reservoirs. • Create stable geomorphic landforms with integrated drainage and high habitat variability. • Ensure enough topsoil or suitable growth medium to sustain revegetation. • Prepare a spoil management plan in consultation with key agencies.
Amenity • increased traffic and road safety • increased dust and noise	• The main roads used for the project, including the Snowy Mountains Highway, Link Road and Lobs Hole Ravine Road have sufficient spare capacity to accommodate the increased construction traffic. • Some road upgrades would be required to improve accessibility and safety and a traffic management plan would be required to manage scheduling, peak periods, over sized vehicle deliveries and break downs.

Issue	Consideration
	• The potential impacts can be further reduced by requiring Snowy Hydro to minimise the water quality, dust, noise, visual and traffic impacts of the project. *Conditions* • Require Snowy Hydro to minimise the traffic and noise of the project through a traffic management plan and a construction noise management plan. • Upgrade roads and intersections to the satisfaction of TfNSW and NPWS. • Schedule heavy vehicle movements to minimise disruptions and rapidly respond to incidents. • Implement all reasonable and feasible measures to minimise dust, odour, fume and blast emissions.

Appendix I – Department's Engagement

Date	Description	Attendees
24 October 2018	Site visit	Snowy Hydro, NPWS, Commonwealth DOEE
21 June 2019	Planning focus meeting	Snowy Hydro, NPWS, BCD, EPA, DPI, Commonwealth DOEE, Snowy Monaro Regional Council, Snowy Valleys Council
18 July 2019	Key matters meeting	Snowy Hydro, NPWS, EPA, DPI
1 August 2019	Biodiversity offsets meeting	Snowy Hydro, NPWS, BCD, Commonwealth DOEE
2 August 2019	Spoil emplacement meeting	Snowy Hydro, NPWS, EPA
7 August 2019	Biodiversity meeting	NPWS, BCD
19 August 2019	Spoil emplacement and biodiversity meeting	Snowy Hydro, NPWS, EPA
21 August 2019	Aquatic workshop	DPI
3 October 2019	Aquatic workshop	DPI
16 -1 7 October 2019	Community information sessions	General Public, Talbingo Progress Association, Snowy Valleys Council
17 October 2019	Site visit	NPWS, BCD
17 October 2019	Project briefing for local government	Snowy Monaro Regional Council
25 October 2019	KNP meeting	NPWS
31 October 2019	Interagency meeting	Snowy Hydro, NPWS, EPA, DPI
6 November 2019	Aquatic meeting	Snowy Hydro, DPI
7 November 2019	KNP and offsets meeting	Snowy Hydro, NPWS
19 November 2019	Biodiversity offsets meeting	Snowy Hydro, Department
28 November 2019	Aquatic workshop	DPI
10 December 2019	Landforms and recreation meeting	Snowy Hydro, NPWS
18 December 2019	Meeting with NPA	NPA
19 December 2019	Offsets meeting	NPWS, BCD

Date	Description	Attendees
20 January 2020	Project briefing with DOEE	Commonwealth DOEE, Commonwealth Department of Finance
21 January 2020	Project briefing with AEMO	AEMO
22 January 2020	Offsets and groundwater meeting	Snowy Hydro, NPWS
30 January 2020	Spoil management meeting	Snowy Hydro, NPWS
4 February 2020	Spoil management and water quality meeting	Snowy Hydro, NPWS, EPA
5 February 2020	Biodiversity meeting	NPWS
6 February 2020	Biodiversity meeting	NPWS, BCD
13 February 2020	Meeting with NPA	NPA
5 March 2020	Aquatic workshop	DPI
13 March 2020	Aquatic workshop	DPI
18 March 2020	Biodiversity meeting	NPWS, BCD
24 March 2020	Meeting with NPA	NPA