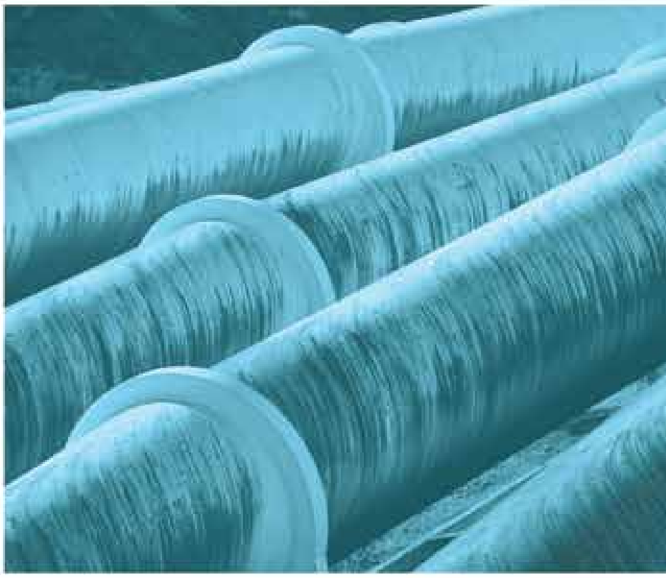

APPENDIX D

# CONSTRUCTION METHODS

# Indicative construction methods for Snowy 2.0

Snowy 2.0 Main Works

**Prepared for Snowy Hydro Limited**
**September 2019**



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Snowy 2.0 Main Works

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# 1 Introduction

## 1.1 Overview

The development of Snowy 2.0 within KNP will result in the creation of permanent infrastructure required to operate the project. The design of these infrastructure elements has been integrated into the KNP with careful consideration of its values, as well as maintaining public access to the KNP during construction where safe to do so, and in the long-term once construction has finished.

The following key design elements are proposed as part of Snowy 2.0 Main Works as they are needed for the operation of Snowy 2.0, and are referred to as operational infrastructure:

- an underground pumped hydro-electric power station complex;
- water intake structures at Tantangara and Talbingo reservoirs;
- power waterway tunnels, chambers and shafts;
- access tunnels;
- new and upgraded roads to allow ongoing access and maintenance; and
- power and communication infrastructure, including:
  - a cable yard to facilitate connection between the NEM electricity transmission network and Snowy 2.0;
  - permanent auxiliary power connection; and
  - permanent communication cables.

Figure 1.1 shows the permanent infrastructure proposed to be built within the KNP as part of Snowy 2.0 Main Works. To build the permanent infrastructure required for Snowy 2.0, several construction elements are needed. The construction elements proposed as part of Snowy 2.0 Main Works include:

- construction compounds, portals, stockpile areas, yards, maintenance and laydown areas to provide areas for plant and equipment, and storage of construction materials, at Talbingo Reservoir, Lobs Hole, Marica, and Tantangara Reservoir;
- access tunnels and adits to support main tunnelling activities and construction of the underground power station complex;
- a construction logistics site at Rock Forest;
- site-based accommodation camps to house the temporary workforce at Lobs Hole, Marica and Tantangara;
- road establishment and other access improvements and upgrades to allow access to construction sites;
- management of excavated rock from tunnelling and excavation activities, including:
  - permanent storage of excavated rock within Talbingo and Tantangara reservoirs;

  - temporary and/or permanent on-land storage within the KNP and temporary and/or permanent storage outside of KNP;

- temporary water supply for water required by construction activities;

- temporary water and wastewater treatment facilities where needed to manage the above sites and construction activities;

- continued use of the Lobs Hole substation for construction power (note that this component is subject to a modification to the current Exploratory Works for Snowy 2.0 approval requesting its construction and operation for the Exploratory Works phase of Snowy 2.0); and

- continued access to Talbingo Reservoir by barge (established during Exploratory Works for Snowy 2.0) and establishment of barge access at Tantangara Reservoir for construction of the intake.

Once Snowy 2.0 Main Works are completed, temporary construction elements (such as construction compounds and accommodation camps) will be removed and on-going rehabilitation and revegetation programs implemented.

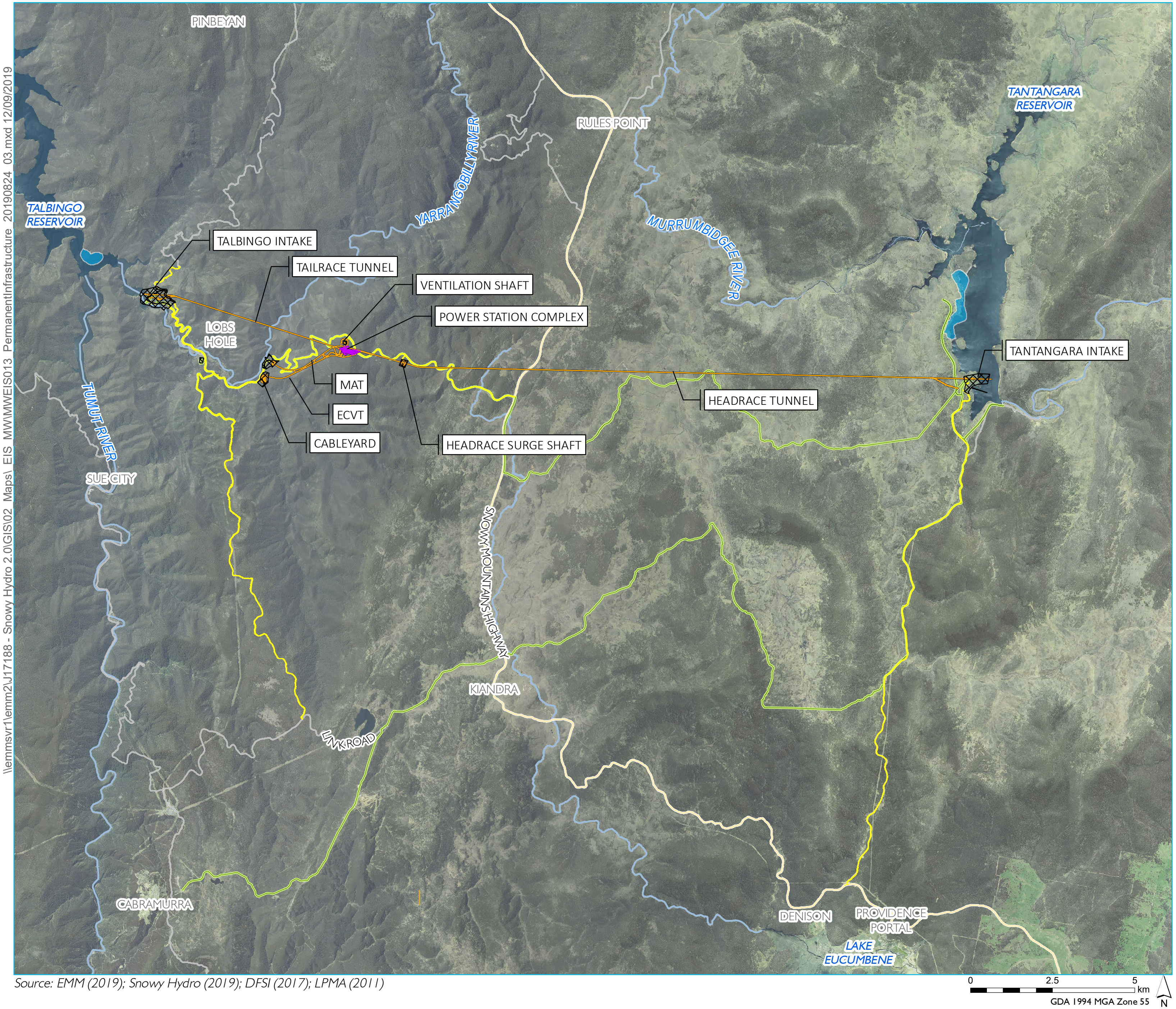
## 1.2 Methods

The construction of Snowy 2.0 Main Works requires multiple techniques and methods to achieve efficient and cost-effective delivery. Construction primarily involves surface disturbance works through the creation of construction areas to build infrastructure as well as sites where deep excavation works (primarily utilising tunnel boring machines (TBMs)) can launch from. This chapter provides an overview of the key activities, methods and location for the construction of Snowy 2.0 Main Works.

The excavation of the tunnels and caverns (which will form the power station complex) represent most of the activities required. Two primary methods of excavation will be used for the underground works: TBM and drill and blast. Figure 1.2 shows the likely locations of where these two primary methods will be used.

Broadly, drill and blast will be initially used to excavate access adits to allow for excavation of the headrace and tailrace tunnels through use of TBM. Drill and blast will also be used for the initial section of the main access tunnel (MAT, approved under Snowy 2.0 Exploratory Works) and emergency egress, cabling and ventilation tunnel (ECVT) until there is competent rock to launch the TBMs to undertake the remainder of the excavation. Drill and blast will be used to excavate the underground caverns as well as permanent access and construction adits around the power station complex, as well as to excavate some areas at the surface such as intakes and access roads.

Other methods of excavation proposed during construction include, but are not limited to, open cut (intake construction, road works), and raise bore and blind sink (to excavate shafts and chambers).

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

KEY

Operational footprint

Existing environment

- Main road
- Local road
- Watercourse

Snowy 2.0 Main Works operational elements

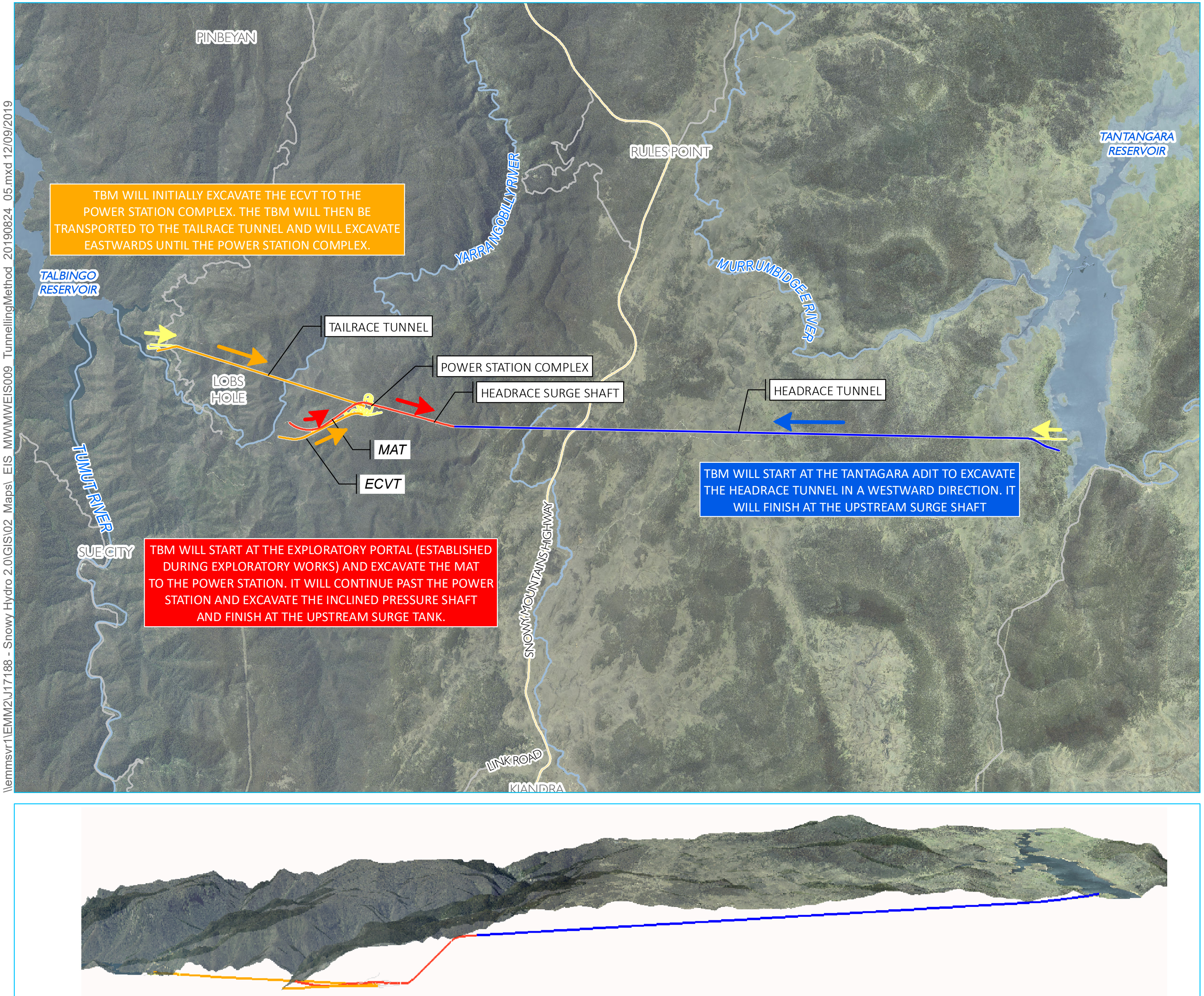
- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road
- Indicative rock emplacement area

Snowy 2.0 Main Works - permanent infrastructure

Snowy 2.0
Indicative construction methods for Snowy 2.0 Main Works
Figure 1.1

snowy 2.0

EMM creating opportunities

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**KEY**

Tunnelling method
- Drill and blast
- TBM 1
- TBM 2
- TBM 3
- Tunnelling direction

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

Primary excavation methods – drill and blast and tunnel boring machine

Snowy 2.0
Indicative construction methods for Snowy 2.0
Main Works
Figure 1.2

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

0 2.5 5 km
GDA 1994 MGA Zone 55
N

snowy 2.0
EMM creating opportunities

## 1.3 Construction stages

Snowy 2.0 Main Works will involve phases of works associated its construction ensuring an efficient sequencing into operation where it will contribute to the security and reliability of the NEM. This is shown indicatively in Figure 1.3 below.

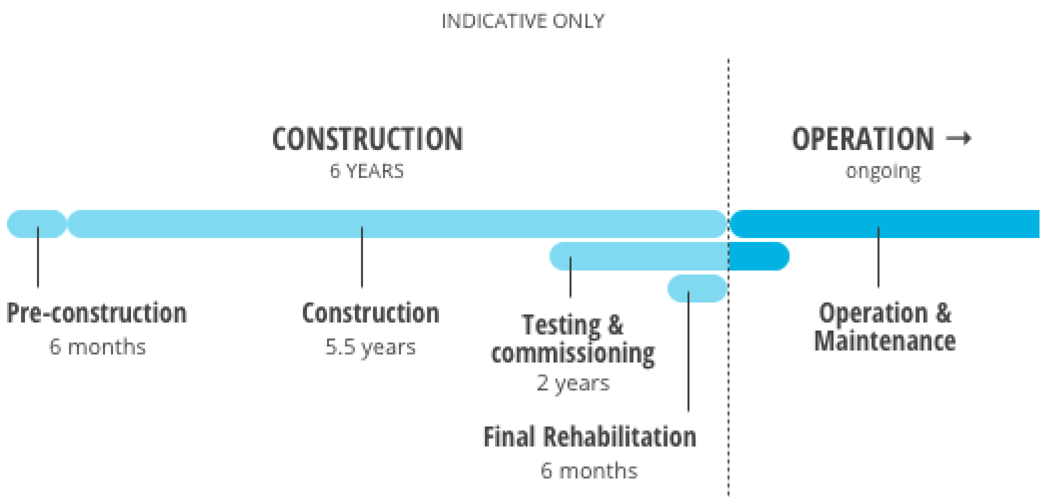



**Figure 1.3 Snowy 2.0 Main Works timing and sequencing**

## 1.1 Construction phases and activities

The construction of Snowy 2.0 Main Works has different and overlapping phases during the approximate six year period. The indicative construction sequencing is shown in Figure 1.4, with each of the different phases described in the sections below.

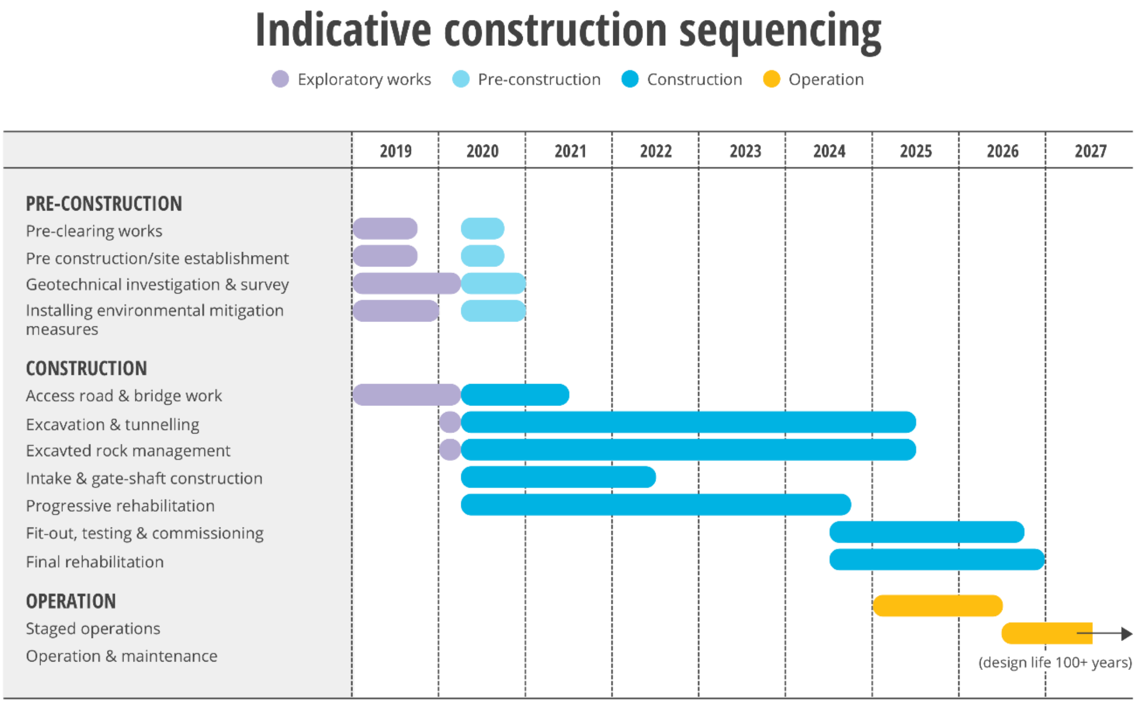



**Figure 1.4 Indicative construction sequencing**

### i Pre-construction works

Pre-construction works will follow well-established practices with the following indicative steps carried out:

- prior to the commencement of work, all sites will be surveyed and clearly marked;
- site fencing will be erected to provide security and safety;
- erection of a temporary site compound at each site to support pre-construction activities;
- erosion and sediment control measures will be installed on site. This includes mitigation around stockpile areas. Topsoil and general fill material will be stockpiled in clearly separated areas;
- trees and shrubs will be cleared only within the demarcated disturbance boundary (clearing works includes removing tree stumps and roots up to 600 millimetres (mm) below ground);
- hazardous tree assessment of trees that are outside the disturbance boundary but within close proximity, and removal of any trees deemed to be hazardous or at-risk to ensure the safety of workers; and
- expansion of the initial site compound to provide facilities for the main construction activities.

Table 1.1 provides a summary of the activities to be carried out during the pre-construction phase of the works.

**Table 1.1 Overview of pre-construction activities and methods**

| Component/stage | Construction area | Typical activities |
|---|---|---|
| Site establishment | • All | • Site boundary delineation and establishment of survey control network<br>• Clearing and grubbing<br>• Hazardous tree assessment within and adjacent to disturbance boundary and removal/trimming of hazardous trees as per assessment recommendations<br>• Drainage and environmental controls<br>• Earthworks and levelling<br>• Establish construction ancillary facilities and access<br>• Construct water and wastewater treatment facilities<br>• Continued use of construction power substation |
| Construction – geotechnical investigation and survey | • All | • Clearing and levelling of drill pads including temporary access tracks and support infrastructure such as water supply and waste management systems<br>• Drilling and in situ testing and characterisation |
| Archaeological and heritage salvage and test excavations | • All | • Carry out archaeological and heritage surveys of project area as required<br>• Record sites as required<br>• Salvage items as required and carry out reporting as documented in Aboriginal Cultural Heritage Assessment (ACHA) and Historic Heritage Assessment |
| Pre-clearance surveys | • All | • Carry out ecological surveys in accordance with requirements of the Biodiversity Development Assessment Report (BDAR) and relevant species |
| Building and road dilapidation studies | • Lobs Hole<br>• Tantangara<br>• Relevant public roads | • Identify buildings and/or roads to be subject to dilapidation studies<br>• Carry out dilapidation surveys and report<br>• Execute relevant recommendations of dilapidation studies |

### Table 1.1 Overview of pre-construction activities and methods

| Component/stage | Construction area | Typical activities |
|---|---|---|
| Environmental management, monitoring and mitigation | • All | • Establish committed environmental management, monitoring and management measures |
| Groundwater monitoring bores | • All | • Clearing and levelling of drill pads including temporary access tracks and support infrastructure such as water supply and waste management systems<br>• Drilling and bore establishment<br>• Rehabilitation of drill pad with access maintained |

Management plans will be prepared as required by the conditions of approval and submitted to the relevant authority.

#### ii Construction and progressive rehabilitation

A detailed schedule will be prepared for the construction of Snowy 2.0 Main Works. It is anticipated the schedule will further detail the sequencing of construction and is expected to include the following discrete but overlapping activities:

- **Construction works**: Once relevant designs are completed and approved, construction works will commence. The timing of the construction works is shown in Figure 1.4. Construction activities will occur concurrently at several sites across the project area.
- **Progressive revegetation and rehabilitation, management and monitoring**: Rehabilitation will be carried out progressively during the construction works where practicable. All non-permanent infrastructure will be decommissioned, and the disturbance area rehabilitated in accordance with a rehabilitation plan.

### Table 1.2 Overview of construction activities and sequencing

| Component/stage | Construction area | Typical activities |
|---|---|---|
| Construction - access road and bridge work | • All | • Site preparation of all roads (new or upgraded), including:<br>– Clearing boundary is surveyed and pegged out<br>– Removal/trimming of any hazardous trees following pre-construction survey if required as per assessment recommendations<br>– Any pre-clearing activities are completed, such as facilitating the egress of fauna<br>– Erosion and sediment control measures will be installed prior to works commencing, or as early as practicable<br>• Construct retaining walls where needed<br>• Excavate road level<br>• Lay road base, pavement and drainage<br>• Construct bridges and culverts<br>• Install road furniture such as signs and safety barriers |

### Table 1.2 Overview of construction activities and sequencing

| Component/stage | Construction area | Typical activities |
|---|---|---|
| Construction - excavation and tunnelling | • Talbingo Reservoir<br>• Lobs Hole<br>• Marica<br>• Tantangara Reservoir | • Construct portals and adits<br>• Mobilisation and site setup of TBMs (where required)<br>• Excavate power waterways, power station cavern, and associated tunnel infrastructure<br>• Install ground support where required<br>• Receipt and use of precast segments for tunnels where required<br>• Excavated rock management and haulage |
| Construction - excavated rock management | • Talbingo Reservoir<br>• Lobs Hole<br>• Marica<br>• Tantangara Reservoir | • Transport of excavated rock from tunnels, adits, portals and surge shaft to stockpile areas<br>• Testing of excavated rock for suitability of placement (where required)<br>• Transport to and filling of placement areas within the reservoirs and on-land placement for construction pads and/or permanent landforming |
| Construction - intake and gate shaft construction | • Talbingo Reservoir<br>• Tantangara Reservoir | • Clearing and grubbing<br>• Cut excavation and benching to required depth, retaining a temporary rock plug to allow dry works zone<br>• Install permanent rock anchors where required<br>• Concrete works<br>• Removal of rock plug<br>• Dredging and excavation with underwater blasting to establish approach channels |
| Construction – progressive rehabilitation | • All | • Collection and storage of indigenous/native seed and alpine sods<br>• Progressive rehabilitation comprising:<br>– Stabilisation of slopes and preparation of sites for revegetation<br>– Mitigation of sediment runoff<br>– Hydroseeding/hydro mulching/planting of slopes<br>• Decommissioning of infrastructure by removal of all temporary facilities<br>• Reinstatement of topsoil and seeding and planting of vegetation<br>• Protection of revegetation and weed management |

#### iii Testing and commissioning

Commissioning activities will be carried out over approximately a two-year period and will involve:

- operation and testing of all plant in both generating and pumping modes, at all required power output and input ranges for operations;
- the associated transfer of water between Tantangara and Talbingo reservoirs at various reservoir levels; and
- the testing of operating and protection systems for the plant and equipment.

### Table 1.3 Overview of testing and commissioning activities and methods

| Component/stage | Construction area | Typical activities |
|---|---|---|
| Commissioning - fit-out, testing and commissioning | • Talbingo Reservoir<br>• Lobs Hole<br>• Marica<br>• Tantangara Reservoir | • Operation of all plant and equipment at all required outputs<br>• Corrective works where an issue is identified<br>• Re-testing of all necessary equipment post reticification |

#### iv Final rehabilitation

Most disturbed areas, not retained for operations, will be returned to land uses generally consistent with their pre-disturbance use, subject to ongoing consultation with NPWS. Snowy Hydro will liaise closely with NPWS to determine the extent of decommissioning of temporary construction facilities and rehabilitation activities to be carried out during and following the construction of Snowy 2.0.

This approach will be taken to ensure that decommissioning allows for integration with future planned recreational uses of these areas and to maintain the values of KNP and be consistent with the KNP Plan of Management (PoM) (NPWS 2006).

### Table 1.4 Overview of final rehabilitation activities and methods

| Component/stage | Construction area | Typical activities |
|---|---|---|
| Completion of rehabilitation | • All | • Detailed completion criteria, performance measures and associated indicators will be used to demonstrate success of rehabilitation. These include:<br>– Phase 1: Active<br>– Phase 2: Decommissioning<br>– Phase 3 – Landform establishment<br>– Phase 4 – Growth medium development<br>– Phase 5 – Ecosystem and Land use establishment<br>– Phase 6 – Ecosystem and Land use development<br>– Phase 7 – Rehabilitation complete |
| Rehabilitation monitoring | • All | • Ongoing monitoring will be carried out as required using analogue/references sites for a comparison of the development and success of rehabilitation |

## 1.4 Purpose of this document

This document presents the indicative construction methods to be used in the construction of Snowy 2.0 Main Works.

The Project Description (refer to Chapter 2) within the environmental impact statement (EIS) comprises a summary of the key construction methods from this document. This document provides further information on the techniques associated with these methods.

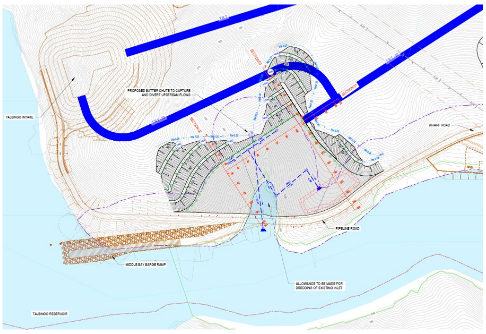
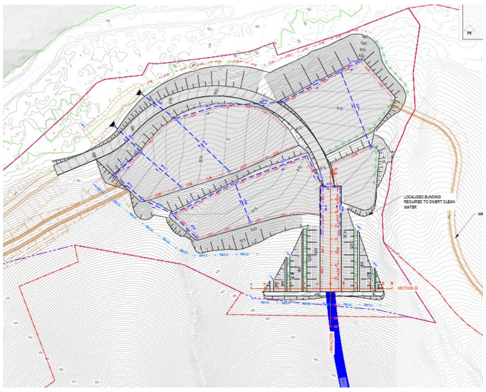
# 2 Supporting construction sites and infrastructure

## 2.1 Construction portals, tunnels and adits

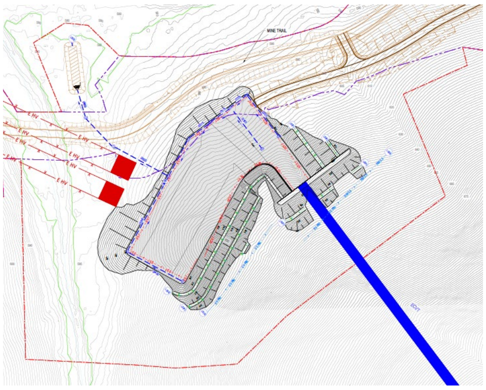
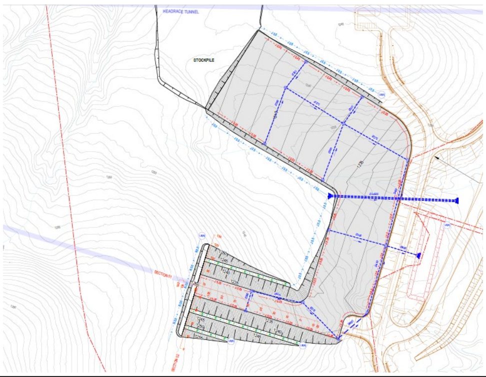
Numerous construction adits are needed to provide access and facilitate the construction of the power station complex, tailrace tunnel (TRT) and headrace tunnel (HRT). The adits will be excavated and accessed from portals established at Tantangara and Talbingo, as well as the MAT and ECVT portals.

A level site area (a construction pad) is needed for launching TBMs from the portals. Therefore, construction of these sites will involve clearing and levelling of the site, with hardstand areas established. The portals and adits will be excavated using drill and blast techniques, with rock support and concrete works as needed.

**Table 2.1 Portals to underground works**

| Portal | Purpose and description | Indicative layout |
|---|---|---|
| Talbingo (tailrace) portal | The TRT portal will be at Middle Bay. The area is appropriately sized to allow for delivery and assembly of the TBM and the necessary facilities to support its operation, including power plant, site offices, warehouse and workshops, TBM parts and tools storage, grouting system, water storage and storage of precast concrete rings. The TRT portal will be decommissioned and rehabilitated at the end of construction. |  |
| MAT portal | The MAT portal will be established as part of Exploratory Works and will continue to be used during Snowy 2.0 Main Works. The facilities and activities carried out at the MAT during Snowy 2.0 Main Works will be consistent with Exploratory Works. While the MAT portal will be used to facilitate construction, it will be a permanent tunnel and portal used during operation. |  |

### Table 2.1 Portals to underground works

| Portal | Purpose and description | Indicative layout |
|---|---|---|
| ECVT portal | The ECVT is south of the MAT. Although designed as its own construction area, due to its proximity and shared construction methodology with the MAT it is intended to share some construction facilities between the two sites (such as water treatment plant). The works site will however accommodate individual ventilation. Access to the ECVT works site will be via Mine Trail Road. While the ECVT portal will be used to facilitate construction, it will be a permanent tunnel and portal used during operation. |  |
| Tantangara (headrace) portal | The HRT portal will be on the western side of Tantangara. The area is appropriately sized to allow for delivery and assembly of the TBM and the necessary facilities to support its operation, including power plant, site offices and worker facilities, warehouse and workshops, TBM parts and tools storage, grouting system, water storage and storage of precast concrete lining segments. The HRT adit will be used for final storage of contaminated materials excavated during construction and blanked off permanently. |  |

## 2.2 Primary construction compounds and laydown areas

Several temporary construction compounds will be required to provide construction support facilities, such as concrete batching plants, water and wastewater treatment facilities, material storage, material testing and laboratory facilities, bath house, lay down areas, stockpiles and hardstand areas.

### 2.2.1 Talbingo and Tantangara portals and construction areas

As described previously, these areas provide the portals and adits for the TBM to excavate the heardace and tailrace tunnels. They will accommodate the necessary facilities to support TBM operation, including power plant, site offices, warehouse and workshops, TBM parts and tools storage, grouting system, water storage and storage of precast concrete rings.

Construction will require the areas to be cleared of vegetation and earthworks involving cut and fill to ensure a level site area.

### 2.2.2 Main yard

The Main yard will be the largest construction compound, providing a majority of ancillary construction facilities and areas for laydown. While the final layout is subject to detailed design, the Main yard will include the following:

- ancillary construction facilities – such as concrete batching plant;

- warehouses – warehouses are needed to store parts and shipments;
- maintenance sheds – mechanical workshop for servicing and repairing plant and equipment;
- first aid buildings, medical facilities and helipad;
- explosive storage yard – Lobs Hole will be set up as the main explosive storage yard, while satellite storage yards will be established close to other construction areas where they are needed;
- stockpiles – aggregate, and other materials;
- truck and vehicle parking;
- workshops and stores, offices and site worker facilities;
- site laboratory for testing of materials including concrete, aggregate, excavated rock and water quality;
- wood carpentry workshop;
- steel bending yard; and
- main site offices.

### 2.2.3 Surge shaft yard

The surge shaft yard is a level site area needed to excavate the surge shaft, including storage of equipment, explosives and stockpiles for excavated rock. The area will also allow for site office, first aid and worker facilities.

Construction will involve clearing and levelling of the site, a crane bridge to support blind sinking excavation downward excavation to the HRT, rock support, concrete works and steel works.

### 2.2.4 Rock Forest logistics yard

Rock Forest is at the entrance to KNP along Snowy Mountains Highway. It will be used as a storage and staging/logistics area for the delivery of materials to site. During adverse weather or unsafe conditions, the site would be used to hold deliveries and staff for a short timeframe. Facilities likely to be established at the site include:

- main warehouse;
- storage yards (for segments and other goods);
- training facilities for new workers prior to be sent on site;
- offices, cribs, services to accommodate people working on the site;
- turn around and parking yard for trailer/trucks;
- helipad for emergency only;
- E&M yards (sheds and accommodation); and
- sheds and temporary accommodation for use during delays to the main camp.

A weigh bridge would also be established for use on entry to the site.

## 2.3 Ancillary construction facilities

Several supporting facilities are required to support the construction compounds.

### 2.3.1 Concrete batching plants

Concrete batching plants are needed to supply key construction activities and sites. Due to the remote location of Snowy 2.0, it's not feasible to use batching plants outside KNP. As such, these plants will be established on site. Batching plants will be located as centrally as possible, to minimise the transport distance for concrete. In particular, batch plants are expected to be needed at:

- MAT Portal (established during Exploratory Works);
- main yard at Lobs Hole;
- Tantangara; and
- Marica.

Concrete aggregate will be stockpiled at each batch plant location to ensure uninterrupted supply of concrete, particularly during critical, large scale pours.

### 2.3.2 Crushing plants

Crushing plants are needed to reduce rock size where material is to be reused, for suitable road base for example. Crushing plants are expected to be needed at:

- Talbingo portal (400 – 600 t/hr); and
- Tantangara (400 – 600 t/hr).

Crushing plants would be capable of being loaded directly by truck, to receive excavated material directly from the intakes and other sources such as cuts from road works.

### 2.3.3 Laydown areas

Laydown areas are a key part of each construction site. Laydown areas must be easily accessible for large transport vehicles within construction areas. These areas will host temporary installation such as machinery, formwork and oversize deliveries, as well as use for short-term storage or work areas. Laydown areas will be provided at each of the main construction yards, providing space to store all plant, equipment and materials required for all construction activities.

All laydown yards will have a well-drained hardstand surface with capacity to withstand the storage and operation of heavy vehicles and equipment.

### 2.3.4 Stockpile areas

A number of stockpiles are needed to support both excavated rock from tunnelling and clearing activities, as well as aggregate imported for construction. These stockpiles will be as close to their final destination as possible and chosen to minimise environmental impacts. Stockpiles are generally expected at most construction sites, with longer-term stockpiles expected at:

- Talbingo portal;
- main yard;
- ECVT and MAT portals;
- Marica; and
- Tantangara.

### 2.3.5 Laboratory and other construction management facilities

A laboratory will be a prefabricated structure building, fully furnished and stocked for laboratory testing of materials. The laboratory will be equipped to test materials such as concrete, cement, aggregate, geotechnical and rock quality, and water quality.

## 2.4 Accommodation camps

The remote nature of the project necessitates the implementation of numerous temporary facilities within the project area to ensure all construction activities can be carried out within program requirements. This includes the need to provide on-site accommodation for workers. Three accommodation camps are needed to deliver Snowy 2.0 Main Works:

- Lobs Hole accommodation camp, with capacity to house about 1,400 people;
- Marica accommodation camp, with capacity to house about 100 people; and
- Tantangara accommodation camp, on the western side of Tantangara Reservoir, north of the HRT, with capacity to house about 500 people.

Snowy 2.0 Main Works will also include continued use of the Exploratory Works accommodation camp, with a currently approved capacity of up to 150 people. It should be noted that a Modification to the Exploratory Works approval, known as Modification 2, has sought to increase this to 250 beds.

Snowy 2.0 Main Works will also utilise existing accommodation at Snowy Hydro's Cabramurra township where possible. There is the potential to increase this number by constructing additional temporary accommodation which is being investigated.

Each camp will be fully equipped to be self-contained and provide facilities and services including security gates, fencing and lighting, laundry blocks, fire refuge building and related fire safety services, admin building/office, medical clinic, kitchen and dining facilities, recreational facilities, parking area and bus shelters, power generator and reticulation, and water and wastewater treatment plants and pumping facilities.

Minor earthworks by way of benching is anticipated to achieve a flat topography for the sites. Final layouts and camp design will be completed during detailed design.

## 2.5 Water and wastewater services

### 2.5.1 Water supply for construction activities

Water servicing is a key requirement for the project. Snowy 2.0 is in a remote location with no municipal potable water supply available in the area. New infrastructure is required to service the proposed construction activities and sites. Some water supply infrastructure will be retained permanently for use during operation (to supply the power station, ECVT and MAT), however the majority of infrastructure is needed for construction only and will be removed and rehabilitated once work is completed.

The majority of the construction water demand does not require potable water. Hence a separate raw water and potable water reticulation network are proposed within each site to limit the volume of water treatment required. Groundwater released during the excavation process will be captured and processed, and where required recycled back into the system to be re-used.

### 2.5.2 Raw water supply

Talbingo and Tantangara reservoirs will be the primary water source for water supply during construction, and will be used for:

- concrete mixing and supply to concrete batching plants;
- tunnelling activities and supply to TBM (TBM cooling) and drill and blast sites; and
- dust suppression and firefighting supply.

Water supply will be reticulated from the reservoirs to supply sites by buried pipelines within access roads. For more remote sites (eg Marica), options to source water locally (eg via groundwater supply wells) or transported to site (eg water carts) will be investigated during detailed design in order to reduce environmental impacts.

#### i Potable water

The reservoirs will also be the source for potable water for accommodation camps however will require the commissioning of water treatment plants at these sites. Raw water quality from both reservoirs is considered very good. Therefore, it is expected that a simple treatment process will be sufficient to treat the water to drinking water standards. Potable water will be reticulated to facilities in each accommodation camp site (ie Lobs Hole, Marica and Tantangara) via a reticulated system or via truck mounted water bowser.

The Tantangara water supply system is considerably smaller than the Talbingo water supply system due to smaller supply demands.

### 2.5.3 Wastewater management and treatment

There are three main wastewater streams that require some form of treatment before discharging to the environment, including:

- tunnel seepage and construction wastewater (process water);
- domestic sewer (wastewater); and
- construction site stormwater (stormwater).

### i Process water

A separate collection and treatment system is proposed to manage the tunnel seepage and construction wastewater (referred to as process water), such as TBM-associated water. Each tunnel will require a groundwater dewatering system and water treatment prior to reuse or discharge to reservoirs. Once lining/shotcrete/grouting is installed, the quantum of groundwater inflow will reduce. The treated seepage water will be prioritised for reuse to supply construction demands, such as TBM drilling water, dust suppression and wash down to reduce reliance on drawing raw water from Talbingo and Tantangara reservoirs. The HRT TBM is a slurry machine which will have a higher water demand requirement than the other two TBMs used in the Project.

Tunnel seepage, and construction wastewater from tunnelling will be collected by the tunnel drainage system and rerouted to the surface (via tunnel portal). The process water pumped out from the tunnel will be directed to storage tanks before being directed to process water treatment plants for treatment. Treated water will be reused onsite where possibly to reduce the amount of discharge to reservoirs, however excess treated water will be discharged to the reservoirs.

### ii Wastewater

Sewage will be generated at accommodation camps from showers, kitchens, laundries and toilet facilities. Collected sewage will be treated at sewage treatment plants to meet the specified discharge limits before effluent is discharged. Sewage treatment plants (STPs) will be needed at the accommodation camp locations.

While the configuration of STPs is yet to be finalised, best reasonable and feasible technologies will be employed to achieve water quality suitable for re-use in non-potable applications.

### iii Stormwater

To minimise raw water intake and runoff, stormwater will be captured and reused as much as possible. Captured water will be used for non-potable uses, such as dust suppression and other activities where possible. Stormwater would be captured at accommodation camps where practical. Sedimentation basins and stormwater diversions would be installed as part of erosion and sediment control measures. In some instances, stormwater treatment will be required before being released to the environment.

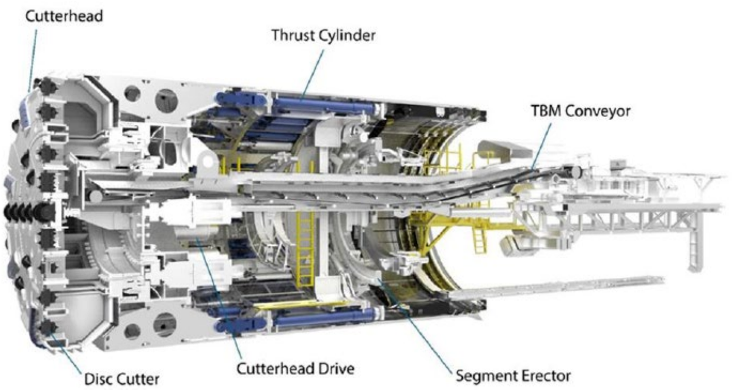
Higher order erosion and sediment controls such as clean and dirty water separation and minimisation of disturbed areas will significantly reduce the quantity and improve the quality of sediment-laden water required to be treated. Any stormwater to be treated and released to the surrounding environment would need to meet specific water quality criteria before being discharged.

# 3 Excavation and tunnelling methods

This section details methods for all types of excavation including:

- conventional excavation method used at open excavation of soil and rippable hard material (not rock);
- drill and blast method used where material cannot be excavated by normal excavator and ripper tool-mounted excavator, both in an open area and tunnels;
- horizontal excavation using a TBM, which provides better advance rates than conventional drill and blast method as the excavation progresses underground and into the tunnel;
- vertical boring, the most efficient method of vertical shaft excavation;
- underwater excavation, only applicable at the intakes' rock plug removal works done using rotating cutter or underwater control blasting; and
- dredging work used for the intakes' rock plug removal works where the top layer (underwater) is weak enough to be dredged and sucked to spoil.

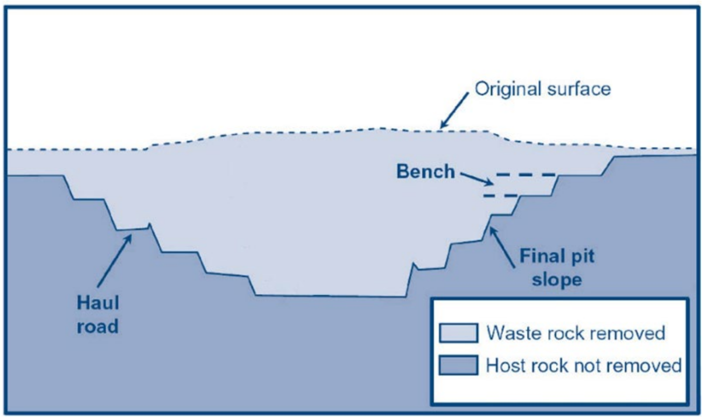
**Table 3.1 Excavation and tunnelling methods**

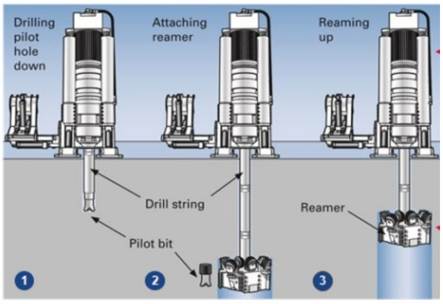
<table>
<tr><th>Construction method</th><th>Description</th></tr>
<tr><td>Tunnel boring machines</td><td>
Tunnel boring machines are used to excavate tunnels with a circular cross section. The selection of the TBM is one of the most important technical aspects of the project.
Two types of TBMs are proposed for Snowy 2.0:
<ul><li>Single shield TBM</li><li>Multi-mode TBM – Combination of single shield and slurry TBM.</li></ul>


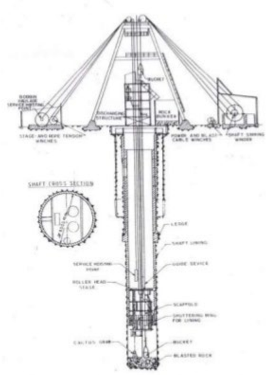
At this stage, prior to detail design of the two tunnel boring machines, it is envisaged an excavation diameter of approximately 11.60 m, however this may increase an additional 100-200mm. Each machine will be fully equipped to perform the excavation, ventilation, lining, removal of excavated material and management of naturally occurring asbestos (NOA).
Non-systematic surveys will also be conducted ahead of the TBMs to identify potentially critical areas with poor rock conditions, high fracturing or the presence of an aquifer. The TBMs will be equipped with devices to perform the following surveys:
<ul><li>Seismic reflection surveys</li><li>Geoelectrical surveys</li><li>Systematic probing using percussive drilling and core recovery.</li></ul>
</td></tr>
</table>

## Table 3.1 Excavation and tunnelling methods

| | |
|---|---|
| | The survey results will be used to assess the draining and pre-excavation grouting requirements before advancing excavation.<br><br>The TBMs will be equipped with drilling machines to drill drainage holes with PVC pipes to relieve groundwater pressures. If required, pre-excavation grouting will also be used to seal-off groundwater inflow and to improve the stability of the excavation face.<br><br>Post-excavation grouting from the segmental lining may also be used to further consolidate the surrounding rock and/or prevent water ingress if required. |
| Open cut | Open cut excavation involves the removal of soil or rock from a site to form an open face, hole or cavity using tools, machinery or explosives. It involves excavating down to below ground level to the desired depth. |
| Raise boring | Raise boring is a process used to create a circular hole between an underground cavern or tunnel and the surface, without the need for explosives.<br><br>A raise boring machine is at the surface and a pilot hole is drilled down to the underground cavern. Once it has broken through, a reaming head is used to create the required tunnel size by raising the head back up to the surface. |
| Blind sink | Blind sinking refers to the fact that there is no access to the bottom of the shaft by some other means. Initial excavation occurs from the surface and bores down. The shaft 'sinks' as it is lowered into the ground as excavation continues to progress down to the desired depth.<br><br>The 'blind sink' methodology uses drill and blast practices and blasted rock is hoisted or cycled back to the surface. A temporary portal crane will be constructed on the surface that will facilitate the transport of personnel and materials into and out of the shaft. |

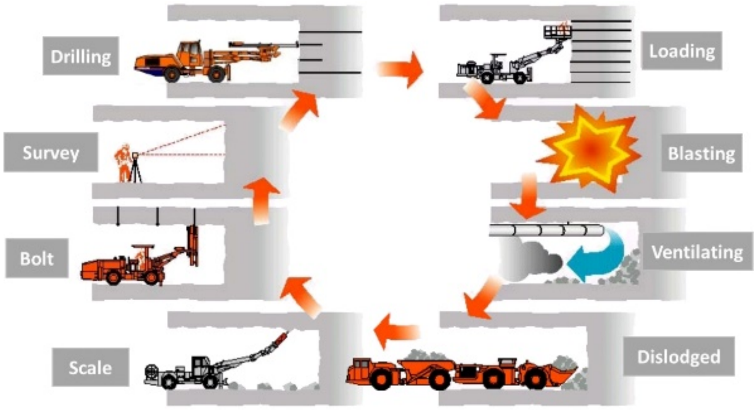


## Table 3.1 Excavation and tunnelling methods

<table>
<tr>
<td>Drill and blast</td>
<td>
Drill and blast involves the drilling of holes into a rock face (or ground) and inserting explosives to break up and excavate rock.




A typical cycle of D&B activities will involve:

- Surveying – alignment and pattern mark-up
- Positioning of the drilling equipment to the face or front to be excavated
- Drilling of the holes according to the blasting pattern
- Charging of the holes according to the blasting pattern
- Blasting
- Ventilation
- Scaling of the excavated surface
- Removal or 'mucking' of the excavated material
- Scaling completion and cleaning
- Geological mapping .

D&B method has been considered most suitable for the deep underground excavation works involving short length and changing geometries.
</td>
</tr>
</table>

# 4 Permanent infrastructure

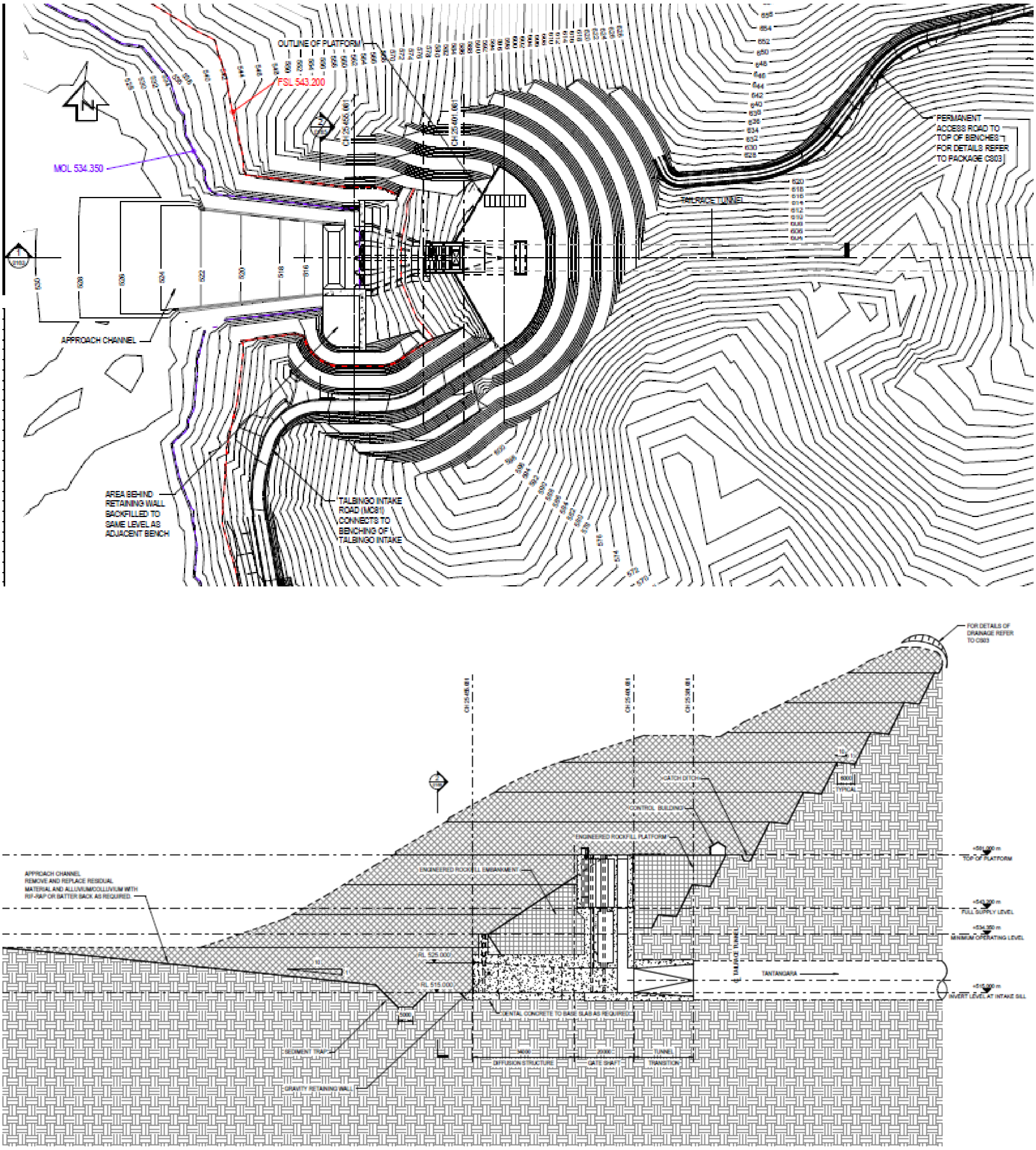
## 4.1 Intake structures and gate shafts

Water intakes are required at the Tantangara and Talbingo reservoirs to convey water in and out of the power waterway and ultimately to and from the Snowy 2.0 Main Works power station. Both intake structures are designed to operate in either generating or pumping mode with minimum head losses and with minimum impact on the environmental setting of the structures within KNP. Each intake will comprise:

- an approach channel permanently submerged below the minimum operating level of the reservoir; and
- an integrated gate valve tower and diffuser structure.

Indicative finished layouts and cross-sections of the intake structures is shown in Figure 4.1 and Figure 4.2 for Talbingo and Tantangara reservoirs, respectively.

The construction of intake structures will be divided into two stages. Firstly, the intake structures will be constructed with a rock plug in place to prevent reservoir water flowing into the tunnel and flooding the underground works. The rock plug will be removed in the second stage once all underground and tunnelling works are completed. Detailed description of the construction process for each intake is provided in Figure 4.3 for Talbingo intake, and in Figure 4.4 for Tantangara intake.




## Figure 4.1 Talbingo intake indicative layout and cross-section

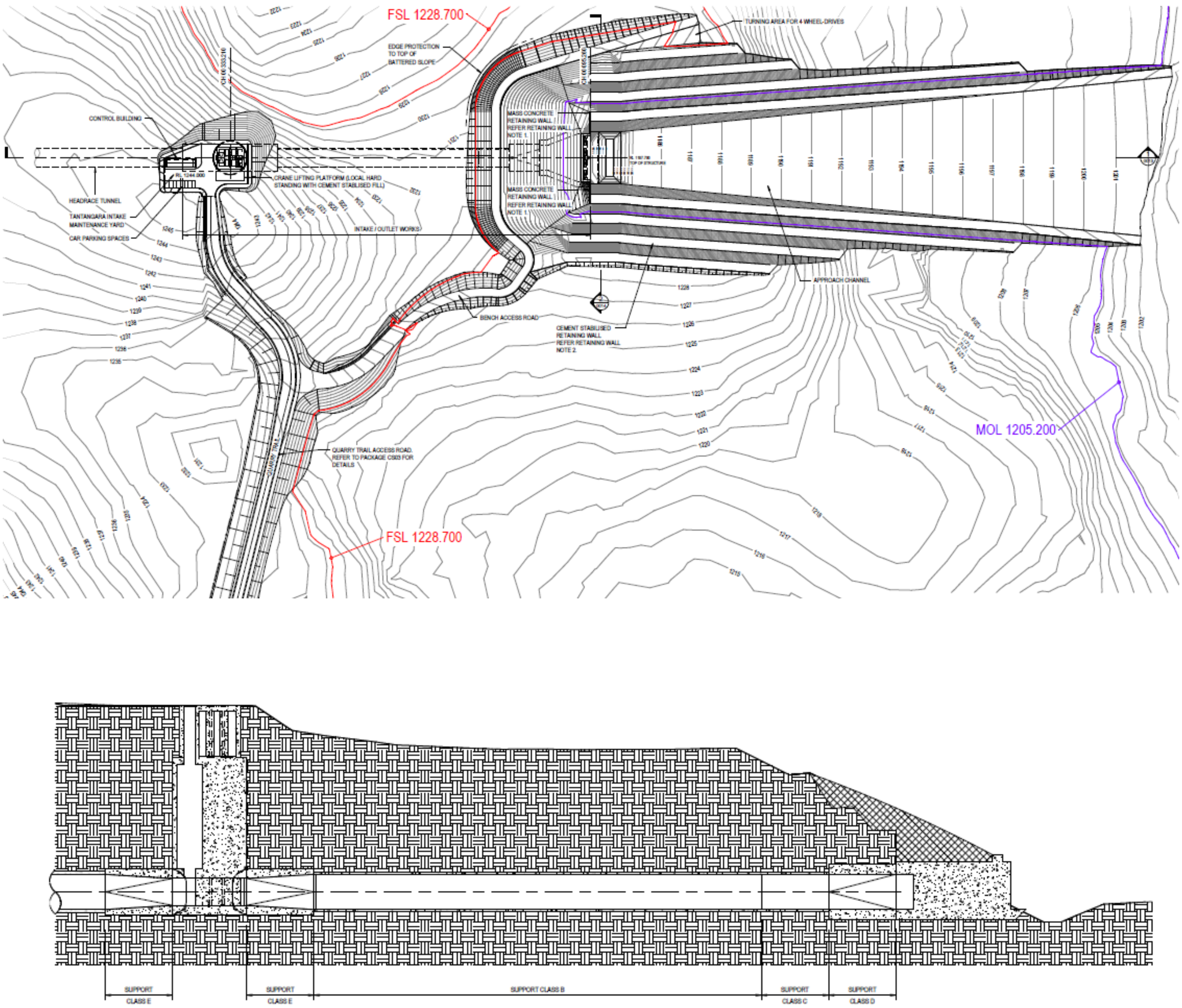



**Figure 4.2 Tantangara intake indicative layout and cross-section**

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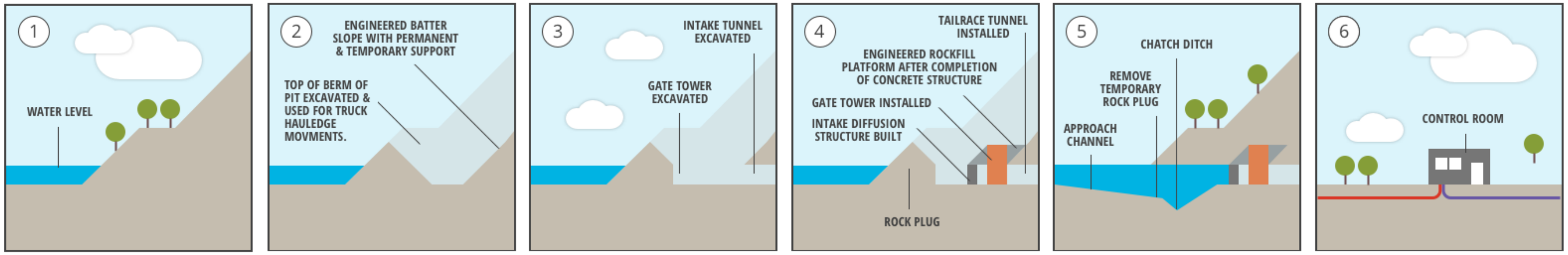


## TEMPORARY WORKS AND PRECONSTRUCTION ACTIVITIES

Temporary works and significant pre-construction activities to prepare for commencement of the main works include installation of:

- Setting out of the construction battery limits
- Temporary erosion and sediment control measures
- Clearing and grubbing within the battery limit
- Temporary bench access road from the Quarry Trail
- Security fence, entrance gate and safety signs around the construction and stockpile area battery limit
- Temporary stormwater drainage channel for work area and stockpile area.

## EXCAVATION OF THE INTAKE

Future Gen will construct this intake using the open cut method. Drilling, blasting and mass excavation will be carried out to reach the bottom of the intake structure with design batter slope for corresponding rock materials.

As the excavation progress downwards, permanent rock anchors will be installed to stabilise the cut surface depending on the rock materials found on site.

A temporary pit will be fitted with a pump to remove any possible surface water and rain water that accumulates during construction.

## EXCAVATION OF THE GATE SHAFT

To gain access at the bottom area of the Intake Structure, Future Gen will excavate an additional tunnel from the Tailrace Adit tunnel. This tunnel will then be connected to the benching platform via a shaft done in Raise Boring method.

The remaining excavation from the FSL level will be carried out from the surface, with spoil mucking through the shaft and out of the access tunnel. Figure 2 shows the sequence of excavation and how to gain access in to the invert level of intake structure.

## INSTALLATION OF INTAKE INFRASTRUCTURE & CONCRETE WORKS

The unique design at Talbingo intake requires the gate tower to be constructed as a freestanding tower from ground up. Once the concrete works of each lift of the intake structure have been completed and obtained sufficient design strength, backfilling works will commence to form the ground for construction of the next lift of the gate tower. Suitable site-won materials or materials improved with a mix of other materials and compacted to earthworks specification will be used for backfilling. A concrete face wall will be designed and constructed parallel to the mouth of intake opening to retain the base of this backfill work. The estimated backfill volume is 110,000m3.

The finished, backfilled batter slope will be rehabilitated with landscaping features as detailed in the contract landscaping reference design drawings.

Significant concrete works are required to construct both intake structures, specifically the diffusion structure and gate shaft.

The exposed portion of the diffusion structure will be constructed using conventional reinforced concrete, which will commence once excavation reaches the intake invert levels.

## REMOVAL OF ROCK PLUG

The rock plug will be removed from the front of the intake structure. Due to the large volume of rock to be excavated and discarded, various excavation options are being considered.

The rock plugs will be removed using a combination of the following construction methods:

• Drill and blast to remove a portion of the rock plugs (to be confirmed with during the project execution phase) from the dry side in the excavated pit area. The amount of rock excavation to be completed to remove the plugs at Tantangara intake site is significant however, the majority could may be able to be removed by blasting during dry conditions while the reservoir water level is low

• Underwater blasting to break down the remaining rock material in the plug and remove by dredging machine or barge-mounted excavator

• Long-arm excavator on a barge to remove bigger boulders, which are then crushed into smaller sizes before being transported to the dumping site, if required.

## CONTROL ROOM/ CABLES & CONDUITS

The control room will house all equipment such as the hydro mechanical components, hoist, control instrumentation, sensors, DC Systems, transformers, switchboards and emergency diesel generator.

This building will be pre-fabricated with all components fitted and tested in factory before transporting it to site for connection, testing and commissioning. The trenches will be formed for laying the cables and conduits.

**Figure 4.3 Indicative construction method – Talbingo intake**

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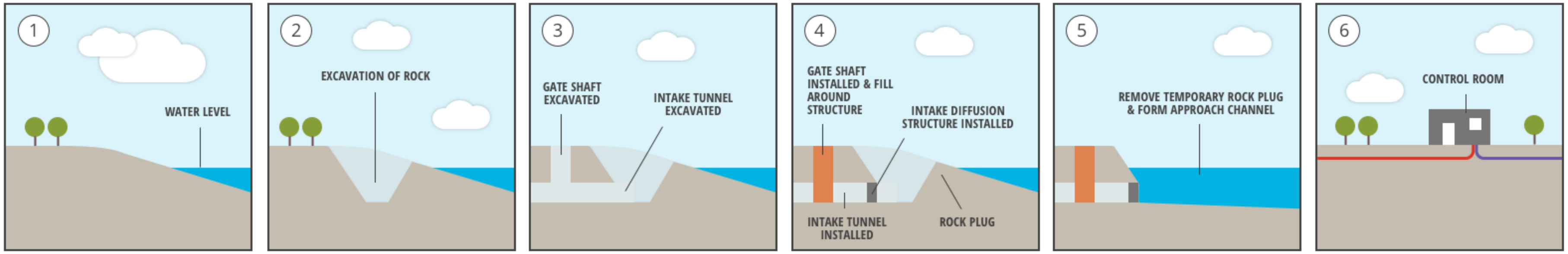



### TEMPORARY WORKS & PRECONSTRUCTION ACTIVITIES

Temporary works and significant pre-construction activities to prepare for commencement of the main works include installation of:

- Setting out of the construction battery limits
- Temporary erosion and sediment control measures
- Clearing and grubbing within the battery limit
- Temporary bench access road from the Quarry Trail
- Security fence, entrance gate and safety signs around the
- Construction and stockpile area battery limit
- Temporary stormwater drainage channel for work area and stockpile area.

### EXCAVATION OF THE INTAKE

The intake pit excavation incorporates an open-cut trench in to the various excavation levels as the work progress down below the natural surface level.

There will be drilling, blasting and mass excavation to be carried out to reach to the bottom of the intake structure.

As the excavation progress downwards, permanent rock anchors will be installed to stabilise the cut surface.

The temporary pit will be fitted with a pump to remove any water that accumulates during construction.

### EXCAVATION OF THE GATE SHAFT

The shaft for the gate tower will be bored at the highest ground along the wet tunnel alignment, approximately 200m away from the intake mouth and will be completely hidden underground. Therefore, the intake transition piece will be connected to the gate tower transition piece with a stretch of wet tunnel.

The gate tower in Tantangara intake will be formed by a blind sink shaft boring method and the gate tower will be constructed from the bottom up with concrete filling in the void between the tower and shaft.

### INSTALLATION OF INTAKE INFRASTRUCTURE & CONCRETE WORKS

Significant concrete works are required to construct both intake structures, specifically the diffusion structure and gate shaft.

The exposed portion of the diffusion structure will be constructed using conventional reinforced concrete, which will commence once excavation reaches the intake invert levels.

The diffusion structure at the opening of the Tantangara intake site will be open excavated from the top down and the concrete works will be constructed from the bottom up. Once completed concrete works, it shall be backfilled with local site-won material, which will be crushed to a consistent size to meet design backfill requirements.

### REMOVAL OF ROCK PLUG

The rock plug will be removed from the front of the intake structure. Due to the large volume of rock to be excavated and discarded, various excavation options are being considered.

The rock plugs will be removed using a combination of the following construction methods:

- Drill and blast to remove a portion of the rock plugs from the dry side in the excavated pit area
- Underwater blasting to break down the remaining rock material in the plug and remove by dredging machine or barge-mounted excavator
- Long-arm excavator on a barge to remove bigger boulders, which are then crushed into smaller sizes before being transported to the dumping site.
- Personnel will use of depth silt curtain around the dredging and underwater blasting work zone during the construction phase to contain water pollution away from the rest of the reservoir.

### CONTROL ROOM, CABLES AND CONDUITS

The control room will house all equipment such as the hydromechanical components, hoist, control instrumentation, sensors, DC Systems, transformers, switchboards and emergency diesel generator.

This building will be pre-fabricated with all components fitted and tested in factory before transporting it to site for connection, testing and commissioning.

The trenches will be formed for laying the cables and conduits.

**Figure 4.4 Indicative construction method – Tantangara intake**

## 4.2 Power waterway tunnels, chambers and shafts

The main power waterway comprises the HRT and the TRT. However, there are a number of other underground tunnels, chambers and shafts that enable the transfer of water between the two reservoirs and through the underground power station. Most of the power waterway infrastructure will be established underground, with access to the surface provided via several access tunnels and portals. The proposed power waterway tunnels, chambers and shafts are summarised in Table 4.1.

For the headrace and tailrace tunnels in particular, two single shielded Tunnel Boring Machines (TBMs) will be utilised. TBM used to excavate the HRT will be dual mode, capable to go as single shield and in slurry mode to manage potential NOA contaminated formation expected along the way. The choice of the shielded TBM has been driven by safety considerations during construction and a higher rate of advance. When compared with D&B, TBM excavation requires far less personnel, does not involve blasting, and provides almost no exposure of workers to an unsupported rock mass.

The TBM machines will be fully equipped to perform the excavation, ventilation, lining, removal of excavated material. Geotechnical drilling or 'probing' as well as seismic reflection and geo-electrical surveys will also be conducted ahead of the TBMs to identify potentially critical areas with poor rock conditions, high fracturing or the presence of an aquifer. Application, where required, of pre-grouting and secondary grouting from the TBM to prevent excessive leakage and aquifer drainage during tunnel construction as well as reduce the risk of jamming the TBM will be undertaken.

### Table 4.1 Power waterway tunnels, chambers and shafts

| Tunnel | Location / purpose | Tunnelling/construction method | Size and length |
|---|---|---|---|
| Headrace tunnel | The HRT connects the Tantangara intake structure to the upstream surge tank, to the west, upstream of the powerhouse location. The horizontal and vertical alignment would be predominantly straight until the headrace surge shaft (where the inclined pressure shaft portion of the headrace descends to the power station manifold). | Initial excavation will be by drill and blast to establish the portal, with the remainder of the tunnel excavation by TBM.<br>One TBM will be launched from the Tantangara construction adit. This TBM will operate in slurry mode through zones of NOA. | The excavated diameter will be approximately 10.9 m, with the final internal diameter at this stage of the design of 9.80 m. The approximate length of the tunnel is 17.6 km. |
| Tailrace tunnel | The TRT alignment will link the tailrace surge tank, downstream of the powerhouse complex, to the Talbingo intake. The horizontal and vertical alignments will be predominantly straight except for the last portion where a manifold for the six collector tunnels is forecast. | Initial excavation will be by drill and blast (from the Talbingo adit to the intake), with the remainder of the tunnel excavation by TBM.<br>The TBM will excavate upstream to the tailrace surge shaft. This TBM will be the same TBM used for the ECVT tunnel. | The excavated diameter will be approximately 10.9 m, with the final internal diameter at this stage of the design of 9.80 m. The approximate length of the tunnel is 7.2 km |
| Headrace surge shaft | The upstream surge shaft will absorb sudden rises of pressure on top of the HRT extension. The shaft is characterised by a depth of about 250 m from ground level divided into surge shaft and lower surge raiser, and extends to about 13 m above surface level. | The upstream surge shaft will be constructed using blind sink methods. | The surge shaft will be characterised by an internal diameter of 25 m for the upper part (including at the surface) while the lower part will have an internal diameter of 9 m. |

## Table 4.1 Power waterway tunnels, chambers and shafts

| Tunnel | Location / purpose | Tunnelling/construction method | Size and length |
|---|---|---|---|
| Tailrace surge shaft and chamber | The shaft is characterised by a depth of about 140 m from ground level and does not surface. | This shaft will be excavated with a combination of blind sink method and raise boring.<br>Raise boring construction will be utilised initially, followed by conventional drill and blast practises to widen the shaft to the final diameter. | The tailrace surge shaft will be characterised by an internal diameter of 25 m. The surge shaft chamber is 30 m. |
| Single inclined pressure shaft | The inclined pressure shaft connects the headrace surge shaft to the underground power station. | The shaft will be excavated by utilising the TBM that excavates the MAT, by continuing past (east) the powerhouse complex and up to the upstream end of the high pressure tunnel manifolds | The inclined pressure shaft will be a tunnel of about 9.8 m completed diameter subject to finalised detailed design. |
| Penstock tunnels | Connects the machine hall with the manifold of the inclined pressure shaft | Drill and blast | Penstock tunnels will each be about 4 to 5 m in finished diameter. Penstock tunnels are steel lined. |
| Draft tubes | The draft tube tunnels will allow transfer of water exiting from the turbine through the draft tube valve gallery to the bifurcate connection with the collector tunnels (beneath the transformer hall). | Drill and blast | Draft tube tunnels will each be about 3 to 4 m in finished diameter. Draft tube tunnels are steel lined. |
| Collector tunnels | The collector tunnels will allow transfer of water exiting from the turbine through the draft tubes and the collector tunnel bifurcation and into the tailrace surge shaft. | Drill and blast | Collector tunnels will be about 5 to 6 m in finished diameter. Collector tunnels are steel lined and encased in concrete |

## 4.3 Power station complex

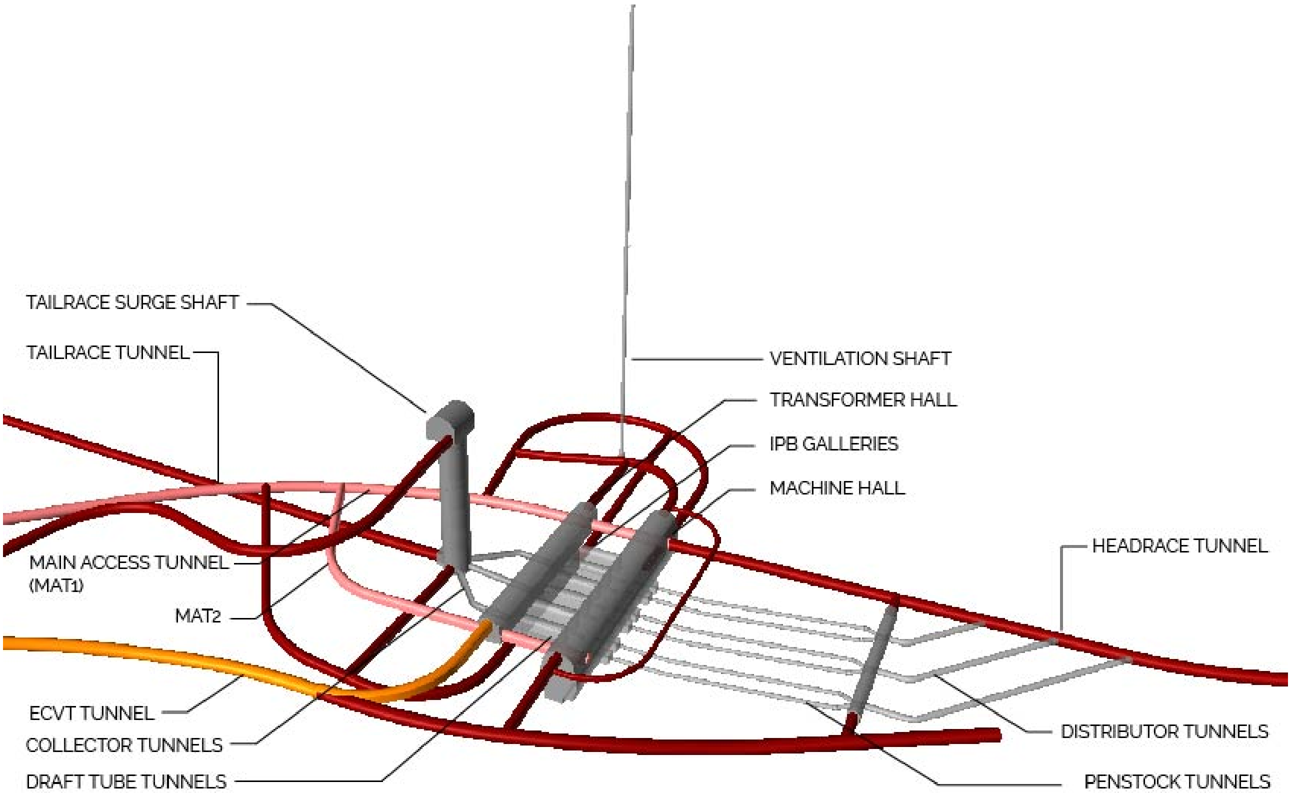
Central to the operation of Snowy 2.0 is the power station, at a site to be optimised as a result of the geotechnical investigations as set out in the Exploratory Works phase of development. While the location of the power station is to be the subject of further refinement as a result of the underground geotechnical drilling program (as described in the Exploratory Works EIS), the prelimineary design and main features of the power station are predominantly fixed.

The power station comprises two main caverns; the machine hall and the transformer hall. The machine hall will house six 340 MW pump-turbine generating units and associated plant facilities required for operating the power station. The transformer hall will house the power station’s six transformers, power transmission equipment and the draft tube valves. The two caverns will be connected through Isolated Phase Busduct (IPB) galleries, which contain electrical equipment needed between the generating units and transformers.

The cavern complex is underground between elevation 429 and elevation 480, and will be accessible from the MAT and from the ECVT (described in the next section). The construction methods for the key components of the underground power station are shown in Table 2.8. The drill and blast method has been considered most suitable for the deep underground excavation works involving short length and changing geometries.

### Table 4.2 Snowy 2.0 power station complex

| Component | Description / location | Construction method | Size |
|---|---|---|---|
| Machine hall | Houses the six turbines | Drill and blast | About 240 m long, 34 m wide and 55 m high |
| Transformer hall | Houses the six transformers | Drill and blast | About 204 m long, 20 m wide and 34 m high |
| IPB galleries | Houses electrical equipment between generating units and transformers | Drill and blast | About 50 m long, 10 m wide, and 16 m high |
| Ventilation shaft and air intake structure | From the power station to the surface. The shaft and air intake structure (at the surface) will provide air to the cavern during construction and operation of the power station. | Raise bore | About 4 m in diameter below surface and about 680m in height from the power station to the surface<br>Air intake structure at the surface is 7.5 m long, 7.5 m wide and about 6 m high |




### Figure 4.5 Powerhouse complex indicative layout (3D)

## 4.4 Power station MAT and the ECVT

Access tunnels are needed to provide efficient and safe access to permanent infrastructure. Access tunnels are considered to be permanent tunnels, which may also be used during construction of operational infrastructure. Access tunnels proposed for Snowy 2.0 Main Works are summarised in Table 4.3.

All access tunnels will have portals and surface infrastructure established to facilitate entry. Portal positions for the permanent tunnels have been defined based on the topography, geological environment and spatial dimensions of the tunnel. Tunnels requiring surface infrastructure (ie portals) are the MAT and ECVT (at the tailrace end) and the Marica Tunnel (at the headrace end).

The MAT is the Exploratory Works tunnel, refitted and redesigned, as required, to provide the permanent main entry to the underground power station, power waterway tunnels, chambers and shafts.

**Table 4.3 Permanent access tunnels**

| Access tunnel | Description | Construction method | Size and length |
|---|---|---|---|
| MAT | The MAT is the primary access conduit to the power station complex during operation. It is required for the transportation of the major mechanical and electrical equipment into the power station. As the MAT is constructed as part of Exploratory Works (the exploratory tunnel), only fit-out is required during Snowy 2.0 Main Works. | Drill and blast approximately first 300 m, and then TBM | 9.8 m diameter. Length of the tunnel is about 2.5 km. |
| ECVT | The ECVT provides a passage through which the high voltage cables connect to the cable yard at the surface for onward connection to the transmission network. It also provides a secondary point of access or egress in the event of an emergency, as well as a source of natural ventilation to the powerhouse complex.<br>The tunnel will be accessed through a portal near the MAT, along Mine Trail and will run alongside the MAT to the underground Power Station Complex | TBM For majority of the tunnel with drill and blast for the last section connecting the tunnel to the transformer hall | 9.8 m diameter. Length of the tunnel is about 2.4 km. |

## 4.5 Substations and power connection

One substation is required to provide permanent power to Snowy 2.0, at Lobs Hole. This substation will be built as part of Exploratory Works with a capacity of 80 MVA. It will continue to be used for Snowy 2.0 Main Works, however requires the establishment of further power supply cables to provide power to the work sites and TBM at Tantangara, as well as Talbingo, in particular to power the TBMs via the MAT, ECVT, Talbingo and Tantangara portals. The supporting high voltage cable route therefore follows access roads to these locations.

The cables will be either overhead or buried from Lobs Hole to Marica and then buried via trench to Tantangara, within existing or proposed access roads, generally along the same alignment as the communication system cable discussed below. The cable trenches will be cut using a trenching machine to the required depth and in some areas direct drilled (such as for crossing sensitive environments such as watercourses). Bedding sand will be laid, and the conduit placed. Trenches will be backfilled and compacted with the excavated material.

The Lobs Hole substation will become a permanent feature of Snowy 2.0, with power to be reticulated to the power station and other operational facilities at Lobs Hole including the Talbingo intake control buildings and gates.

## 4.6 Communication system

In addition to communications and construction power links established for exploratory works as shown on table (below) communications infrastructure will be established as part of the Snowy 2.0 Main Works and will connect infrastructure at Tantangara and Talbingo reservoirs to the existing communications system at the Tumut 3 power station (via the submarine communications cable in Talbingo Reservoir established during Exploratory Works) and to Snowy Hydro’s communications infrastructure at Cabramurra. This system will include optical fibre cables, and will serve all fixed construction communication needs, as well as providing the permanent communication supply. This will involve a buried conduit linking the Talbingo intake, the underground power station, headrace valve chamber, HRT surge shaft and Tantangara intake.

The cable will be buried in conduits within access roads, which involves excavating a trench, laying the conduits, pulling the cables through, and backfilling and restoring the surface. Where cables are to be laid in conduits beneath gravel roads. Communication pits will be required along the route to provide access for maintenance. Watercourse crossings will be carried out in a manner that minimises environmental impacts where possible, and may include:

- trenching of ephemeral creeks during dry periods only;
- temporary creek diversion and burying conduits below watercourse beds; or
- horizontal drilling or underbore methods, to minimise impacts to the watercourse and adjacent riparian zone.

Horizontal drilling methods will also be considered to minimise impacts to other sensitive areas where possible, as identified in the EIS.

# 5 Minor construction works

## 5.1 Access road construction and upgrades

### 5.1.1 Access roads

Where possible, road alignments have been designed to follow existing tracks as much as possible, however deviations are required in order to make the roads safe to accommodate the vehicle types and volumes expected for the duration of construction, and during permanent operations.

In general, all roads will require initial clearing and grubbing to provide the required width, as well as earthworks to create the desired final width of road and working base from which to construct the pavement. Indicative pavement types are shown in Figure 5.1.

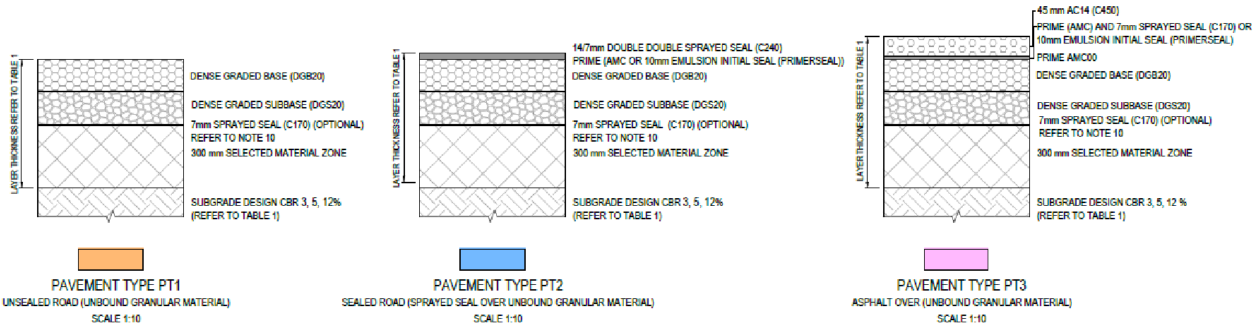



**Figure 5.1 Indicative pavement types**

The majority of constructed roads will remain as permanent infrastructure for the project. There will be a small number of temporary tracks constructed specifically to support construction which will be rehabilitated once no longer required. These include access tracks within construction areas such as those needed to connect batch plants with stockpiles areas.

### 5.1.2 Bridges

A reinforced concrete deck girder bridge will be built as part of Snowy 2.0 Main Works, which is on Tantangara Road over Nungar Creek.

Construction method is as follows:

- Use existing crossing for access to both sides of the bridge – new bridge to be built adjacent.
- Excavate embankments into the rock layer and prepare surface for abutments.
- Abutments to be cast-in-situ, then install scour protection.
- Girders will come in 12m lengths, spliced together on site and installed by crane.
- Cross bracing will be installed.

- Decking plates are then installed.
- Concrete deck is cast-in place on the decking plates.
- Barriers and railing installed.

## 5.2 Geotechnical investigation methods

### 5.2.1 Drilling

Drilling activities for geotechnical investigation and hydrogeology monitoring, including borehole establishment and in situ testing, will typically include the following:

- establishment of works and equipment storage areas, non-concurrent, including erosion and sediment controls, equipment storage and mobile ablution will be established. Each works and equipment storage areas (Figure 1 and Figure 2) will contain one borehole;
- drilling of boreholes using auger and rotary wash bore drilling techniques through soils and weathered rock followed by coring or rock hammering to a maximum depth of approximately 10 m;
- rock core drilling using triple tube diamond coring techniques to the nominated target depth;
- containment of excess drilling fluids and cuttings in re-circulation tanks, excess fluids will be stored in portable containers and disposed of to an NSW Environment Protection Authority (EPA) licenced facility;
- in situ permeability testing using water pressure tests;
- other downhole testing as required;
- clean water flushing of boreholes upon reaching target depths;
- downhole borehole survey using acoustic teleview cameras and instruments;
- survey of the as-built borehole location using GPS or suitable survey techniques;
- install of downhole monitoring instrument, for example vibrating wire piezometers and/or standpipes;
- grout of borehole upon completion of in-situ testing or downhole install;
- rectification of road surface back to previous, unsealed, compacted condition; and
- ongoing maintenance of the equipment and site as required.

A typical drill rig is shown in Photograph 5.1. A typical drill rig pad layout and cross section is shown in Figure 4.

**Photograph 5.1 Indicative drill rig**

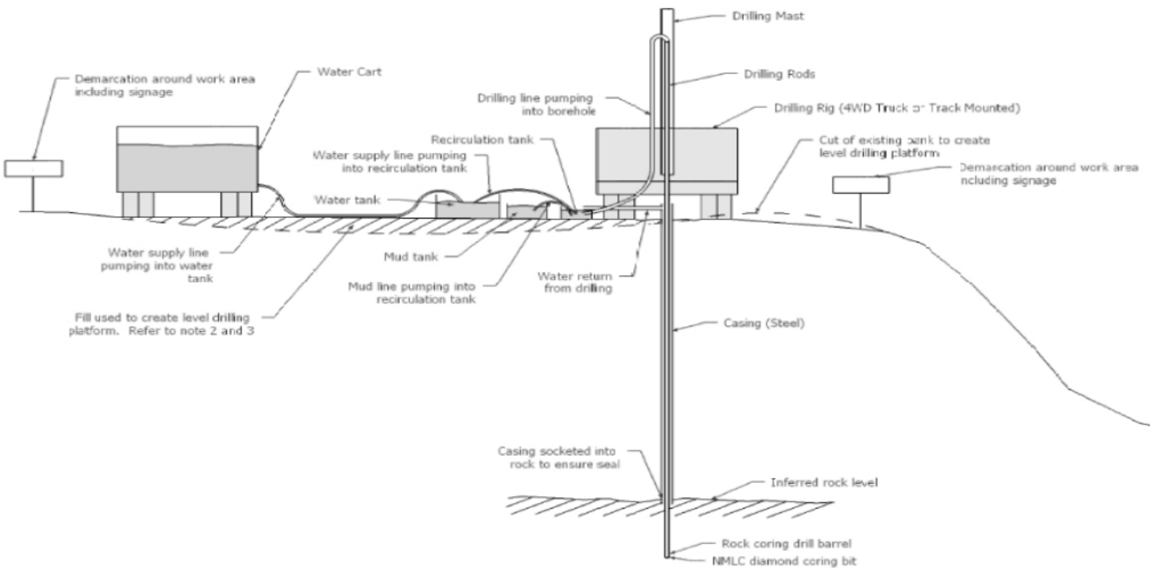



**Figure 5.2 Typical drill rig and pad cross-section**

### i Ancillary activities

Activities associated with shallow drilling activities include the daily mobilisation of site crew (drillers, geotechnical engineer etc) as well as delivery of materials as may be required. Removal of drill core logs (contained in light steel core trays), intermediate bulk containers (IBCs) and other equipment may also be undertaken as required on a daily basis. Deliveries and crew mobilisation will be serviced from works and equipment storage area and adjoined equipment storage area that will be established within the roadway in a linear arrangement.

Water supply infrastructure including pumps, tanks and overland piping may also be established within work and equipment storage areas.

The following types of materials would typically be delivered, stored and used during the geotechnical investigation program:

- drill rods, casing and equipment;
- IBCs which will be used to store excess drill fluids and cuttings will be stored and then transported from site prior to offsite disposal at an EPA licenced facility;
- light steel core trays to be used for storing rock core samples, once core trays are removed from site, they will be transported to an off-site storage facility;
- fuel supplies for the drilling rig and support equipment to be stored in areas on site;
- drilling water to be stored in IBC and transported to site using water truck or pumping from Main Works construction water supply;
- cement used to grout boreholes (to be stored in the equipment storage area, covered under tarpaulins or similar or in a container);
- a portable ablution able to be delivered and removed by a road vehicle; and
- other instruments to be installed downhole.

### ii Demobilisation and Road Reinstatement

Following successful completion of borehole drilling and in situ testing and sampling, the following borehole decommissioning activities would typically occur:

- decommissioning of all equipment and environmental controls from the boreholes and works and equipment storage area;
- grouting of boreholes and reinstatement of road surface; and
- visual inspection by work crew to ensure that no materials associated with the drilling activities have been left at the drill pads.

The site would be decommissioned and grouted at the completion of works and will not be required for ongoing monitoring purposes.

Following completion of all site activities, a visual inspection of the site by Snowy Hydro and NPWS personnel will be undertaken to ensure that the location of the drilling activities has been reinstated to an acceptable, pre-existing road quality.

### iii Proposed plant, equipment and materials

The plant and equipment for clearing, access track and drilling pad construction, site establishment and drilling activities will include the following:

- track mounted drill rig;
- light and medium 4x4 vehicles; and
- rigid truck for transport of equipment and materials.

Support vehicles including, light and medium 4x4 vehicles etc will be parked in-line with the work and equipment storage area. Helicopter lifting may also be used as required.

As the project involves geotechnical drilling and investigations, materials required for the work will be re-used from site to site, including casing, rods and environmental controls.

Other materials such as cement used for grouting will be brought to site as required or temporarily stored on the site prior to use.

Other materials are expected to include environmental controls such as silt fencing, stakes and geo-fabric products used to mitigate sedimentation and dirty water issues. Flagging, bunting or similar to mark out no go zones will also be used as required.

### iv Drilling resources, timing and hours of operation

Typical shallow geotechnical drilling, mobilisation and demobilisation would take approximately 1 – 2 weeks subject to weather. Drilling is generally proposed to be undertaken during daytime hours only, however for certain deep geotechnical investigation holes, particularly those in the Marica area, 24 hour drilling operations will be required. Approximately four site staff will be involved in drilling activities at each drill site.

# 6 Excavated rock placement in reservoirs

The information within this chapter has been provided by Future Generation Joint Venture to describe the preferred method of placing excavated rock materials within Talbingo and Tantangara reservoirs.

## 6.1 Talbingo Reservoir

### 6.1.1 Description of rock placement / construction methods

Placement of excavated rock in Ravine Bay (known as Ravine Bay Placement) involves placement of materials within Talbingo reservoir from an edge based placement approach. This involves placement of material from the shoreline into the Talbingo Reservoir by conventional earth-moving plant, such as dumping trucks and excavators, and installing a rock armour layer formed by large size excavated rock on excavated rock emplacement slope. The final emplacement area will be established at least one metre above FSL to allow for long term rehabilitation of the area. Landforming of this final area will be undertaken to ensure natural drainage features are maintained and that the final landform ties into the existing natural landform.

### 6.1.2 Description of how the works be staged

Placement of excavated rock in Talbingo Reservoir will be carried out in stages when surplus quantity of excavated rock from construction activities becomes available. The proposed construction staging can be illustrated in Figures 6.1 and 6.2 below.

The footprints of excavated rock emplacement versus time are determined from the quantity of excavated rock available for placement during construction. The summary of the excavated rock volume versus time in determining the footprints of the excavated rock emplacement is shown in the following table. These are estimates of excavated material and will be finalised once detailed design is complete.

**Table 6.1 Estimated excavated rock volume for construction staging at Talbingo**

| Material type | 6 months | 12 months | 18 months | 24 months | Total $bm^3$ |
|---|---|---|---|---|---|
| TBM | 561,129 | 202,407 | 377,323 | 192,152 | 1,333,370 |
| Drill and blast | 332,024 | 516,565 | 425,447 | 253,390 | 1,527,425 |
| | | | | **Total** | **2,860,796** |

The indicative development of emplacement area footprints versus time is shown in attached Figure 6.3. Upon the completion of excavated rock disposal, the footprint and typical section of the excavated rock emplacement area are shown in attached Figure 6.4.

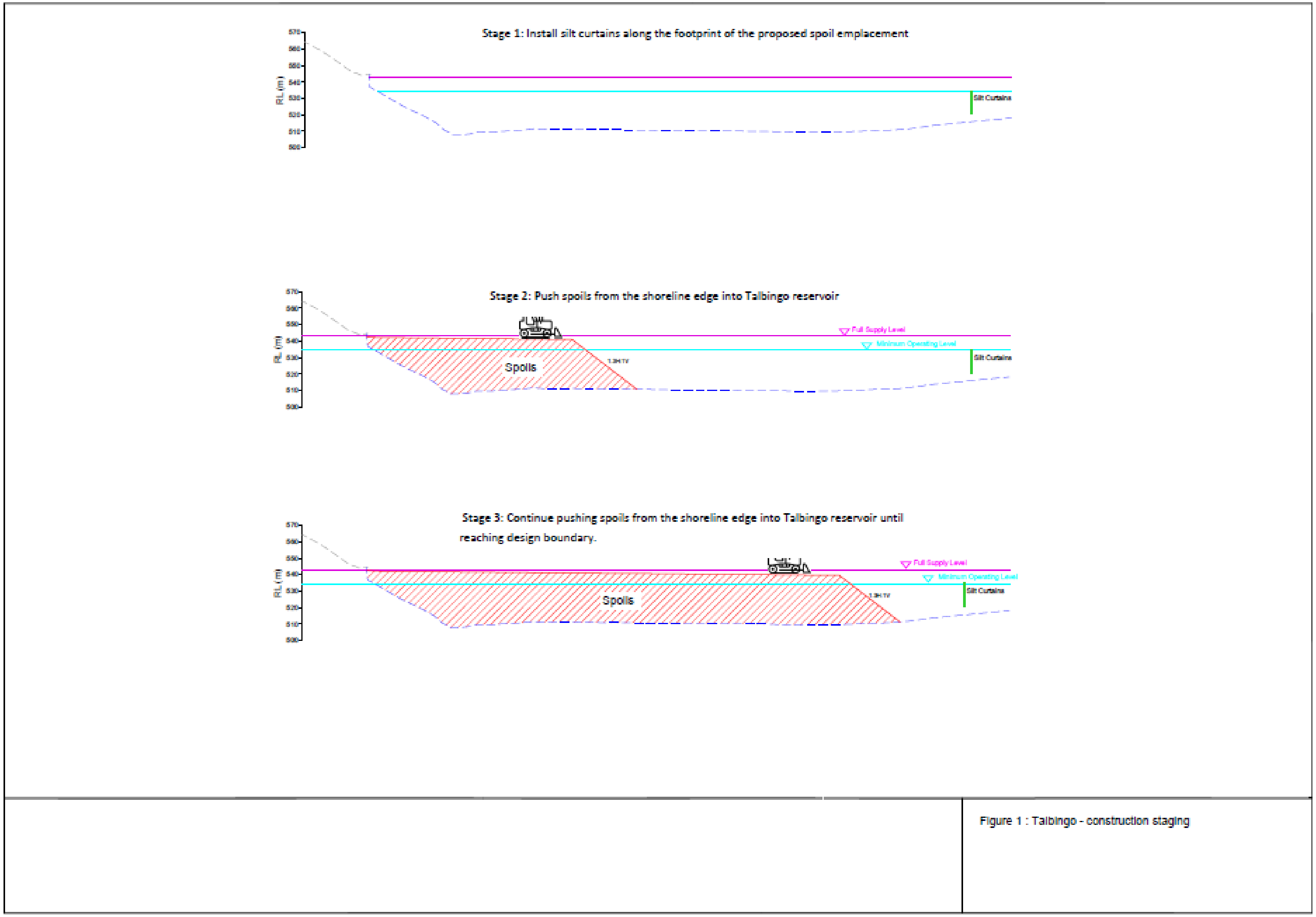



**Figure 6.1 Ravine Bay placement staging**

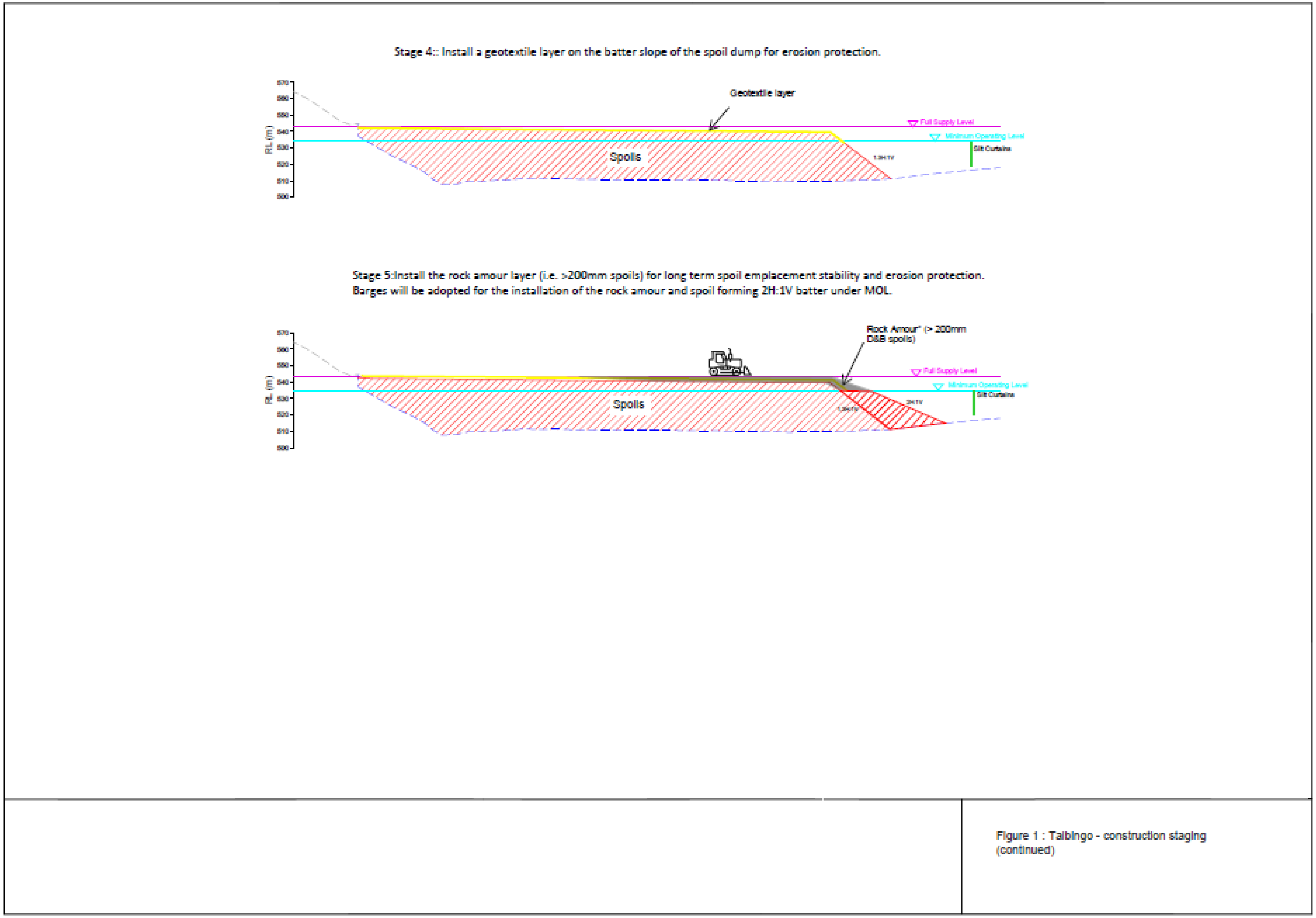
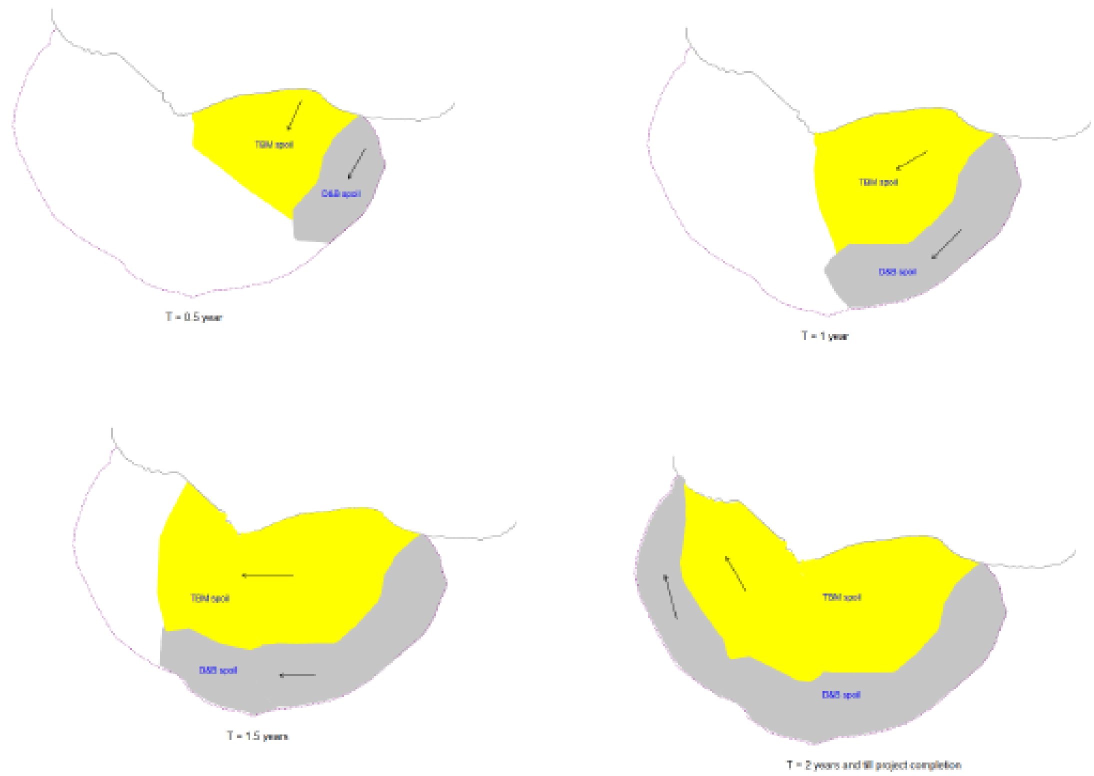



**Figure 6.2 Ravine Bay placement staging (continued)**




| Spoil vol. (Bank volume, $m^3$) for construction staging at Talbingo | | | | | |
|---|---|---|---|---|---|
| Incremental vol. | 0.5 year | 1yr | 1.5yr | 2yrs | subtotal |
| TBM spoils | 561,129 | 202,407 | 377,323 | 192,512 | 1,333,370 |
| D&B spoils | 332,024 | 516,565 | 425,447 | 253,390 | 1,527,425 |
| | | | | | 2,860,796 |

Figure 2:

Indicative development of Talbingo spoil emplacement footprints versus time

**Figure 6.3 Indicative development of Ravine Bay placement footprints staging**

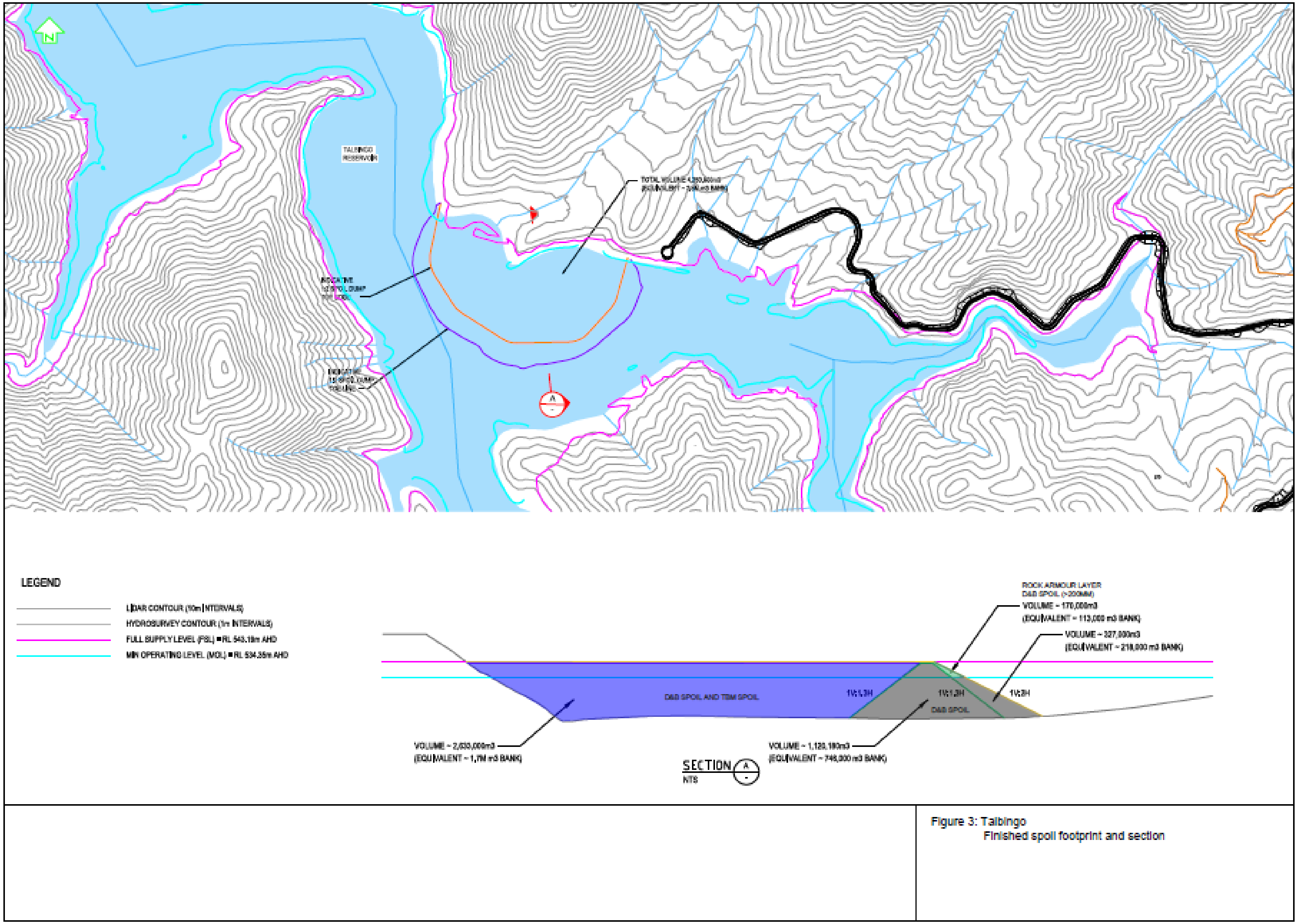



**Figure 6.4** **Ravine Bay placement footprint and section**

### 6.1.3 Breakdown of the material to be placed

The source and total volume of excavated rock to be placed in Talbingo Reservoir are presented in the Tables 6.2 and 6.3 below. At this stage of the design, a total volume (bank volume) of 4,974,784 $m^3$ excavated rock will be generated near Talbingo Reservoir from construction activities, among which approximately half will be reused for construction of marine infrastructure, temporary and permanent portals, pads, and access roads, and the other half of excavated rock will be placed in Talbingo Reservoir before rehabilitation work.

**Table 6.2 Source of excavated rock materials**

| Type | Area | Cut ($m^3$) | Fill ($bm^3$) | Net ($bm^3$) |
|---|---|---|---|---|
| Camp | Exploratory Works Lob Hole Camp | 104,558 | 23,153 | 81,405 |
| Camp | Main Works Lobs Hole Camp | 217,264 | 124,253 | 93,011 |
| Intakes | Talbingo intake | 635,000 | - | 635,000 |
| Intakes | Talbingo plug (underwater) | 50,500 | - | 50,500 |
| Intakes | Talbingo plug (above water level) | 50,500 | 112,000 | -61,500 |
| Site | Main Yard (Construction work site) | 155,500 | 1,293,000 | -1,138,000 |
| Portal | MAT portal | 121,000 | 300,500 | -179,550 |
| Portal | ECVT portal | 166,816 | 22,248 | 144,568 |
| Portal | Talbingo portal | 189,300 | 25,090 | 164,210 |
| Roads | Snowy 2.0 Main Works roads | 697,921 | 680,685 | 17,237 |
| *Subtotal* | - | *2,388,359* | *2,581,479* | *-193,120* |
| Tunnelling drill and blast | MAT01 – Exploratory Works | 40,697 | | 40,697 |
| Tunnelling TBM | MAT01 – Main Works | 238,057 | | 238,057 |
| Tunnelling drill and blast | MAT02 – drill and blast | 25,118 | | 25,118 |
| Tunnelling TBM | ECVT – TBM | 282,624 | | 282,624 |
| Tunnelling drill and blast | ECVT – drill and blast | 18,180 | | 18,180 |
| Tunnelling drill and blast | Tail race tunnel TRT01 – drill and blast | 77,155 | | 77,155 |
| Tunnelling TBM | Tail race tunnel TRT01 – TBM | 501,780 | | 501,780 |
| Tunnelling drill and blast | Tail race tunnel adit – TRT02 – drill and blast | 82,411 | | 82,411 |
| Tunnelling drill and blast | Tail race tunnel adit – TRT03 – drill and blast | 29,212 | | 29,212 |
| Tunnelling drill and blast | Underground – chambers, adits, etc | 943,056 | | 943,056 |
| Tunnelling drill and blast | Inclined shaft and HRT (partial) | 348,207 | | 348,207 |
| *Subtotal* | | *2,586,425* | | *2,586,425* |
| **Total materials** | | **4,974,784** | | **2,393,306** |

Upon the completion of the major construction activities, a total volume of 440,906 $m^3$ excavated rock placed in ground will be removed and placed into Talbingo Reservoir as per the Ravine Bay placement method and/or permanent on-land placement with landforming and rehabilitation. The volume of 2,140,573 $m^3$ excavated rock will remain permanently in ground, which include 1,000,000 $m^3$ qualified quantity of excavated rock and 1,140,573 $m^3$ as part of permanent structures, such as roads, permanent pads, and rock armour for rehabilitation work.

**Table 6.3 Excavated rock materials breakdown for placement**

| Item | Volume ($bm^3$) |
|---|---|
| Total excavated rock materials generated | 4,974,784 |
| Reuse or permanent pads (road, armour, permanent backfills, gabions etc) | 1,140,573 |
| Excavated rock materials to remain at Lobs Hole and shaped and landformed | 1,000,000 |
| **Total excavated rock material generated for placement** | **2,834,212** |

In summary, as shown in Table 6.3 after leaving a volume of 2,140,573 $m^3$ excavated rock in ground forming permanent structures, a volume of 2,834,212 $m^3$ of spoils will be placed in Talbingo Reservoir.

At this stage of the project, little information is available on the properties of excavated rock that will be generated from construction. Based on the current construction planning and published results from other projects that employed similar construction methods in rocks, a set of particle size distribution (PSD) of excavated rock has been proposed in assisting the assessment of excavated rock management for the EIS study. The breakdown volume of excavated rock to be placed in Talbingo Reservoir is shown in Table 6.4 below. It is considered that excavated rock (> 200mm) used for rock armour can be obtained during construction.

**Table 6.4 Volumes of different sizes of excavated materials for Talbingo Reservoir ($bm^3$)**

| Size | Drill and blast | | TBM | | Total | |
|---|---|---|---|---|---|---|
| | Percentage | Volume | Percentage | Volume | Percentage | Volume |
| > 200 mm | 40% | 585,417 | - | - | 21% | 585,417 |
| < 200 mm | 60% | 878,126 | 100% | 1,370,668 | 79% | 2,248,794 |
| **Total** | **100%** | **1,463,543** | **100%** | **1,370,668** | **100%** | **2,834,211** |

## 6.1.4 Indicative construction schedule

In terms of excavated rock generation Figure 6.5 represents the net quantity per month, considered as the delta between total cut and total fill in the Talbingo management system.

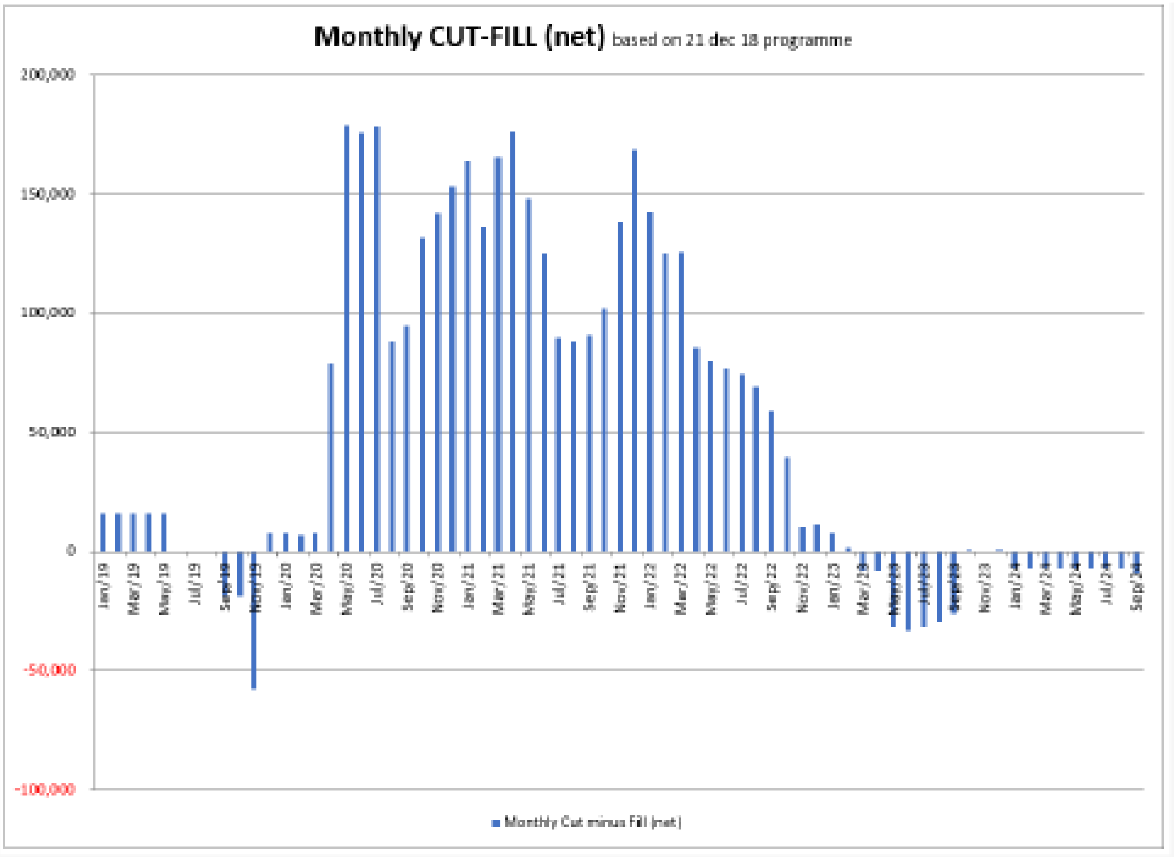



**Figure 6.5 Monthly cut and fill (net)**

## 6.1.5 Design measures to minimise impacts

### i Optimisation of spoil emplacement slope batter

Slope stability assessment has been carried out to determine optimal excavated rock emplacement slope batter for placement. A commercially available computer software, Geostudio 2016, was adopted in the analyses with the following assumptions:

- excavated rock properties
  - unit weight ( $\gamma$ ) = 18 kN/m$^3$
  - cohesion (c) = 0 kPa
  - friction angle = 38$_0$
- Talbingo Reservoir bed is impenetrable, ie slip surfaces will not pass through the reservoir bed.
- Reservoir water impact is not considered.
- Design surface of 20 kPa is considered.
- Minimum factor of safety (FOS) for short term slope stability during construction = 1.0.

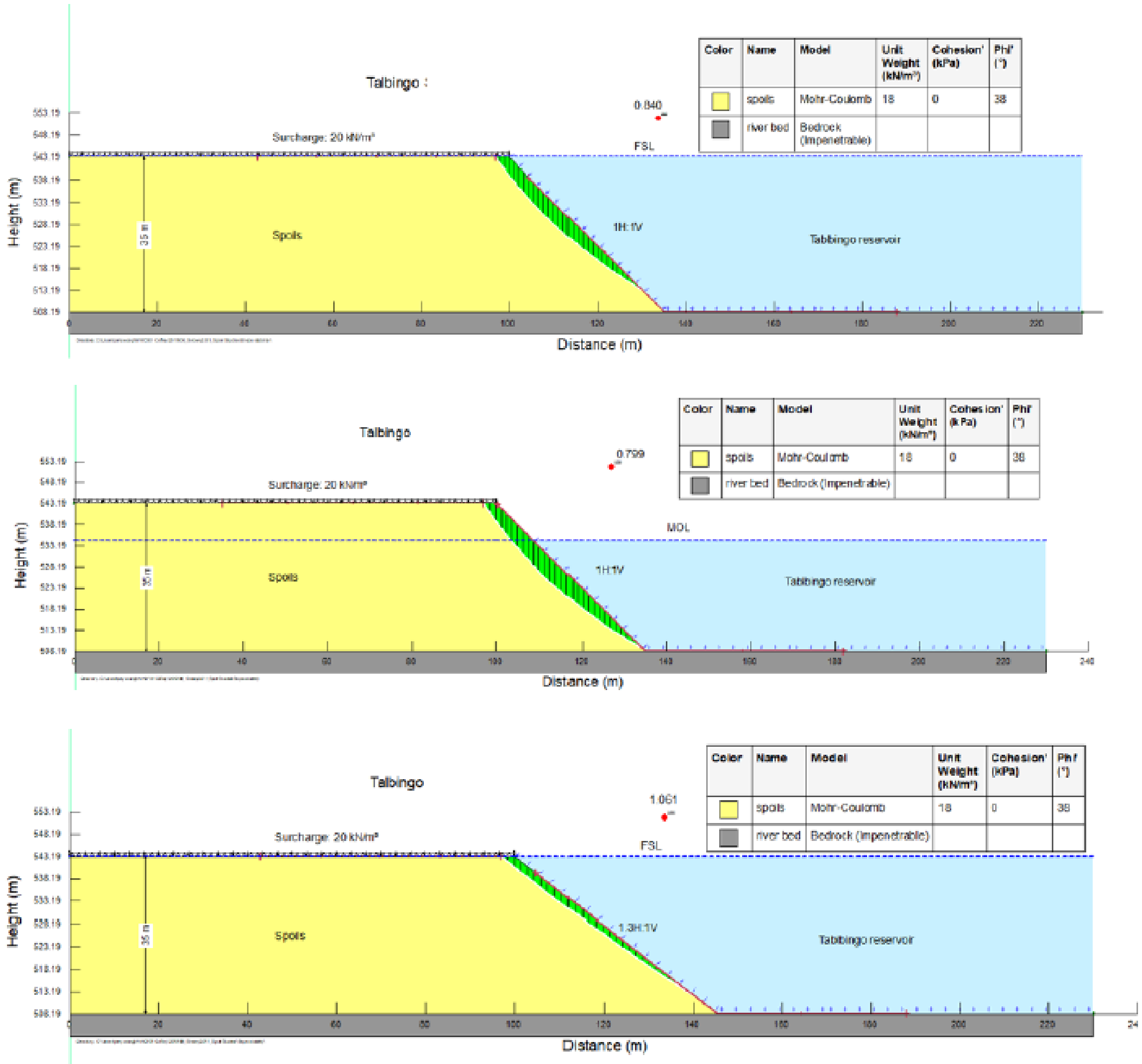
- Minimum FOS for long term slope stability = 1.5.
- Highest water level = RL 543.19 m AHD (Full supply level).
- Lowest water level = RL 534. 35 m AHD (Minimum operating level).

Table 6.5 below summarises the slope stability assessment results. It indicates that a temporary excavated rock emplacement with a minimum slope batter of 1.3H:1V will likely be formed through Ravine Bay Placement into Talbingo Reservoir. To achieve the long term stability for a permanent excavated rock emplacement, a minimum slope batter of 2H:1V will be required.

### Table 6.5 Minimum factor of safety for Ravine Bay placement

| Slope batter | Talbingo Reservoir water level | | Notes |
|---|---|---|---|
| | Full supply level | Minimum operating level | |
| 1H: 1V | 0.84 | 0.8 | - |
| 1.3H: 1V | 1.06 | 1.01 | Factor of safety >1, temporary slope batter during Ravine Bay placement |
| 2H: 2V | 1.589 | 1.487 | Factor of safety >1.5, permanent slope batter after completion |

The outputs in the above table are provided in Figures 6.6 and 6.7 below.




## Figure 6.6 Slope stability assessments

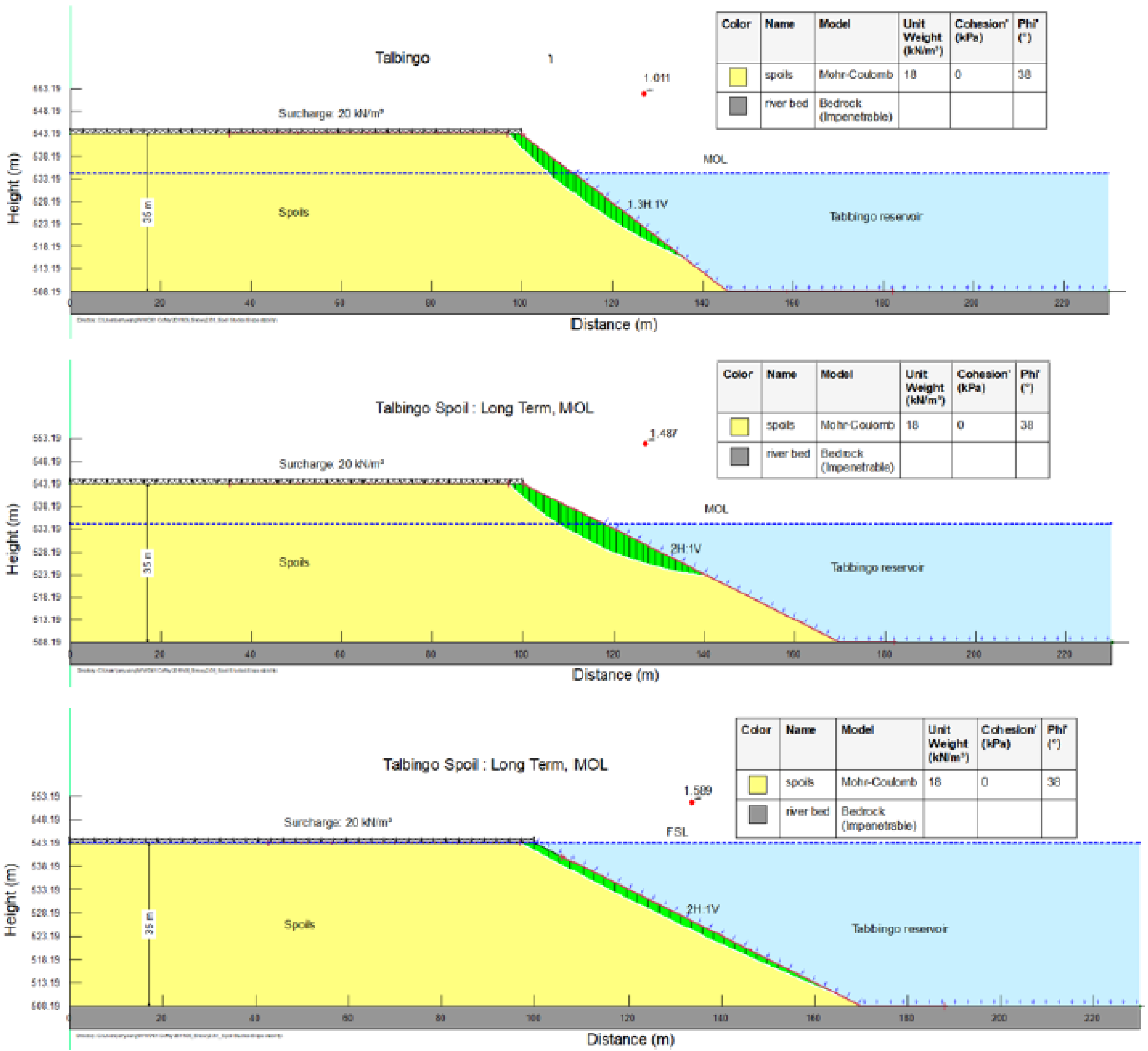



**Figure 6.7 Slope stability assessment (continued)**

### ii Installation of geotextile for fine contents protection

To reduce the potential of fine content loss related to the fluctuation of Talbingo water levels during operation, a geotextile layer of BIDIM A40 or equivalent may be installed on the excavated rock emplacement slope surfaces.

### iii Installation of rock armour for slope surface protection

A nominal 1m thick rock armour layer above MOL will be installed for the protection of excavated rock emplacement slope surface. The rock armour consists of spoil greater than 200 mm, which is to be obtained by screening D&B materials on site. The rock armour so defined will be installed along the shore exposed from MOL to FSL. The area below MOL is considered as rock armour but will be composed of mixed D&B material since it's required for long term stability of the slope's purposes only. To achieve a factor of safety equivalent to 1.5 the slope has to be 2H:1V.

### 6.1.6 Management measures

As discussed previously, a nominal 1 m thick rock armour above MOL will be installed for the protection of excavated rock emplacement slope surface. The rock armour will consist of suitable materials which is most likely to be obtained from D&B excavated rock.

To reduce the potential environment impact related to excavated rock placement in Talbingo Reservoir, silt curtains will be installed around the footprint of the excavated rock emplacement. Single Class 3, XR5 heavy duty premium Silt Curtains are suitable for medium risk applications with moderate wind and/or water forces such as rivers and calm harbours, and therefore are proposed for the project.

## 6.2 Tantangara Reservoir

### 6.2.1 Description of rock placement / construction methods

Placement of spoils in Tantangara involves staged spoil placement in active storage areas of Tantangara reservoir by conventional earth-moving plant, such as dumping trucks and excavators.

### 6.2.2 Description of how the works be staged

Placement of excavated rock in Tantangara Reservoir will be carried out in stages from the boundary of FSL towards the active storage areas of the reservoir. To minimise the disturbed areas and unprotected excavated rock emplacement slope surface, staged containment spoil cells are planned. The indicative construction staging is shown in attached Figure 6.8. The finished footprint and section of the excavated rock emplacement are shown in attached Figure 2 and Figure 3.

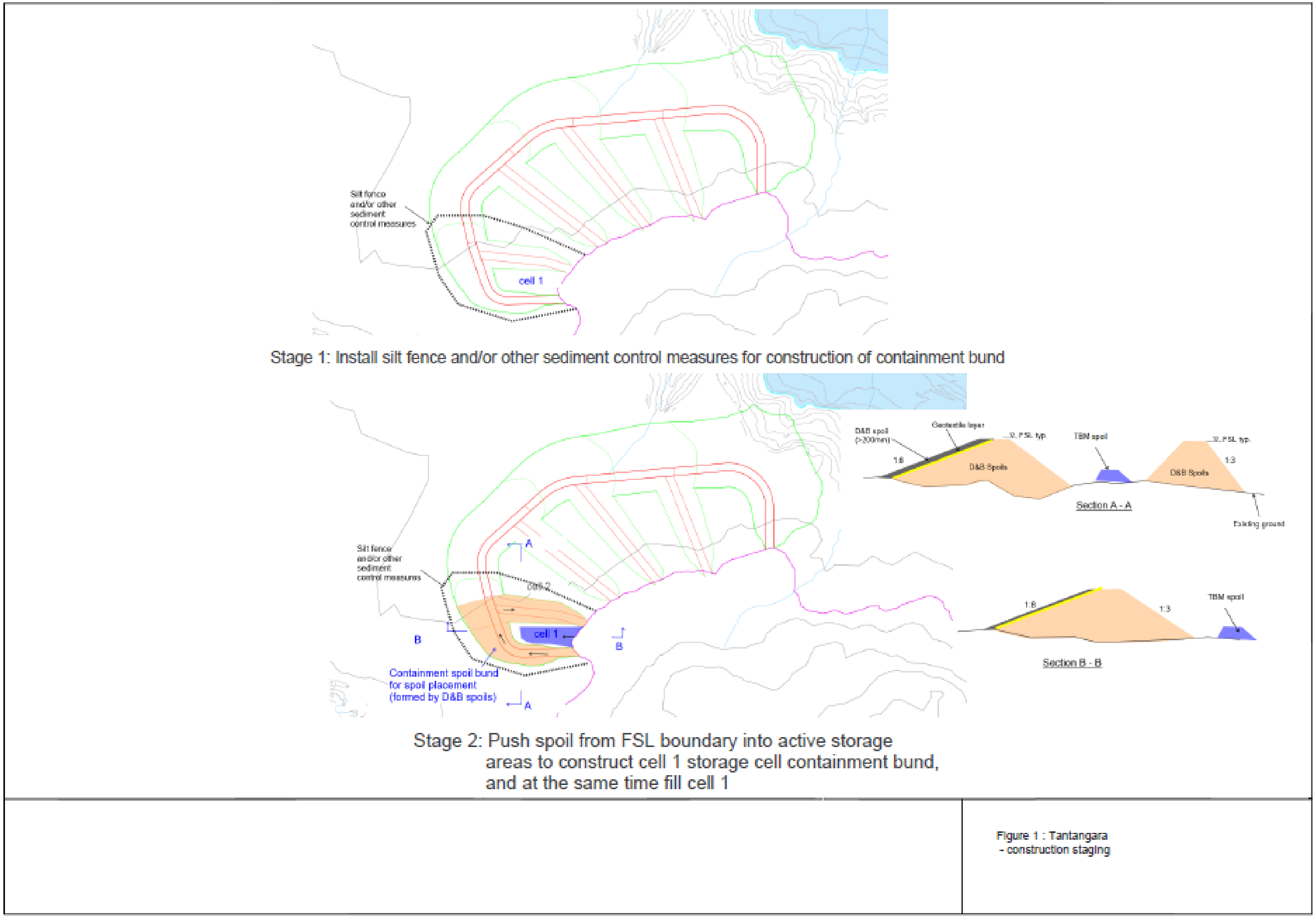
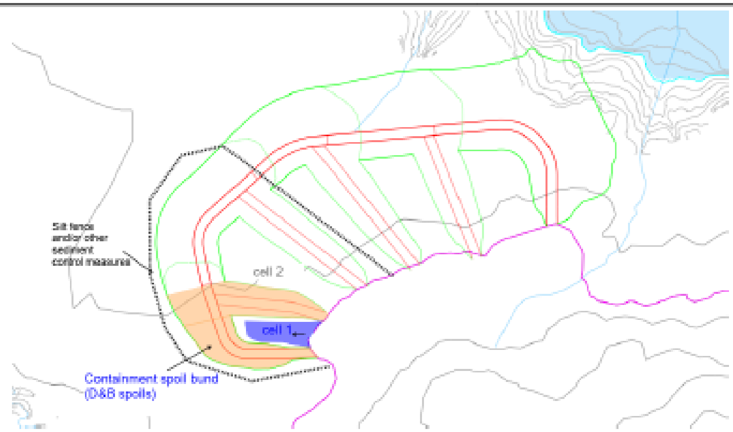
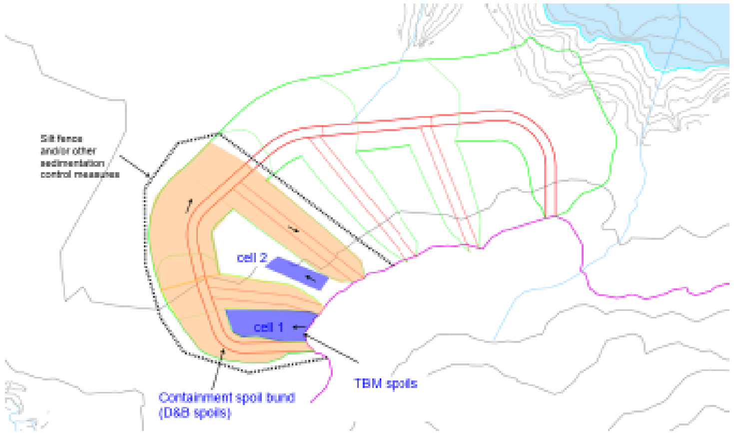



**Figure 6.8 Tantangara Reservoir placement staging – Stages 1 and 2**



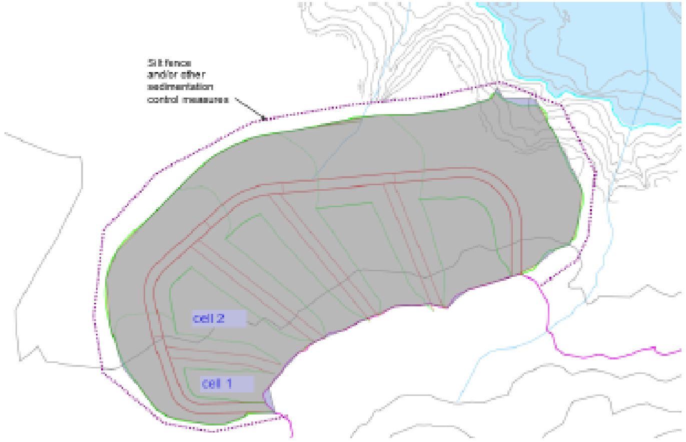

Stage 3: Continue pushing spoil into cell1, and install silt fence for construction of cell 2 spoil bund




Stage 4: Continue pushing spoil to fill cell 1;
construct cell 2 spoil containment bund for placement

Figure 1 : Tantangara - construction staging
(continued)

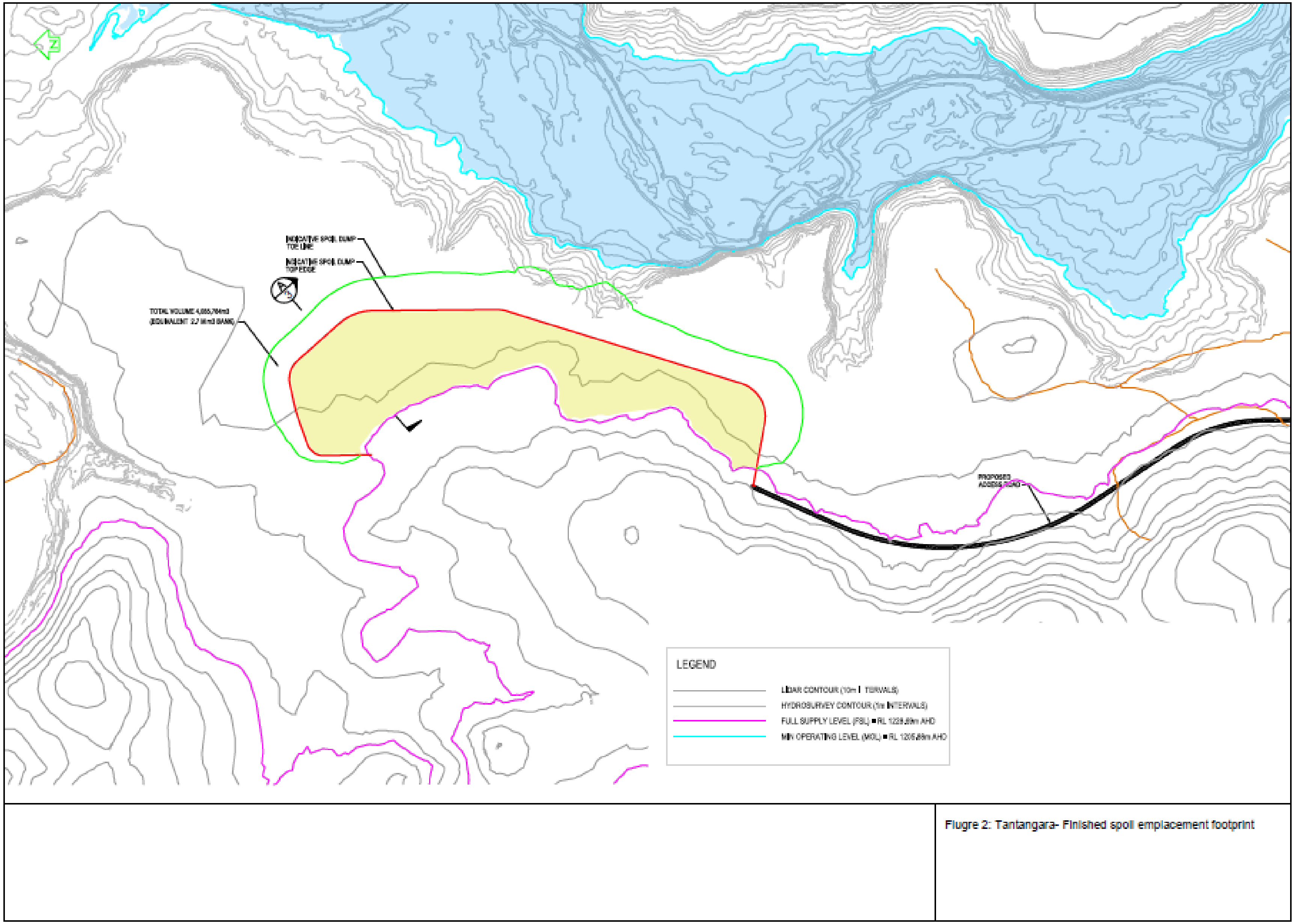
**Figure 6.9 Tantangara Reservoir placement staging – Stages 3 and 4**




Stage 5: Repeat the same construction staging until completion

Figure 1 : Tantangara - construction staging
(continued)

**Figure 6.10 Tantangara Reservoir placement staging – Stage 5**




## Figure 6.11 Tantangara Reservoir emplacement area footprint

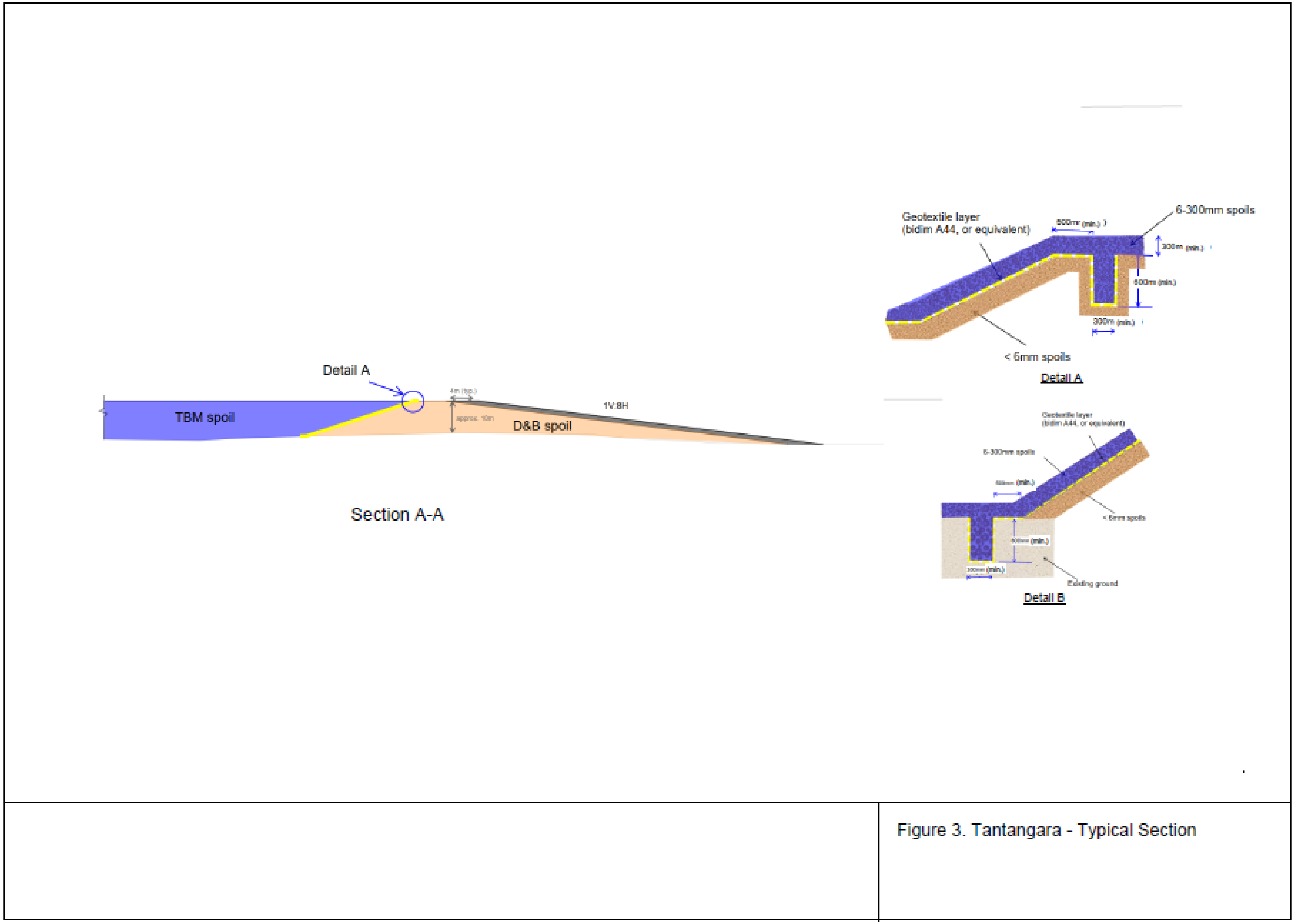



**Figure 6.12 Tantangara Reservoir emplacement area – typical section**

### 6.2.3 Breakdown of the material to be placed in the emplacements

The source and total volume of excavated rock to be placed in Tantangara Reservoir are presented in Table 6.6 below. A total volume (bank volume) of 3,267,230 $m^3$ spoils will be generated near Tantangara reservoir from construction activities, among which a volume of 764,338 $m^3$ of excavated rock will be reused to facilitate the construction, such as construction of marine infrastructure, temporary and permanent portals, pads, and access roads, and a net volume of 2,502,892 $m^3$ of excavated rock will be placed in Tantangara Reservoir before rehabilitation work.

**Table 6.6 Sources of excavated rock for Tantangara Reservoir placement**

| Element | Source | Cut ($bm^3$) | Fill ($bm^3$) | Net ($bm^3$) |
|---|---|---|---|---|
| Camp | Tantangara camp | 15,276 | 71,647 | -56,371 |
| Portal | Tantangara portal | 138,291 | 44,450 | 93,841 |
| Intakes | Tantangara intake | 627,635 | - | 627,635 |
| Intakes | Tantangara plug (above water level) | 514,265 | 353,800 | 160,465 |
| Intakes | Tantangara plug (underwater) | 170,000 | - | 170,000 |
| Roads | All Snowy 2.0 Main Works roads/trails in Marica and Plateau area | 247,877 | 249,469 | -1,592 |
| Roads | Sub-base fill | - | 44,972 | -44,972 |
| Marica | | 360,189 | 178,501 | 181,688 |
| Subtotal | | 2,073,533 | 942,839 | 1,130,694 |
| Tunnelling – TBM | HRT Adit – Tantangara Portal to ch 1392 | 112,377 | - | 112,377 |
| Tunnelling – TBM | HRT – ch 1392 to ch 15400 | 1,353,613 | - | 1,353,613 |
| Tunnelling – drill and blast | HRT – Intake to ch 1392 | 87,896 | - | 87,896 |
| Subtotal | | 1,553,886 | - | 1,553,886 |
| Total | | 3,627,419 | 942,839 | 2,684,580 |

Upon the completion of the major construction activities, as shown in Table 6.7, a total volume of 2,140,573 $m^3$ excavated rock will remain permanently in ground as part of permanent structures, such as roads, permanent pads, and rock armour for rehabilitation work. A total volume of 116,097 m3 excavated rock placed in ground will be removed and placed into Tantangara Reservoir as per the discussed placement method and/or permanent on-land placement with landforming and rehabilitation.

**Table 6.7 Excavated rock breakdown for placement**

| Item | Volume ($bm^3$) |
|---|---|
| Total excavated rock materials generated | 3,627,419 |
| Reuse or permanent pads (road, armour, permanent backfills, gabions etc) | 826,742 |
| **Total excavated rock material generated for placement** | **2,800,677** |

In summary, the total volume of 2,800,677 m$^3$ excavated rock will be placed in Tantangara Reservoir.

At this stage of the project, little information is available on the properties of excavated rock that will be generated from construction. Based on the current construction planning and published results from other projects that employed similar construction methods in rocks, a set of PSD of spoil has been proposed in assisting the assessment of excavated rock management for the EIS. The breakdown volume of excavated rock to be placed in Tantangara Reservoir is shown in the table below.

**Table 6.8 Volumes of different sizes of excavated materials for Tantangara Reservoir (bm$^3$)**

| Size | Drill and blast | | TBM | | Total | |
|---|---|---|---|---|---|---|
| | Percentage | Volume | Percentage | Volume | Percentage | Volume |
| > 200 mm | 40% | 543,667 | - | - | 18% | 543,667 |
| < 200 mm | 60% | 815,500 | 100% | 1,441,509 | 82% | 2,257,009 |
| **Total** | **100%** | **1,359,168** | **100%** | **1,441,509** | **100%** | **2,800,677** |

### 6.2.4 Design measures to minimize impacts

#### i Staged placement of spoil during construction

To minimize the disturbed areas and unprotected spoil emplacement slope surface, staged containment excavated rock cells are planned. The indicative construction staging is shown in attached Figure 1.

#### ii Installation of geotextile layer for fine contents protection

To reduce the potential of fine content loss related to the fluctuation of Tantangara Reservoir water levels during operation, a geotextile layer of BIDIM A40 or equivalent is suggested to be installed on the excavated rock emplacement slope surfaces.

#### iii Installation of rock armour for slope surface protection

A nominal 1 m thick rock armour layer will be installed for the protection of excavated rock emplacement slope surface. constructed with D&B.

### 6.2.5 Management measures

#### i Design measures

A nominal 1 m thick rock armour layer will be installed for the protection of the emplacement slope surface constructed with D&B.

To reduce visual impact, a slope batter of 8H:1V is proposed for emplacement in Tantangara Reservoir. A nominal bench width of 3 m is proposed for every 5 m high excavated rock emplacement. This is provided to minimise the velocity of runoff on the emplacement slope surface.

To reduce the potential of fine content loss related to the fluctuation of Tantangara Reservoir water levels during operation, a geotextile layer of BIDIM A40 or equivalent is suggested to be installed on the emplacement slope surfaces. The geotextile layer is to be installed as early as practicable during placement.

This will facilitate the placement of rock armour layer on the slope surface to reduce the loss and erosion of excavated rock related to runoff during construction.

#### ii Erosion and sediment controls

Temporary diversion drains around the footprint of the proposed excavated rock emplacement will be installed during construction. The drains will catch runoff from working areas. The runoff will be collected and managed in a temporary sediment control pond and reused on site where possible or a series of other best practice erosion and sediment control devices which would be determined during detailed design and construction on a PESCP prepared by a suitably qualified and experienced erosion and sediment control professional.

Silt fences and other active sediment measures, such as temporary diversion drains, will be implemented around the footprint of the excavated rock placement cell during construction. To minimise the loss of excavated rock due to runoff, the excavated emplacement slope batters will be covered by larger size of excavated rock (> 200 mm) as early as practicable.

The works will be undertaken in accordance with a progressive erosion and sediment control plan (PESCP) prepared by an appropriate qualified and experienced soil conservation professional. If water levels in Tantangara Reservoir are to incidentally rise in the reservoir, silt curtains would also be deployed around the works areas.

#### iii Flooding

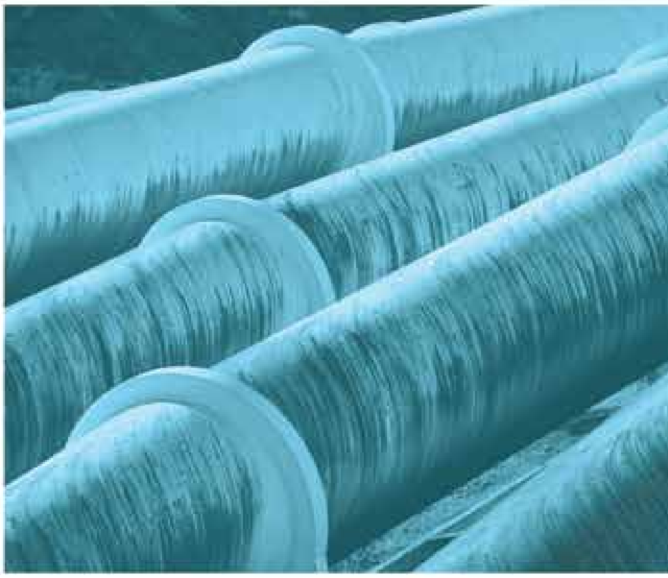
A temporary flood protection levee, enclosed by silt fences, can be installed close to the boundary of the proposed excavated rock emplacement. Detailed design of the levee will be carried out in the next stage of design.

#### iv Trigger Action Response Plan

A TARP will be developed as part of the CEMP water management plans and subject to further detailed design and will consider:

- the normal reservoir water level during construction and that it will be at MOL.
- the risk level of +- 7m MOL due to natural floods. Future Generation Joint Venture will ensure controls and designs avoid this lower level.

Daily controls such as temporarily covering the surface of the spoil emplacement under construction by geotextile would be investigated followed by other site-specific controls identified in the PESCP's.



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