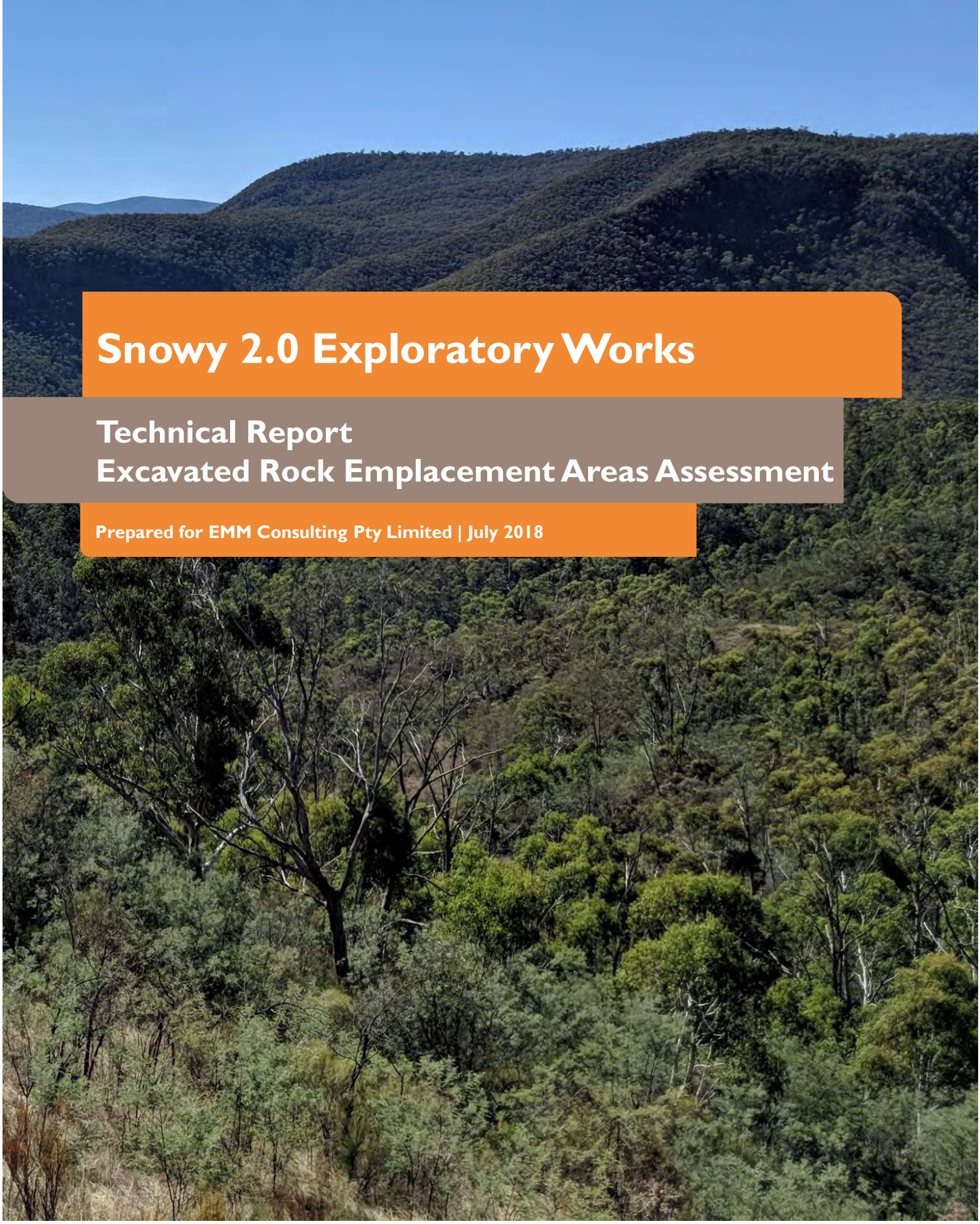
APPENDIX K

EXCAVATED ROCK EMPLACEMENT AREAS ASSESSMENT



Snowy 2.0 Exploratory Works

Technical Report
Excavated Rock Emplacement Areas Assessment

Prepared for EMM Consulting Pty Limited | July 2018

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Snowy 2.0 Exploratory Works

Technical Report

Excavated Rock Emplacement Areas Assessment

Prepared for EMM Consulting Pty Limited | 6 July 2018

Project number:	18013
Document title:	Snowy 2.0 Exploratory Works | Technical Report | Excavated Rock Emplacement Areas Assessment
Revision:	V1-1
Date:	6 July 2018
Client:	EMM Consulting Pty Limited
Project manager:	T Rohde
Author:	T Rohde

SGM environmental Pty Limited
T 0488 111 722
E admin@sgmenvironmental.com
W www.sgmenvironmental.com

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Document history and status

Revision	Date	Description	By	Review	Approved
V0-1	17 April 2018	Draft	T Rohde	EMM	T Rohde
V1-1	5 June 2018	Draft	T Rohde	EMM	T Rohde
V2-1	6 July 2017	Final	T Rohde	-	T Rohde

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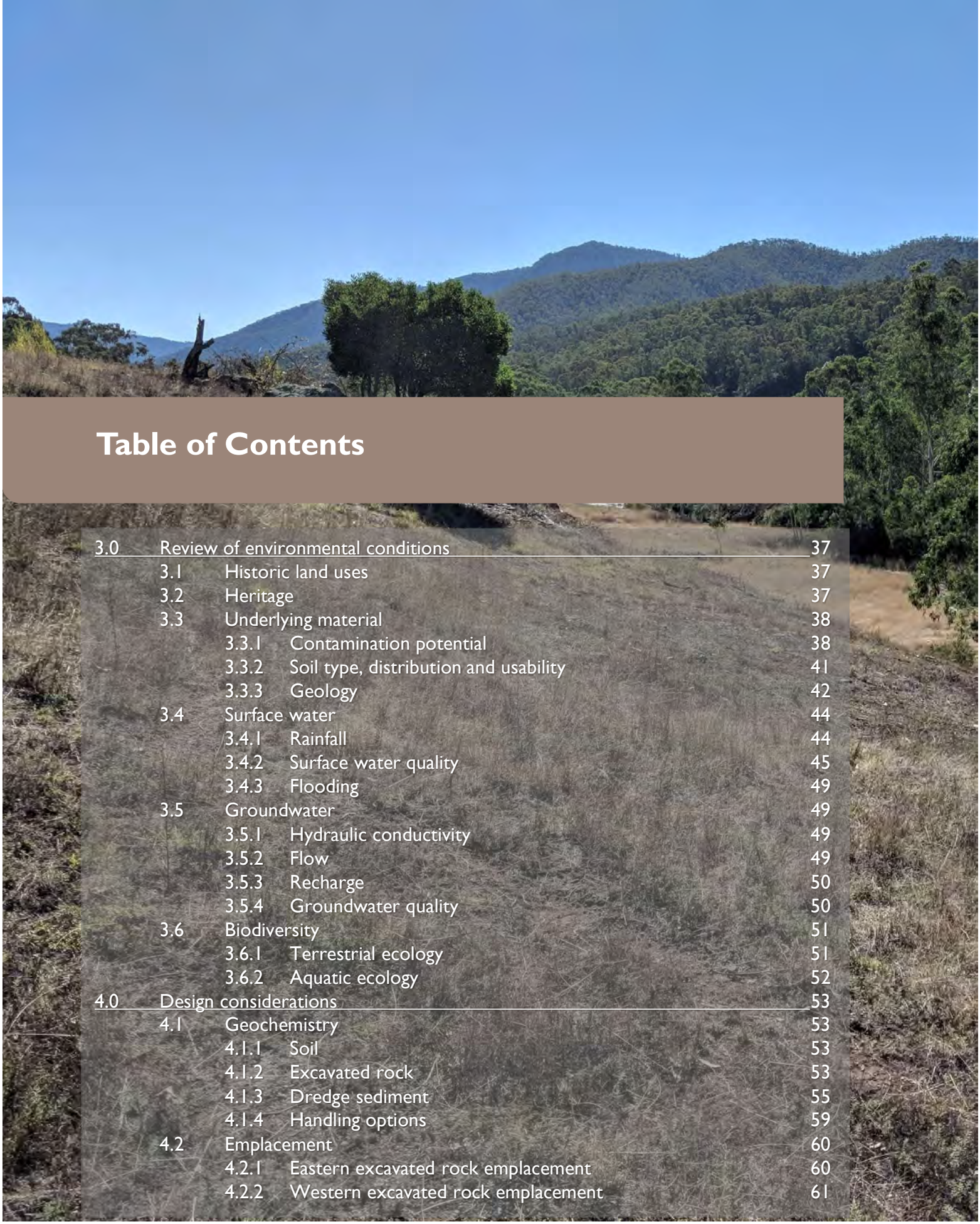

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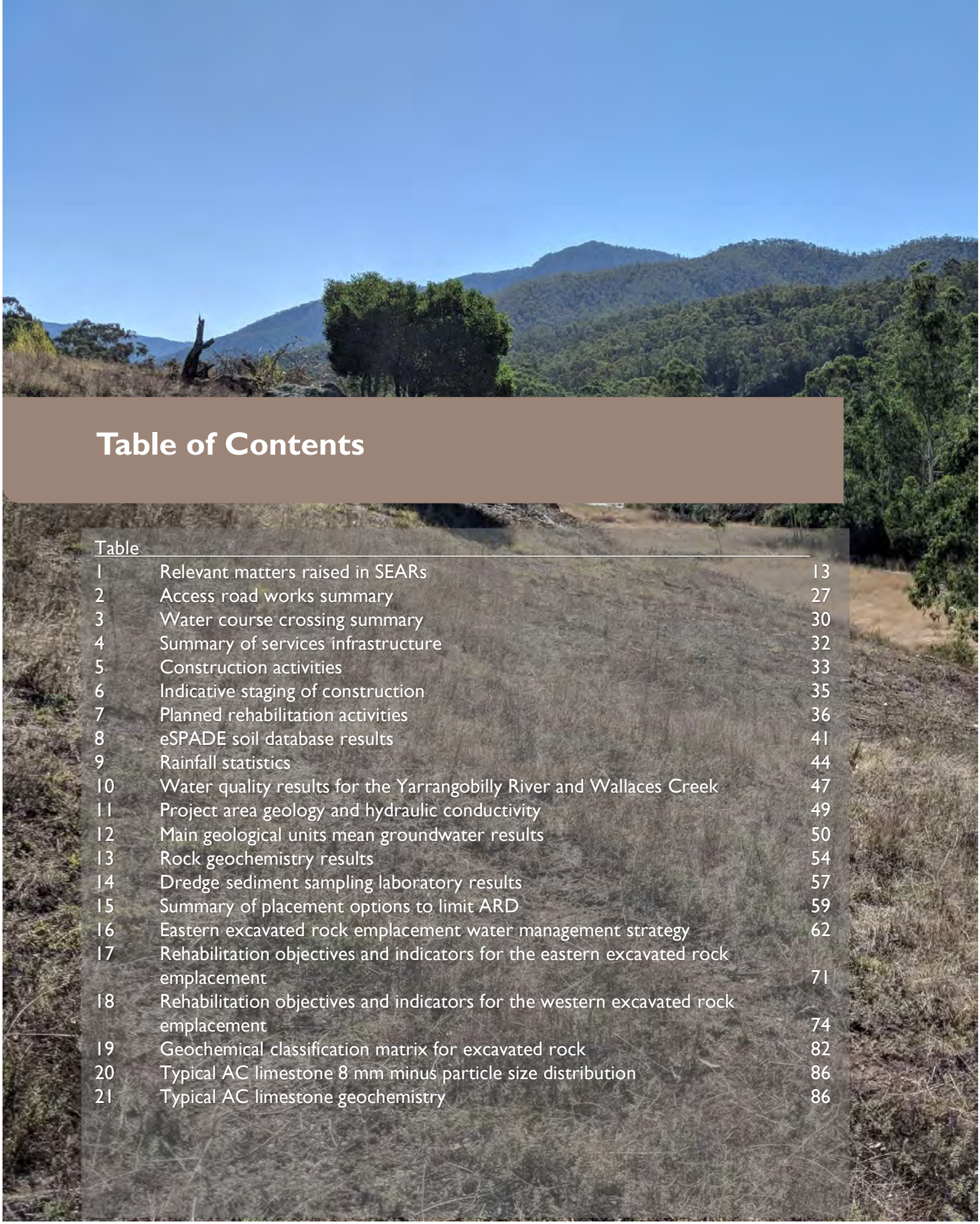

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Important note about your report

The sole purpose of this report and the associated services performed by SGM environmental Pty Limited (SGME) is to prepare an evaluation of environmental risk and conceptual design for two excavated rock emplacement areas (the conceptual design) in accordance with the scope of services set out in the contract between SGME and EMM Consulting Pty Limited (EMM). That scope of services, as described in this report, was developed with the Client.

In preparing this report, SGME has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by EMM and/or from other sources or third parties. Except as otherwise stated in the report, SGME has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

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SGME has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

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Executive summary

It is estimated that up to 750,000 cubic metres (m^3) of rock and soil (the material) will be excavated, mostly from the exploratory tunnel and construction pad with additional quantities from road upgrade works. These materials will be placed in one of two excavated rock emplacement areas at Lobs Hole.

The proposed eastern excavated rock emplacement has a capacity of up to 600,000 m^3 of excavated rock. It will be approximately 25 m maximum depth and will be benched down to the northern edge of the emplacement which maintains a 50 metres (m) exclusion zone from the Yarrangobilly River.

The proposed western excavated rock emplacement area will be used to store excavated rock should it not be able to be placed within the eastern excavated rock emplacement area. It is envisaged this excavated rock emplacement area will be used to store excavated material suitable for re-use within the construction of Exploratory Works (the project area) or for use by NSW parks and Wildlife Services (NPWS) in Kosciuszko National Park (KNP) maintenance activities. All remaining material placed in this excavated rock emplacement area will be removed following the completion of Exploratory Works.

Consultation with NPWS throughout the design process has identified an opportunity for the proposed eastern excavated rock emplacement area to form a permanent landform that enables greater recreational use of Lobs Hole following the completion of the projects construction. This is however subject to being able to design a landform that is safe, stable, sustainable and non-polluting.

Eastern excavated rock emplacement

Lobs Hole has a long history of European settlement including the operation of the Lobs Hole Mine. Remnants of the mine remain, and the design of the eastern excavated rock emplacement has avoided the disturbance of a locally significant heritage site. Further, the design of the eastern excavated rock emplacement includes the addition of acid consuming (AC) limestone at the base and in intermittent layers throughout the eastern excavated rock emplacement to treat potential acid rock drainage (ARD) from the Lobs Hole Mine and from the eastern excavated rock emplacement.

Other potential risks from the excavated material may include spontaneous combustion and asbestiform fibres; however, the assessment presented within this report has shown the risks to be very low. Notwithstanding, the proposed construction technique, of building the eastern excavated rock emplacement in 1 m lifts, will disrupt the ingress of oxygen and infiltration and will further reduce the potential for spontaneous combustion and ARD.

Dredge sediment will also be delivered to the eastern excavated rock emplacement and while the assessment has shown that some metals are concentrated, they are expected to remain insoluble. Notwithstanding, the dredge sediment must be placed away from the batter slopes to limit the future potential for elevated nutrient loads in the Yarrangobilly River.

The eastern excavated rock emplacement will require surface water management to protect the receiving environment. The proposed water management design for the eastern excavated rock emplacement promotes infiltration of runoff from Lick Hole Gully. The water management strategy avoids the need to establish a permanent flow diversion of Lick Hole Gully and drop structures or rock chutes to move runoff from the flat top to the toe of the eastern excavated rock emplacement. Infiltrated water will percolate along the base of the eastern excavated rock emplacement, through an AC limestone pad and seep from the northern end toe, into the existing Lick Hole Gully before flowing into the Yarrangobilly River.

A high flow diversion drain will also be established at the top of the eastern rock emplacement to divert excess runoff from Lick Hole Gully around the eastern excavated rock emplacement during flood events or extended periods of wet weather.

Other water management structures for the eastern excavated rock emplacement include benches. Benches will be graded back towards the eastern excavated rock emplacement and bunded so that any runoff from direct

rainfall onto the benches and upslope lift will pond against the toe of the above lift forming plant available water. As a result, no surface runoff from the benches is expected to occur.

Western excavated rock emplacement

The western excavated rock emplacement is temporary and will be completely removed and the underlying land rehabilitated at the end of construction. The western excavated rock emplacement will be used to store material that has a low geochemical risk. The landform will be built in a manner that limits compaction and will be soiled and vegetated to stabilise the landform.

The western excavated rock emplacement does not require diversions or drop drains. However, the western excavated rock emplacement will be designed to prevent the risk of being entrained in flood waters during a 0.2% annual exceedance probability (AEP) event. This will be achieved by a flood protection berm or rock armouring along the northern toe.

Subaqueous placement

A trial program for the placement of excavated material within Talbingo Reservoir also forms part of Exploratory Works. The program will be implemented in an appropriate section of Talbingo Reservoir in accordance with a detailed management plan based on an engineering method informed through the materials' geochemistry and reservoir's characteristics. The purpose of the program is to confirm the suitability of the emplacement method for future excavated material from the construction of the project, should it proceed.

All placement within the reservoir would occur within silt curtains and would be subject to a detailed monitoring regime including survey monitoring of pre-placement and post-placement bathymetry, water quality monitoring during placement, and monitoring of aquatic ecology and the recolonisation of benthic species and fish species to the placement area following the placement program. The management, mitigation and monitoring measures would be refined following the ongoing investigations.

Subject to a positive result the trial may be extended to include potentially acid forming (PAF) material. Pending the results of the trial the eastern excavated rock emplacement may be greatly reduced in size or not be required at all.

1.0 Introduction

1.1 The project

Snowy Hydro Limited (Snowy Hydro) proposes to develop Snowy 2.0, a large scale pumped hydro-electric storage and generation project which would increase hydro-electric capacity within the existing Snowy Mountains Hydro-electric Scheme (Snowy Scheme). This would be achieved by establishing a new underground hydro-electric power station that would increase the generation capacity of the Snowy Scheme by almost 50%, providing an additional 2,000 megawatts (MW) generating capacity, and providing approximately 350,000 megawatt hours (MWh) of storage available to the National Electricity Market (NEM) at any one time, which is critical to ensuring system security as Australia transitions to a decarbonised NEM. Snowy 2.0 will link the existing Tantangara and Talbingo reservoirs within the Snowy Scheme through a series of underground tunnels and hydro-electric power station.

Snowy 2.0 has been declared to be State significant infrastructure and critical State significant infrastructure (CSSI) by the NSW Minister for Planning under the provisions of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and is defined in Clause 9 of Schedule 5 of the *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP). Separate applications and environmental impact statements (EIS) for different phases of Snowy 2.0 are being submitted under Part 5, Division 5.2 of the EP&A Act. This technical assessment has been prepared to support an EIS for Exploratory Works to undertake investigative works to gather important technical and environmental information for the main Snowy 2.0 project. The main project will be subject of a separate application and EIS next year.

The purpose of Exploratory Works for Snowy 2.0 is primarily to gain a greater understanding of the conditions at the proposed location of the power station, approximately 850 metres (m) below ground level. Understanding factors such as rock conditions (such as stress conditions) and ground temperature is essential to inform decisions about the precise location of the power station cavern and confirm the cavern construction methods.

Exploratory Works comprises:

- an exploratory tunnel to the site of the underground power station for Snowy 2.0;
- horizontal and other test drilling, investigations and analysis in situ at the proposed cavern location and associated areas, and around the portal construction pad, access roads and excavated rock management areas all within the disturbance footprint;
- a portal construction pad for the exploratory tunnel;
- an accommodation camp for the Exploratory Works construction workforce;
- road works and upgrades providing access and haulage routes during Exploratory Works;
- barge access infrastructure, to enable access and transport by barge on Talbingo reservoir;
- excavated rock management, including subaqueous placement within Talbingo Reservoir;
- services infrastructure such as diesel-generated power, water and communications; and
- post-construction revegetation and rehabilitation, management and monitoring.

1.2 Purpose of the report

This excavated rock emplacement area assessment supports the EIS for the Exploratory Works. It documents the excavated rock emplacement area assessment methods and results, the initiatives built into the project design to avoid and minimise associated impacts, and the mitigation and management measures proposed to address any residual impacts not able to be avoided.

1.3 Location of Exploratory Works

Snowy 2.0 and Exploratory Works are within the Australian Alps, in southern NSW. The regional location of Exploratory Works is shown on Figure 1.1. Snowy 2.0 is within both the Snowy Valleys and Snowy Monaro Regional local government areas (LGAs), however Exploratory Works is entirely within the Snowy Valleys LGA. The majority of Snowy 2.0 and Exploratory Works are within Kosciuszko National Park (KNP). The area in which Exploratory Works will be undertaken is referred to herein as the project area, and includes all of the surface and subsurface elements further discussed in Section 2.1.

Exploratory Works is predominantly in the Ravine region of the KNP. This region is between Talbingo Reservoir to the north-west and the Snowy Mountains Highway to the east, which connects Adaminaby and Cooma in the south-east to Talbingo and Tumut to the north-west of the KNP. Talbingo Reservoir is an existing reservoir that forms part of the Snowy Scheme. The reservoir, approximately 50 kilometres (km) north-west of Adaminaby and approximately 30 km east-north-east of Tumbarumba, is popular for recreational activities such as boating, fishing, water skiing and canoeing.

The nearest large towns to Exploratory Works are Cooma and Tumut. Cooma is approximately one hour and forty five minutes drive (95 km) south-east of Lobs Hole. Tumut is approximately half an hour (45 km) north of Talbingo. There are several communities and townships near the project area including Talbingo, Tumbarumba, Batlow, Cabramurra and Adaminaby. Talbingo and Cabramurra were built for the original Snowy Scheme workers and their families. Adaminaby was relocated to alongside the Snowy Mountains Highway from its original location (now known as Old Adaminaby) in 1957 due to the construction of Lake Eucumbene. Talbingo and Adaminaby provide a base for users of the Selwyn Snow Resort in winter. Cabramurra was modernised and rebuilt in the early 1970s and is owned and operated by Snowy Hydro. It is still used to accommodate Snowy Scheme employees and contractors. Properties within Talbingo are now predominantly privately owned. Snowy Hydro now only owns 21 properties within the town.

Other attractions and places of interest in the vicinity of the project area include Selwyn Snow Resort, the Yarrangobilly Caves complex and Kiandra. Kiandra has special significance as the first place in Australia where recreational skiing was undertaken and is also an old gold rush town.

The project area is shown on Figure 1.2 and comprises:

- **Lobs Hole:** Lobs Hole will accommodate the excavated rock emplacement areas, an accommodation camp as well as associated infrastructure, roads and laydown areas close to the portal of the exploratory tunnel and portal construction pad at a site east of the Yarrangobilly River;
- **Talbingo Reservoir:** installation of barge access infrastructure near the existing Talbingo Spillway, at the northern end of the Talbingo Reservoir, and also at Middle Bay, at the southern end of the reservoir, near the Lobs Hole facilities, and installation of a submarine cable from the Tumut 3 power station to Middle Bay, providing communications to the portal construction pad and accommodation camp. A program of subaqueous rock placement is also proposed;
- **Mine Trail Road** will be upgraded and extended to allow the transport of excavated rock from the exploratory tunnel to sites at Lobs Hole that will be used to manage excavated material, as well as for the transport of machinery and construction equipment and for the use of general construction traffic; and
- several sections of **Lobs Hole Ravine Road** will be upgraded in a manner that protects the identified environmental constraints present near the current alignment.

The project is described in more detail in Chapter 2.

1.4 Proponent

Snowy Hydro is the proponent for Exploratory Works. Snowy Hydro is an integrated energy business — generating energy, providing price risk management products for wholesale customers and delivering energy to

homes and businesses. Snowy Hydro is the fourth largest energy retailer in the NEM and is Australia's leading provider of peak renewable energy.

1.5 Assessment guidelines and requirements

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

The SEARs must be addressed in the EIS. Table 1 lists the matters relevant to this assessment and where they are addressed in this report.

Table 1 Relevant matters raised in SEARs

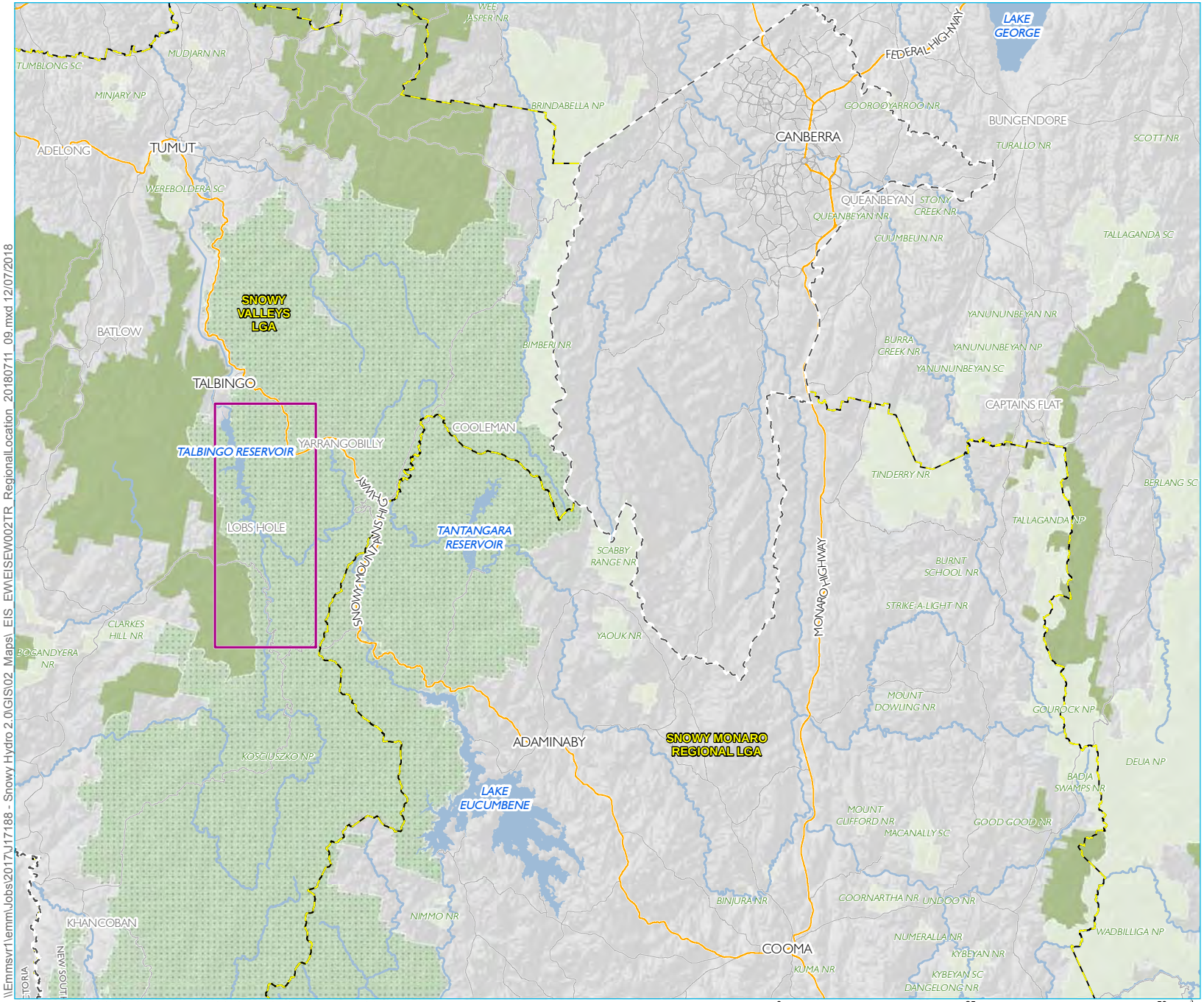
Requirement	Section addressed
Land – including: • An assessment of the compatibility of the risk of soil contamination based on the predicted geochemistry of the excavated rock.	This report provides information on the management of excavated material, including re-use, temporary storage and permanent emplacement within Lobs Hole.

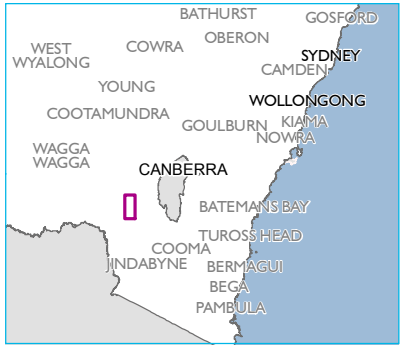
To inform preparation of the SEARs, the Department of Planning and Environment (DPE) invited relevant government agencies to advise on matters to be addressed in the EIS. These matters were considered by the Secretary for DPE when preparing the SEARs.

1.5.1 Other relevant reports

This excavated rock emplacement areas assessment has been prepared with reference to other technical reports that were prepared as part of the Exploratory Works EIS. The other relevant reports referenced in this excavated rock area assessment are listed below:

- *Aboriginal Cultural Heritage Assessment* (NSW Archaeology 2018) — Appendix O of the EIS;
- *Aquatic Ecology Assessment* (Cardno 2018) — Appendix G of the EIS;
- *Barge Access Infrastructure* (RHDHV 2018) — Appendix L of the EIS;
- *Biodiversity Development Assessment* (EMM 2018a) — Appendix F of the EIS;
- *Dredging and Dredging Impact Assessment* (RHDHV 2018) — Appendix C of the EIS;
- *Groundwater Assessment* (EMM 2018b) — Appendix N of the EIS;
- *Historic Cultural Heritage Assessment* (NSW Archaeology 2018) — Appendix P of the EIS;
- *Phase 1 Contamination Assessment* (EMM 2018c) — Appendix J of the EIS;
- *Rehabilitation Strategy* (SMEC 2018) — Appendix E of the EIS;
- *Soils and Land Assessment* (EMM 2018d) — Appendix H of the EIS;
- *Subaqueous Excavated Rock Placement Assessment* (RHDHV 2018) — Appendix D of the Barge acces infrastructure (Appendix L of the EIS);
- *Surface Water Assessment* (EMM 2018e) — Appendix M of the EIS; and
- *Traffic and Transport Assessment Report* (SCT 2018) — Appendix Q of the EIS.





KEY

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

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

Regional location of Snowy 2.0 and Exploratory Works

Snowy 2.0
WRD design
Exploratory Works
Figure 1

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

0 2.5 5 km

N

GDA 1994 MGA Zone 55

Exploratory Works project area

KEY

- Exploratory tunnel
- Access road upgrade
- Access road extension
- Communications cable
- Main road
- Local road
- Major watercourse
- On land rock management
- Subaqueous excavated rock placement
- Disturbance footprint
- Avoidance footprint

Snowy 2.0
WRD design
Exploratory Works
Figure 2

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2.0 Project description

2.1 Overview

Exploratory Works comprises construction associated with geotechnical exploration for the underground power station for Snowy 2.0. The Exploratory Works elements are shown on Figure 2.1 and involve:

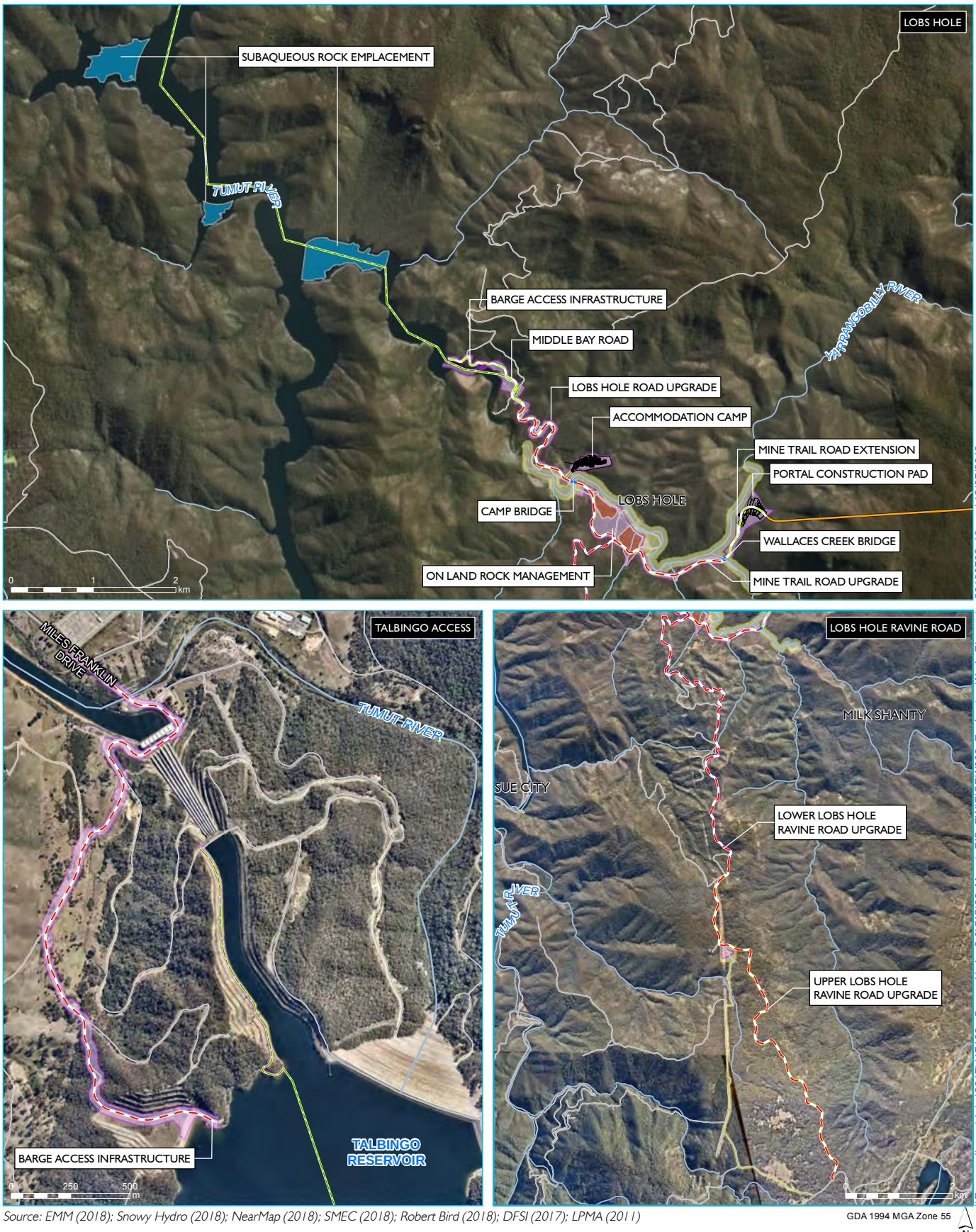
- establishment of an exploratory tunnel to the site of the underground power station for Snowy 2.0;
- horizontal and other test drilling, investigations and analysis in situ at the proposed cavern location and associated areas, and around the portal construction pad, access roads and excavated rock management areas all within the disturbance footprint;
- establishment of a portal construction pad for the exploratory tunnel;
- establishment of an accommodation camp for the Exploratory Works construction workforce;
- road works and upgrades providing access and haulage routes during Exploratory Works;
- establishment of barge access infrastructure, to enable access and transport by barge on Talbingo reservoir;
- excavated rock management, including subaqueous placement within Talbingo Reservoir;
- establishment of services infrastructure such as diesel-generated power, water and communications; and
- post-construction revegetation and rehabilitation, management and monitoring.

2.2 Exploratory tunnel

An exploratory tunnel of approximately 3.1 km is proposed to provide early access to the location of the largest cavern for the underground power station. This will enable exploratory drilling and help optimise the location of the cavern which, in turn, will optimise the design of Snowy 2.0.

The exploratory tunnel is proposed in the north-east section of Lobs Hole and will extend in an east-west direction with the portal construction pad to be outside the western end of the tunnel at a site east of the Yarrangobilly River, as shown on Figure 4.

The location of the proposed exploratory tunnel and portal construction pad is shown in Figure 4. The exploratory tunnel will be excavated by drill and blast methods and have an 8 x 8 m D-Shaped cross section, as shown on Figure 5.



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

GDA 1994 MGA Zone 55

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KEY

- Exploratory tunnel
- Access road upgrade
- Access road extension
- Permanent bridge
- Portal construction pad and accommodation camp conceptual layout
- Communications cable
- Local road or track
- Watercourse
- On land rock management
- Subaqueous rock emplacement area
- Disturbance footprint
- Avoidance footprint

Exploratory Works elements

Snowy 2.0
WRD design
Exploratory Works
Figure 3

snowy 2.0 EMM

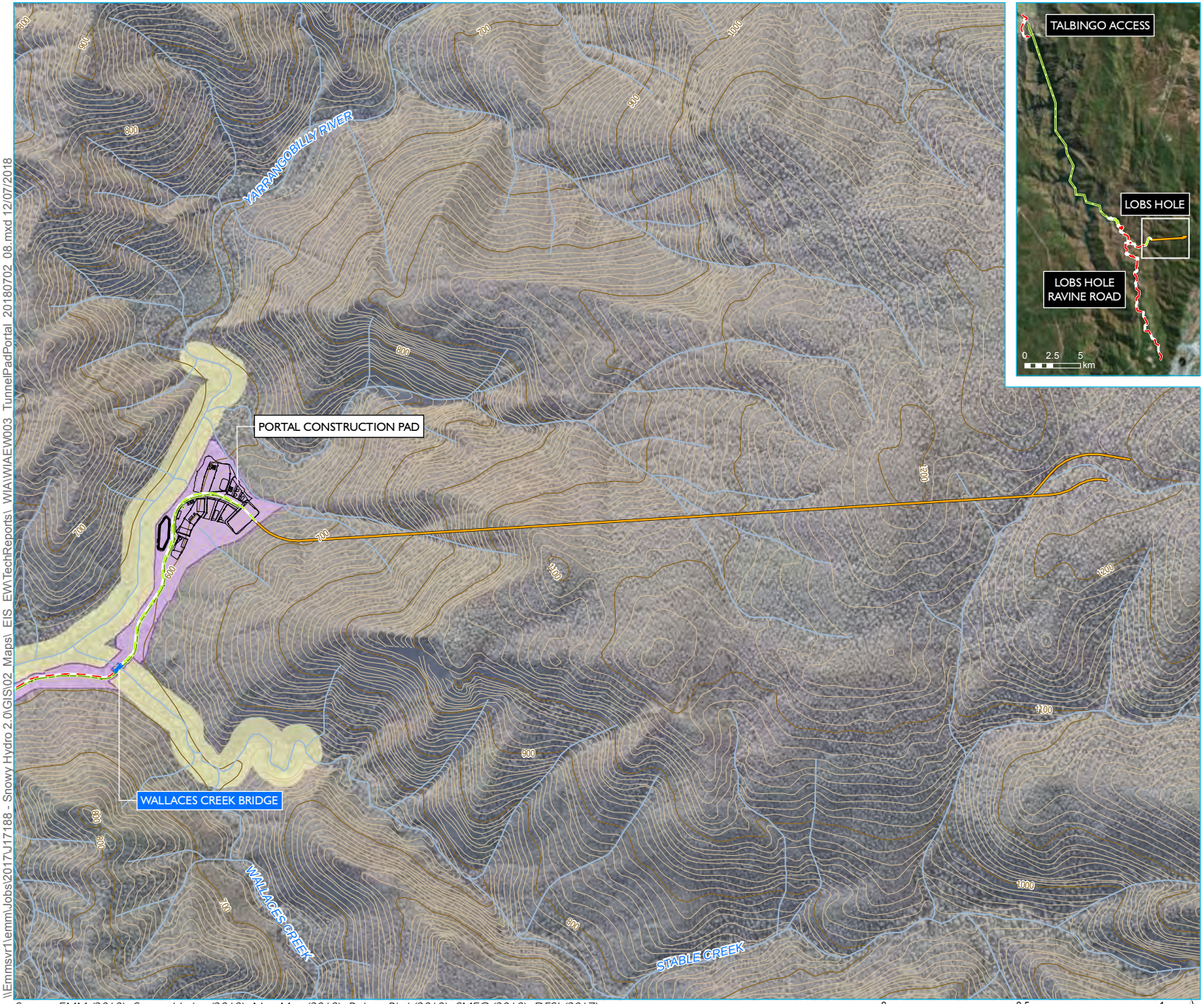
The drill and blast excavation process will be repeated cyclically throughout the tunnelling works, involving:

- marking up and drilling blast holes in a predetermined pattern in the working face of the tunnel;
- loading the blast holes with explosives, attaching detonators and connecting the holes into a blast sequence, and detonating the blast;
- ventilating the tunnel to remove blast fumes and dust;
- removing blasted rock;
- scaling and wash down of the tunnel roof and walls to remove loosened pieces of rock;
- geological mapping of the exposed rock faces and classification of the conditions to determine suitable ground support systems for installation;
- installing ground support; and
- advancing construction ventilation ducting and other utilities including power, water, compressed air and communications.

The exploratory tunnel will be shotcrete-lined with permanent anchor support and incorporate a groundwater management system. The exploratory tunnel shape and dimensions are designed to allow two-lane traffic for the removal of excavated material, along with additional space for ventilation and drainage of groundwater inflows. Groundwater intersected during tunnelling will be contained and transferred to the portal for treatment and management. Areas identified during forward probing with the potential for high groundwater flows may require management through a detailed grouting program or similar.

The tunnel portal will be established at the western end of the exploratory tunnel and provide access and utilities to the exploratory tunnel during construction. The portal will house power, communications, ventilation and water infrastructure. The portal will also provide a safe and stable entrance to the exploratory tunnel.

It is anticipated that the exploratory tunnel will be adapted for multiple functions during construction of the subsequent stages of the Snowy 2.0 project. The exploratory tunnel will also eventually be utilized to form the main access tunnel (MAT) to the underground power station during the operational phase of Snowy 2.0, should it proceed.



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

Exploratory tunnel location

Snowy 2.0
WRD design
Exploratory Works
Figure 4

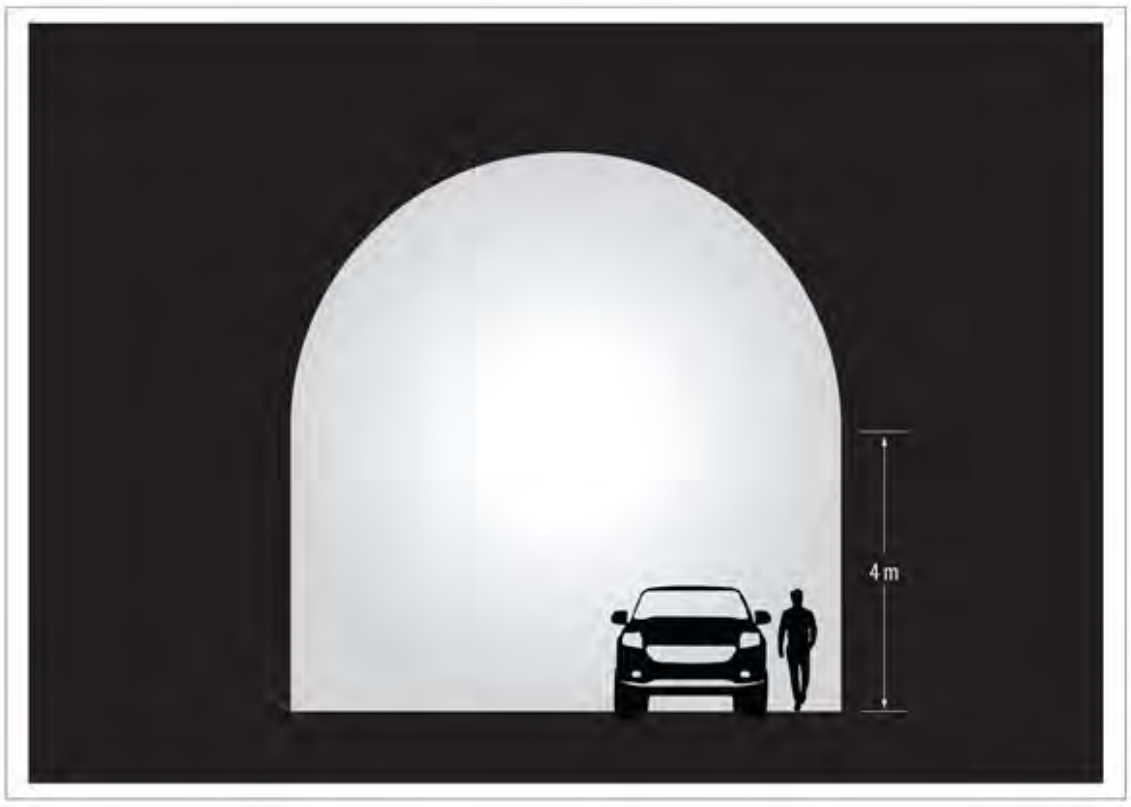


Figure 5 Exploratory tunnel cross section

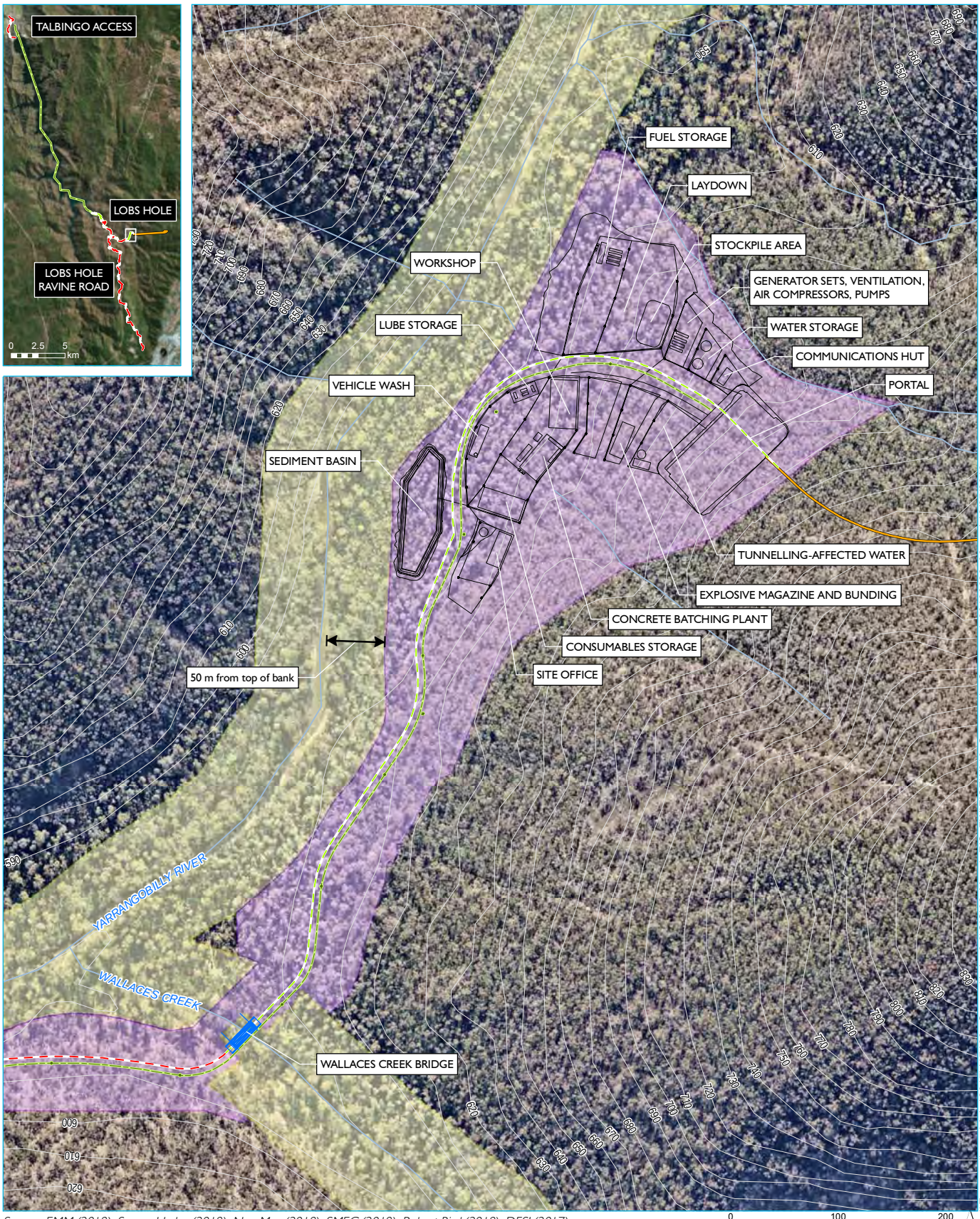
2.3 Portal construction pad

A construction pad for the exploratory tunnel will provide a secure area for construction activities. Infrastructure at the construction pad, shown in Figure 6, will primarily support tunnelling activities and include a concrete batching plant and associated stockpiles, site offices, maintenance workshops, construction support infrastructure, car parking and equipment laydown areas. Stockpile areas will allow for around two to three months' supply of concrete aggregate and sand for the concrete batching plant to ensure that the construction schedule for the proposed access road works do not interfere with the exploratory tunnel excavation schedule. A temporary excavated rock stockpile area is also required to stockpile rock excavated during tunnel construction prior to its transfer to the larger excavated rock emplacement areas.

The construction pad will be excavated to provide a level construction area with a near vertical face for the construction of the portal and tunnelling. The layout of the proposed construction pad is provided in Figure 6. The exploratory tunnel construction pad will be adjacent to the tunnel portal at the western end of the exploratory tunnel. The area required for the construction pad is approximately 100,000 square metres (m^2).

Site establishment works for the construction pad are anticipated to include:

- identifying and flagging areas that are to be avoided during the Exploratory Works period;
- clearing of vegetation, typically using chainsaws, bulldozers and excavators;
- civil earthworks to create a stable and level area suitable for establishment of the construction pad — this will involve a cut and fill approach to minimise the requirement for imported material;
- installation of site drainage, soil erosion and other permanent environmental controls;
- surface finishing, compacting only existing material where possible, or importing additional material where suitable, this material will be sourced locally (eg from upgrade works to Lobs Hole Ravine Road); and
- set up and commissioning of infrastructure including concrete batching plant, site office, workshops and other facilities.



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

0 100 200 m
GDA 1994 MGA Zone 55

KEY

- Access road upgrade
- Access road extension
- Permanent bridge
- Portal construction pad conceptual layout
- Exploratory tunnel
- Communications cable
- Watercourse
- Contour (10m)
- Disturbance footprint
- Avoidance footprint

Conceptual layout – portal construction pad

Snowy 2.0
WRD design
Exploratory Works
Figure 6

2.4 Excavated rock management

It is estimated that approximately 750,000 m^3 of bulked material will be excavated, mostly from the exploratory tunnel and portal construction pad with additional quantities from road upgrade works. Subject to geochemical testing of material, excavated material will be placed either on land or subaqueously within Talbingo Reservoir.

2.4.1 On land disposal

Excavated materials will be placed in one of two excavated rock emplacement areas at Lobs Hole as shown on Figure 7.

The strategy for excavated rock management is for excavated material to be emplaced at two areas with the final placement of excavated material to be determined later.

Consultation with NPWS throughout the design process has identified an opportunity for the eastern excavated rock emplacement area to form a permanent landform that enables greater recreational use of Lobs Hole following the completion of Snowy 2.0's construction. It is envisaged that the excavated rock emplacement area will provide, in the long-term, a relatively flat final landform suitable for camping and basic recreational facilities to be confirmed in consultation with NPWS.

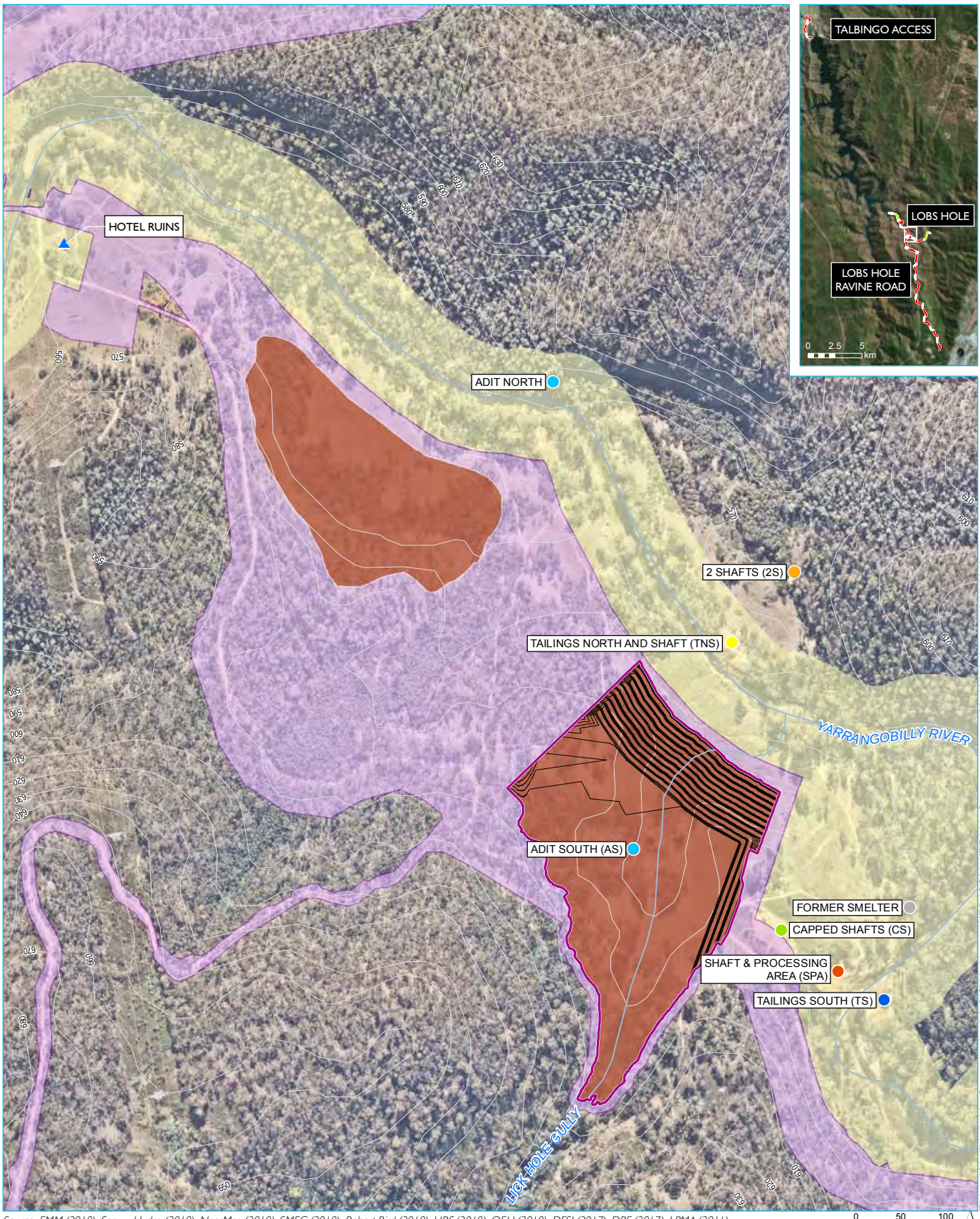
The eastern excavated rock emplacement area has a capacity of up to 600,000 m^3. It will be approximately 25 m maximum depth and will be benched down to the northern edge of the emplacement which is setback 50 m from the Yarrangobilly River.

The western excavated rock emplacement will be used to store excavated material should it not be able to be placed within the eastern excavated rock emplacement. It is envisaged this excavated rock emplacement area will be used to store excavated materials suitable for re-use within the construction of Exploratory Works or for use by NPWS in KNP maintenance activities. All remaining material placed in this excavated rock emplacement area will be removed following the completion of Exploratory Works.

The guiding principles for the design, construction method and management of the excavated rock emplacement areas undertaken for Exploratory Works have been as follows:

- reducing potential for acid rock drainage (ARD) from the excavated rock emplacement areas entering the Yarrangobilly River or forming groundwater recharge;
- avoid known environmental constraints; and
- manage existing surface water flows from Lick Hole Gully.

The design and management of the excavated rock emplacement areas have not yet been finalised due to the need for further investigations to determine the likely geochemical characteristics of the excavated material. Following further investigation and prior to construction of Exploratory Works a management plan will be prepared and implemented.



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

0 50 100 m
GDA 1994 MGA Zone 55

N

KEY

- Washington Hotel heritage site
- URS sampling locations
  - Audit
  - 2 shafts (2S)
  - Tailings north and shaft (TNS)
  - Capped shafts (CS)
  - Shaft and processing area (SPA)
  - Tailings south (TS)
- Former smelter
- Watercourse
- Contour (10m)
- On land rock management
- Conceptual WRD design contour
- Conceptual WRD design footprint
- Disturbance footprint
- Avoidance footprint

Conceptual layout - excavated rock emplacement areas

Snowy 2.0
WRD design
Exploratory Works
Figure 7

snowy 2.0 EMM

2.4.2 Subaqueous placement

An initial program for the placement of excavated material within Talbingo Reservoir also forms part of Exploratory Works. The program will be implemented in an appropriate section of Talbingo Reservoir in accordance with a detailed management plan based on an engineering method informed through the materials' geochemistry and reservoir's characteristics. The purpose of the program is to confirm the suitability of the emplacement method for future excavated material from the construction of Snowy 2.0, should it proceed.

The rock for subaqueous placement will be taken from the excavated rock emplacement areas as described above. Testing of the rock would be conducted during excavation to assess geochemical properties. Any rock assessed as unsuitable for subaqueous placement based on the prior geochemical and leachability testing would be separately stockpiled and not used in the program. Suitable (ie non-reactive material) would be transported and loaded to barge, for placement at the deposition area. Suitable placement locations have been identified for Exploratory Works and are shown indicatively on Figure 8.

All placement within the reservoir would occur within silt curtains and would be subject to a detailed monitoring regime including survey monitoring of pre-placement and post-placement bathymetry, water quality monitoring during placement, and monitoring of aquatic ecology and the recolonisation of benthic species and fish species to the placement area following the placement program. The management, mitigation and monitoring measures would be refined following the ongoing investigations.

2.5 Accommodation camp

An accommodation camp is proposed to provide accommodation and supporting services for workers near the exploratory tunnel. The accommodation camp layout is shown on Figure 9 and includes ensuite rooms surrounding central facilities including a kitchen, tavern, gym, admin office, laundry, maintenance building, sewage and water treatment plants and parking that will service the Exploratory Works workforce. The accommodation camp access road will connect to the north side of Lobs Hole Road at Lobs Hole. The conceptual layout of the accommodation camp is shown on Figure 9.

2.6 Road and access provisions

Existing road and access will need to be upgraded to a suitable standard to:

- provide for the transport of excavated material between the exploratory tunnel and the excavated rock emplacement areas;
- accommodate the transport of oversized loads as required; and
- facilitate the safe movement of plant, equipment, materials and construction staff to the portal construction pad.

Given the topographic constraints of the area, the standard of the existing roads and the environmental values associated with KNP, the option of barging larger and oversized loads to the site is available. This is discussed further at Section 2.7.

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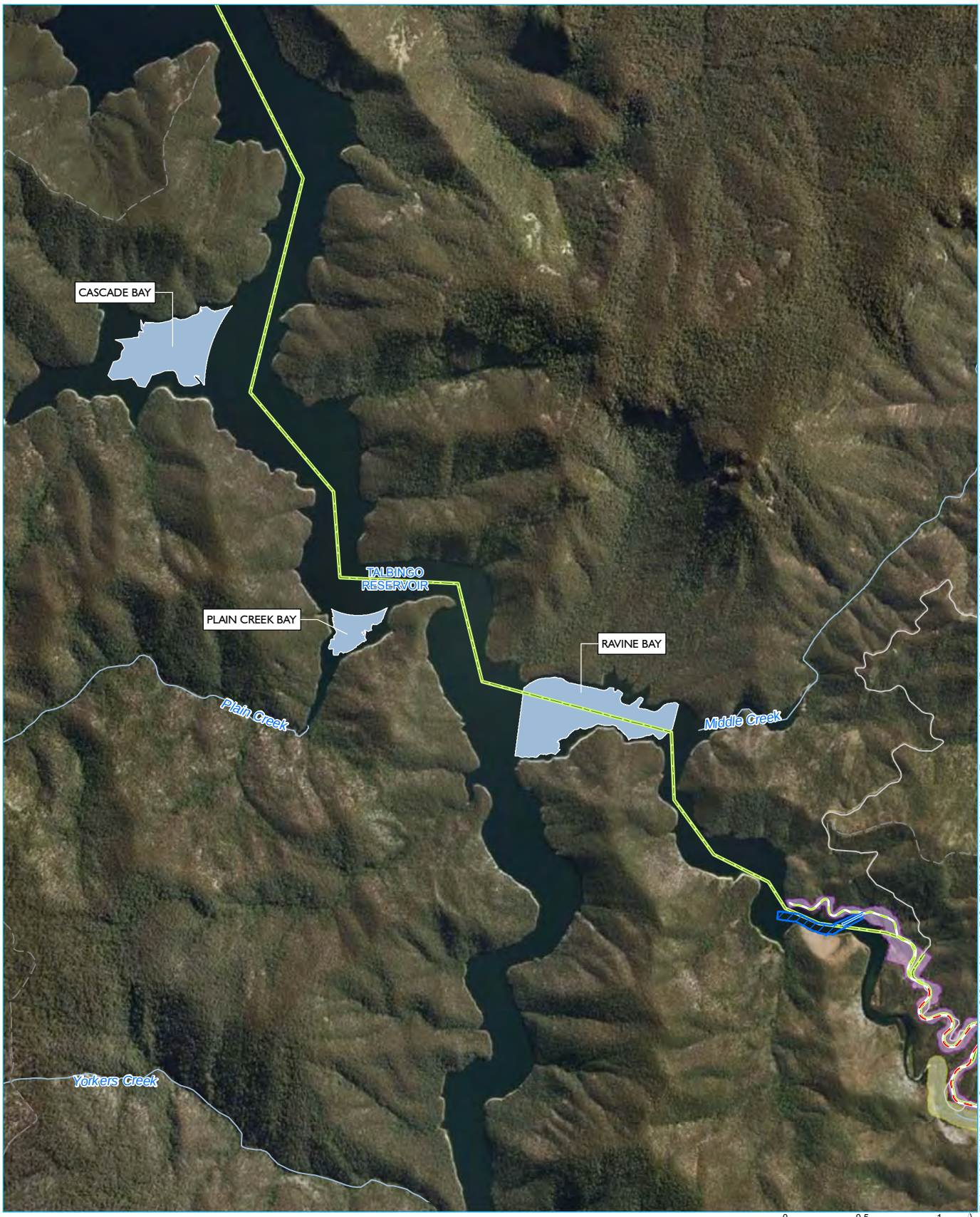

Source: EMM (2018); Snowy Hydro (2018); ESRI (2018); SMEC (2018); DFSI (2018); GA (2017); LPMA (2011)

0 0.5 1 km
GDA 1994 MGA Zone 55
N

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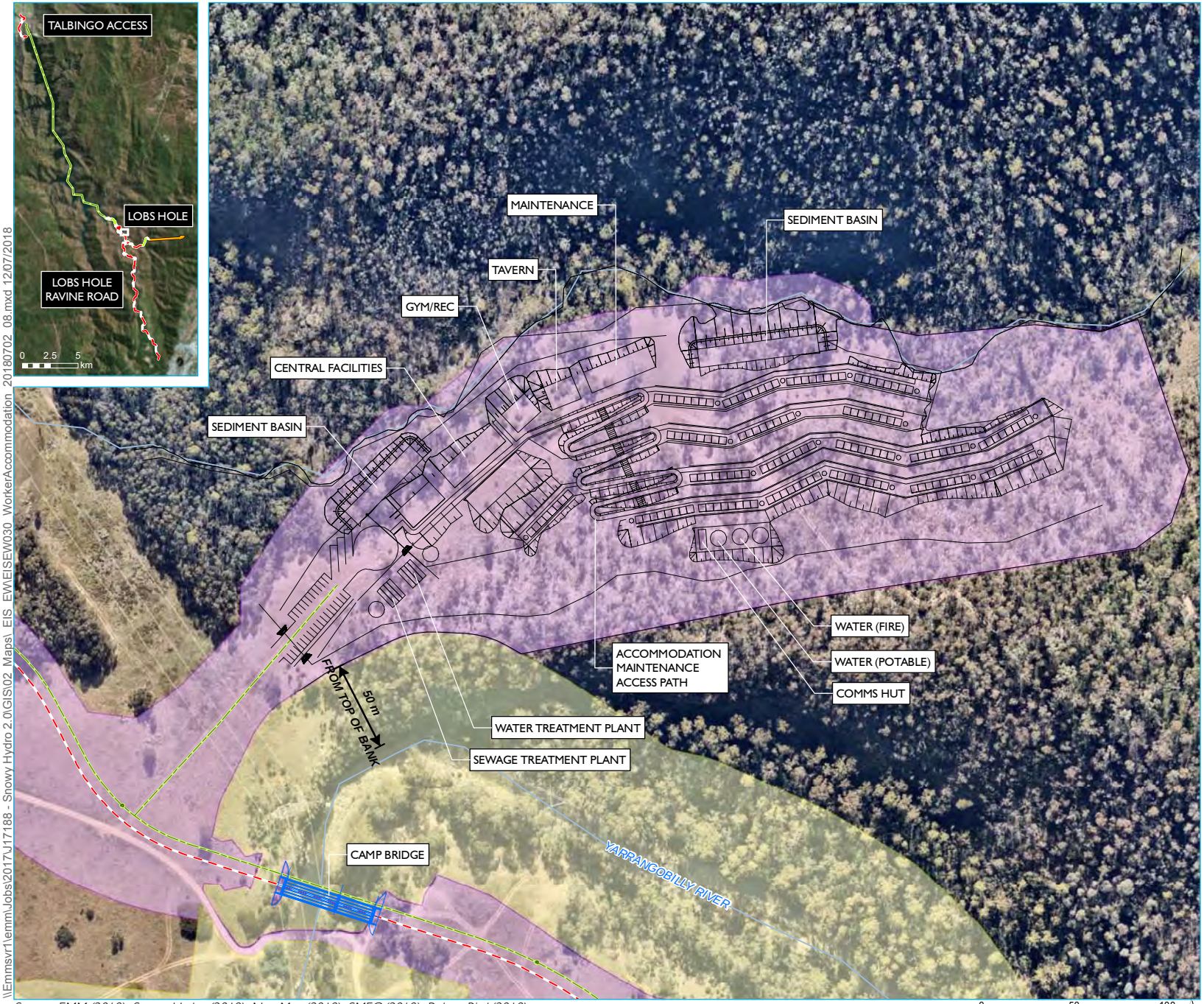
KEY

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

Subaqueous excavated rock placement

Snowy 2.0
WRD design
Exploratory Works
Figure 8

snowy 2.0 EMM



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

Conceptual layout – accommodation camp

Snowy 2.0
WRD design
Exploratory Works
Figure 9

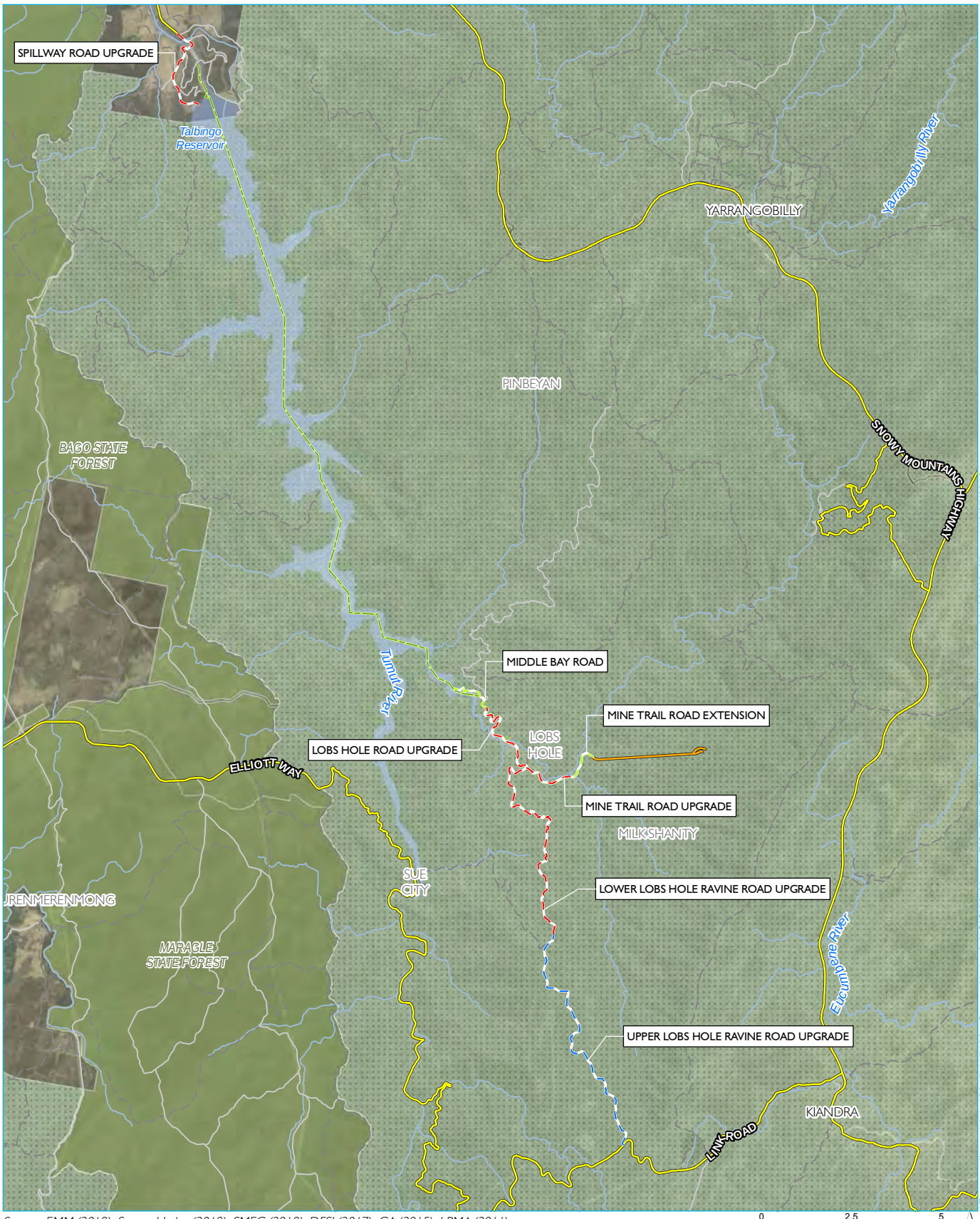
2.6.1 Access road works

The access road upgrades will be designed based on access for a truck and dog trailer. The proposed road works are shown in Figure 10 and described in Table 2. It is expected that most of materials and equipment will travel along the Snowy Mountains Highway, Link Road and Lobs Hole Ravine Road, with some required to travel on Miles Franklin Drive via Talbingo to Talbingo Dam Wall and be transferred via a barge to site. The primary haul routes for construction material on site are provided in Figure 11. Where existing roads are replaced by new access roads or road upgrades, the existing roads will be removed and rehabilitated in line with the rehabilitation strategy for Exploratory Works.

Table 2 Access road works summary

Roadwork area	Overview
Upper Lobs Hole Ravine Road upgrade	Minor upgrades to 7.5 km section of existing road. Only single lane access will be provided. No cut and fill earthworks or vegetation clearing will be undertaken.
Lower Lobs Hole Ravine Road upgrade	Upgrades to 6 km section of existing road involving cut and fill earthworks in some sections. Only single lane access will be provided.
Lobs Hole Road upgrade	Upgrade to 7.3 km section of existing road providing two-way access.
Mine Trail Road upgrade	Upgrade to 2.2 km section of existing track to two-way access.
Mine Trail Road extension	Establishment of a new two-way road providing access to the exploratory tunnel portal.
Middle Bay Road	Establishment of a new two-way road to the proposed Middle Bay barge ramp.
Spillway Road	Upgrade of a 3 km section of existing road to provide two-way access to the proposed Spillway barge ramp.

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



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

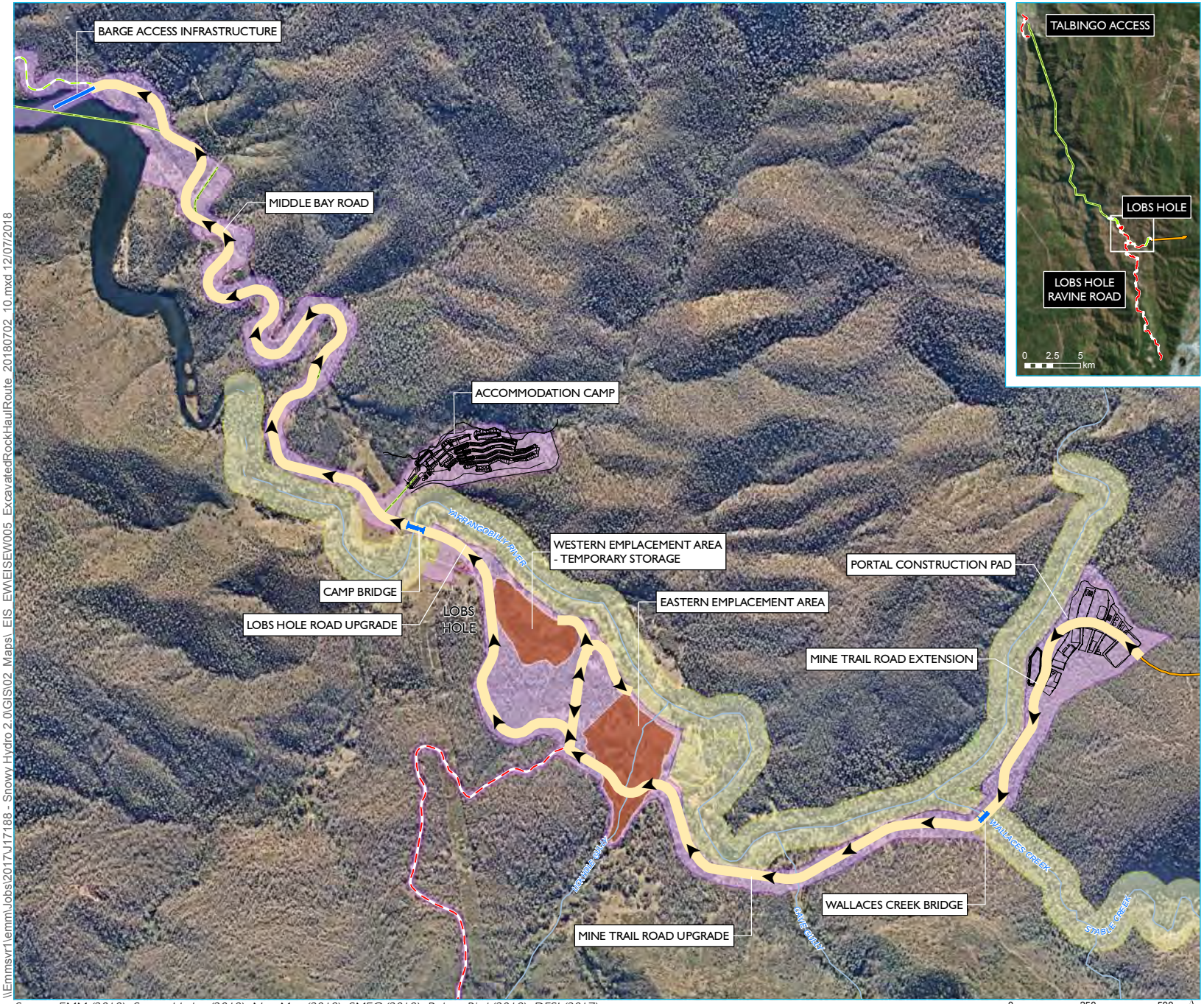
0 2.5 5 km
GDA 1994 MGA Zone 55

KEY

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

Access road upgrades and establishment

Snowy 2.0
WRD design
Exploratory Works
Figure 10



KEY

- Access road upgrade
- Access road extension
- Permanent bridge
- Exploratory tunnel
- Portal construction pad and accommodation camp conceptual layout
- Communications cable
- Excavated rock haul route
- Watercourse
- On land rock management
- Middle Bay barge access
- Disturbance footprint
- Avoidance footprint

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

Excavated material haul route

Snowy 2.0
WRD design
Exploratory Works
Figure 11

2.6.2 Watercourse crossings

Bridge construction will be required at two locations as described in Table 3. The locations of proposed bridge works are shown in Figure 11.

Table 3 Water course crossing summary

Bridge works area	Overview
Camp bridge	An existing crossing on Yarrangobilly River will be used as a temporary crossing while a new permanent bridge is built as part of Lobs Hole Road upgrade. The existing crossing will require the crossing level to be raised with rocks to facilitate vehicle passage. The rocks used to raise the crossing level will be removed and the crossing no longer used once the permanent bridge has been constructed. The new bridge (Camp bridge) will be a permanent crossing and used for both Exploratory Works and Snowy 2.0 main works, should it proceed.
Wallaces Creek bridge	Establishment of a new permanent bridge at Wallaces Creek as part of the Mine Trail Road extension. Establishment of this bridge will require an initial temporary pre-fabricated 'Bailey bridge' to be constructed, which will be removed before the end of the Exploratory Works.

The design for permanent bridges at both crossings will consist of steel girders with a composite deck. This is the most common type of permanent bridge constructed in and around the existing Snowy Scheme. Lightweight steel girders are easy to transport and will therefore allow for efficiencies in the construction schedule and permit the use of smaller-scale lifting equipment at the construction site.

2.7 Barge access infrastructure

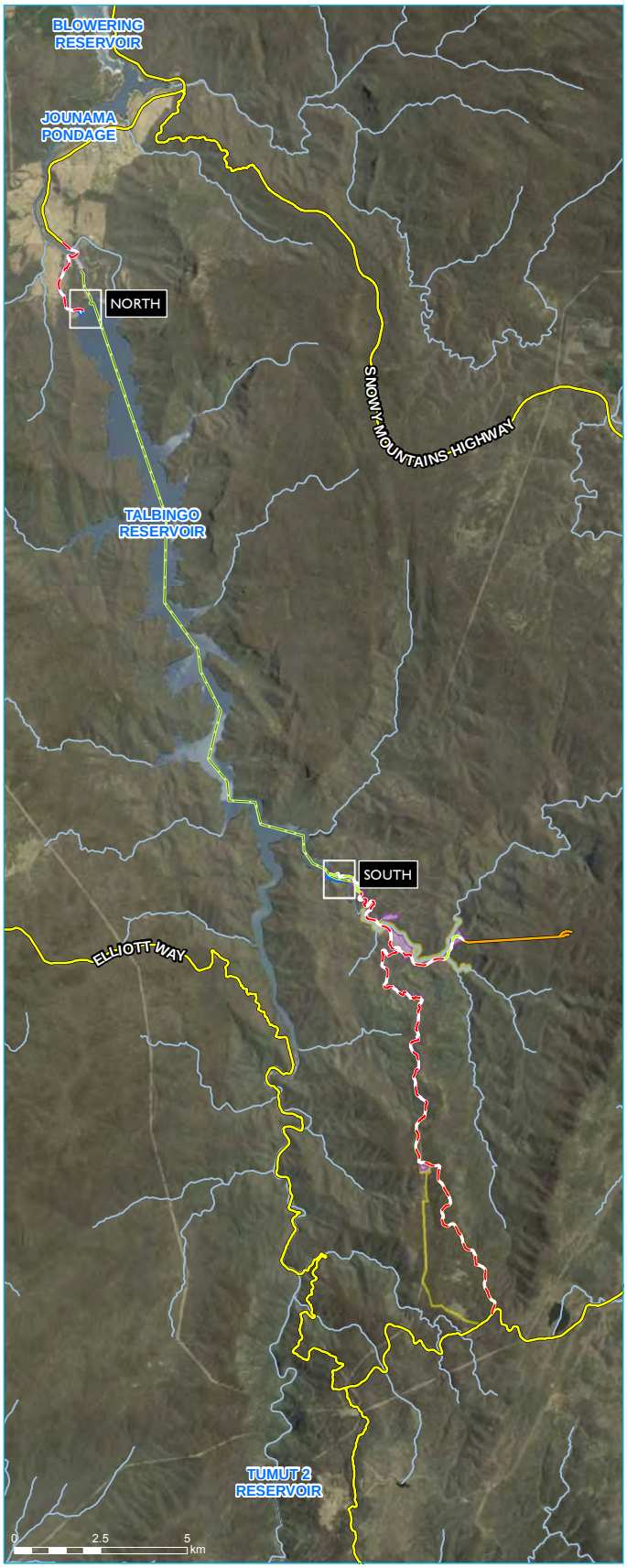
To provide an alternative to road access, a barge option is proposed, not only for bulky and heavy equipment but for materials and in case of emergency. During Exploratory Works, barges will be loaded at the northern barge ramp (Talbingo barge ramp), travel about 18 km along Talbingo Reservoir and be unloaded at the southern barge ramp (Middle Bay barge ramp) before returning to the north. Some loads may also be transported in the reverse direction.

Barge access infrastructure will comprise two dedicated barge ramps at Middle Bay and Talbingo Spillway, with a slope of approximately 1 vertical to 10 horizontal (1V: 10H) at each location. A navigation channel is also required adjacent to the Middle Bay barge ramp. Construction will involve:

- geophysical and geotechnical investigation of the barge access area to inform detailed design;
- site establishment and excavation of barge access area;
- installation of precast concrete panels at the ramp location;
- installation of bollards for mooring lines;
- removal of trees and debris to establish a navigation channel allowing barge access; and
- minor dredging to allow barge access at the reservoir minimum operating level.

To facilitate construction, laydown areas are proposed adjacent to the Middle Bay barge ramp and adjacent to the water inlet pipeline. Laydown will also be used within the footprint of the Talbingo barge ramp.

Dredged material will be placed as part of the subaqueous placement program or within one of the designated on land excavated rock emplacement areas. The infrastructure proposed for the Talbingo Spillway barge ramp and Middle Bay barge ramp is provided in Figure 12.



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

GDA 1994 MGA Zone 55

N

KEY

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

Barge access locations

Snowy 2.0
WRD design
Exploratory Works
Figure 12

2.8 Services and infrastructure

Exploratory Works will require additional power and communication infrastructure. Water services are also needed and include a water services pipeline and water and waste water (sewage) treatment facilities. A summary of services required is provided at Table 4.

Table 4 Summary of services infrastructure

Services infrastructure	Description
Power	Power will be provided at the portal construction pad and accommodation camp by diesel generators, with fuel storage provided at the portal construction pad.
Communication	Communication will be provided via fibre optic link. The fibre optic service has been designed to incorporate a submarine cable from Tumut 3 power station across Talbingo Reservoir to Middle Bay, and then via a buried conduit within the access roads to the accommodation camp and the portal construction pad.
Water and waste water (sewage)	A water services pipeline is proposed for the supply and discharge of water for the Exploratory Works which will pump water between Talbingo Reservoir and the exploratory tunnel portal, portal construction pad and accommodation camp.
	A package water treatment plant is proposed at the accommodation camp to provide potable water to the accommodation camp and portal construction pad facilities and will be treated to a standard that complies with the Australian Drinking Water Guidelines. The accommodation camp water supply will be pumped via the water pipeline from Talbingo Reservoir at Middle Bay.
	A package waste water (sewage) treatment plant (STP) is proposed at the accommodation camp for Exploratory Works waste water. The STP will produce effluent quality comparable to standard for inland treatment facilities in the region (eg Cabramurra). Following treatment waste water will be discharged to Talbingo reservoir via the water services pipeline connecting the accommodation camp to Talbingo Reservoir.

2.9 Construction and schedule

2.9.1 Geotechnical investigations

To assist the design development for the portal construction pad, accommodation camp, Middle Bay Road, Spillway Road, and Lobs Hole Ravine Road, further survey of ground conditions is required. A program of geotechnical investigations including geophysical survey, construction of test pits, and borehole drilling within the disturbance footprint, will be undertaken as part of construction activities. Excavation of test pits in areas where information on relatively shallow subsurface profiles is required, or where bulk sampling is required for laboratory testing. Borehole drilling is required to facilitate the detailed design of cuttings, bridge foundations, retaining wall foundations, and drainage structures.

2.9.2 Construction activities

A disturbance footprint has been identified for Exploratory Works. The extent of the disturbance footprint is shown on Figure 3 and shows the area required for construction, including the buildings and structures, portal construction pad, road widenings and bridges, laydown areas, and excavated rock emplacement areas. Typical construction activities that will occur within the footprint are summarised in Table 2.4.

Table 5 Construction activities

Activity	Typical method
Geophysical and geotechnical investigation	Geophysical surveys will generally involve: • laying a geophone cable at the required location and establishing seismic holes; • blasting of explosives within seismic holes; and • in-reservoir geophysics surveys will use an air gun as the seismic source. Geotechnical surveys will generally involve: • establishing a drill pad including clearing and setup of environmental controls where required; • drilling a borehole to required depth using a tracked or truck mounted drill rig; and • installing piezometers where required for future monitoring program. Geophysical and geotechnical investigation within Talbingo Reservoir will be carried out using barges and subject to environmental controls.
Site establishment for portal construction pad, accommodation camp, rock placement areas and laydown areas	Site establishment will generally involve: • identifying and flagging areas that are to be avoided during the Exploratory Works period; • clearing of vegetation within the disturbance footprint, typically using chainsaws, bulldozers and excavators; • civil earthworks to create a stable and level area suitable for establishment. This will involve a cut and fill approach where required to minimise the requirement for imported material; • installing site drainage, soil erosion and other permanent environmental controls where required; • surface finishing, compacting only existing material where possible, or importing additional material. Where suitable, this material will be sourced locally (eg from upgrade works to Lobs Hole Ravine Road); and • set up and commissioning of supporting infrastructure, including survey marks.
Road works	Upgrades of existing tracks (no widening) will generally involve: • identifying and flagging areas that are to be avoided during the Exploratory Works period; and • removing high points, infilling scours, levelling of rutting, and compacting surfaces. Extension or widening of existing tracks will generally involve: • identifying and flagging areas that are to be avoided during the Exploratory Works period; • installing site drainage, soil erosion and other permanent environmental controls where required; • clearing and earthworks within the disturbance footprint; and • placing road pavement material on the roadway.
Bridge works	Establishment of permanent bridges will generally involve: • installing erosion and sedimentation controls around watercourses and installing scour protection as required; • establishing temporary diversions within the watercourse where required, including work to maintain fish passage;

Activity	Typical method
	• establishing temporary bridges to facilitate permanent bridge construction; • constructing permanent bridges including piling, establishment of abutments and piers; and • removal and rehabilitation of temporary bridges and diversions.
Barge access works	Establishment of barge access infrastructure will generally involve: • installing sediment controls; • excavating and dredging of barge ramp area and navigation channel; • installing precast concrete planks and bollards; and • set up and commissioning of supporting infrastructure.
Exploratory tunnel construction	The drill and blast excavation process will be repeated cyclically throughout the tunnelling works, involving: • marking up and drilling blast holes in a predetermined pattern in the working face of the tunnel; • loading the blast holes with explosives, attaching detonators and connecting the holes into a blast sequence, and detonating the blast; • ventilating the tunnel to remove blast fumes and dust; • removing blasted rock; • scaling and wash down of the tunnel roof and walls to remove loosened pieces of rock; • geological mapping of the exposed rock faces and classification of the conditions to determine suitable ground support systems for installation; • installing ground support; and • advancing construction ventilation ducting and other utilities including power, water, compressed air and communications.

2.9.3 Ancillary construction areas

Ancillary facilities and laydown areas have been identified within the conceptual layout for the portal construction pad and accommodation camp. Several other indicative construction and laydown areas have also been identified to support Exploratory Works. A summary of these sites is:

- Upper Lobs Hole Ravine Road laydown area;
- excavated rock emplacement area laydown, storage and ancillary uses;
- barge access infrastructure laydown areas at Talbingo and Middle Bay; and
- other minor laydown areas as needed during site establishment of watercourse crossings.

All laydown areas are within the disturbance footprint identified for Exploratory Works. In addition, an area near Camp Bridge has been identified to be used for a plant nursery and organic stockpile area.

2.9.4 Construction workforce requirements and schedule

2.9.4.1 Staffing levels

It is currently expected that workforce for Exploratory Works will be approximately 200 people in total at peak construction. Workers are anticipated to work a 'swing' shift, for example two weeks on and one week off. These workers will be accommodated within the accommodation camp at Lobs Hole when rostered on.

The majority of the workforce will work on a fly-in fly-out and drive-in drive-out basis. It is expected that the majority of workers will fly in and out of either Cooma Airport or Canberra Airport and then travel to site via bus.

During construction of the accommodation camp, workers will be accommodated at Cabramurra. Some workers may also be accommodated at Snowy Hydro existing accommodation units at Talbingo during construction of the Talbingo barge ramp. No accommodation will be required outside of Cabramurra, the construction accommodation camp or Talbingo for the Exploratory Works workforce.

2.9.4.2 Hours of operation

It is expected that construction of the exploratory tunnel and haulage of rock material between the tunnel and excavated rock emplacement areas at Lobs Hole will be 24 hours a day, seven days a week for the duration of the tunnel drilling and blasting operation. Other construction activities, including the establishment works, road and infrastructure works, will normally work a 12 hour day, seven days a week.

The transport of materials along the haul route from Snowy Mountains Highway, Link Road and Upper Lobs Hole Ravine Road will only occur during day time hours (except during emergency), to avoid impacts to threatened species (Smoky Mouse). Transport by barge will be 24 hours a day, seven days a week.

2.9.5 Timing and staging

Exploratory Works are expected to take about 34 months, with the exploratory tunnel expected to be completed by late 2021.

It is expected that the construction works will be completed largely in parallel. However, road and access works are expected to be completed within the first six months from commencement. The proposed staging of construction activities is highlighted in Table 6.

Table 6 Indicative staging of construction

Construction works	2018	2019	2020	2021
Access roads				
Construction pad				
Accommodation camp				
Services infrastructure				
Barge access infrastructure				
Tunnelling				
Excavated rock management				

2.10 Site rehabilitation

All Exploratory Works align with components of the main works for Snowy 2.0. However, should Snowy 2.0 not be approved or not progress, the project area will need to be rehabilitated, and project elements decommissioned in consultation with NPWS. Anticipated rehabilitation activities are summarised in Table 7.

Table 7 Planned Exploratory Works rehabilitation activities

Exploratory Works element	Indicative rehabilitation activities
Exploratory tunnel	Tunnel to remain open and allowed to flood in lower portion provided groundwater impacts are negated.
Exploratory tunnel portal area	Permanent portal facade to be constructed, portal to be sealed from entry.
Portal construction pad and associated infrastructure	To be demobilised and all infrastructure removed. Site to be revegetated and returned to "original state".
Excavated rock emplacement areas	Emplaced excavated material in the western excavated rock emplacement area to be removed offsite and area to be revegetated and returned to "original state". The eastern excavated rock emplacement could remain in-situ and the landform rehabilitated as agreed with NPWS.
Accommodation camp	To be demobilised and all infrastructure removed. Site to be revegetated and returned to "original state".
Road access works	No remediation required as works are to be designed to be permanent.
Barge access infrastructure	No remediation works required as wharf and loading ramps are designed as permanent. Wharf can be removed if desired.

2.11 Decommissioning

Should Snowy 2.0 not proceed following the commencement or completion of Exploratory Works, elements constructed are able to be decommissioned and areas rehabilitated. Given works are within KNP, Snow Hydro will liaise closely with NPWS to determine the extent of decommissioning and types of rehabilitation to be undertaken. This approach will be taken to ensure that decommissioning allows for integration with future planned recreational use of these areas and to maintain the values of KNP.

2.12 Key aspects relevant to the excavated rock emplacement areas

Potential issues have been identified from reviewing the proposed Exploratory Works and associated activities. This identification process has considered the proposed project activities and the types of impacts to the receiving environment, and the following aspects are considered relevant to this assessment:

- Exploratory tunnel and construction pad — It is estimated that up to 750,000 m^3 of bulked excavated material will be placed in one of two excavated rock emplacement areas at Lobs Hole.
- Access road works — It is estimated that excess excavated material from the access road works will be placed in one of two excavated rock emplacement areas at Lobs Hole.
- Barge access infrastructure — minor dredge sediment volumes dredged to allow barge access at the reservoir minimum operating level will be placed in one of two excavated rock emplacement areas at Lobs Hole.

The excavated rock emplacement areas have the potential to impact on water quality and hydrology, primarily due to clearing of vegetation, stockpiling of excavated material and management of runoff and seepage which may be altered due to chemical reactions from excavated material oxidation and/or weathering. Notwithstanding, Lobs Hole has also been impacted by historical mining and any ground disturbance will need to consider historical land use.

3.0 Review of environmental conditions

The following review was prepared based on a desktop assessment from reports listed in Section 1.5.1 and:

- Envirolab Services Certificate of Analysis 203616;
- Envirolab Services Certificate of Analysis 204079;
- Envirolab Services Certificate of Analysis 204084;
- Envirolab Services Certificate of Analysis 204085;
- Envirolab Services Certificate of Analysis 205098;
- Envirolab Services Certificate of Analysis 205099;
- Eurofins Certificate of Analysis 599074-S;

This review of environmental conditions relates to the sites for the excavated rock emplacement areas ie the eastern excavated rock emplacement and western excavated rock emplacement shown in Figure 7.

3.1 Historic land uses

Historically Lobs Hole was used for the township of Ravine, extending to the north beyond the Yarrangobilly River and the Lobs Hole Mine.

Mining of copper (Cu) at Lobs Hole Mine began in 1874. Most of the early works were done on the surface but shafts were eventually sunk between 15 and 46 m below ground level. In 1908 Lobs Hole Mine was expanded underground. Surface works included a draw-lift pump on the main shaft, a dam, a water race, a hydraulic plant, and reverberatory furnace (On Site Cultural Heritage Management 2015). A smelter was added in 1909. Mining continued intermittently until 1916. At the time of closure, the Lobs Hole Mine consisted of six shafts, two adits and spoil stockpiles. Remnants of Lobs Hole Mine remain including some items of local significance. Further there are Hotel ruins to the north-west, downstream along the Yarrangobilly River and the remains of a Hutt to the south of the eastern excavated rock emplacement including a wooden cross. However, they are outside of the eastern excavated rock emplacement and will not be disturbed.

Finally, the Lobs Hole Mine also included workings at the tailings south, former smelter, tailings north and shaft and adit north, all of which are located on the northern side of the Yarrangobilly River and are outside the excavated rock emplacement areas and will not be disturbed.

3.2 Heritage

A historic cultural heritage assessment of Lobs Hole was completed by NSW Archaeology (2018). The historic and cultural heritage survey recorded 127 items of which 15 were of local significance and three of those locally significant items are within the eastern excavated rock emplacement. None of the recorded heritage items are assessed to be of state significance:

- Item R90 (NSW Archaeology 2018) is recorded as a Lick Hole Gully Adit (adit south) and includes examples of mining techniques and equipment of the era including mining timbers, railway tracks and mounds of excavated rock.
- Item R91 (NSW Archaeology 2018) is recorded as possibly Mine Shaft Number 4 and has been filled in.
- Item R96 (NSW Archaeology 2018) is recorded as open cut in Lick Hole Gully containing backfilled bricks, brick fragments and slag.

The historic and cultural heritage survey recorded three items within the western excavated rock emplacement, but none of those items are of local or state significance.

It has been recommended that loss of the above-mentioned locally significant items from the construction of the eastern excavated rock emplacement are mitigated by archival recording. Archival recording will preserve the history of Lobs Hole by filling in the gaps in the existing history of settlement and mining.

It should be noted that R109 (NSW Archaeology 2018) located south of the eastern excavated rock emplacement is likely the remains of Paterick house and includes a fallen wooden cross for Emily. Whilst R109 does not meet any criteria for local or state significance it remains outside of the eastern excavated rock emplacement and will not be disturbed as part of the Exploratory Works.

3.3 Underlying material

3.3.1 Contamination potential

There is a potential for the Lobs Hole Mine and surrounding land to be contaminated from historical activities.

The *NSW Contaminated Land Management Act 1997* (CLM Act) defines contaminated land as:

> Contamination of land, for the purposes of this Act, means the presence in, on or under the land of a substance at a concentration above the concentration at which the substance is normally present in, on or under (respectively) land in the same locality, being a presence that presents a risk of harm to human health or any other aspect of the environment.

The "concentration at which the substance is normally present" in soil would be the concentration of the substance (the constituent) prior to mining activities taking place (referred to as background concentrations herein). In the absence of background concentrations, the potential for contamination can be conservatively determined by exceeding the appropriate health investigation limit (HIL) reported in the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPM). Therefore, the potential risk can be determined by comparing constituent concentrations to the NEPM for HIL for public open space and recreational areas (HIL C) and residential sites with minimal soil access (health screening levels (HSL) B), being the closest description of the current and future land use of land at Lobs Hole and the accommodation camp respectively.

3.3.1.1 Contamination survey methods

a URS investigation

An investigation and remediation assessment of Lobs Hole Mine was previously completed by URS (2015) (the URS investigation). The objective of the URS investigation was to identify sources of contamination associated with Lobs Hole Mine and determine if constituents had migrated into the Yarrangobilly River. The URS investigation included seven test pits, 0.3-0.5 m below ground level:

- capped shafts area;
- shaft and processing area;
- tailings south;
- tailings north and shafts;
- northern shafts;
- adit south (the Lick Hole Gully Adit); and
- slag pile.

15 soil samples were analysed for metals, metalloids, iron (Fe), total alkalinity, acidity, toxicity characteristic leaching procedure (TCLP), net acid generation (NAG), net acid producing potential (NAPP), pH, and electrical conductivity (EC).

The URS sample locations are shown in Figure 13.

b EMM investigation

A limited soil sampling program was conducted as part of the *Phase 1 Contamination Assessment* (EMM 2018c) (the EMM investigation) to support the EIS for the Exploratory Works. The purpose of the field sampling program was to provide a record of existing site conditions prior to construction, at select locations within the disturbance area at Lobs Hole. It should be noted that the purpose was not to provide characterisation of a contaminated site. A total of ten shallow soil samples were collected between 0.2-0.5 m below ground level at ten locations across Lobs Hole.

Samples were analysed for a suite of heavy metals, total recoverable hydrocarbons (TRH)/benzene, toluene, ethylbenzene and xylene (BTEX), cation exchange capacity (CEC) and exchangeable cations. Selected samples were analysed for the presence of asbestos.

The EMM investigation sample locations are shown in Figure 13.

3.3.1.2 Contamination survey results

a URS investigation

The URS investigation found that eight out of 15 soil samples exceeded HIL C for As. The eight samples were collected from the shaft and processing area, tailings north and shafts, and tailings south. No other constituents exceeded HIL C. Further all soil samples analysed had high NAPP.

It should be noted that the Lick Hole Gully Adit will be located beneath the eastern excavated rock emplacement and will have some localised soil contamination.

b EMM investigation

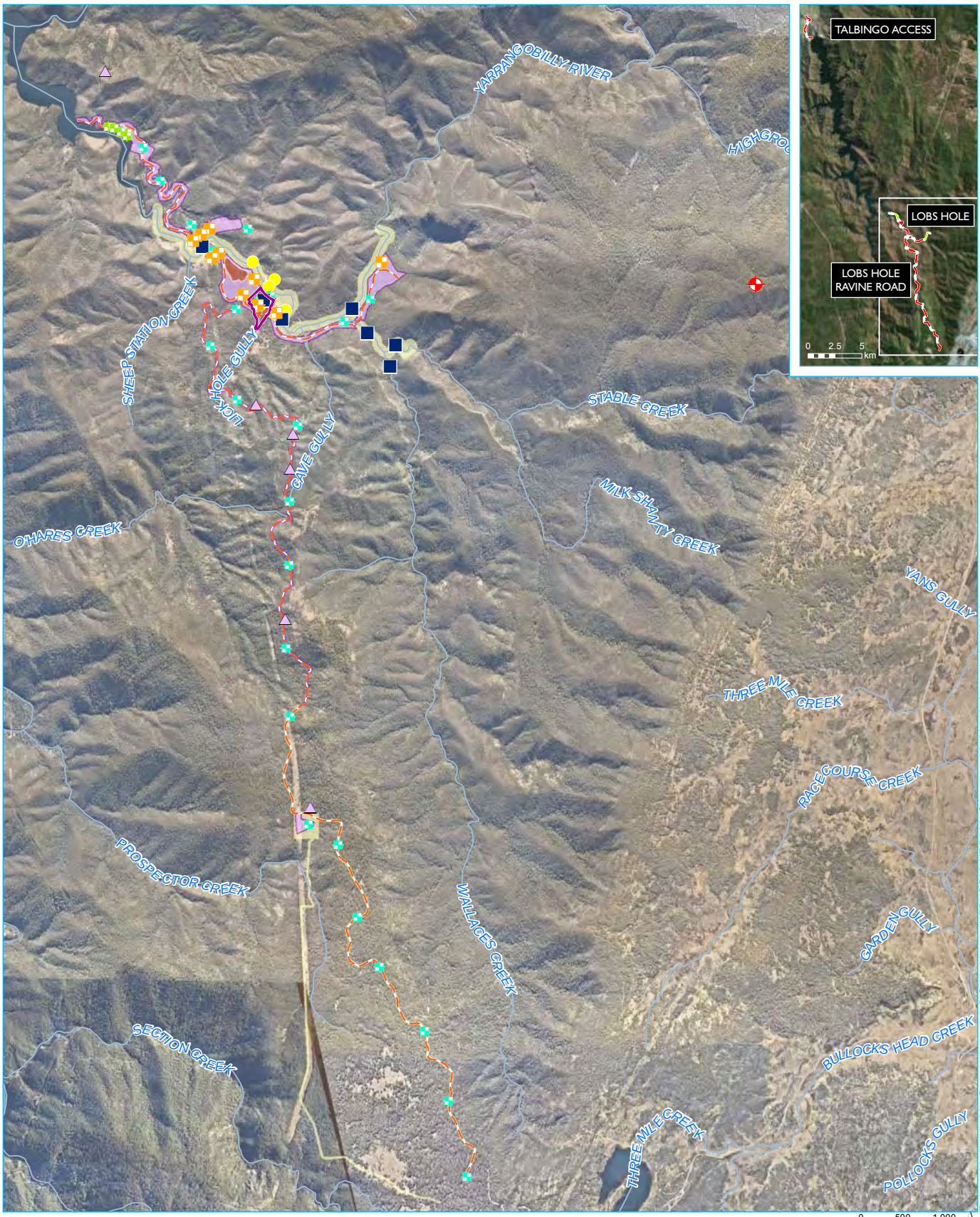
The results of the soil analysis were compared with NEPM HIL C and HSL B. Samples show that all metal and hydrocarbon concentrations were below the applicable HIL C and HSL B criteria at all locations.

The results of sampling reported heavy metal concentrations above ecological investigation levels (EILs) for areas of ecological significance:

- Cu: exceeded the ecological significance EIL criteria at four locations. Two of the locations (CONTAMINATION 1 and CONTAMINATION 2) are in the accommodation area. The exceedances may be attributed to background levels in the soil, or minor impacts from previous land use (ie ad-hoc camping and four-wheel driving). The exceedances detected at the Lick Hole Gully Adit and Lobs Hole Mine (CONTAMINATION 9 and CONTAMINATION 10) are remnant of the former mining at these locations.
- Nickel (Ni): exceeded EILs criteria at seven locations.
- Arsenic (As): exceeded EIL at one location (CONTAMINATION 9 (0.1-0.3 m below ground level), which is near Lick Hole Gully Adit.
- Zinc (Zn): exceeded the EIL at three locations (CONTAMINATION 1 (0.2-0.5 m below ground level) near the accommodation camp, CONTAMINATION 3 (0.1-0.3 m below ground level) in an open area along the path of the proposed roadway, and CONTAMINATION 9 (0.1-0.3 m below ground level) at the Lick Hole Gully Adit. These exceedances may be attributed to historic and recent use of Lobs Hole.

Background concentrations and physical soil properties were not taken into consideration to derive site specific ecological criteria; therefore, these conclusions are conservative. Lobs Hole is an area within the KNP with a long history and use, thus disturbance and impact are to be expected.

The sampling conducted has shown that despite being within the KNP, the shallow soils in and surrounding Lobs Hole are impacted with heavy metals. However, the magnitude of these exceedances is representative of the historic use at, or near, the sample locations. For example, the Cu exceedances around the Lobs Hole Mine (CONTAMINATION 9 and CONTAMINATION 10) far exceed those measured in areas of minimal disturbance, such as CONTAMINATION 5 and CONTAMINATION 6.



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

0 500 1,000 m
GDA 1994 MGA Zone 55

N

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KEY

- BH5102
- Surface water sampling location
- Contamination soil sample location
- Soil sample site
- ASS sample site
- eSPADE soil location
- URS sampling location
- Watercourse
- On land rock management
- Exploratory Works access road
- Conceptual WRD design footprint
- Disturbance footprint
- Avoidance footprint

Excavated rock, soil, river sediment and water sample locations

Snowy 2.0
WRD design
Exploratory Works
Figure 13

snowy 2.0

EMM

3.3.2 Soil type, distribution and usability

The Australian soil resource information system (ASRIS) mapping indicated that five soil types are present in the project area:

- Tenosols and Rudosols are associated with high exposed ridges and elevated stony slopes;
- Dermosols are found on the upper slopes with subsoil clay content increasing at down slope;
- Kurosols are found on the lower slopes and tableland areas adjacent to the mountains; and
- Organosols are found in basins and depressions in valley floors where water collects all year round.

An eSPADE soil profile database search identified information on soil profiles surveyed in the project area and submitted to the Soil and Land Information System (SALIS) database (OEH 2018). Six profiles occur within the project area (Table 8 and Figure 13).

Table 8 eSPADE soil database results

Australian Soil Classification	Great Soil Group	Surface pH	Surface texture	Identification number	Easting	Northing
Tenosol	Red Earth	6.5	Sandy clay loam	83	624693	6041104
Ferrosol	Krasnozem	6	Silty clay	88	627163	6032244
Tenosol	Lithosol	6	Silty clay loam	87	626863	6034514
Tenosol	Lithosol	7	Sandy clay loam	86	626923	6036324
Rudosol	Lithosol	7	Sandy clay loam	84	626513	6037094
Rudosol	Lithosol	7	Light clay loam	85	626953	6036744

It is likely that the described ASRIS and eSPADE mapped soils have low agricultural value either due to land area constraints, low fertility or because of localised contamination. Noting that the potential soil contamination from the Lick Hole Gully Adit has not impacted vegetation growth, as illustrated in Photograph 1. Further, they have a low to moderate erosion potential. Notwithstanding, provided the soil are harvested and managed in stockpiles they would be suited for use in rehabilitation of the excavated rock emplacement areas by encouraging growth of endemic vegetation species.

Photograph 1 Lick Hole Gully beneath the Lick Hole Gully Adit

A limited soil sampling program was conducted to support the EIS for the Exploratory Works and is reported in the *Soils and Land Assessment* (EMM 2018d). The results indicated limited similarities between ASRIS/eSPADE and the *Soils and Land Assessment* (EMM 2018d). Both in terms of soil types and general patterns of distribution. For example, the ASRIS/eSPADE assessment indicates Tenosols with a small pocket of Kurosols in the north. By comparison the soil sampling program (EMM 2018d) found that the landscape was dominated by Kandosols with a pocket of Vertosols on a floodplain in the southern corner and a pocket of Dermosols just south of the Vertosols. Notwithstanding, Tenosols were encountered on steeper slopes in the north.

Given the differences in information from the above-listed sources, and difficulty in verifying the methods or results of studies by others, the eSPADE data has not been used further in this report.

Based on the *Soils and Land Assessment* (EMM 2018d) it is estimated that soil can be stripped from the excavated rock emplacement areas to a depth of 0.5 m below ground level.

Management and mitigation measures to protect the soil stockpiles are presented in the *Soil and Land Assessment* (EMM 2018d).

3.3.3 Geology

The project area is located within a geologic domain referred to as the 'Ravine Incised Area' (EMM 2018b) which includes three geological units (Figure 14 and Table 11).

KEY

- BH5102
- Groundwater monitoring bore
- Exploratory Works access road
- Exploration tunnel and portal
- Perennial watercourse
- Conceptual WRD design footprint
- Long Plain Fault (interpreted)

Geology (1:250,000)

- *w* - Water

Quaternary

- *Qa* - Alluvium

Tertiary

- *Tbm* - Basalt

Cainozoic

- *Cz* - Unknown (undifferentiated)

Devonian

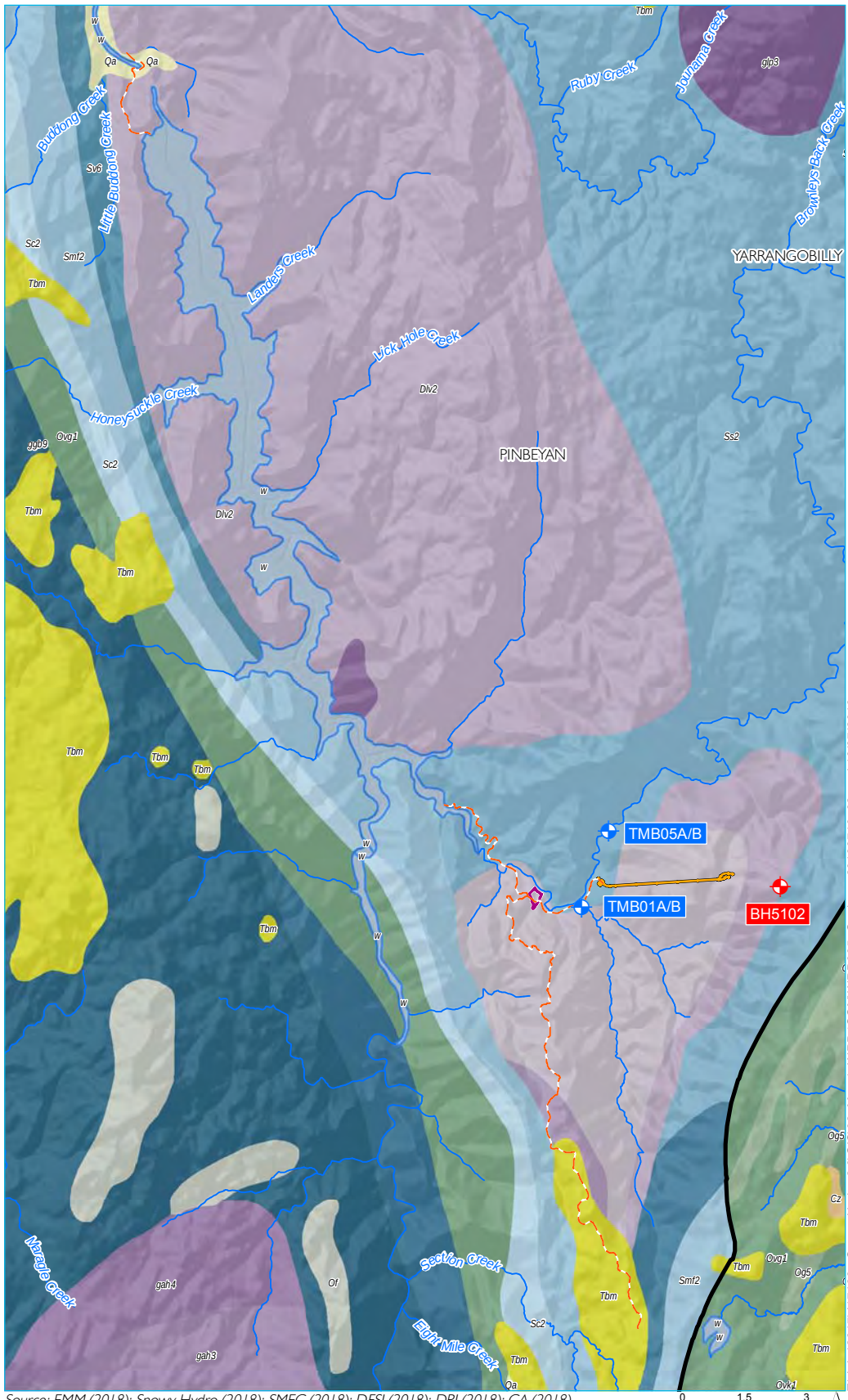
- *Dls1* - Byron Range Group (undifferentiated)
- *Dlv2* - Boraig Group (unnamed)
- *Dlv3* - Black Range Group (Mountain Creek Volcanics)
- *gah3* - Free Damper Suite (Free Dampier Adamellite)
- *gah4* - Free Damper Suite (Pennyweight Adamellite)
- *glp2* - Tumut Granites (Lobs Hole Adamellite)
- *glp3* - Bogong Suite (Bogong Granite)

Silurian

- *Sc2* - Unknown (Tumut Ponds Sepentinite)
- *Smf2* - Unknown (Jackalass Slate)
- *Ss2* - Bredbo Group (Ravine Beds/Yarrangobilly Limestone)
- *Sv5* - Young Suite (Goobarragandra Volcanics)
- *Sv6* - Unknown (Blowering Formation)
- *Sv7* - Unknown (Kings Cross Formation)
- *ggb29* - Tom Groggin Suite (Rough Creek Tonalite)
- *ggb9* - Tom Groggin Suite (Green Hills Granodiorite)

Ordovician

- *Of* - Adaminaby Group (Adaminaby Group)
- *Og5* - Unknown (Shaw Hill Gabbro)
- *Ovg1* - Unknown (Gooandra Volcanics)
- *Ovk1* - Kiandra Group (unnamed)



Source: EMM (2018); Snowy Hydro (2018); SMEC (2018); DFSI (2018); DPI (2018); GA (2018)

0 1.5 3 km
GDA 1994 MGA Zone 55
N

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Project area geology, groundwater and drill hole sampling

Snowy 2.0
WRD design
Exploratory Works
Figure 14

3.4 Surface water

3.4.1 Rainfall

The following Bureau of Meteorology (BoM) rainfall gauges are located close to the Yarrangobilly River Catchment and provide available data to describe rainfall:

- Talbingo (BoM station 72131). This rainfall gauge is located within the township of Talbingo, approximately 3.5 km to the north of the Tumut 3 Power Station and 26 km to the north-west of Lobs Hole. The gauge elevation is 395 m Australian Height Datum (AHD).
- Cabramurra SMHEA AWS (BoM station 72161). This rainfall gauge is located approximately 8 km to the south-west of the head waters of Wallaces Creek, which is a major tributary to the Yarrangobilly River Catchment. The gauge elevation is 1,482 m AHD.
- Yarrangobilly Caves (BoM station 72141). This rainfall gauge is located centrally in the Yarrangobilly River Catchment. The gauge elevation is 980 m AHD.

Table 9 presents key information and statistical data from the three rainfall gauges. Noting that some of the precipitation will occur as snow but has been referred to as rainfall to maintain consistency with other sections of the EIS.

Table 9 Rainfall statistics

Rainfall Statistics (annualised)	Units	Talbingo	Cabramurra SMHEA AWS	Yarrangobilly Caves
Rainfall record	km	1997-present	1996-present	1906-1919 1978-present
Distance from lobs hole	m AHD	25 km north-west	15 km south	15 km north-east
Elevation	millimetres per year (mm/year)	395	1,482	980
Average rainfall	mm/year	952	1,178	1,169
Lowest rainfall	mm/year	361	567	552
5th percentile rainfall	mm/year	663	877	818
10th percentile rainfall	mm/year	771	992	905
Median rainfall	mm/year	946	1,202	1,158
90th percentile rainfall	mm/year	1,220	1,386	1,511
95th percentile rainfall	mm/year	1,313	1,427	1,535
Highest rainfall	mm/year	1,343	1,634	1,902

The median annual rainfall within the Yarrangobilly River Catchment ranges from 1,400 mm/year in the head water catchments to 950 mm/year at Lobs Hole. The spatial variation in median rainfall generally reflects the variation in topography within the catchment.

3.4.2 Surface water quality

3.4.2.1 Contamination potential

Following the definition for contamination presented in the CLM Act (Section 3.3.1) the "concentration at which the substance is normally present" in sediment and water in the Yarrangobilly River can be conservatively determined by comparison to (the water guidelines):

- Australian and New Zealand Environment and Conservation Council (ANZECC) aquatic ecosystems guideline;
- ANZECC freshwater and recreation guideline; and
- Australian drinking water guideline (ADWG).

3.4.2.2 Surface water quality method

a URS investigation

An investigation into surface water quality at Lobs Hole was previously completed by URS (2015) (the URS investigation). The objective of the URS investigation was to identify sources of contamination associated with Lobs Hole Mine and determine if constituents had migrated into the Yarrangobilly River. The URS investigation included:

- six water samples analysed for total metals, metalloids, dissolved metals, cations/anions and total alkalinity and acidity; and
- four river sediment samples analysed for total alkalinity, acidity, total metals, metalloids, TCLP, NAG and NAPP, pH and EC.

b EMM investigation

A surface water characterisation program commenced for the project area in February 2018. This program includes water quality sampling from Tantangara and Talbingo Reservoirs and all major watercourses that contribute runoff to the reservoirs and watercourses from the project area.

Further details on the sampling locations and water sample analysis methods can be reviewed in the *Surface Water Assessment* (EMM 2018e).

3.4.2.3 Surface water quality results

a URS investigation

The URS investigation found that As, Cu, Ni and Zn exceeded ANZECC freshwater and recreation guideline and ADWG in a range of samples collected around Lobs Hole Mine. Further, the poorest quality water was found in the shaft and processing area (adjacent to the east side of the eastern excavated rock emplacement).

The URS investigation also found that As, Pb, mercury (Hg), Cu, Ni and Zn exceeded the ANZECC aquatic ecosystem guidelines in river sediment directly below Lobs Hole Mine. However, TCLP analysis indicated that the constituents were relatively immobile.

Notwithstanding, contamination of water and river sediment appears to be localised with no water quality and river sediment exceedances recorded beyond 700 m downstream of Lobs Hole Mine.

b EMM investigation

Table 10 (EMM 2018e) provides a summary of water quality results for the Yarrangobilly River and Wallaces Creek, which includes the Yarrangobilly River adjacent to the excavated rock emplacement areas (Figure 13). The water quality during base flow conditions can be characterised as:

- Neutral to slightly alkaline, with pH measurements ranging between 7.5 to 8.4.
- High carbonate, hardness and alkalinity levels. This is expected to be associated with the groundwater origins of base flows. Lower carbonate levels are expected during non-base flow conditions.
- Low salinity, with EC (an indicator of salinity) ranging between 32 to 185 micro Semens per centimetre (µS/cm).
- Low levels of suspended solids and turbidity. Suspended solids and turbidity were consistently either below detection limits or within the lower end of the guideline range. This is in line with expectations given the base flow conditions and clear appearance of the water.
- Low levels of nutrients (phosphorus (P), nitrogen (N) and carbon). P and N concentrations were below guideline values in all samples except for a single sample from the Yarrangobilly River that recorded a Nitrate concentration of 1.9 milligrams per litre (mg/l).
- Low levels of metals. All dissolved metal concentrations were below guideline values following hardness adjustments except for:
    - a single sample of Aluminium (Al) was marginally elevated relative to the guideline value;
    - all samples of Barium (Ba) were elevated relative to the low reliability trigger value; and
    - a single sample of Fluoride (F) was elevated relative to a low reliability trigger value.

Table 10 Water quality results for the Yarrangobilly River and Wallaces Creek

				Yarrangobilly River				Wallaces Creek		
Description/ constituent	**Unit**	**Guideline value**	**Number of samples**	**10th percentile[5]**	**Median**	**90th percentile**	**Number of samples[5]**	**Minimum**	**Median**	**Maximum**
Field parameters										
Temperature	°C	-	11	13	19	22	5	13	15	16
Dissolved oxygen	%	90 – 110[1]	8	**75**	**85**	93	5	**75**	**78**	**92**
EC	µS/cm	30 – 350[1]	11	32	171	185	5	65	178	185
pH	pH unit	6.5 – 8.5[1]	11	7.5	7.9	8.1	5	7.5	7.6	8.4
Oxidising and reducing potential		-	11	112	130	143	5	62	133	146
Turbidity	Nephelometric Turbidity Units (NTU)	2 - 25	7	<2	<2	5	3	<2	<2	<2
General										
Suspended solids	mg/L	-	11	<5	<5	<5	5	<5	<5	<5
Total Alkalinity (as calcium carbonate ($CaCO_3$))	mg/L	-	7	15	86	109	3	38	99	104
Total Hardness (as $CaCO_3$)	mg/L	-	4	9	89	97	2	87	96	94
Nutrients										
Ammonia	mg/L	0.013	7	<0.01	<0.01	<0.01	2	<0.01	<0.01	<0.01
Oxidised N	mg/L	0.015	7	0.01	**0.03**	**1.9**	2	**0.03**	**0.035**	**0.04**
Total kjeldahl N	mg/L	-	7	<0.1	<0.1	<0.1	2	<0.1	<0.1	<0.1
Total N	mg/L	0.25	7	<0.1	<0.1	**1.9**	2	<0.1	<0.1	<0.1
Reactive P	mg/L	0.015	4	<0.01	<0.01	<0.01	2	<0.01	<0.01	<0.01
Total P	mg/L	0.020	7	0.01	0.01	0.02	2	<0.01	<0.01	<0.01
Total organic carbon	mg/L	-	4	1	11	23	2	8	16.5	25
Dissolved organic carbon	mg/L	-	4	<1	<1	<1	2	<1	<1	<1
Dissolved inorganics										
F	mg/L	0.1153	7	0.1	0.1	**0.6**	3	0.1	0.1	0.1
Dissolved metals										
Al	mg/L	0.055	4	0.01	0.01	**0.06**	2	<0.01	<0.01	<0.01
As	mg/L	0.013	4	<0.001	<0.001	<0.001	2	<0.001	<0.001	<0.001
Ba	mg/L	0.008[3]	4	**0.011**	**0.0285**	**0.042**	2	**0.088**	**0.097**	**0.106**
Boron (B)	mg/L	0.370	4	<0.05	<0.05	<0.05	2	<0.05	<0.05	<0.05
Cobalt (Co)	mg/L	0.0014[3]	4	<0.001	<0.001	<0.001	2	<0.001	<0.001	<0.001
Total Chromium (Cr)	mg/L	0.001	7	<0.001	<0.001	<0.001	3	<0.001	<0.001	<0.001
Cu	mg/L	0.0014	4	<0.001	<0.001	<0.001	2	0.001	0.0024	0.0034

				Yarrangobilly River				Wallaces Creek		
Description/ constituent	**Unit**	**Guideline value**	**Number of samples**	**10th percentile[5]**	**Median**	**90th percentile**	**Number of samples[5]**	**Minimum**	**Median**	**Maximum**
Manganese (Mn)	mg/L	1.9	4	0.001	0.001	0.002	2	0.001	0.0015	0.002
Ni	mg/L	0.011	7	0.001	0.001	0.002	3	0.001	0.002	0.002
Pb	mg/L	0.0034	4	<0.001	<0.001	<0.001	2	<0.001	<0.001	<0.001
Selenium (Se)	mg/L	0.005	4	<0.01	<0.01	<0.01	2	<0.01	<0.01	<0.01
Silver (Ag)	mg/L	0.0005	4	<0.001	<0.001	<0.001	2	<0.001	<0.001	<0.001
Vanadium (V)	mg/L	0.006[3]	4	<0.01	<0.01	<0.01	2	<0.01	<0.01	<0.01
Zn	mg/L	0.008	4	<0.005	<0.005	<0.005	3	<0.005	<0.005	<0.005
Hg	mg/L	0.00006	4	<0.0001	<0.0001	<0.0001	2	<0.0001	<0.0001	<0.0001
Iron (Fe)	mg/L	0.3[3]	4	0.05	0.05	0.06	2	<0.05	<0.05	<0.05

Notes: 1. The Guideline Values for field parameters and nutrients refer to the trigger values for physical and chemical stressors in south-east Australia (upland rivers) that are reported in Tables 3.3.2 and 3.3.3 of ANZECC (2000).

2. Unless otherwise stated, the Guideline Values for dissolved metals refer to the trigger values for slightly-moderately disturbed ecosystems that are reported in Table 3.4.1 of ANZECC (2000). It is noted that no hardness adjustments have been made.

3. The Guideline Value refers to a low reliability trigger value that has been established using the methods recommended in Section 8.3.4.5 of ANZECC (2000).

4. Value is below guideline values once adjustments for hardness are made using the hardness adjustment algorithms provided in Table 3.4.3 of ANZECC (2000).

5. If less than 10 samples are available, the minim value is reported instead of the 10th percentile value and the maximum value is reported instead of the 90th percentile value.

3.4.3 Flooding

The Exploratory Works have been located to avoid flood prone land where possible. However, the western excavated rock emplacement location cannot avoid the flood plain along the Yarrangobilly River but has been sited to prevent the risk of the rock emplacement being entrained in flood waters during a 0.2% AEP event. GRC Hydro Limited undertook flood modelling for the project area including the western excavated rock emplacement. The full analysis can be reviewed in the *Surface Water Assessment* (EMM 2018e). Notwithstanding the modelling has been undertaken in accordance with the methods recommended in the *Australian Rainfall and Runoff Guideline A Guide to Flood Estimation* (Commonwealth of Australia 2016). The flood model results have been used to establish flood characteristics within Lobs Hole (including the Lick Hole catchment) for the 20%, 5%, 1%, 0.2%, 0.05% annual exceedance probability (AEP) and probable maximum flood (PMF) events.

The outcome of the flood modelling assessment is that the western excavated rock emplacement can be located on the flood plain along the Yarrangobilly River but will however require some flood mitigation such as toe armouring or a flood protection berm.

3.5 Groundwater

A groundwater characterisation program commenced in February 2018. This program includes 20 groundwater monitoring bores at 11 locations; where more than bore is installed at a single location, this is called a nested location. Each bore at a nested location is installed to a different depth, monitoring a different zone within the groundwater systems.

Further details on the sampling locations and water sample analysis methods can be reviewed in the *Groundwater Assessment* (EMM 2018b).

3.5.1 Hydraulic conductivity

Hydraulic conductivity of the geological units (Section 3.3.3) is considered to range from very low to high. That is 0.00034-3.59 metres per day (m/day) equating to approximately 1×10^{-9} metres per second (m/s) to 1×10^{-5} m/s (Table 11) (EMM 2018b).

Table 11 Project area geology and hydraulic conductivity

Geological unit	Hydraulic conductivity (m/day)
Ravine Beds (weathered)	0.03-0.17
Ravine Beds (competent fractured rock)	0.00034
Boraig Group (Rhyolite)	3.08-3.59

3.5.2 Flow

The regional groundwater flow direction in the main hydrogeological unit of the project area, the Ravine Beds, is influenced by the location of major hydraulic boundaries in the landscape, including:

- topography;
- recharge areas, particularly north of the project area boundary at elevated areas where the Ravine Beds outcrop with limited vegetation cover;
- discharge areas, typically associated with lower or steep topographic gradients, such as cliff escarpments or Talbingo Reservoir; and
- stratigraphic dip of the geological units.

The main groundwater flow direction in the Ravine Beds is regionally from areas of higher elevation in the west towards the east; this is consistent with the regional topography and stratigraphic dip (Wyborn and Owen 1990).

3.5.3 Recharge

There are likely two primary sources of groundwater recharge:

1. Rainfall recharge (dominant recharge source) is estimated to be up to 10% within the Ravine region and between 10-30% within the higher plateau area east of the project area. This higher than average recharge estimate is considered appropriate given the unconsolidated, fractured and leaky aquifer nature of overlying colluvial sediments and basaltic ridge caps.
2. Direct leakage from rivers and storages (secondary recharge source) is likely to occur in some areas, particularly adjacent to the Yarrangobilly River where the water level is elevated above the regional groundwater table.

Given the prominence of groundwater springs across the incised area, it is likely that the water table is locally elevated within this area. The shallow water table is likely to be contributing to local drainage lines, fens, swamps and larger creek systems. However, during periods of extended drought and seasonal fluxes associated with wet and dry seasons, hydraulic gradients may be reversed, prompting surface water systems to discharge to a reduced groundwater table.

3.5.4 Groundwater quality

Groundwater quality results collected between February 2018 and April 2018 are presented as a mean for the main geological units of the project area in Table 12. Figure 14 shows the monitoring bore locations.

Table 12 Main geological units mean groundwater results

Analyte	**Units**	**TMB05A**	**TMB05B**	**TMB01A**	**TMB01B**
Geological unit		**Ravine Beds (weathered)**	**Ravine Beds**	**Boraig Group**	**Ravine Beds**
Field		8.18	9.18	7.62	7.37
pH	-	948	613	470	1,050
EC	µS/cm	18.2	18.8	16.3	19
Temperature	ºC	1.7	2.88	3.09	6.57
Dissolved oxygen		8.18	9.18	7.62	7.37
Laboratory					
Total dissolves solids	mg/L	627	484	1,530	765
Major ions	mg/L				
Ca	mg/L	35	6	11	21
Cl	mg/L	9	10	21	63
Mg	mg/L	8	4	6	13
Na	mg/L	148	142	99	248
K	mg/L	11	8	4	9
Sulfate (SO_4)	mg/L	348	22	4	4

Analyte	Units	TMB05A	TMB05B	TMB01A	TMB01B
Geological unit		**Ravine Beds (weathered)**	**Ravine Beds**	**Boraig Group**	**Ravine Beds**
F	mg/L	1.1	1.5	1.8	3
Alkalinity					
Bicarbonate as $CaCO_3$	mg/L	117	198	267	572
Carbonate as $CaCO_3$	mg/L	<1	128	<1	<1
Hydroxide as $CaCO_3$	mg/L	<1,000	<1,000	<1,000	<1,000
Total as $CaCO_3$	mg/L	117	326	267	572
Total Metals					
As	mg/L	0.01	0.011	0.006	0.023
Cd	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Cr (III+VI)	mg/L	0.003	0.013	<0.001	<0.001
Cu	mg/L	0.004	0.003	<0.001	0.002
Hg	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Ni	mg/L	0.001	0.003	0.002	0.008
Zn	mg/L	0.007	0.012	0.006	0.128
Pb	mg/L	<0.001	<0.001	<0.001	<0.001
Nutrients					
Ammonia as Nitrogen (N)	mg/L	300	80	40	<10
Total kjeldahl N	mg/L	0.6	0.3	2.6	0.1
Nitrate (as N)	mg/L	0.03	0.2	18.5	0.04
Nitrite (as N)	mg/L	<0.01	<0.01	<0.01	<0.01
Total N	mg/L	600	500	21,100	100
P	mg/L	0.66	0.03	0.48	0.01

The groundwater quality results (Table 12) are reasonably comparable between the different target formations across the project area. The pH is slightly alkaline, averaging 7.5. Salinity is marginal (780 µS/cm) and concentrations of most dissolved metals are typically low, with many measurements below detection limits. This is typical of groundwater with reasonably neutral pH and in alpine areas where the groundwater is readily recharged via rainfall and snow melt.

3.6 Biodiversity

3.6.1 Terrestrial ecology

Extensive ecology surveys and assessments have been completed for the project area. The details and results of the ecology surveys are described in the *Biodiversity Assessment* (EMM 2018a). The ecology survey considered threatened species as well as mapping the baseline ecology across the project area.

There are no listed high-priority terrestrial or groundwater dependent ecosystems.

The Yarrangobilly River was identified as providing habitat to threatened species including the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 listed Booroolong Frog (*Litoria booroolongensis*).

3.6.2 Aquatic ecology

Exploratory Works have the potential to impact the aquatic ecology of Talbingo Reservoir, Yarrangobilly River, Wallace's Creek and some of their minor tributaries. Yarrangobilly River and Wallace's Creek support relatively undisturbed aquatic habitat and the threatened Murray crayfish (Cardno 2018).

The primary potential impact to these watercourses is associated with reductions in water quality associated with release of sediment laden water during Exploratory Works. The presence of other constituents and nutrients in any discharge may also affect aquatic biota. Such impacts could be adequately controlled by successful implementation of standard erosion and sediment controls and strict water quality controls.

4.0 Design considerations

4.1 Geochemistry

4.1.1 Soil

The soil within the excavated rock emplacement areas likely has low fertility; however, it is considered a valuable resource for the rehabilitation of the eastern excavated rock emplacement once it is constructed.

The URS (2006) and EMM (2018c) investigations have shown that the soil adjacent to Lick Hole Gully Adit is contaminated from Lobs Hole Mine. This soil and excavated rock should be avoided and will preferentially be used to backfill the Lick Hole Gully Adit. Once backfilled the ground surface will be track rolled and graded so that it is consistent with the surrounding topography.

4.1.2 Excavated rock

An assessment was undertaken to determine the potential for acid rock drainage (ARD), spontaneous combustion and the presence of asbestiforms in excavated rock (the reactive rock).

The analysis does not include an assessment of geology or where the most reactive excavated rock will be encountered in the exploratory tunnel sequence. It is however believed that reactive rock does occur at depth and that it is likely that at least some reactive rock will be excavated and placed in the eastern excavated rock emplacement.

4.1.2.1 Potential for acid rock drainage

An assessment (from Envirolab Services Certificate of Analysis) was completed for seven samples from drill hole BH5102 (Figure 14) and is provided in Appendix A.

Whether rock is potentially acid forming (PAF) or non-acid forming (NAF) and/or acid consuming (AC) is determined from the acid-base account. The acid-base account involves static laboratory analysis that evaluates the balance between acid generating processes (oxidation of sulfide minerals) and acid neutralising processes (dissolution of alkaline carbonates, displacement of exchangeable bases, and weathering of silicates).

The values arising from the acid base account are referred to as the acid producing potential (APP) and the acid neutralising capacity (ANC) which are expressed as kilograms of sulfuric acid per tonne of rock (kg H_2SO_4/t). The difference between the APP and the ANC is referred to as the NAPP.

Table 13 presents a summary of the geochemistry desktop assessment for rock samples from drill hole BH5102 which runs in the general vicinity of the exploratory tunnel. The classification of PAF, NAF and/or AC rock has been made based on the classification scheme presented in Appendix B (AMIRA 2002). Table 13 shows that the two samples collected at the proposed depth of the exploratory tunnel are PAF with an acid forming potential of between 4.6-6.3 kg H_2SO_4/t. However, it should be noted that the other rock samples had excess acid neutralising capacity (ANC) and are classified as AC. There is therefore potential that any acidity produced by PAF rock is consumed by the AC rock. Further, the pH results show that all rock samples are alkaline, and the EC results do not indicate a potential salinity risk.

Table 13 Rock geochemistry results

		Sample number						
Analysis	Units	BH5102 tray 102	BH5102 tray 122	BH5102 tray 131	BH5102 tray 134	BH5102 tray 179	BH5102	BHS102
Depth	m	393.39-393.42	470.81-470.85	506.95	520.70	699.46-699.56	798.12-798.20	830.35-830.41
Total S	%	0.03	0.04	0.05	0.06	0.10	0.24	0.30
pH (1:2)	pH unit	8.70	8.70	8.80	9.10	9.00	8.90	9.10
EC (1:2)	µS/cm	240.00	250.00	230.00	460.00	280.00	170.00	110.00
APP	kg H_2SO_4/t	0.90	1.20	1.5	1.8	3.10	7.30	9.20
ANC	kg H_2SO_4/t	9.80	13.00	20.00	98.00	54.00	6.40	6.40
NAPP	kg H_2SO_4/t	-8.99	-12.00	-19.00	-96.00	-50.00	0.90	2.80
NAG pH 7.0	kg H_2SO_4/t	<0.50	<0.50	<0.50	<0.50	<0.50	4.60	6.30
ANC:APP	-	10.89	10.83	13.33	54.44	17.42	<0.00	<0.00
NAG:NAPP	-	>0.50	>0.50	>0.50	>0.50	>0.50	5.11	2.25
Classification	-	NAF	NAF	NAF	NAF	NAF	PAF	PAF

The URS (2006) and EMM (2018c) investigations have shown that the main constituents of concern are As, Pb, Hg, Cu and Ni. All of which are highly soluble when pH ≤4. However, metal hydroxides of these constituents would readily form when pH≥6 and their solubility would be less than 0.001 mg/L when pH≥9 when calcium carbonates are present (Peters & Shem 1982). Calcium carbonates would be available from the AC rock.

Overall the risk of ARD from excavated rock is considered low. Further, runoff from Lobs Hole Mine will continue to travel through Lick Hole Gully, even after construction of the eastern excavated rock emplacement, and will therefore be passively treated by the AC rock. Further detail on passive treatment of runoff from Lobs Hole Mine is presented in Section 4.0.

4.1.2.2 Potential for spontaneous combustion

The potential risk of spontaneous-combustion in the eastern excavated rock emplacement is considered very low because historically there have been no incidences of self-heating or spontaneous-combustion within PAF rock at Lobs Hole Mine. Spontaneous-combustion is usually controlled through a combination of selective placement of PAF excavated rock, encapsulation with AC excavated rock and compaction of the surface to limit oxygen convection and advection.

Spontaneous-combustion is a chemical fire and cannot be extinguished by water. In fact, like any chemical fire the addition of water would make it more intense. In rock emplacements where self-heating occurs, heat may be transferred from hot to cold regions through the evaporation of moisture (water vapour) in hot areas and subsequent condensation in colder areas. This heat transfer is in addition to the transport of heat by natural convection and advection.

4.1.2.3 Potential for asbestiform mineral fibres

An early geological report (SMEHA 1953) has identified amphibole minerals in some samples from the Ravine Beds. To better understand the potential occurrences of asbestiform minerals in the project area a desktop geological assessment was carried out.

According to Deer et al. (1970), rock forming amphiboles have a range of compositions, but the calcic rich Hornblende is the most common amphibole. Drilling (part of the Exploratory Works) has tentatively identified tremolite and actinolite in the Gooandra Formation. Tremolite is calcic rich and is associated with low grade metamorphic rocks. Including the mineral chlorite-greenschist facies metamorphism that is seen across the project area, including in the Ravine Beds. The propensity to form fibrous minerals is noted, but true asbestiform mineral occurrences are not common.

Although the Ravine Beds are predominantly a sedimentary sequence there are noted occurrences of igneous rocks, such as volcanic tuffs. Drilling (part of the Exploratory Works) to the east of the Yarrangobilly valley, near the surge shaft site (Figure 3), has found felsic volcanic rocks but no amphiboles have been observed.

The Boraig Group appears to be dominated by volcanic rocks, being mostly felsic in nature. The record of observations by SMHEA (1953) must be relied upon. Therefore, during the remaining drilling investigations within the Ravine Beds and Boraig Group any occurrences of rock types that may potentially include amphibole minerals need to be carefully examined both in drill cores and under a microscope to check for fibrous or asbestiform minerals. Such occurrences are expected to be well bound in the crystalline fabric of the rock and occurrences of fibrous veining is unlikely.

4.1.3 Dredge sediment

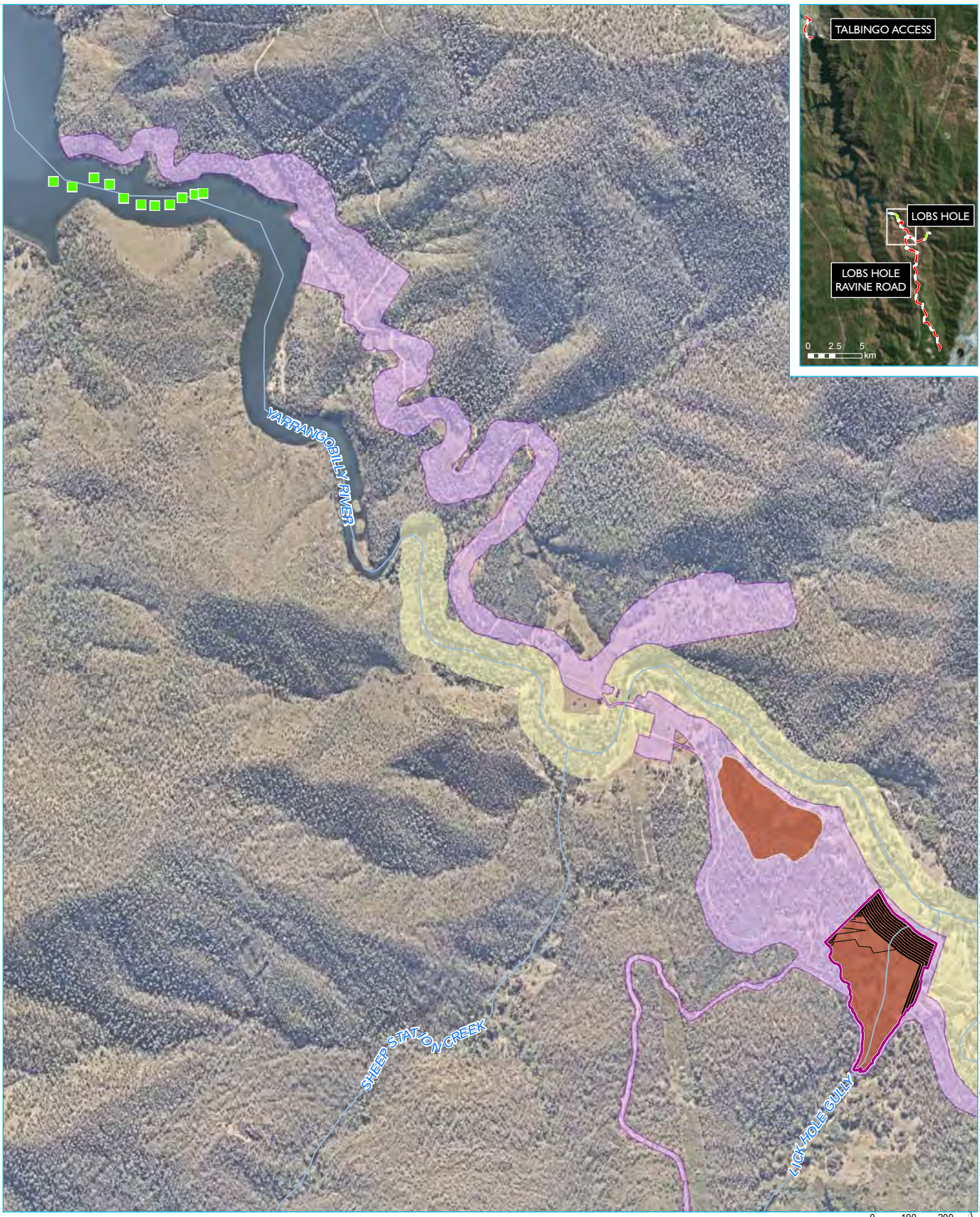
An assessment (from Eurofins Certificate of Analysis) of dredge sediment samples from Middle Bay was completed for 12 samples (Figure 15) and is provided in Appendix C.

Table 14 presents the laboratory results for the dredge sediment samples which show elevated concentrations of N, Al, Fe and Mn. The concentrations of metals are measured as total and given that the dredge sediment has been submerged in Middle Bay it is assumed that the metals are relatively insoluble. The nitrogen however, may

create elevated nutrient loads of the Yarrangobilly River if not adequately handled ie runoff from the eastern excavated rock emplacement to the Yarrangobilly River should be avoided.

Table 14 Dredge sediment sampling laboratory results

Constituent	Units Sample	MBSQ01	MBSQ01B	MBSQ02	MBSQ03	MBSQ04	MBSQ05	MBSQ06	MBSQ07	MBSQ08	MBSQ09	MBSQ10	MBSQ11
Ammonia (as N)	milligrams per kilogram (mg/kg)	79	82	86	74	70	69	110	91	84	53	68	65
Nitrate and nitrite (as N)	mg/kg	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
P	mg/kg	510	470	470	470	480	430	580	490	460	420	440	410
Sulphur	mg/kg	400	380	330	360	380	340	480	400	370	350	350	370
Total inorganic carbon	%	0.2	0.1	< 0.1	0.1	0.1	< 0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total kjeldahl N	mg/kg	1,100	1,100	930	1,000	1,000	1,000	1,000	1,000	1,000	1,100	1,100	1,000
Total organic carbon	%	4.6	4.8	4.1	4.3	5.2	4.1	6.7	4.9	4.7	4.4	4.3	4.7
Heavy metals													
Al	mg/kg	21,000	20,000	22,000	22,000	23,000	21,000	24,000	22,000	21,000	22,000	22,000	21,000
As	mg/kg	9.2	9	10	10	9.9	9.7	9.2	9.4	10	11	11	8.8
Ba	mg/kg	180	180	180	180	190	170	190	170	170	180	190	170
Be	mg/kg	< 2	< 2	< 2	< 2	2	< 2	2.3	< 2	< 2	< 2	< 2	< 2
B	mg/kg	11	< 10	< 10	< 10	< 10	< 10	< 10	< 10	11	< 10	< 10	< 10
Cd	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Cr	mg/kg	42	42	44	45	47	45	46	43	45	47	51	43
Co	mg/kg	12	12	13	14	14	13	14	13	14	14	14	12
Cu	mg/kg	57	56	58	62	63	66	54	58	65	71	73	60
Fe	mg/kg	24,000	24,000	25,000	26,000	27,000	26,000	27,000	25,000	26,000	26,000	27,000	24,000
Pb	mg/kg	26	25	26	26	27	26	26	25	26	27	28	24
Manganese (Mn)	mg/kg	400	400	420	400	400	350	430	410	400	370	370	340
Hg	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Mo	mg/kg	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Ni	mg/kg	48	47	49	51	52	51	51	48	50	52	57	48
Selenium (Se)	mg/kg	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Silver (Ag)	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
V	mg/kg	28	28	29	30	31	29	31	28	29	30	32	28
Zn	mg/kg	86	85	87	90	92	87	94	85	87	90	94	83



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

0 100 200 m
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KEY

- Dredge sediment sampling location
- Watercourse
- On land rock management
- Conceptual WRD design contour
- Conceptual WRD design footprint
- Disturbance footprint
- Avoidance footprint

Dredge sediment sampling from Middle Bay

Snowy 2.0
WRD design
Exploratory Works
Figure 15

snowy 2.0

EMM

4.1.4 Handling options

Based on the review presented the eastern excavated rock emplacement must consider handling options to prevent ARD, limit the potential for runoff from dredge sediment being discharged and protect biodiversity.

4.1.4.1 ARD

Handling of PAF rock usually involves segregation or ideal blending to limit the potential for ARD to be transported to the receiving environment (Table 15).

Table 15 Summary of placement options to limit ARD

Segregation	Ideal blend	Near ideal blend	Incomplete blend	Non-blended
Alkaline conditions dominate because the PAF spoil is adequately encapsulated.	Alkaline conditions dominate throughout the rock emplacement.	Locally acidic conditions may occur, but neutralisation occurs rapidly.	Locally acidic conditions occur and migration of acidic pore water leaches surrounding spoil before neutralisation.	Acidic conditions occur with metal leaching. No blending and does not result in neutralisation.
The rock emplacement seepage is pH neutral, low trace metal and sulfate concentrations.	The rock emplacement seepage is pH neutral, low trace metal and sulfate concentrations.	The rock emplacement seepage is pH neutral and low trace metal concentrations, but likely has moderate to high sulfate.	The rock emplacement seepage is pH neutral, has high sulfate, low transition metal concentrations but potentially elevated ion concentrations.	The rock emplacement seepage produces acid and/or metalliferous drainage.

Notes:
1. Green = desirable outcome
2. Amber = decreasing desirability (outcome) from left to right
3. Orange = non-desirable outcome

Given the limited information regarding the volume and frequency of occurrence of PAF and AC rock it is unlikely that a reliance on ideal blending alone would limit the potential risk of ARD.

Segregation can be achieved by including a layer of AC limestone (a source of calcium carbonate) between each lift of the rock emplacement. Further the potential for ARD can be further limited by constructing the eastern excavated rock emplacement from the bottom-up. The bottom-up construction method would limit the potential for ARD by limiting oxygen convection and advection and limiting rainfall infiltration, percolation and seepage.

Notwithstanding, the strategy to limit ARD must also consider the potential risk from mine impacted runoff from the Lobs Hole Mine.

4.1.4.2 Potential for elevated nutrients in surface runoff

To prevent elevated nutrients in surface runoff from the emplacement areas reaching the Yarrangobilly River all dredge sediment must be placed away from the outer edges of the eastern excavated rock emplacement to prevent runoff.

4.1.4.3 Biodiversity

A 50 m exclusion zone has been established from the bank of the Yarrangobilly River to avoid and minimise impacts to threatened species (Booroolong Frog) habitat. This exclusion zone aims to avoid and minimise impacts to riparian vegetation and land that may provide habitat.

Once the excavated rock emplacement areas are constructed the exclusion zone should be managed to improve the habitat value by promoting a more diverse vegetation community.

4.2 Emplacement

The following emplacement strategies have been identified to limit the future risks that may arise from ARD, elevated nutrients in surface runoff, biodiversity and potentially impacted water from Lobs Hole Mine.

4.2.1 Eastern excavated rock emplacement

4.2.1.1 Geometry

It is important to consider the potential impact that rainfall would have on the water balance ie ponding, infiltration, storage and seepage. A rock emplacement built as a single lift would have a greater proportion of flat top area than side (batter) slope area. A greater flat top area would limit the opportunity for ponding of water followed by infiltration and seepage because the flat top area could be graded to promote runoff. Conversely, building the spoil stockpile higher (ie multiple lifts) would result in a smaller flat top area and an increased side batter slope area, which would result in an increased potential for infiltration and seepage because the side batter slopes would be less trafficked and more readily allow rainfall to infiltrate.

4.2.1.2 Soil and vegetation stripping

The soil within Lick Hole Gully likely has poor fertility; however, it is considered useful for treatment of benches of the eastern excavated rock emplacement to encourage vegetation growth. Vegetation growth would limit the potential for erosion.

Based on the review, soil within Lick Hole Gully can be stripped to a depth of 0.5 m below ground level, yielding 36,100 m^3 of soil excluding the Lick Hole Adit. Stripped soil will be stored on the western excavated rock emplacement.

Further, vegetation can also be stripped and mulched and used for treatment of the benches. Mulched vegetation in addition to the soil would be a valuable source of seed to establish vegetation.

Both the soil and vegetation stockpiles would be managed in accordance with the *Soil and Land Assessment* (EMM 2018d).

4.2.1.3 AC pad

An AC pad is required to separate Lick Hole Gully from the overlying PAF excavated rock. The AC pad should be 1 m thick and straddle 20 m either side of the low point in Lick Hole Gully (ie 40 m wide).

In addition to separating sub-lateral flow from Lick Hole Gully from the eastern excavated rock emplacement the AC pad would also passively treat mine impacted runoff from Lobs Hole Mine that flows through Lick Hole Gully.

4.2.1.4 Lift height and bench width

The target permeability of the rock emplacement should approach the natural rate of groundwater recharge, that is, 1×10^{-5} m/s (Section 3.5.1). Therefore, the eastern excavated rock emplacement should be built in thin lifts (1 m excavated rock layers) so that each excavated rock layer can be compacted by trafficking and roller compaction. Each lift can be 2 m high but should be built in two 1 m layers.

Each lift should be separated from the lift above by a 4 m bench. The crest of each bench should be bunded so that any runoff from the batter slope above the bench can be captured. Further, the benches should be soiled, mulched and seeded to promote vegetation growth. Therefore, any runoff captured on the bench will become plant available water, reducing the overall potential for seepage from the eastern excavated rock emplacement entering the Yarrangobilly River or forming groundwater recharge.

Each bench should be rehabilitated as soon as practical.

4.2.1.5 AC limestone layers

The geochemical assessment has identified that some PAF rock will be present in the eastern excavated rock emplacement. The acid forming potential of the PAF excavated rock is expected to be between 4.6-6.3 kg H_2SO_4/t. However, it should be noted that the other excavated rock is expected to have excess ANC and will have AC capacity. There is therefore potential that any acidity produced by PAF excavated rock is consumed by the AC excavated rock. Further, the pH results show that all rock samples are alkaline, and the EC results do not indicate a potential salinity risk.

To further limit the geochemical risk, a layer of AC limestone should be placed above each 1 m thick rock layer, so that there are two layers of AC limestone in every lift. Adoption of this strategy will promote the formation of metal hydroxides and reduce the risk of constituents being transported to the Yarrangobilly River where they may impact terrestrial and aquatic habitats (refer to Section 4.1.2.1).

The limestone layers should be constructed from AC limestone that is at least 95% pure.

4.2.1.6 Batter slope treatment

Batter slopes are to be constructed from excavated rock, all dredge sediment is to be placed away from batter slopes to prevent potential elevated nutrients reaching of the Yarrangobilly River.

The batter slopes can either be left as exposed excavated rock or can be rehabilitated as per the instructions provided in Section 4.2.1.4.

Each batter slope face would be approximately 8 m long (1(V):1.3(H)) and therefore the erosion potential from such a small catchment is likely to be small. Further, the batter slopes would be armoured because of their construction (ie drill-and-blast-rock) which would further limit the potential for erosion. If left bare the batter slopes would eventually be blocked from view by vegetation growth on the benches.

4.2.2 Western excavated rock emplacement

The western excavated rock emplacement will be used to temporarily store material that has a low geochemical risk and cleared vegetation for. Low geochemical risk material will be reused or disposed of within Talbingo Reservoir. The landform will be built in a manner that limits compaction and will be soiled and vegetated to stabilise the landform.

4.3 Water management

The following sections summarises the proposed water management strategy for the eastern and western excavated rock emplacements. Further detail on water management design can be reviewed in the *Surface Water Assessment* (EMM 2018e).

4.3.1 Eastern excavated rock emplacement

The proposed water management design for the eastern excavated rock emplacement promotes infiltration of runoff from Lick Hole Gully. The water management strategy avoids the need to establish a permanent flow diversion of Lick Hole Gully and drop structures or rock chutes to move runoff from the flat top to the toe of the rock emplacement. Infiltrated water will percolate along the base of the rock emplacement, through an AC limestone pad and seep from the northern end toe, into the existing Lick Hole Gully before flowing into the Yarrangobilly River.

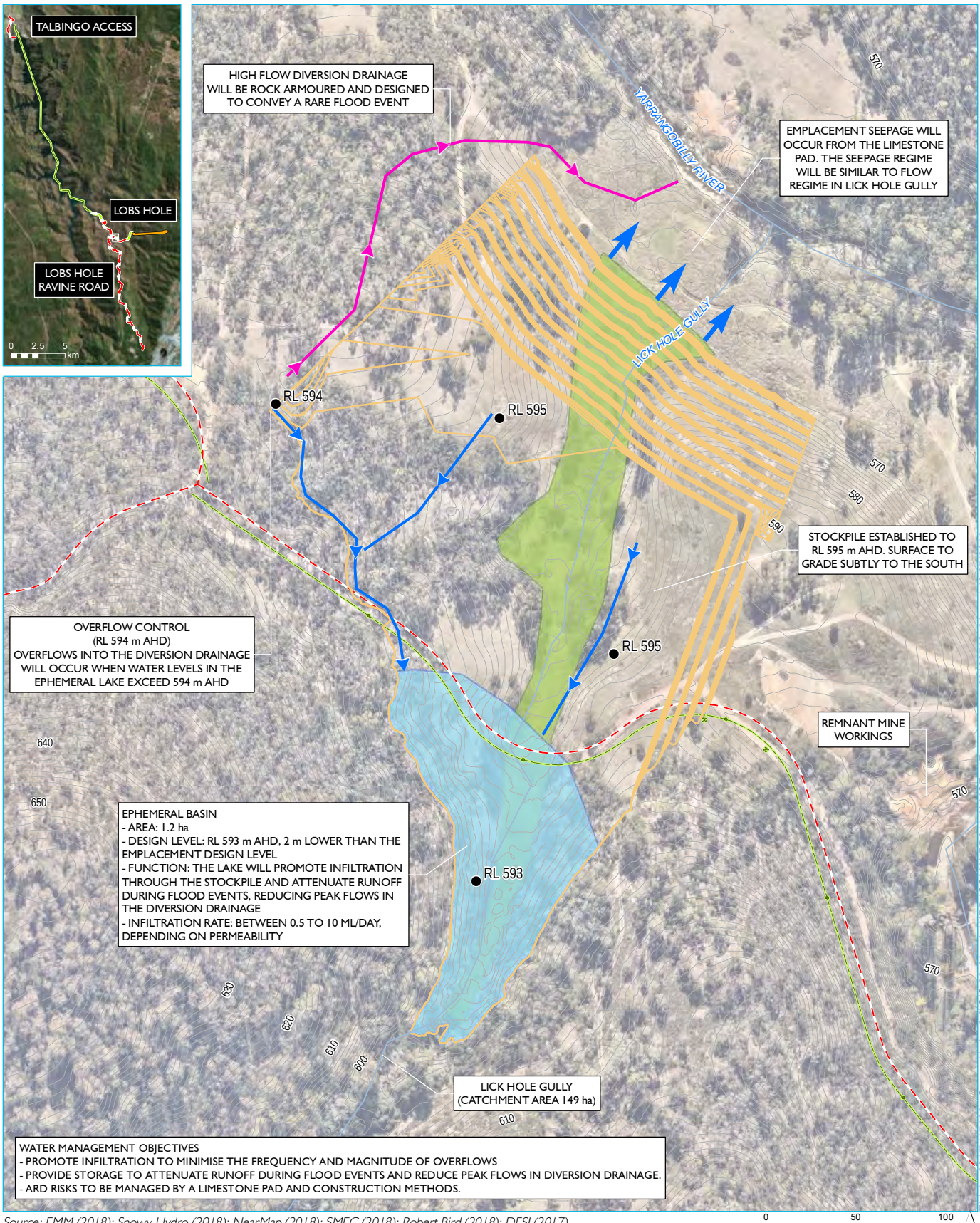
A high flow diversion drain will also be established at the top of the eastern excavated rock emplacement to divert excess runoff from Lick Hole Gully around the eastern excavated rock emplacement during flood events or extended periods of wet weather.

The proposed water management concept is described in Table 16 and presented conceptually in Figure 16. Further detail on the proposed water management strategy can be reviewed in the *Surface Water Assessment* (EMM 2018e).

Table 16 Eastern excavated rock emplacement water management strategy

Design aspect	Design approach
Management of runoff from Lick Hole Gully	Runoff from Lick Hole Gully will pond in an ephemeral basin that will be established within the southern extent of the rock emplacement (Figure 16). The ephemeral basin will be established approximately 2 m below the flat top level (595 m AHD). The floor of the ephemeral basin will be excavated rock and/or AC limestone. During normal stream flow conditions, all runoff will slowly infiltrate into the rock emplacement. Calculating the rate of infiltration is complex, however it is expected to be 0.5-10 mega litres per day (ML/day). The large variance in range is due to uncertainties around hydraulic conductivity and percolation rates through the rock emplacement. During significant flood events and/or periods of extended rainfall, the ephemeral basin will fill because the rate of inflow will exceed the rate of infiltration. When the basin level reaches 594 m AHD (1 m deep), it will overflow to the west into a diversion drain (Figure 16). During major flood events, storage above 594 m AHD will reduce peak flows through Lick Hole Gully, reducing overflow rates by more than 50% into the diversion drain.
High flow diversion drainage	Overflows from the ephemeral basin will occur during significant flood events and/or periods of extended rainfall. Diversion drainage is required to move overflows into the Yarrangobilly River to the north. The proposed diversion drain alignment is indicated in Figure 16. The diversion drain will need to be adequately designed to convey peak flows from flood events. This will require rock armouring for diversion drain sections located in gullies and excavated drains for sections that are along the contour. As discussed above, the storage provided by the ephemeral basin will significantly reduce the peak flow rates by more than 50%, resulting in smaller drains and reduced failure risks.
Management of runoff from the flat top	The rock emplacement is expected to have medium to high permeability rates. Accordingly, surface runoff from the flat top will only occur during intense bursts

Design aspect	Design approach
	of rainfall. Surface runoff will be directed to the south (Figure 16) and will drain into the ephemeral basin. Runoff volumes from the flat top are expected to be insignificant when compared to runoff volumes from Lick Hole Gully.
Management of runoff from the benches	All runoff from the rock emplacement flat top will be directed to the south, away from the benches. The benches will be graded back towards the rock emplacement and bunded so that any runoff from direct rainfall onto the benches and upslope lift will pond against the toe of the above lift forming plant available water. As a result, no surface runoff from the benches is expected to occur.



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

KEY

- Design level
- Exploratory tunnel and portal
- Access road upgrade
- Communications cable
- Eastern emplacement design contours
- Watercourse
- Contour (1m LiDAR)
- Emplacement drainage
- Diversion drainage
- Ephemeral lake
- Limestone pad

Eastern excavated rock emplacement water management strategy

Snowy 2.0
WRD design
Exploratory Works
Figure 16

4.3.2 Western excavated rock emplacement

The western excavated rock emplacement does not require diversions or drop drains. As discussed in Section 3.4.3, the western excavated rock emplacement will be designed to prevent the risk of the rock emplacement being entrained in flood waters during a 0.2% AEP event. This will be achieved by a flood protection berm or rock armouring along the northern toe.

5.0 Recommended design

5.1 Eastern excavated rock emplacement

The recommended eastern excavated rock emplacement design is shown in Figure 17. The following sections describes site preparation, construction and operation and management and monitoring of the eastern excavated rock emplacement.

Since the geochemical nature of the excavated rock cannot be adequately described at this stage, the design removes the need to characterise and separate PAF excavated rock from NAF excavated rock. Rather design can allow non-ideal blending (Table 15) and then uses compaction and limestone to limit the future potential reactivity of the PAF excavated rock. That is, the design disrupts oxygen and water flow paths, both of which are required for the oxidation of PAF excavated rock. This is achieved by building the eastern excavated rock emplacement in thin layers of 1 m, which is effectively compacted by trafficking and compaction rollers. The trafficked layers disrupt the flow of oxygen, which usually occurs through the base of a rock emplacement. Further, the trafficked layers also disrupt infiltration which will likely exit the eastern excavated rock emplacement on the benches, forming plant available water, as opposed to infiltrating the full thickness of the eastern excavated rock emplacement where it will be discharged to the Yarangobilly River or form groundwater recharge. Finally, the inclusion of limestone layers throughout the eastern excavated rock emplacement provides excess ANC which will limit future potential for ARD.

The eastern excavated rock emplacement would contain the following approximate volumes:

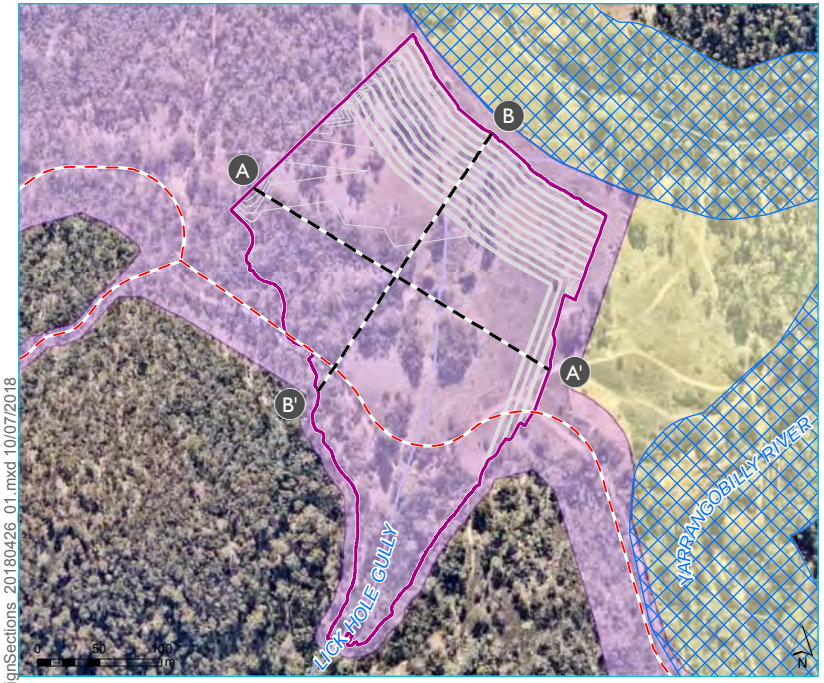
- excavated rock — 455,000 m^3;
- AC Limestone — 58,000 m^3 assuming 100 mm layers; and
- Dredge sediment — 45,000 m^3.

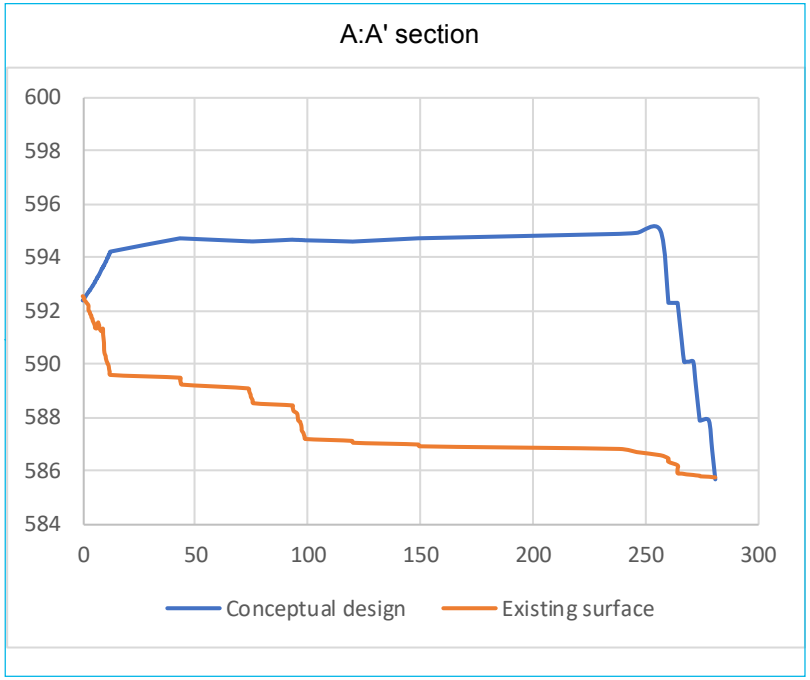
It should be noted that excavated material will also be sub-aqueously disposed within Talbingo Reservoir, this is described in further detail in Section 6.2.

5.1.1 Site preparation

Prior to constructing the eastern excavated rock emplacement, the Lick Hole Gully Adit would be backfilled, and track rolled. Once this is completed the remaining eastern excavated rock emplacement would be stripped of its soil and vegetation to a depth of 0.5 m below ground level. The soil and vegetation would be placed on the western excavated rock emplacement. Once the soil has been stripped the base of Lick Hole Gully will be lined with a 1 m thick and 40 m wide AC limestone pad. The purpose of the AC limestone pad is to:

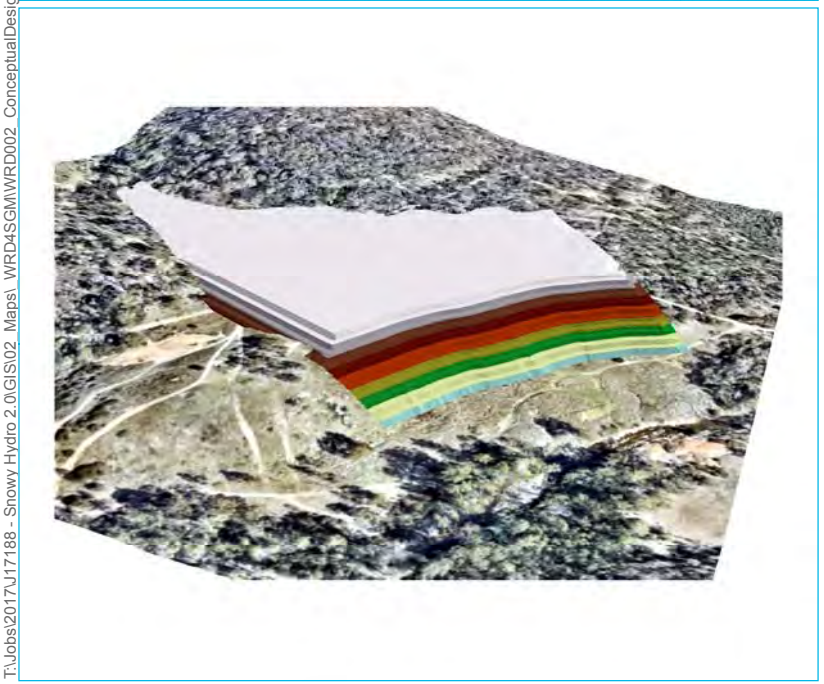
- separate flow in Lick Hole Gully from the eastern excavated rock emplacement under low flow conditions; and
- passively treat impacted drainage from Lobs Hole Mine by encouraging the formation of metal hydroxides ie the metals would precipitate, reducing their concentrations in discharge entering the Yarrangobilly River.

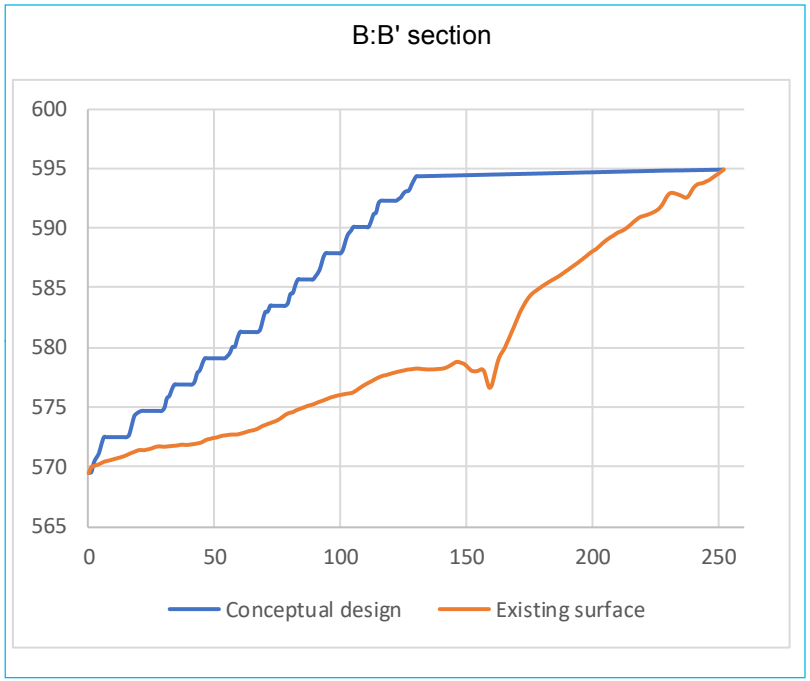




KEY

- Cross-section
- Access road upgrade
- Watercourse
- Conceptual WRD design contour
- Conceptual WRD design footprint
- Yarrangobilly exclusion area
- Disturbance footprint
- Avoidance footprint





Eastern excavated rock emplacement

Snowy 2.0
WRD design
Exploratory Works
Figure 17

Source: EMM (2018); Snowy Hydro (2018); SMEC (2018); NearMap (2018)

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5.1.2 Construction and operation

The eastern excavated rock emplacement would be built from the bottom-up on-top of the AC limestone pad and would maintain a minimum 50 m distance to the Yarrangobilly River. The 50 m standoff would be surveyed from the top of bank prior to construction of the eastern excavated rock emplacement and physically marked out on the ground using survey stacks.

The target permeability of the temporary spoil stockpile should approach the natural rate of groundwater recharge, that is, 1×10^{-5} m/s. The target permeability would be achieved by trafficking or roller compacting each layer during construction.

Excavated rock will be transported along Mine Trail Road to the eastern excavated rock emplacement, with access provided on its western side (ie avoiding trafficking over the former Lobs Hole Mine area). Transportation will include the following controls:

- truck trays will be sealed to prevent releases of liquids during transport and will be covered;
- truck wheel wash facilities will be put in place at the exploratory tunnel portal and eastern excavated rock emplacement exit points to remove material from transport vehicles and prevent spreading along the transport route;
- surfaces at entrance and exit points of the exploratory tunnel, stockpile and eastern excavated rock emplacement will be treated with lime (if and as required) to limit the potential for ARD; and
- truck transport registers will be kept ensuring all loads are tracked and not misplaced.

It should be noted that Mine Trail Road will remain unaffected by the construction of the eastern excavated rock emplacement.

The eastern excavated rock emplacement would be built in eleven 2 m lifts. Each lift would be built in two 1 m layers. Dredge sediment will be placed well away from the batter slopes of the eastern excavated rock emplacement.

The excavated rock layers would be separated by an AC limestone layer. It is recommended that the layers of AC limestone should be at a minimum 100 mm thick, but should be thicker (Figure 18) if the average NAG pH 7.0 result is greater than 65 kg H_2SO_4/t.

If the average NAG pH 7.0 result is equal to the limit of detection at the laboratory (0.5 kg H_2SO_4/t) then an AC limestone layer is not required.

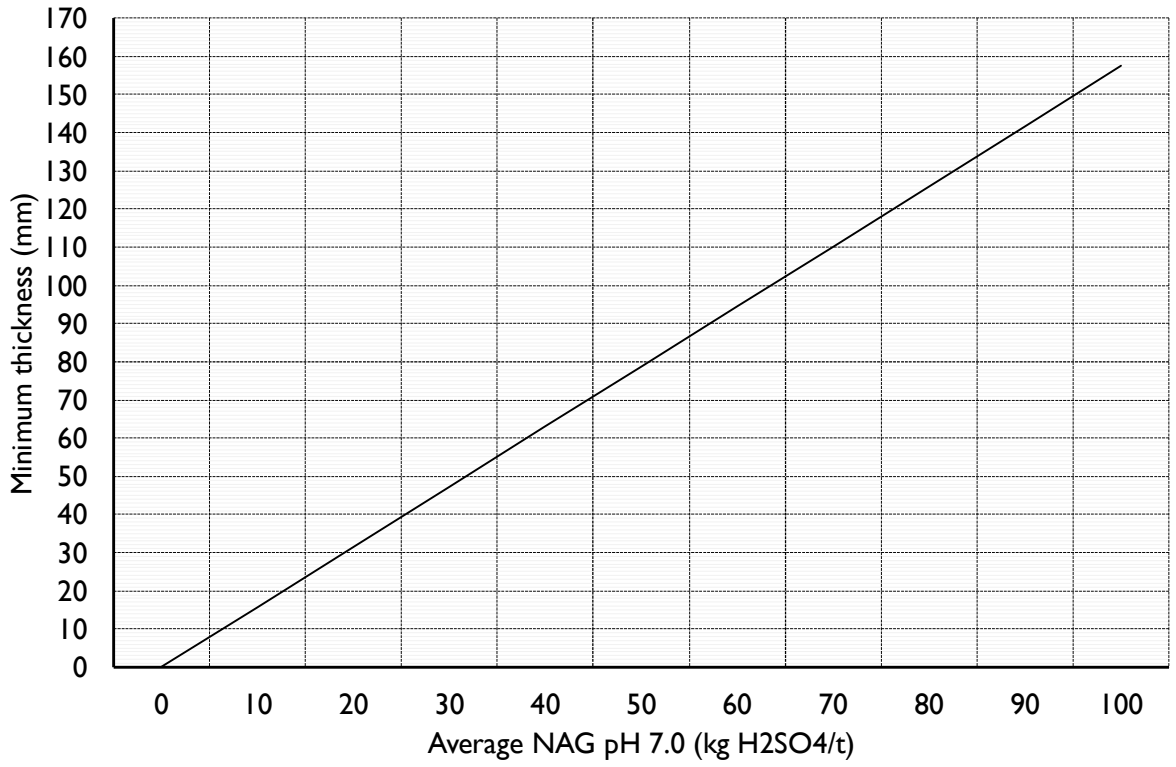


Figure 18 AC Limestone layer thickness based on average NAG pH 7.0

The AC limestone should be ordered and delivered in advance of each excavated rock layer being completed. The AC limestone should be stockpiled on a completed section of the eastern excavated rock emplacement and spread as soon as the excavated rock layer is complete.

Each lift is separated from the lift above by a 4 m bench. The benches will be graded back towards the rock emplacement and bunded so that any runoff from direct rainfall onto the benches and upslope lift will pond against the toe of the above lift. As a result, no surface runoff from the benches is expected to occur. Benches will be soiled, mulched and seeded to promote vegetation growth. Therefore, any runoff captured on the bench would become plant available water.

The batter slopes can either be left as exposed excavated rock or can be rehabilitated as per the instructions above. Each batter slope face is approximately 8 m long and therefore the erosion potential from such a small catchment is also small. Further, the batter slopes are armoured because of their construction (ie drill-and-blast-rock) which limits the potential for erosion. Once vegetation is established the batter slopes will be less visible.

5.1.2.1 AC limestone physical and chemical properties

AC Limestone for the eastern excavated rock emplacement can be sourced locally from sources external to KNP:

- AC Limestone used for the AC pad should be run-of-mine and sourced directly from a local supplier. That is, the AC pad should be constructed from drill-and-blast AC limestone that has not been crushed and screened.
- The AC limestone layers should be constructed from 8 mm minus AC limestone. This product is produced at Moss Vale by crushing and screening. A typical particle size distribution for this product is presented in Appendix D.
- The AC limestone should be at least 95% pure. Typical chemical analysis for AC limestone sourced locally is presented in Appendix D.

5.1.3 Management and monitoring

5.1.3.1 Soil management

Management and mitigation measures to protect stripped soil are presented in the *Soil and Land Assessment* (EMM 2018d).

5.1.3.2 Sampling of excavated rock

A one kilogram spoil sample should be collected either daily or approximately every 6 m of exploratory tunnel advance, whichever is the greater of the two.

Samples should be collected in a sealed plastic bag and kept cool and dry.

Samples should be submitted to a NATA laboratory on a weekly basis for the following analysis:

- ANC; and
- NAG pH 7.0.

The laboratory results are to be used to decide on the AC limestone layer thickness applied to the final surface of each excavated rock layer.

5.1.3.3 Monitoring

Monitoring of the eastern excavated rock emplacement will be completed for erosion, surface water, groundwater and monitoring of the rehabilitated landform to make sure that it is safe, stable, sustainable and non-polluting.

a Erosion

Regular monitoring of construction, operation and rehabilitation activities of the eastern excavated rock emplacement will occur.

Contractor(s) conducting construction and rehabilitation works will be responsible for monitoring and maintaining surface water diversion structures and erosion control measures implemented through the construction phase ie benches and berms.

Routine inspections of all construction, operation and rehabilitation areas, drainage structures and temporary sediment and erosion controls will be done every month during the construction and rehabilitation of the eastern excavated rock emplacement until such time that the landform is accepted as safe, stable, sustainable and non-polluting. In addition, inspection of these areas will be done prior to expected rainfall and after significant rainfall to ensure the measures outlined in Section 4.3 are performing. An appropriately qualified person will undertake these inspections.

b Surface water

Surface water monitoring will occur in the diversion drain and upstream and downstream of the eastern excavated rock emplacement in the Yarrangobilly River. Water sampling will be completed fortnightly during construction ie from ground disturbance at the construction camp and monthly during operation of the excavated rock emplacement areas. Water samples will be sent to a NATA accredited laboratory and tested for pH, EC, metals and total suspended solids. Analysis of water samples will be against project area background water quality which is being assessed as part of the *Surface Water Assessment* (EMM 2018e).

c Groundwater

Three groundwater monitoring wells will be installed around the excavated rock emplacement areas. The wells will be installed as soon as possible prior to construction commencing to assess current baseline conditions. The groundwater quality may be impacted by Lobs Hole Mine and may be low in pH and elevated in dissolved metals. Monitoring will continue during construction and operation — fortnightly during construction and monthly during operations. Water samples will be sent to a NATA accredited laboratory and tested for pH, EC, metals and total suspended solids. Analysis of water samples will be against project area background water quality which is being assessed as part of the *Groundwater Assessment* (EMM 2018b).

d Final landform

The goal is to achieve a rehabilitated landform which is:

- safe;
- stable;
- self-sustaining; and
- non-polluting.

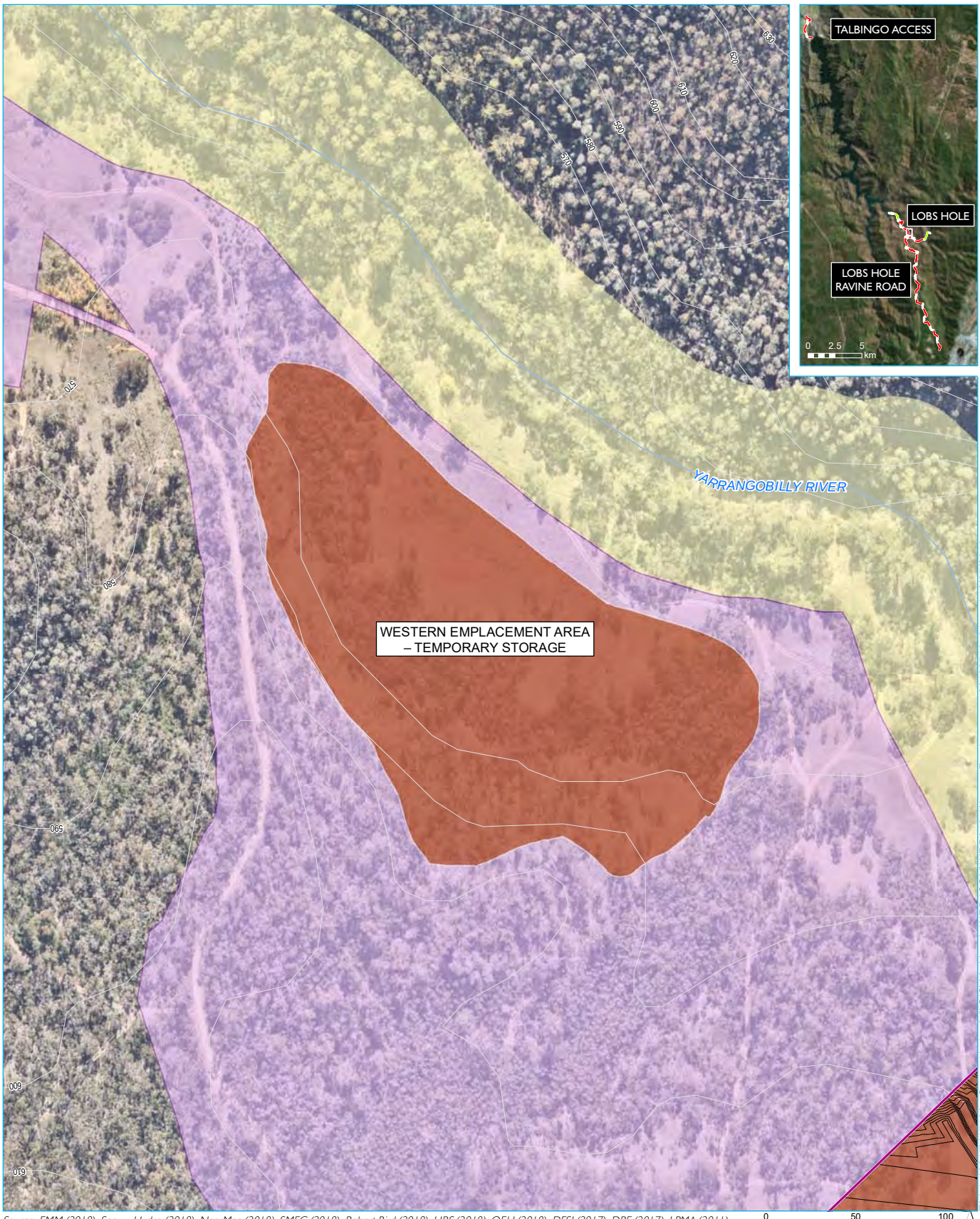
The objectives and indicators are described in Table 17.

Table 17 Rehabilitation objectives and indicators for the eastern excavated rock emplacement

Objectives	Indicators
Site is safe for humans and animals	A risk assessment of the landform is to be undertaken to make sure the site is safe, non-polluting and in a state, which is conducive to the desired post-construction land use.
Water quality protected	Water quality is not impacted.
Contaminated land	All areas contaminated by hydrocarbons or other chemicals used during construction are to be excavated and disposed of appropriately.
Minimise erosion	Soil is to be replaced on benches to the minimum specified depth.
Vegetation cover	A minimum vegetation cover across all flat areas will be required. Areas not covered by vegetation will be minimised and vegetation growth is to be promoted if required.
Species composition (flora)	The species composition will be like appropriate reference sites chosen based on their current land use, soil type, vegetation community type and health and in consultation with NPWS.
Community structure	Vegetation community structure (groundcover, understorey and overstorey) will be like appropriate reference sites chosen based on their current land use, soil type, vegetation community type and health.
Species diversity (fauna)	Faunal species diversity after rehabilitation will be like current species diversity as documented in the *Biodiversity Assessment* (EMM 2018a).

5.2 Western excavated rock emplacement

The western excavated rock emplacement is temporary and will be completely removed and the underlying land rehabilitated at the end of construction. The western excavated rock emplacement is shown in Figure 19. The following sections describes site preparation, construction and operation and management and monitoring of the western excavated rock emplacement.



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

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KEY

- Watercourse
- Contour (10m)
- On land rock management
- Conceptual WRD design contour
- Conceptual WRD design footprint
- Disturbance footprint
- Avoidance footprint

Western excavated rock emplacement

Snowy 2.0
WRD design
Exploratory Works
Figure 19

snowy 2.0 EMM

5.2.1 Site preparation

The land beneath the western excavated rock emplacement will not be stripped of soil since the landform will be reinstated after the western excavated rock emplacement is removed at the end of construction.

5.2.2 Construction and operation

The western excavated rock emplacement will be used to temporarily store material that has a low geochemical risk. The landform will be built in a manner that limits compaction and will be soiled and vegetated to stabilise the landform.

Low geochemical risk material will be transported along Mine Trail Road to the western excavated rock emplacement. Transportation will include the covering of loads to minimise dust generation and the use of the wash down facilities installed for the eastern excavated rock emplacement.

A 50 m exclusion zone is to be established from the bank of the Yarrangobilly River to avoid and minimise impacts to threatened species and their habitat.

5.2.3 Management and monitoring

5.2.3.1 Management

The western excavated rock emplacement does not require diversions or drop drains. As discussed in Section 3.4.3, the western excavated rock emplacement will be designed to prevent the risk of the rock emplacement being entrained in flood waters during a 0.2% AEP event. This will be achieved by a flood protection berm or rock armouring along the northern toe.

5.2.3.2 Monitoring

Monitoring of the western excavated rock emplacement will be completed for erosion, surface water, groundwater and monitoring of the reinstated landform to make sure that it is safe, stable, sustainable and non-polluting.

a Erosion

Regular monitoring of construction and operation of the western excavated rock emplacement will occur.

Contractor(s) conducting construction and operation works will be responsible for monitoring and maintaining flood protection structures and erosion control measures implemented through the construction phase.

Routine inspections will be done every month during construction and rehabilitation of the western excavated rock emplacement until such time that the reinstated landform is accepted as safe, stable, sustainable and non-polluting. In addition, inspection of these areas will be done prior to expected rainfall and after significant rainfall. An appropriately qualified person will undertake these inspections.

b Surface water

Surface water monitoring will occur upstream and downstream of the western excavated rock emplacement in the Yarrangobilly River. Water sampling will be completed fortnightly during construction and monthly during operations. Water samples will be sent to a NATA accredited laboratory and tested for pH, EC, metals and total suspended solids. Analysis of water samples will be against project area background water quality which is being assessed as part of the *Surface Water Assessment* (EMM 2018e).

c Groundwater

Three groundwater monitoring wells will be installed around the excavated rock emplacement areas. The wells will be installed as soon as possible prior to construction commencing to assess current baseline conditions. Monitoring will continue during construction and operation — fortnightly during construction and monthly during operations. Water samples will be sent to a NATA accredited laboratory and tested for pH, EC, metals and total suspended solids. Analysis of water samples will be against project area background water quality which is being assessed as part of the *Groundwater Assessment* (EMM 2018b).

d Reinstated landform

The goal is to achieve a reinstated landform which is:

- safe;
- stable; and
- self-sustaining.

The objectives and indicators are described in Table 18.

Table 18 Rehabilitation objectives and indicators for the western excavated rock emplacement

Objectives	Indicators
Site is safe for humans and animals	A risk assessment of the landform is to be undertaken to make sure the site is safe, non-polluting and in a state, which is conducive to the desired post-construction land use.
Water quality protected	Water quality is not impacted.
Contaminated land	All areas contaminated by hydrocarbons or other chemicals used during construction are to be excavated and disposed of appropriately.
Vegetation cover	Ground cover to be reinstated.
Species composition (flora)	The species composition will be like appropriate reference sites chosen based on their current land use, soil type, vegetation community type and health.
Community structure	Vegetation community structure (groundcover, understorey and overstorey) will be like appropriate reference sites chosen based on their current land use, soil type, vegetation community type and health.
Species diversity (fauna)	Faunal species diversity after rehabilitation will be like current species diversity as documented in the *Biodiversity Assessment* (EMM 2018a).

6.0 Reuse opportunities

6.1 Materials available for NPWS

Up to 40,000 bulk m^3 of low geochemical risk material will be made available to NPWS from the western excavated rock emplacement.

Excavated rock from the eastern excavated rock emplacement would also be made available opportunistically. That is, NPWS would be able to access fill from a layer/lift prior to AC limestone placement provided the average NAG pH 7.0 result is equal to the laboratory limit of detection and ANC analysis returns a positive result. If the excavated rock does not meet these criteria, then it cannot be established that the excavated rock is a low geochemical risk.

6.2 Subaqueous placement

Snowy Hydro is currently investigating the option to dispose of low risk geochemical rock into the Talbingo Reservoir. The subaqueous disposal is subject to further geochemical characterisation of the rock to be excavated from the exploratory tunnel to a level of detail that PAF rock can be selectively taken to the eastern rock emplacement, with the remaining low geochemical risk excavated rock discharged below water surface.

The on-going success of subaqueous disposal will be dependent on ongoing monitoring to be completed:

- water quality monitoring before, during and after discharge for physio-chemical and chlorophyll;
- sediment monitoring before and after discharge for physio-chemical and chlorophyll; and
- a full assessment to determine water and sediment quality and aquatic ecology resilience.

Subject to a positive result the subaqueous disposal may be extended to include PAF rock. Pending the results, the eastern rock emplacement may be greatly reduced in size or not required at all.

7.0 Conclusions

The primary storage option adopted in this report is to store the excavated rock at Lobs Hole. The eastern excavated rock emplacement would contain:

- rock — 455,000 bulk m^3;
- AC Limestone — 58,000 bulk m^3 assuming 100 mm layers; and
- road cuttings — 45,000 bulk m^3.

7.1 Eastern excavated rock emplacement

The design of the eastern excavated rock emplacement overcomes several environmental risks including:

- the potential of ARD;
- potential environmental harm currently caused by Lobs Hole Mine;
- low soil fertility;
- conservation of the listed Booroolong Frog habitat adjacent to the Yarrangobilly River; and
- management of surface water moving through Lick Hole Gully.

Controls that would be established to manage the environmental risks include:

- building an AC pad beneath the eastern excavated rock emplacement to separate potential PAF rock from flow through Lick Hole Gully;
- passive treatment of runoff from Lobs Hole Mine by passive treatment in the AC pad;
- passive treatment of potential PAF rock by the introduction of AC limestone layers into the eastern excavated rock emplacement at 1 m intervals;
- developing an operational testing method to make sure that adequate AC limestone is included in each layer to neutralise the potential acidity from PAF rock beneath the layer;
- constructing the eastern excavated rock emplacement in a manner that maximises compaction, thereby reducing the hydraulic conductivity of the rock and reducing the potential for groundwater recharge and/or discharge to the Yarrangobilly River;
- including capacity for seepage storage on each bench, which also improves the plant available water for vegetation;
- the inclusion of water management structures in Lick Hole Gully above the eastern excavated rock emplacement to divert runoff during peak flow events;
- including a method to stabilise the eastern excavated rock emplacement using stockpiled soil and vegetation;
- maintaining a 50 m clearance with the Yarrangobilly River to protect the habitat of the Booroolong Frog;
- improving outcomes for the Booroolong Frog by committing to improving habitat value through increased vegetation diversity in the 50 m clearance zone; and
- providing rock to NPWS.

7.2 Western excavated rock emplacement

The western excavated rock emplacement is temporary and will be completely removed and the underlying land rehabilitated at the end of construction. The western excavated rock emplacement will be used to store material that has a low geochemical risk. The landform will be built in a manner that limits compaction and will be soiled and vegetated to stabilise the landform.

The western excavated rock emplacement does not require diversions or drop drains. However, the western excavated rock emplacement will be designed to prevent the risk of the rock emplacement being entrained in

flood waters during a 0.2% AEP event. This will be achieved by a flood protection berm or rock armouring along the northern toe.

7.3 Subaqueous placement

Excavated rock from the exploratory tunnel will be subaqueously disposed of within Talbingo reservoir. The program will be implemented in accordance with a detailed management plan based on an engineering method informed through the excavated rock's geochemistry and reservoir's characteristics. The purpose of the program is to confirm the suitability of the emplacement method for future excavated rock from the construction of the project, should it proceed.

Subject to a positive result the material to be disposed of may be extended to include PAF rock. Pending the results of the trial the eastern rock emplacement may be greatly reduced in size or not required at all.

7.4 Closing statement

The described controls manage the expected environmental risks to an acceptable level and results in an eastern excavated rock emplacement after rehabilitation that is consistent with the surrounding landscape and rehabilitation of the site of the western excavated rock emplacement. Notwithstanding, subject to the outcome of the initial subaqueous placement control program, the eastern excavated rock emplacement may be reduced in size, or not required at all.

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Wyborn D, Owen M & Wyborn L 1990. Kosciusko National Park (1:250,000 scale map).

Appendix A – Envirolab Services certificates of analysis

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph 08 9317 2505 fax 08 9317 4163
lab@mpl.com.au
www.mpl.com.au

CERTIFICATE OF ANALYSIS 204079

Client Details

Client	Smec Australia Pty Ltd
Attention	Dave Evans
Address	L5, 20 Berry Street, NORTH SYDNEY, NSW, 2060

Sample Details

Your Reference	**Snowy 2.0**
Number of Samples	2 rocks
Date samples received	04/12/2017
Date completed instructions received	04/12/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	15/12/2017
Date of Issue	15/12/2017

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Stacey Hawkins, Acid Soils Supervisor

Authorised By

Todd Lee, Laboratory Manager

Miscellaneous Inorg - soil			
Our Reference		204079-1	204079-2
Your Reference	UNITS	BH5102 Tray 102	BH5102 Tray 122
Depth		393.39-393.42	470.81-470.85
Date Sampled		16/11/2017	18/11/2017
Type of sample		Rock	Rock
Date prepared	-	04/12/2017	04/12/2017
Date analysed	-	06/12/2017	06/12/2017
pH (1:2 soil:water)	pH Units	8.7	8.7
EC (1:2 soil:water)	µS/cm	240	250

Net Acid Generation			
Our Reference	UNITS	204079-1	204079-2
Your Reference		BH5102 Tray 102	BH5102 Tray 122
Depth		393.39-393.42	470.81-470.85
Date Sampled		16/11/2017	18/11/2017
Type of sample		Rock	Rock
Date Prepared		04/12/2017	04/12/2017
Date Analysed		06/12/2017	06/12/2017
NAG pH	pH units	7.4	9.4
NAG pH 4.5	kg H2SO4/tonne	<0.5	<0.5
NAG pH 7.0	kg/H2SO4/tonne	<0.5	<0.5

Net Acid Production Potential			
Our Reference		204079-1	204079-2
Your Reference	UNITS	BH5102 Tray 102	BH5102 Tray 122
Depth		393.39-393.42	470.81-470.85
Date Sampled		16/11/2017	18/11/2017
Type of sample		Rock	Rock
Date Prepared		04/12/2017	04/12/2017
Date Analysed		07/12/2017	07/12/2017
NAPP*	kg H2SO4/tonne	-8.9	-12
APP (acid production pot.)	kg H2SO4/tonne	0.9	1.2
ANC	kg H2SO4/tonne	9.8	13
Sulphur - Total*	%	0.03	0.04

Method ID	Methodology Summary
AMD-001	Acid Mine Drainage determined by AMIRA International - Acid Rock Drainage Test Handbook.
Ext-053	Analysed by Genalysis, accreditation number 3244
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.

QUALITY CONTROL: Miscellaneous Inorg - soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			04/12/2017	1	04/12/2017	04/12/2017		04/12/2017	[NT]
Date analysed	-			06/12/2017	1	06/12/2017	06/12/2017		06/12/2017	[NT]
pH (1:2 soil:water)	pH Units		INORG-001	[NT]	1	8.7	8.7	0	100	[NT]
EC (1:2 soil:water)	µS/cm	1	INORG-002	[NT]	1	240	230	4	102	[NT]

QUALITY CONTROL: Net Acid Generation						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date Prepared				04/12/2017	1	04/12/2017	04/12/2017		04/12/2017	[NT]
Date Analysed				06/12/2017	1	06/12/2017	06/12/2017		06/12/2017	[NT]
NAG pH	pH units	0.1	AMD-001	[NT]	1	7.4	7.6	3	88	[NT]
NAG pH 4.5	kg H2SO4/tonne	0.5	AMD-001	[NT]	1	<0.5	<0.5	0	113	[NT]
NAG pH 7.0	kg/H2SO4/tonne	0.5	AMD-001	[NT]	1	<0.5	<0.5	0	104	[NT]

QUALITY CONTROL: Net Acid Production Potential						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date Prepared				04/12/2017	1	04/12/2017	04/12/2017		04/12/2017	[NT]
Date Analysed				07/12/2017	1	07/12/2017	07/12/2017		07/12/2017	[NT]
NAPP*	kg H2SO4/tonne	-10000	AMD-001	[NT]	1	-8.9	-8.8	-1	[NT]	[NT]
APP (acid production pot.)	kg H2SO4/tonne	-10000		[NT]	1	0.9	0.9	0	[NT]	[NT]
ANC	kg H2SO4/tonne	0.5	AMD-001	[NT]	1	9.8	9.7	1	100	[NT]
Sulphur - Total*	%	0.01	Ext-053	[NT]	1	0.03	0.03	0	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

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Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

Total Sulfur analysis performed by MacQuarie Geotech, report numbers B44459-TS and B44460-TS.

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph 08 9317 2505 fax 08 9317 4163
lab@mpl.com.au
www.mpl.com.au

CERTIFICATE OF ANALYSIS 204084

Client Details

Client	Smec Australia Pty Ltd
Attention	Dave Evans
Address	L5, 20 Berry Street, NORTH SYDNEY, NSW, 2060

Sample Details

Your Reference	**Snowy 2.0**
Number of Samples	2 rocks
Date samples received	04/12/2017
Date completed instructions received	04/12/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	15/12/2017
Date of Issue	15/12/2017

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Results Approved By
Stacey Hawkins, Acid Soils Supervisor

Authorised By

Todd Lee, Laboratory Manager

Miscellaneous Inorg - soil			
Our Reference		204084-1	204084-2
Your Reference	UNITS	BH5102 TRAY 131	BH5102 TRAY 134
Depth		506.95m	520.70m
Date Sampled		19/11/2017	19/11/2017
Type of sample		Rock	Rock
Date prepared	-	04/12/2017	04/12/2017
Date analysed	-	06/12/2017	06/12/2017
pH (1:2 soil:water)	pH Units	8.8	9.1
EC (1:2 soil:water)	µS/cm	230	460

Net Acid Generation			
Our Reference		204084-1	204084-2
Your Reference	UNITS	BH5102 TRAY 131	BH5102 TRAY 134
Depth		506.95m	520.70m
Date Sampled		19/11/2017	19/11/2017
Type of sample		Rock	Rock
Date Prepared		04/12/2017	04/12/2017
Date Analysed		06/12/2017	06/12/2017
NAG pH	pH units	10.4	9.91
NAG pH 4.5	kg H2SO4/tonne	<0.5	<0.5
NAG pH 7.0	kg/H2SO4/tonne	<0.5	<0.5

Net Acid Production Potential			
Our Reference		204084-1	204084-2
Your Reference	UNITS	BH5102 TRAY 131	BH5102 TRAY 134
Depth		506.95m	520.70m
Date Sampled		19/11/2017	19/11/2017
Type of sample		Rock	Rock
Date Prepared		04/12/2017	04/12/2017
Date Analysed		07/12/2017	07/12/2017
NAPP*	kg H2SO4/tonne	-19	-96
APP (acid production pot.)	kg H2SO4/tonne	1.5	1.8
ANC	kg H2SO4/tonne	20	98
Sulphur - Total*	%	0.05	0.06

Method ID	Methodology Summary
AMD-001	Acid Mine Drainage determined by AMIRA International - Acid Rock Drainage Test Handbook.
Ext-053	Analysed by Genalysis, accreditation number 3244
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.

QUALITY CONTROL: Miscellaneous Inorg - soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			04/12/2017	[NT]	[NT]	[NT]	[NT]	04/12/2017	[NT]
Date analysed	-			06/12/2017	[NT]	[NT]	[NT]	[NT]	06/12/2017	[NT]
pH (1:2 soil:water)	pH Units		INORG-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]
EC (1:2 soil:water)	µS/cm	1	INORG-002	[NT]	[NT]	[NT]	[NT]	[NT]	100	[NT]

QUALITY CONTROL: Net Acid Generation						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date Prepared				04/12/2017	[NT]	[NT]	[NT]	[NT]	04/12/2017	[NT]
Date Analysed				06/12/2017	[NT]	[NT]	[NT]	[NT]	06/12/2017	[NT]
NAG pH	pH units	0.1	AMD-001	[NT]	[NT]	[NT]	[NT]	[NT]	88	[NT]
NAG pH 4.5	kg H2SO4/tonne	0.5	AMD-001	[NT]	[NT]	[NT]	[NT]	[NT]	113	[NT]
NAG pH 7.0	kg/H2SO4/tonne	0.5	AMD-001	[NT]	[NT]	[NT]	[NT]	[NT]	104	[NT]

QUALITY CONTROL: Net Acid Production Potential						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date Prepared				04/12/2017	[NT]	[NT]	[NT]	[NT]	04/12/2017	[NT]
Date Analysed				07/12/2017	[NT]	[NT]	[NT]	[NT]	07/12/2017	[NT]
ANC	kg H2SO4/tonne	0.5	AMD-001	[NT]	[NT]	[NT]	[NT]	[NT]	100	[NT]

Result Definitions

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NA	Test not required
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>	Greater than
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Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

Total Sulfur Analysis performed by MacQuarie Geotech, report numbers B44461-TS and B44462-TS.

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph 08 9317 2505 fax 08 9317 4163
lab@mpl.com.au
www.mpl.com.au

CERTIFICATE OF ANALYSIS 204085

Client Details

Client	Smec Australia Pty Ltd
Attention	Dave Evans
Address	L5, 20 Berry Street, NORTH SYDNEY, NSW, 2060

Sample Details

Your Reference	**Snowy 2.0**
Number of Samples	1 rock
Date samples received	04/12/2017
Date completed instructions received	04/12/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	15/12/2017
Date of Issue	15/12/2017

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Results Approved By
Stacey Hawkins, Acid Soils Supervisor

Authorised By

Todd Lee, Laboratory Manager

Miscellaneous Inorg - soil		
Our Reference		204085-1
Your Reference	UNITS	BH5102 TRAY 179
Depth		699.46-699.56
Date Sampled		27/11/2017
Type of sample		Rock
Date prepared	-	04/12/2017
Date analysed	-	06/12/2017
pH (1:2 soil:water)	pH Units	9.0
EC (1:2 soil:water)	µS/cm	280

Net Acid Generation		
Our Reference		204085-1
Your Reference	UNITS	BH5102 TRAY 179
Depth		699.46-699.56
Date Sampled		27/11/2017
Type of sample		Rock
Date Prepared		04/12/2017
Date Analysed		06/12/2017
NAG pH	pH units	10.5
NAG pH 4.5	kg H2SO4/tonne	<0.5
NAG pH 7.0	kg/H2SO4/tonne	<0.5

Net Acid Production Potential		
Our Reference		204085-1
Your Reference	UNITS	BH5102 TRAY 179
Depth		699.46-699.56
Date Sampled		27/11/2017
Type of sample		Rock
Date Prepared		04/12/2017
Date Analysed		07/12/2017
NAPP*	kg H2SO4/tonne	-50
APP (acid production pot.)	kg H2SO4/tonne	3.1
ANC	kg H2SO4/tonne	54
Sulphur - Total*	%	0.10

Method ID	Methodology Summary
AMD-001	Acid Mine Drainage determined by AMIRA International - Acid Rock Drainage Test Handbook.
Ext-053	Analysed by Genalysis, accreditation number 3244
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.

QUALITY CONTROL: Miscellaneous Inorg - soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			04/12/2017	[NT]	[NT]	[NT]	[NT]	04/12/2017	[NT]
Date analysed	-			06/12/2017	[NT]	[NT]	[NT]	[NT]	06/12/2017	[NT]
pH (1:2 soil:water)	pH Units		INORG-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]
EC (1:2 soil:water)	µS/cm	1	INORG-002	[NT]	[NT]	[NT]	[NT]	[NT]	100	[NT]

QUALITY CONTROL: Net Acid Generation						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date Prepared				04/12/2017	[NT]	[NT]	[NT]	[NT]	04/12/2017	[NT]
Date Analysed				06/12/2017	[NT]	[NT]	[NT]	[NT]	06/12/2017	[NT]
NAG pH	pH units	0.1	AMD-001	[NT]	[NT]	[NT]	[NT]	[NT]	88	[NT]
NAG pH 4.5	kg H2SO4/tonne	0.5	AMD-001	[NT]	[NT]	[NT]	[NT]	[NT]	113	[NT]
NAG pH 7.0	kg/H2SO4/tonne	0.5	AMD-001	[NT]	[NT]	[NT]	[NT]	[NT]	104	[NT]

QUALITY CONTROL: Net Acid Production Potential						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date Prepared				04/12/2017	[NT]	[NT]	[NT]	[NT]	04/12/2017	[NT]
Date Analysed				07/12/2017	[NT]	[NT]	[NT]	[NT]	07/12/2017	[NT]
ANC	kg H2SO4/tonne	0.5	AMD-001	[NT]	[NT]	[NT]	[NT]	[NT]	100	[NT]

Result Definitions

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Report Comments

Total Sulfur analysis performed by MacQuarie Geotech, report number B44463-TS.

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph 08 9317 2505 fax 08 9317 4163
lab@mpl.com.au
www.mpl.com.au

CERTIFICATE OF ANALYSIS 205098

Client Details

Client	Smec Australia Pty Ltd
Attention	Dave Evans
Address	L5, 20 Berry Street, NORTH SYDNEY, NSW, 2060

Sample Details

Your Reference	**Snowy 2.0**
Number of Samples	1 rock
Date samples received	28/12/2017
Date completed instructions received	28/12/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

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Report Details

Date results requested by	15/01/2018
Date of Issue	09/01/2018

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Results Approved By
Stacey Hawkins, Acid Soils Supervisor

Authorised By

Todd Lee, Laboratory Manager

Miscellaneous Inorg - soil		
Our Reference		205098-1
Your Reference	UNITS	BHS102
Depth		830.35-830.41
Date Sampled		01/12/2017
Type of sample		Rock
Date prepared	-	28/12/2017
Date analysed	-	09/01/2018
pH (1:2 soil:water)	pH Units	8.9
EC (1:2 soil:water)	µS/cm	170

Net Acid Generation		
Our Reference	UNITS	205098-1
Your Reference		BHS102
Depth		830.35-830.41
Date Sampled		01/12/2017
Type of sample		Rock
Date Prepared		28/12/2017
Date Analysed		03/01/2018
NAG pH	pH units	3.6
NAG pH 4.5	kg H2SO4/tonne	2.8
NAG pH 7.0	kg/H2SO4/tonne	6.3

Net Acid Production Potential		
Our Reference		205098-1
Your Reference	UNITS	BHS102
Depth		830.35-830.41
Date Sampled		01/12/2017
Type of sample		Rock
Date Prepared		28/12/2017
Date Analysed		09/01/2018
NAPP*	kg H2SO4/tonne	2.8
APP (acid production pot.)	kg H2SO4/tonne	9.2
ANC	kg H2SO4/tonne	6.4
Sulphur - Total*	%	0.30

Method ID	Methodology Summary
AMD-001	Acid Mine Drainage determined by AMIRA International - Acid Rock Drainage Test Handbook.
Ext-053	Analysed by Genalysis, accreditation number 3244
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.

QUALITY CONTROL: Miscellaneous Inorg - soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			28/12/2017	1	28/12/2017	28/12/2017		28/12/2017	[NT]
Date analysed	-			08/01/2018	1	09/01/2018	09/01/2018		08/01/2018	[NT]
pH (1:2 soil:water)	pH Units		INORG-001	[NT]	1	8.9	8.9	0	101	[NT]
EC (1:2 soil:water)	µS/cm	1	INORG-002	[NT]	1	170	170	0	101	[NT]

QUALITY CONTROL: Net Acid Generation						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date Prepared				28/12/2017	1	28/12/2017	28/12/2017		28/12/2017	[NT]
Date Analysed				03/01/2018	1	03/01/2018	03/01/2018		03/01/2018	[NT]
NAG pH	pH units	0.1	AMD-001	[NT]	1	3.6	3.6	0	102	[NT]
NAG pH 4.5	kg H2SO4/tonne	0.5	AMD-001	[NT]	1	2.8	2.8	0	84	[NT]
NAG pH 7.0	kg/H2SO4/tonne	0.5	AMD-001	[NT]	1	6.3	6.2	2	98	[NT]

QUALITY CONTROL: Net Acid Production Potential						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date Prepared				28/12/2017	1	28/12/2017	28/12/2017		28/12/2017	[NT]
Date Analysed				03/01/2018	1	09/01/2018	09/01/2018		03/01/2018	[NT]
NAPP*	kg H2SO4/tonne	-10000	AMD-001	[NT]	1	2.8	2.8	0	[NT]	[NT]
APP (acid production pot.)	kg H2SO4/tonne	-10000		[NT]	1	9.2	9.2	0	[NT]	[NT]
ANC	kg H2SO4/tonne	0.5	AMD-001	[NT]	1	6.4	6.4	0	101	[NT]
Sulphur - Total*	%	0.01	Ext-053	[NT]	1	0.30	0.30	0	[NT]	[NT]

Result Definitions

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Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

Total Sulfur Analysis performed by MacQuarie Geotech. Report number B44707-TS.

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph 08 9317 2505 fax 08 9317 4163
lab@mpl.com.au
www.mpl.com.au

CERTIFICATE OF ANALYSIS 205099

Client Details

Client	Smec Australia Pty Ltd
Attention	Dave Evans
Address	L5, 20 Berry Street, NORTH SYDNEY, NSW, 2060

Sample Details

Your Reference	**Snowy 2.0**
Number of Samples	1 rock
Date samples received	28/01/2017
Date completed instructions received	28/01/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	15/01/2018
Date of Issue	09/01/2018

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Stacey Hawkins, Acid Soils Supervisor

Authorised By

Todd Lee, Laboratory Manager

Miscellaneous Inorg - soil		
Our Reference		205099-1
Your Reference	UNITS	BH5102 TRAY 204
Depth		798.12-798.20
Date Sampled		30/11/2017
Time Sampled		03:00 PM
Type of sample		Rock
Date prepared	-	28/12/2017
Date analysed	-	09/01/2018
pH (1:2 soil:water)	pH Units	9.1
EC (1:2 soil:water)	µS/cm	110

Net Acid Generation		
Our Reference		205099-1
Your Reference	UNITS	BH5102 TRAY 204
Depth		798.12-798.20
Date Sampled		30/11/2017
Time Sampled		03:00 PM
Type of sample		Rock
Date Prepared		28/12/2017
Date Analysed		03/01/2018
NAG pH	pH units	3.7
NAG pH 4.5	kg H2SO4/tonne	1.8
NAG pH 7.0	kg/H2SO4/tonne	4.6

Net Acid Production Potential		
Our Reference		205099-1
Your Reference	UNITS	BH5102 TRAY 204
Depth		798.12-798.20
Date Sampled		30/11/2017
Time Sampled		03:00 PM
Type of sample		Rock
Date Prepared		28/12/2017
Date Analysed		09/01/2018
NAPP*	kg H2SO4/tonne	0.9
APP (acid production pot.)	kg H2SO4/tonne	7.3
ANC	kg H2SO4/tonne	6.4
Sulphur - Total*	%	0.24

Method ID	Methodology Summary
AMD-001	Acid Mine Drainage determined by AMIRA International - Acid Rock Drainage Test Handbook.
Ext-053	Analysed by Genalysis, accreditation number 3244
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.

QUALITY CONTROL: Miscellaneous Inorg - soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			28/12/2017	[NT]	[NT]	[NT]	[NT]	28/12/2017	[NT]
Date analysed	-			09/01/2018	[NT]	[NT]	[NT]	[NT]	09/01/2018	[NT]
pH (1:2 soil:water)	pH Units		INORG-001	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]
EC (1:2 soil:water)	µS/cm	1	INORG-002	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]

QUALITY CONTROL: Net Acid Generation						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date Prepared				28/12/2017	[NT]	[NT]	[NT]	[NT]	28/12/2017	[NT]
Date Analysed				03/01/2018	[NT]	[NT]	[NT]	[NT]	03/01/2018	[NT]
NAG pH	pH units	0.1	AMD-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]
NAG pH 4.5	kg H2SO4/tonne	0.5	AMD-001	[NT]	[NT]	[NT]	[NT]	[NT]	84	[NT]
NAG pH 7.0	kg/H2SO4/tonne	0.5	AMD-001	[NT]	[NT]	[NT]	[NT]	[NT]	98	[NT]

QUALITY CONTROL: Net Acid Production Potential						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date Prepared				28/12/2017	[NT]	[NT]	[NT]	[NT]	28/12/2017	[NT]
Date Analysed				03/01/2018	[NT]	[NT]	[NT]	[NT]	03/01/2018	[NT]
ANC	kg H2SO4/tonne	0.5	AMD-001	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
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Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

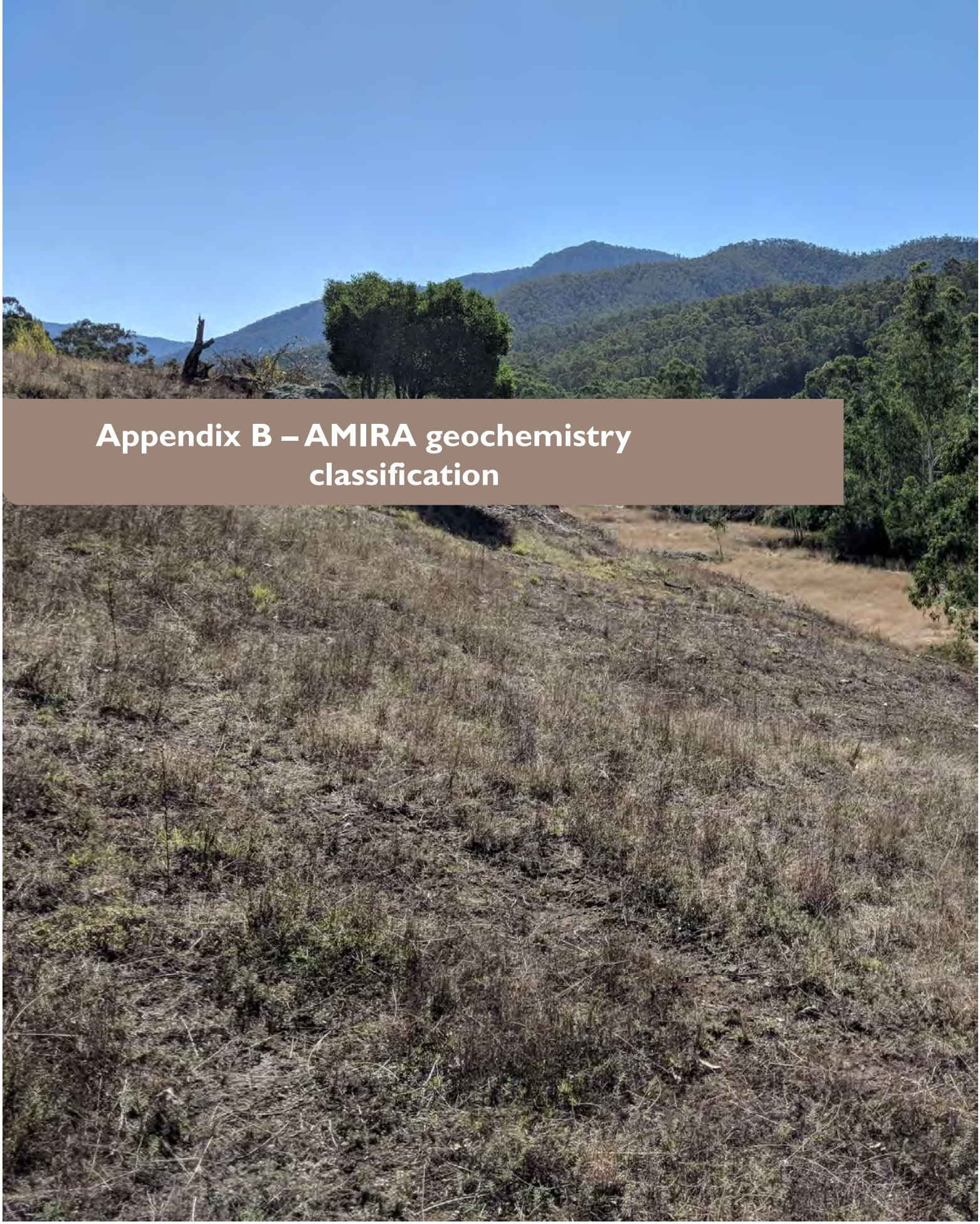
When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

Total Sulfur Analysis performed by MacQuarie Geotech. Report number B44708-TS

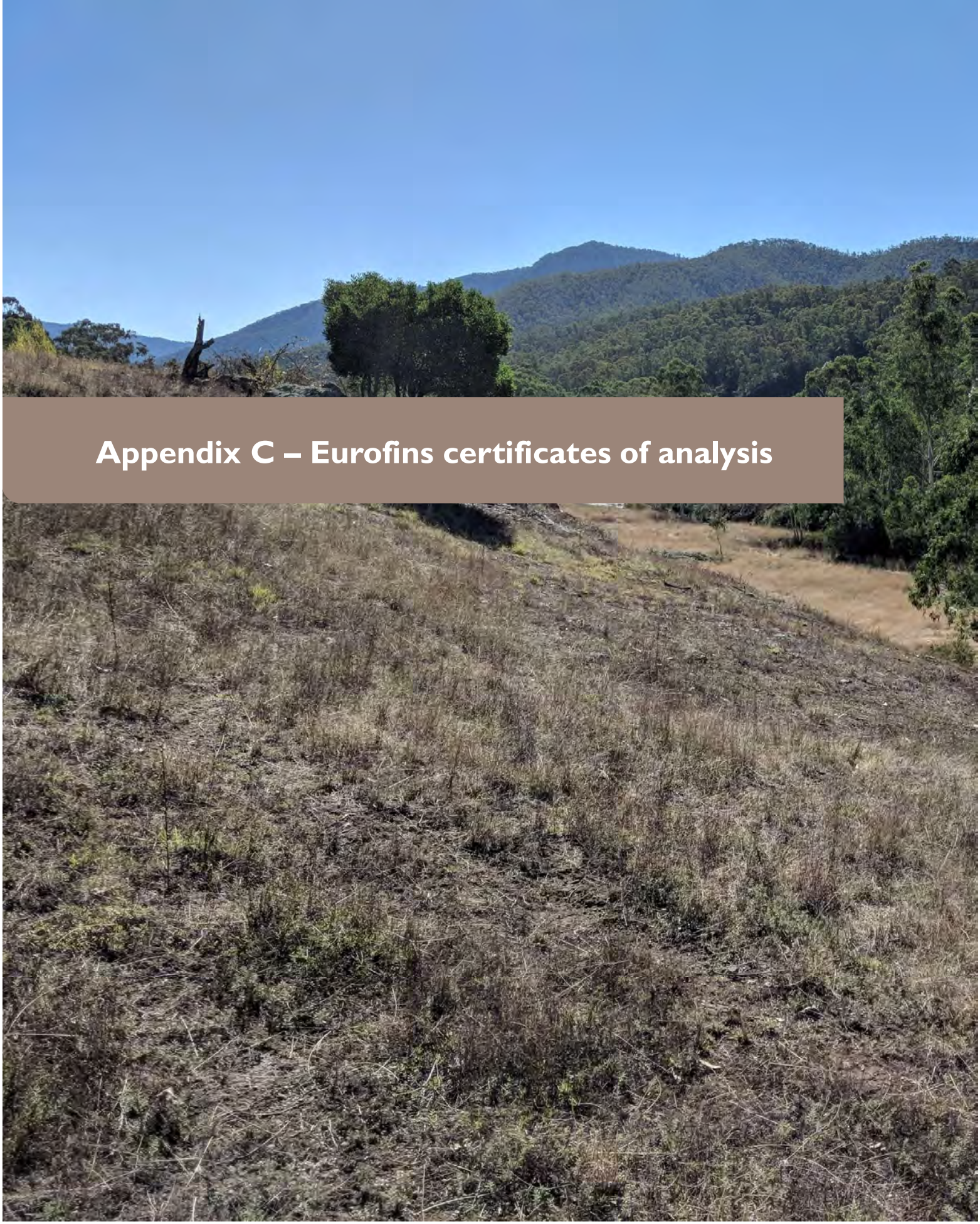


Appendix B – AMIRA geochemistry classification

Table 19 Geochemical classification matrix for excavated rock

Primary geochemical rock type	NAPP (kg H_2SO_4/t)	NAG pH
Potentially acid-forming (PAF)	> 10	<4.5
Potentially acid-forming—low capacity (PAF-LC)	0 to 10	< 4.5
Non-acid-forming (NAF)	Negative	≥ 4.5
Acid-consuming (AC)	less than -100	≥ 4.5
Uncertain (UC)	Positive	≥ 4.5
	Negative	<4.5

Source: AMIRA (2002)



Appendix C – Eurofins certificates of analysis

Certificate of Analysis

Cardno (NSW/ACT) Pty Ltd
Level 9, 203 Pacific Highway
St Leonards
NSW 2065

NATA Accredited
Accreditation Number 1261
Site Number 18217

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Andrew Bradford**

Report **599074-S**
Project name SNOWY HYDRO 2.0 RESERVOIR SAMPLING
Project ID 59918111/003
Received Date May 18, 2018

Client Sample ID			**MBSQ01**	**MBSQ01B**	**MBSQ02**	**MBSQ03**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins | mgt Sample No.			**S18-My24526**	**S18-My24527**	**S18-My24528**	**S18-My24529**
Date Sampled			**May 16, 2018**	**May 16, 2018**	**May 16, 2018**	**May 16, 2018**
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	20	mg/kg	-	< 20	-	-
TRH C10-C14	20	mg/kg	-	< 20	-	-
TRH C15-C28	50	mg/kg	-	< 50	-	-
TRH C29-C36	50	mg/kg	-	< 50	-	-
TRH C10-36 (Total)	50	mg/kg	-	< 50	-	-
BTEX						
Benzene	0.1	mg/kg	-	< 0.1	-	-
Toluene	0.1	mg/kg	-	< 0.1	-	-
Ethylbenzene	0.1	mg/kg	-	< 0.1	-	-
m&p-Xylenes	0.2	mg/kg	-	< 0.2	-	-
o-Xylene	0.1	mg/kg	-	< 0.1	-	-
Xylenes - Total	0.3	mg/kg	-	< 0.3	-	-
4-Bromofluorobenzene (surr.)	1	%	-	69	-	-
Volatile Organics						
1.1-Dichloroethane	0.5	mg/kg	-	< 0.5	-	-
1.1-Dichloroethene	0.5	mg/kg	-	< 0.5	-	-
1.1.1-Trichloroethane	0.5	mg/kg	-	< 0.5	-	-
1.1.1.2-Tetrachloroethane	0.5	mg/kg	-	< 0.5	-	-
1.1.2-Trichloroethane	0.5	mg/kg	-	< 0.5	-	-
1.1.2.2-Tetrachloroethane	0.5	mg/kg	-	< 0.5	-	-
1.2-Dibromoethane	0.5	mg/kg	-	< 0.5	-	-
1.2-Dichlorobenzene	0.5	mg/kg	-	< 0.5	-	-
1.2-Dichloroethane	0.5	mg/kg	-	< 0.5	-	-
1.2-Dichloropropane	0.5	mg/kg	-	< 0.5	-	-
1.2.3-Trichloropropane	0.5	mg/kg	-	< 0.5	-	-
1.2.4-Trimethylbenzene	0.5	mg/kg	-	< 0.5	-	-
1.3-Dichlorobenzene	0.5	mg/kg	-	< 0.5	-	-
1.3-Dichloropropane	0.5	mg/kg	-	< 0.5	-	-
1.3.5-Trimethylbenzene	0.5	mg/kg	-	< 0.5	-	-
1.4-Dichlorobenzene	0.5	mg/kg	-	< 0.5	-	-
2-Butanone (MEK)	0.5	mg/kg	-	< 0.5	-	-
2-Propanone (Acetone)	0.5	mg/kg	-	< 0.5	-	-
4-Chlorotoluene	0.5	mg/kg	-	< 0.5	-	-
4-Methyl-2-pentanone (MIBK)	0.5	mg/kg	-	< 0.5	-	-
Allyl chloride	0.5	mg/kg	-	< 0.5	-	-

Client Sample ID			MBSQ01	MBSQ01B	MBSQ02	MBSQ03
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins | mgt Sample No.			S18-My24526	S18-My24527	S18-My24528	S18-My24529
Date Sampled			May 16, 2018	May 16, 2018	May 16, 2018	May 16, 2018
Test/Reference	LOR	Unit				
Volatile Organics						
Benzene	0.1	mg/kg	-	< 0.1	-	-
Bromobenzene	0.5	mg/kg	-	< 0.5	-	-
Bromochloromethane	0.5	mg/kg	-	< 0.5	-	-
Bromodichloromethane	0.5	mg/kg	-	< 0.5	-	-
Bromoform	0.5	mg/kg	-	< 0.5	-	-
Bromomethane	0.5	mg/kg	-	< 0.5	-	-
Carbon disulfide	0.5	mg/kg	-	< 0.5	-	-
Carbon Tetrachloride	0.5	mg/kg	-	< 0.5	-	-
Chlorobenzene	0.5	mg/kg	-	< 0.5	-	-
Chloroethane	0.5	mg/kg	-	< 0.5	-	-
Chloroform	0.5	mg/kg	-	< 0.5	-	-
Chloromethane	0.5	mg/kg	-	< 0.5	-	-
cis-1.2-Dichloroethene	0.5	mg/kg	-	< 0.5	-	-
cis-1.3-Dichloropropene	0.5	mg/kg	-	< 0.5	-	-
Dibromochloromethane	0.5	mg/kg	-	< 0.5	-	-
Dibromomethane	0.5	mg/kg	-	< 0.5	-	-
Dichlorodifluoromethane	0.5	mg/kg	-	< 0.5	-	-
Ethylbenzene	0.1	mg/kg	-	< 0.1	-	-
Iodomethane	0.5	mg/kg	-	< 0.5	-	-
Isopropyl benzene (Cumene)	0.5	mg/kg	-	< 0.5	-	-
m&p-Xylenes	0.2	mg/kg	-	< 0.2	-	-
Methylene Chloride	0.5	mg/kg	-	< 0.5	-	-
o-Xylene	0.1	mg/kg	-	< 0.1	-	-
Styrene	0.5	mg/kg	-	< 0.5	-	-
Tetrachloroethene	0.5	mg/kg	-	< 0.5	-	-
Toluene	0.1	mg/kg	-	< 0.1	-	-
trans-1.2-Dichloroethene	0.5	mg/kg	-	< 0.5	-	-
trans-1.3-Dichloropropene	0.5	mg/kg	-	< 0.5	-	-
Trichloroethene	0.5	mg/kg	-	< 0.5	-	-
Trichlorofluoromethane	0.5	mg/kg	-	< 0.5	-	-
Vinyl chloride	0.5	mg/kg	-	< 0.5	-	-
Xylenes - Total	0.3	mg/kg	-	< 0.3	-	-
Total MAH*	0.5	mg/kg	-	< 0.5	-	-
Vic EPA IWRG 621 CHC (Total)*	0.5	mg/kg	-	< 0.5	-	-
Vic EPA IWRG 621 Other CHC (Total)*	0.5	mg/kg	-	< 0.5	-	-
4-Bromofluorobenzene (surr.)	1	%	-	69	-	-
Toluene-d8 (surr.)	1	%	-	71	-	-
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.5	mg/kg	-	< 0.5	-	-
TRH C6-C10	20	mg/kg	-	< 20	-	-
TRH C6-C10 less BTEX (F1)[N04]	20	mg/kg	-	< 20	-	-
TRH >C10-C16	50	mg/kg	-	< 50	-	-
TRH >C10-C16 less Naphthalene (F2)[N01]	50	mg/kg	-	< 50	-	-
TRH >C16-C34	100	mg/kg	-	< 100	-	-
TRH >C34-C40	100	mg/kg	-	< 100	-	-

Client Sample ID			MBSQ01	MBSQ01B	MBSQ02	MBSQ03
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins | mgt Sample No.			S18-My24526	S18-My24527	S18-My24528	S18-My24529
Date Sampled			May 16, 2018	May 16, 2018	May 16, 2018	May 16, 2018
Test/Reference	LOR	Unit				
Polycyclic Aromatic Hydrocarbons						
Benzo(a)pyrene TEQ (lower bound) *	0.5	mg/kg	-	< 0.5	-	-
Benzo(a)pyrene TEQ (medium bound) *	0.5	mg/kg	-	0.6	-	-
Benzo(a)pyrene TEQ (upper bound) *	0.5	mg/kg	-	1.2	-	-
Acenaphthene	0.5	mg/kg	-	< 0.5	-	-
Acenaphthylene	0.5	mg/kg	-	< 0.5	-	-
Anthracene	0.5	mg/kg	-	< 0.5	-	-
Benz(a)anthracene	0.5	mg/kg	-	< 0.5	-	-
Benzo(a)pyrene	0.5	mg/kg	-	< 0.5	-	-
Benzo(b&j)fluoranthene[N07]	0.5	mg/kg	-	< 0.5	-	-
Benzo(g.h.i)perylene	0.5	mg/kg	-	< 0.5	-	-
Benzo(k)fluoranthene	0.5	mg/kg	-	< 0.5	-	-
Chrysene	0.5	mg/kg	-	< 0.5	-	-
Dibenz(a.h)anthracene	0.5	mg/kg	-	< 0.5	-	-
Fluoranthene	0.5	mg/kg	-	< 0.5	-	-
Fluorene	0.5	mg/kg	-	< 0.5	-	-
Indeno(1.2.3-cd)pyrene	0.5	mg/kg	-	< 0.5	-	-
Naphthalene	0.5	mg/kg	-	< 0.5	-	-
Phenanthrene	0.5	mg/kg	-	< 0.5	-	-
Pyrene	0.5	mg/kg	-	< 0.5	-	-
Total PAH*	0.5	mg/kg	-	< 0.5	-	-
2-Fluorobiphenyl (surr.)	1	%	-	86	-	-
p-Terphenyl-d14 (surr.)	1	%	-	84	-	-
Organochlorine Pesticides						
Chlordanes - Total	0.1	mg/kg	-	< 0.1	-	-
4.4'-DDD	0.05	mg/kg	-	< 0.05	-	-
4.4'-DDE	0.05	mg/kg	-	< 0.05	-	-
4.4'-DDT	0.05	mg/kg	-	< 0.05	-	-
a-BHC	0.05	mg/kg	-	< 0.05	-	-
Aldrin	0.05	mg/kg	-	< 0.05	-	-
b-BHC	0.05	mg/kg	-	< 0.05	-	-
d-BHC	0.05	mg/kg	-	< 0.05	-	-
Dieldrin	0.05	mg/kg	-	< 0.05	-	-
Endosulfan I	0.05	mg/kg	-	< 0.05	-	-
Endosulfan II	0.05	mg/kg	-	< 0.05	-	-
Endosulfan sulphate	0.05	mg/kg	-	< 0.05	-	-
Endrin	0.05	mg/kg	-	< 0.05	-	-
Endrin aldehyde	0.05	mg/kg	-	< 0.05	-	-
Endrin ketone	0.05	mg/kg	-	< 0.05	-	-
g-BHC (Lindane)	0.05	mg/kg	-	< 0.05	-	-
Heptachlor	0.05	mg/kg	-	< 0.05	-	-
Heptachlor epoxide	0.05	mg/kg	-	< 0.05	-	-
Hexachlorobenzene	0.05	mg/kg	-	< 0.05	-	-
Methoxychlor	0.05	mg/kg	-	< 0.05	-	-
Toxaphene	1	mg/kg	-	< 1	-	-
Aldrin and Dieldrin (Total)*	0.05	mg/kg	-	< 0.05	-	-
DDT + DDE + DDD (Total)*	0.05	mg/kg	-	< 0.05	-	-
Vic EPA IWRG 621 OCP (Total)*	0.1	mg/kg	-	< 0.1	-	-
Vic EPA IWRG 621 Other OCP (Total)*	0.1	mg/kg	-	< 0.1	-	-
Dibutylchlorendate (surr.)	1	%	-	144	-	-
Tetrachloro-m-xylene (surr.)	1	%	-	124	-	-

Client Sample ID			MBSQ01	MBSQ01B	MBSQ02	MBSQ03
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins | mgt Sample No.			S18-My24526	S18-My24527	S18-My24528	S18-My24529
Date Sampled			May 16, 2018	May 16, 2018	May 16, 2018	May 16, 2018
Test/Reference	LOR	Unit				
Ammonia (as N)	5	mg/kg	79	82	86	74
Nitrate & Nitrite (as N)	5	mg/kg	< 5	< 5	< 5	< 5
Total Inorganic Carbon	0.1	%	0.2	0.1	< 0.1	0.1
Total Kjeldahl Nitrogen (as N)	10	mg/kg	1100	1100	930	1000
Total Organic Carbon	0.1	%	4.6	4.8	4.1	4.3
Phosphorus	5	mg/kg	510	470	470	470
Sulphur	5	mg/kg	400	380	330	360
% Moisture	1	%	62	60	59	59
Particle Size Distribution by Sieve and Hydrometer			see attached	see attached	see attached	see attached
Heavy Metals						
Aluminium	10	mg/kg	21000	20000	22000	22000
Arsenic	2	mg/kg	9.2	9.0	10	10
Barium	10	mg/kg	180	180	180	180
Beryllium	2	mg/kg	< 2	< 2	< 2	< 2
Boron	10	mg/kg	11	< 10	< 10	< 10
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	42	42	44	45
Cobalt	5	mg/kg	12	12	13	14
Copper	5	mg/kg	57	56	58	62
Iron	20	mg/kg	24000	24000	25000	26000
Lead	5	mg/kg	26	25	26	26
Manganese	5	mg/kg	400	400	420	400
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Molybdenum	5	mg/kg	< 5	< 5	< 5	< 5
Nickel	5	mg/kg	48	47	49	51
Selenium	2	mg/kg	< 2	< 2	< 2	< 2
Silver	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Vanadium	10	mg/kg	28	28	29	30
Zinc	5	mg/kg	86	85	87	90

Client Sample ID			MBSQ04	MBSQ05	MBSQ06	MBSQ07
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins | mgt Sample No.			S18-My24530	S18-My24531	S18-My24532	S18-My24533
Date Sampled			May 16, 2018	May 16, 2018	May 16, 2018	May 16, 2018
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	20	mg/kg	-	-	< 20	-
TRH C10-C14	20	mg/kg	-	-	< 20	-
TRH C15-C28	50	mg/kg	-	-	< 50	-
TRH C29-C36	50	mg/kg	-	-	< 50	-
TRH C10-36 (Total)	50	mg/kg	-	-	< 50	-
BTEX						
Benzene	0.1	mg/kg	-	-	< 0.1	-
Toluene	0.1	mg/kg	-	-	< 0.1	-
Ethylbenzene	0.1	mg/kg	-	-	< 0.1	-
m&p-Xylenes	0.2	mg/kg	-	-	< 0.2	-
o-Xylene	0.1	mg/kg	-	-	< 0.1	-
Xylenes - Total	0.3	mg/kg	-	-	< 0.3	-
4-Bromofluorobenzene (surr.)	1	%	-	-	97	-

Client Sample ID			MBSQ04	MBSQ05	MBSQ06	MBSQ07
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins | mgt Sample No.			S18-My24530	S18-My24531	S18-My24532	S18-My24533
Date Sampled			May 16, 2018	May 16, 2018	May 16, 2018	May 16, 2018
Test/Reference	LOR	Unit				
Volatile Organics						
1.1-Dichloroethane	0.5	mg/kg	-	-	< 0.5	-
1.1-Dichloroethene	0.5	mg/kg	-	-	< 0.5	-
1.1.1-Trichloroethane	0.5	mg/kg	-	-	< 0.5	-
1.1.1.2-Tetrachloroethane	0.5	mg/kg	-	-	< 0.5	-
1.1.2-Trichloroethane	0.5	mg/kg	-	-	< 0.5	-
1.1.2.2-Tetrachloroethane	0.5	mg/kg	-	-	< 0.5	-
1.2-Dibromoethane	0.5	mg/kg	-	-	< 0.5	-
1.2-Dichlorobenzene	0.5	mg/kg	-	-	< 0.5	-
1.2-Dichloroethane	0.5	mg/kg	-	-	< 0.5	-
1.2-Dichloropropane	0.5	mg/kg	-	-	< 0.5	-
1.2.3-Trichloropropane	0.5	mg/kg	-	-	< 0.5	-
1.2.4-Trimethylbenzene	0.5	mg/kg	-	-	< 0.5	-
1.3-Dichlorobenzene	0.5	mg/kg	-	-	< 0.5	-
1.3-Dichloropropane	0.5	mg/kg	-	-	< 0.5	-
1.3.5-Trimethylbenzene	0.5	mg/kg	-	-	< 0.5	-
1.4-Dichlorobenzene	0.5	mg/kg	-	-	< 0.5	-
2-Butanone (MEK)	0.5	mg/kg	-	-	< 0.5	-
2-Propanone (Acetone)	0.5	mg/kg	-	-	< 0.5	-
4-Chlorotoluene	0.5	mg/kg	-	-	< 0.5	-
4-Methyl-2-pentanone (MIBK)	0.5	mg/kg	-	-	< 0.5	-
Allyl chloride	0.5	mg/kg	-	-	< 0.5	-
Benzene	0.1	mg/kg	-	-	< 0.1	-
Bromobenzene	0.5	mg/kg	-	-	< 0.5	-
Bromochloromethane	0.5	mg/kg	-	-	< 0.5	-
Bromodichloromethane	0.5	mg/kg	-	-	< 0.5	-
Bromoform	0.5	mg/kg	-	-	< 0.5	-
Bromomethane	0.5	mg/kg	-	-	< 0.5	-
Carbon disulfide	0.5	mg/kg	-	-	< 0.5	-
Carbon Tetrachloride	0.5	mg/kg	-	-	< 0.5	-
Chlorobenzene	0.5	mg/kg	-	-	< 0.5	-
Chloroethane	0.5	mg/kg	-	-	< 0.5	-
Chloroform	0.5	mg/kg	-	-	< 0.5	-
Chloromethane	0.5	mg/kg	-	-	< 0.5	-
cis-1.2-Dichloroethene	0.5	mg/kg	-	-	< 0.5	-
cis-1.3-Dichloropropene	0.5	mg/kg	-	-	< 0.5	-
Dibromochloromethane	0.5	mg/kg	-	-	< 0.5	-
Dibromomethane	0.5	mg/kg	-	-	< 0.5	-
Dichlorodifluoromethane	0.5	mg/kg	-	-	< 0.5	-
Ethylbenzene	0.1	mg/kg	-	-	< 0.1	-
Iodomethane	0.5	mg/kg	-	-	< 0.5	-
Isopropyl benzene (Cumene)	0.5	mg/kg	-	-	< 0.5	-
m&p-Xylenes	0.2	mg/kg	-	-	< 0.2	-
Methylene Chloride	0.5	mg/kg	-	-	< 0.5	-
o-Xylene	0.1	mg/kg	-	-	< 0.1	-
Styrene	0.5	mg/kg	-	-	< 0.5	-
Tetrachloroethene	0.5	mg/kg	-	-	< 0.5	-
Toluene	0.1	mg/kg	-	-	< 0.1	-
trans-1.2-Dichloroethene	0.5	mg/kg	-	-	< 0.5	-
trans-1.3-Dichloropropene	0.5	mg/kg	-	-	< 0.5	-

Client Sample ID			MBSQ04	MBSQ05	MBSQ06	MBSQ07
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins | mgt Sample No.			S18-My24530	S18-My24531	S18-My24532	S18-My24533
Date Sampled			May 16, 2018	May 16, 2018	May 16, 2018	May 16, 2018
Test/Reference	LOR	Unit				
Volatile Organics						
Trichloroethene	0.5	mg/kg	-	-	< 0.5	-
Trichlorofluoromethane	0.5	mg/kg	-	-	< 0.5	-
Vinyl chloride	0.5	mg/kg	-	-	< 0.5	-
Xylenes - Total	0.3	mg/kg	-	-	< 0.3	-
Total MAH*	0.5	mg/kg	-	-	< 0.5	-
Vic EPA IWRG 621 CHC (Total)*	0.5	mg/kg	-	-	< 0.5	-
Vic EPA IWRG 621 Other CHC (Total)*	0.5	mg/kg	-	-	< 0.5	-
4-Bromofluorobenzene (surr.)	1	%	-	-	97	-
Toluene-d8 (surr.)	1	%	-	-	99	-
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.5	mg/kg	-	-	< 0.5	-
TRH C6-C10	20	mg/kg	-	-	< 20	-
TRH C6-C10 less BTEX (F1)[N04]	20	mg/kg	-	-	< 20	-
TRH >C10-C16	50	mg/kg	-	-	< 50	-
TRH >C10-C16 less Naphthalene (F2)[N01]	50	mg/kg	-	-	< 50	-
TRH >C16-C34	100	mg/kg	-	-	< 100	-
TRH >C34-C40	100	mg/kg	-	-	< 100	-
Polycyclic Aromatic Hydrocarbons						
Benzo(a)pyrene TEQ (lower bound) *	0.5	mg/kg	-	-	< 0.5	-
Benzo(a)pyrene TEQ (medium bound) *	0.5	mg/kg	-	-	0.6	-
Benzo(a)pyrene TEQ (upper bound) *	0.5	mg/kg	-	-	1.2	-
Acenaphthene	0.5	mg/kg	-	-	< 0.5	-
Acenaphthylene	0.5	mg/kg	-	-	< 0.5	-
Anthracene	0.5	mg/kg	-	-	< 0.5	-
Benz(a)anthracene	0.5	mg/kg	-	-	< 0.5	-
Benzo(a)pyrene	0.5	mg/kg	-	-	< 0.5	-
Benzo(b&j)fluoranthene[N07]	0.5	mg/kg	-	-	< 0.5	-
Benzo(g.h.i)perylene	0.5	mg/kg	-	-	< 0.5	-
Benzo(k)fluoranthene	0.5	mg/kg	-	-	< 0.5	-
Chrysene	0.5	mg/kg	-	-	< 0.5	-
Dibenz(a.h)anthracene	0.5	mg/kg	-	-	< 0.5	-
Fluoranthene	0.5	mg/kg	-	-	< 0.5	-
Fluorene	0.5	mg/kg	-	-	< 0.5	-
Indeno(1.2.3-cd)pyrene	0.5	mg/kg	-	-	< 0.5	-
Naphthalene	0.5	mg/kg	-	-	< 0.5	-
Phenanthrene	0.5	mg/kg	-	-	< 0.5	-
Pyrene	0.5	mg/kg	-	-	< 0.5	-
Total PAH*	0.5	mg/kg	-	-	< 0.5	-
2-Fluorobiphenyl (surr.)	1	%	-	-	57	-
p-Terphenyl-d14 (surr.)	1	%	-	-	58	-
Organochlorine Pesticides						
Chlordanes - Total	0.1	mg/kg	-	-	< 0.1	-
4.4'-DDD	0.05	mg/kg	-	-	< 0.05	-
4.4'-DDE	0.05	mg/kg	-	-	< 0.05	-
4.4'-DDT	0.05	mg/kg	-	-	< 0.05	-
a-BHC	0.05	mg/kg	-	-	< 0.05	-
Aldrin	0.05	mg/kg	-	-	< 0.05	-
b-BHC	0.05	mg/kg	-	-	< 0.05	-
d-BHC	0.05	mg/kg	-	-	< 0.05	-

Client Sample ID			MBSQ04	MBSQ05	MBSQ06	MBSQ07
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins | mgt Sample No.			S18-My24530	S18-My24531	S18-My24532	S18-My24533
Date Sampled			May 16, 2018	May 16, 2018	May 16, 2018	May 16, 2018
Test/Reference	LOR	Unit				
Organochlorine Pesticides						
Dieldrin	0.05	mg/kg	-	-	< 0.05	-
Endosulfan I	0.05	mg/kg	-	-	< 0.05	-
Endosulfan II	0.05	mg/kg	-	-	< 0.05	-
Endosulfan sulphate	0.05	mg/kg	-	-	< 0.05	-
Endrin	0.05	mg/kg	-	-	< 0.05	-
Endrin aldehyde	0.05	mg/kg	-	-	< 0.05	-
Endrin ketone	0.05	mg/kg	-	-	< 0.05	-
g-BHC (Lindane)	0.05	mg/kg	-	-	< 0.05	-
Heptachlor	0.05	mg/kg	-	-	< 0.05	-
Heptachlor epoxide	0.05	mg/kg	-	-	< 0.05	-
Hexachlorobenzene	0.05	mg/kg	-	-	< 0.05	-
Methoxychlor	0.05	mg/kg	-	-	< 0.05	-
Toxaphene	1	mg/kg	-	-	< 1	-
Aldrin and Dieldrin (Total)*	0.05	mg/kg	-	-	< 0.05	-
DDT + DDE + DDD (Total)*	0.05	mg/kg	-	-	< 0.05	-
Vic EPA IWRG 621 OCP (Total)*	0.1	mg/kg	-	-	< 0.1	-
Vic EPA IWRG 621 Other OCP (Total)*	0.1	mg/kg	-	-	< 0.1	-
Dibutylchlorendate (surr.)	1	%	-	-	125	-
Tetrachloro-m-xylene (surr.)	1	%	-	-	128	-
Ammonia (as N)	5	mg/kg	70	69	110	91
Nitrate & Nitrite (as N)	5	mg/kg	< 5	< 5	< 5	< 5
Total Inorganic Carbon	0.1	%	0.1	< 0.1	0.1	0.1
Total Kjeldahl Nitrogen (as N)	10	mg/kg	1000	1000	1000	1000
Total Organic Carbon	0.1	%	5.2	4.1	6.7	4.9
Phosphorus	5	mg/kg	480	430	580	490
Sulphur	5	mg/kg	380	340	480	400
% Moisture	1	%	61	58	70	65
Particle Size Distribution by Sieve and Hydrometer			see attached	see attached	see attached	see attached
Heavy Metals						
Aluminium	10	mg/kg	23000	21000	24000	22000
Arsenic	2	mg/kg	9.9	9.7	9.2	9.4
Barium	10	mg/kg	190	170	190	170
Beryllium	2	mg/kg	2.0	< 2	2.3	< 2
Boron	10	mg/kg	< 10	< 10	< 10	< 10
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	47	45	46	43
Cobalt	5	mg/kg	14	13	14	13
Copper	5	mg/kg	63	66	54	58
Iron	20	mg/kg	27000	26000	27000	25000
Lead	5	mg/kg	27	26	26	25
Manganese	5	mg/kg	400	350	430	410
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Molybdenum	5	mg/kg	< 5	< 5	< 5	< 5
Nickel	5	mg/kg	52	51	51	48
Selenium	2	mg/kg	< 2	< 2	< 2	< 2
Silver	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Vanadium	10	mg/kg	31	29	31	28
Zinc	5	mg/kg	92	87	94	85

Client Sample ID			MBSQ08	MBSQ09	MBSQ10	MBSQ11
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins | mgt Sample No.			**S18-My24534**	**S18-My24535**	**S18-My24536**	**S18-My24537**
Date Sampled			**May 16, 2018**	**May 16, 2018**	**May 16, 2018**	**May 16, 2018**
Test/Reference	LOR	Unit				
Ammonia (as N)	5	mg/kg	84	53	68	65
Nitrate & Nitrite (as N)	5	mg/kg	< 5	< 5	< 5	< 5
Total Inorganic Carbon	0.1	%	0.1	0.1	0.1	0.1
Total Kjeldahl Nitrogen (as N)	10	mg/kg	1000	1100	1100	1000
Total Organic Carbon	0.1	%	4.7	4.4	4.3	4.7
Phosphorus	5	mg/kg	460	420	440	410
Sulphur	5	mg/kg	370	350	350	370
% Moisture	1	%	61	59	59	61
Particle Size Distribution by Sieve and Hydrometer			see attached	see attached	see attached	see attached
Heavy Metals						
Aluminium	10	mg/kg	21000	22000	22000	21000
Arsenic	2	mg/kg	10	11	11	8.8
Barium	10	mg/kg	170	180	190	170
Beryllium	2	mg/kg	< 2	< 2	< 2	< 2
Boron	10	mg/kg	11	< 10	< 10	< 10
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	45	47	51	43
Cobalt	5	mg/kg	14	14	14	12
Copper	5	mg/kg	65	71	73	60
Iron	20	mg/kg	26000	26000	27000	24000
Lead	5	mg/kg	26	27	28	24
Manganese	5	mg/kg	400	370	370	340
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Molybdenum	5	mg/kg	< 5	< 5	< 5	< 5
Nickel	5	mg/kg	50	52	57	48
Selenium	2	mg/kg	< 2	< 2	< 2	< 2
Silver	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
Vanadium	10	mg/kg	29	30	32	28
Zinc	5	mg/kg	87	90	94	83

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Eurofins | mgt Suite B4			
Total Recoverable Hydrocarbons - 1999 NEPM Fractions	Melbourne	May 21, 2018	14 Day
- Method: LTM-ORG-2010 TRH C6-C36			
BTEX	Melbourne	May 21, 2018	14 Day
- Method: TRH C6-C40 - LTM-ORG-2010			
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	Melbourne	May 21, 2018	14 Day
- Method: TRH C6-C40 - LTM-ORG-2010			
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	Melbourne	May 21, 2018	14 Day
- Method: TRH C6-C40 - LTM-ORG-2010			
Polycyclic Aromatic Hydrocarbons	Melbourne	May 21, 2018	14 Day
- Method: LTM-ORG-2130 PAH and Phenols in Soil and Water			
Volatile Organics	Melbourne	May 21, 2018	7 Days
- Method: LTM-ORG-2150 VOCs in Soils Liquid and other Aqueous Matrices			
Organochlorine Pesticides	Melbourne	May 21, 2018	14 Day
- Method: LTM-ORG-2220 OCP & PCB in Soil and Water			
Ammonia (as N)	Melbourne	May 21, 2018	7 Day
- Method: APHA 4500-NH3 Ammonia Nitrogen by FIA			
Nitrate & Nitrite (as N)	Melbourne	May 21, 2018	28 Day
- Method: APHA 4500-NO3/NO2 Nitrate-Nitrite Nitrogen by FIA			
Total Inorganic Carbon	Melbourne	May 23, 2018	28 Day
- Method: APHA 5310B Total Inorganic Carbon			
Total Kjeldahl Nitrogen (as N)	Melbourne	May 21, 2018	28 Day
- Method: LTM-INO-4310 TKN in Waters & Soils by FIA			
Total Organic Carbon	Melbourne	May 23, 2018	28 Day
- Method: APHA 5310B Total Organic Carbon			
Phosphorus	Melbourne	May 21, 2018	180 Day
- Method: USEPA 6010			
Sulphur	Melbourne	May 21, 2018	7 Day
- Method: LTM-MET-3010			
Heavy Metals	Melbourne	May 21, 2018	180 Day
- Method: LTM-MET-3040 Metals in Waters Solids Soils & Sediments by ICP-MS			
Mercury	Melbourne	May 21, 2018	28 Day
- Method: USEPA 7470/1 Mercury			
% Moisture	Melbourne	May 18, 2018	14 Day
- Method: LTM-GEN-7080 Moisture			

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ABN– 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
2-5 Kingston Town Close
Oakleigh VIC 3166
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name: Cardno (NSW/ACT) Pty Ltd
Address: Level 9, 203 Pacific Highway
St Leonards
NSW 2065

Project Name: SNOWY HYDRO 2.0 RESERVOIR SAMPLING
Project ID: 59918111/003

Order No.:
Report #: 599074
Phone: 0294967700
Fax: 02 9499 3902

Received: May 18, 2018 4:06 PM
Due: May 23, 2018
Priority: 3 Day
Contact Name: Andrew Bradford

Eurofins | mgt Analytical Services Manager : Nibha Vaidya

Sample Detail						Aluminium	Ammonia (as N)	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Nitrate & Nitrite (as N)	Particle Size Distribution by Sieve and Hydrometer	Phosphorus	Selenium	Silver	Sulphur	Total Inorganic Carbon	Total Kjeldahl Nitrogen (as N)	Total Organic Carbon	Vanadium	Zinc	Organochlorine Pesticides	Volatile Organics	Moisture Set	Eurofins | mgt Suite B4
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																																				
Brisbane Laboratory - NATA Site # 20794																																				
Perth Laboratory - NATA Site # 23736																																				
External Laboratory																							X													
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																															
1	MBSQ01	May 16, 2018		Soil	S18-My24526	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
2	MBSQ01B	May 16, 2018		Soil	S18-My24527	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3	MBSQ02	May 16, 2018		Soil	S18-My24528	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
4	MBSQ03	May 16, 2018		Soil	S18-My24529	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
5	MBSQ04	May 16, 2018		Soil	S18-My24530	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
6	MBSQ05	May 16, 2018		Soil	S18-My24531	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
7	MBSQ06	May 16, 2018		Soil	S18-My24532	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8	MBSQ07	May 16, 2018		Soil	S18-My24533	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
9	MBSQ08	May 16, 2018		Soil	S18-My24534	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	

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ABN– 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
2-5 Kingston Town Close
Oakleigh VIC 3166
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name: Cardno (NSW/ACT) Pty Ltd
Address: Level 9, 203 Pacific Highway
St Leonards
NSW 2065

Project Name: SNOWY HYDRO 2.0 RESERVOIR SAMPLING
Project ID: 59918111/003

Order No.:
Report #: 599074
Phone: 0294967700
Fax: 02 9499 3902

Received: May 18, 2018 4:06 PM
Due: May 23, 2018
Priority: 3 Day
Contact Name: Andrew Bradford

Eurofins | mgt Analytical Services Manager : Nibha Vaidya

Sample Detail						Aluminium	Ammonia (as N)	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Nitrate & Nitrite (as N)	Particle Size Distribution by Sieve and Hydrometer	Phosphorus	Selenium	Silver	Sulphur	Total Inorganic Carbon	Total Kjeldahl Nitrogen (as N)	Total Organic Carbon	Vanadium	Zinc	Organochlorine Pesticides	Volatile Organics	Moisture Set	Eurofins | mgt Suite B4
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																																				
Brisbane Laboratory - NATA Site # 20794																																				
Perth Laboratory - NATA Site # 23736																																				
10	MBSQ09	May 16, 2018		Soil	S18-My24535	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
11	MBSQ10	May 16, 2018		Soil	S18-My24536	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
12	MBSQ11	May 16, 2018		Soil	S18-My24537	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Test Counts						12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	2	2	12	2

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram

mg/L: milligrams per litre

ug/L: micrograms per litre

ppm: Parts per million

ppb: Parts per billion

%: Percentage

org/100mL: Organisms per 100 millilitres

NTU: Nephelometric Turbidity Units

MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	Quality Systems Manual ver 5.1 US Department of Defense
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 50-150%-Phenols & PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.1 where no positive PFAS results have been reported have been reviewed and no data was affected.

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	mg/kg	< 20			20	Pass	
TRH C10-C14	mg/kg	< 20			20	Pass	
TRH C15-C28	mg/kg	< 50			50	Pass	
TRH C29-C36	mg/kg	< 50			50	Pass	
Method Blank							
BTEX							
Benzene	mg/kg	< 0.1			0.1	Pass	
Toluene	mg/kg	< 0.1			0.1	Pass	
Ethylbenzene	mg/kg	< 0.1			0.1	Pass	
m&p-Xylenes	mg/kg	< 0.2			0.2	Pass	
o-Xylene	mg/kg	< 0.1			0.1	Pass	
Xylenes - Total	mg/kg	< 0.3			0.3	Pass	
Method Blank							
Volatile Organics							
1.1-Dichloroethane	mg/kg	< 0.5			0.5	Pass	
1.1-Dichloroethene	mg/kg	< 0.5			0.5	Pass	
1.1.1-Trichloroethane	mg/kg	< 0.5			0.5	Pass	
1.1.1.2-Tetrachloroethane	mg/kg	< 0.5			0.5	Pass	
1.1.2-Trichloroethane	mg/kg	< 0.5			0.5	Pass	
1.1.2.2-Tetrachloroethane	mg/kg	< 0.5			0.5	Pass	
1.2-Dibromoethane	mg/kg	< 0.5			0.5	Pass	
1.2-Dichlorobenzene	mg/kg	< 0.5			0.5	Pass	
1.2-Dichloroethane	mg/kg	< 0.5			0.5	Pass	
1.2-Dichloropropane	mg/kg	< 0.5			0.5	Pass	
1.2.3-Trichloropropane	mg/kg	< 0.5			0.5	Pass	
1.2.4-Trimethylbenzene	mg/kg	< 0.5			0.5	Pass	
1.3-Dichlorobenzene	mg/kg	< 0.5			0.5	Pass	
1.3-Dichloropropane	mg/kg	< 0.5			0.5	Pass	
1.3.5-Trimethylbenzene	mg/kg	< 0.5			0.5	Pass	
1.4-Dichlorobenzene	mg/kg	< 0.5			0.5	Pass	
2-Butanone (MEK)	mg/kg	< 0.5			0.5	Pass	
2-Propanone (Acetone)	mg/kg	< 0.5			0.5	Pass	
4-Chlorotoluene	mg/kg	< 0.5			0.5	Pass	
4-Methyl-2-pentanone (MIBK)	mg/kg	< 0.5			0.5	Pass	
Allyl chloride	mg/kg	< 0.5			0.5	Pass	
Bromobenzene	mg/kg	< 0.5			0.5	Pass	
Bromochloromethane	mg/kg	< 0.5			0.5	Pass	
Bromodichloromethane	mg/kg	< 0.5			0.5	Pass	
Bromoform	mg/kg	< 0.5			0.5	Pass	
Bromomethane	mg/kg	< 0.5			0.5	Pass	
Carbon disulfide	mg/kg	< 0.5			0.5	Pass	
Carbon Tetrachloride	mg/kg	< 0.5			0.5	Pass	
Chlorobenzene	mg/kg	< 0.5			0.5	Pass	
Chloroethane	mg/kg	< 0.5			0.5	Pass	
Chloroform	mg/kg	< 0.5			0.5	Pass	
Chloromethane	mg/kg	< 0.5			0.5	Pass	
cis-1.2-Dichloroethene	mg/kg	< 0.5			0.5	Pass	
cis-1.3-Dichloropropene	mg/kg	< 0.5			0.5	Pass	
Dibromochloromethane	mg/kg	< 0.5			0.5	Pass	
Dibromomethane	mg/kg	< 0.5			0.5	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Dichlorodifluoromethane	mg/kg	< 0.5			0.5	Pass	
Iodomethane	mg/kg	< 0.5			0.5	Pass	
Isopropyl benzene (Cumene)	mg/kg	< 0.5			0.5	Pass	
Methylene Chloride	mg/kg	< 0.5			0.5	Pass	
Styrene	mg/kg	< 0.5			0.5	Pass	
Tetrachloroethene	mg/kg	< 0.5			0.5	Pass	
trans-1.2-Dichloroethene	mg/kg	< 0.5			0.5	Pass	
trans-1.3-Dichloropropene	mg/kg	< 0.5			0.5	Pass	
Trichloroethene	mg/kg	< 0.5			0.5	Pass	
Trichlorofluoromethane	mg/kg	< 0.5			0.5	Pass	
Vinyl chloride	mg/kg	< 0.5			0.5	Pass	
Method Blank							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
Naphthalene	mg/kg	< 0.5			0.5	Pass	
TRH C6-C10	mg/kg	< 20			20	Pass	
TRH >C10-C16	mg/kg	< 50			50	Pass	
TRH >C16-C34	mg/kg	< 100			100	Pass	
TRH >C34-C40	mg/kg	< 100			100	Pass	
Method Blank							
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	mg/kg	< 0.5			0.5	Pass	
Acenaphthylene	mg/kg	< 0.5			0.5	Pass	
Anthracene	mg/kg	< 0.5			0.5	Pass	
Benz(a)anthracene	mg/kg	< 0.5			0.5	Pass	
Benzo(a)pyrene	mg/kg	< 0.5			0.5	Pass	
Benzo(b&j)fluoranthene	mg/kg	< 0.5			0.5	Pass	
Benzo(g.h.i)perylene	mg/kg	< 0.5			0.5	Pass	
Benzo(k)fluoranthene	mg/kg	< 0.5			0.5	Pass	
Chrysene	mg/kg	< 0.5			0.5	Pass	
Dibenz(a.h)anthracene	mg/kg	< 0.5			0.5	Pass	
Fluoranthene	mg/kg	< 0.5			0.5	Pass	
Fluorene	mg/kg	< 0.5			0.5	Pass	
Indeno(1.2.3-cd)pyrene	mg/kg	< 0.5			0.5	Pass	
Naphthalene	mg/kg	< 0.5			0.5	Pass	
Phenanthrene	mg/kg	< 0.5			0.5	Pass	
Pyrene	mg/kg	< 0.5			0.5	Pass	
Method Blank							
Organochlorine Pesticides							
Chlordanes - Total	mg/kg	< 0.1			0.1	Pass	
4.4'-DDD	mg/kg	< 0.05			0.05	Pass	
4.4'-DDE	mg/kg	< 0.05			0.05	Pass	
4.4'-DDT	mg/kg	< 0.05			0.05	Pass	
a-BHC	mg/kg	< 0.05			0.05	Pass	
Aldrin	mg/kg	< 0.05			0.05	Pass	
b-BHC	mg/kg	< 0.05			0.05	Pass	
d-BHC	mg/kg	< 0.05			0.05	Pass	
Dieldrin	mg/kg	< 0.05			0.05	Pass	
Endosulfan I	mg/kg	< 0.05			0.05	Pass	
Endosulfan II	mg/kg	< 0.05			0.05	Pass	
Endosulfan sulphate	mg/kg	< 0.05			0.05	Pass	
Endrin	mg/kg	< 0.05			0.05	Pass	
Endrin aldehyde	mg/kg	< 0.05			0.05	Pass	
Endrin ketone	mg/kg	< 0.05			0.05	Pass	
g-BHC (Lindane)	mg/kg	< 0.05			0.05	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Heptachlor	mg/kg	< 0.05			0.05	Pass	
Heptachlor epoxide	mg/kg	< 0.05			0.05	Pass	
Hexachlorobenzene	mg/kg	< 0.05			0.05	Pass	
Methoxychlor	mg/kg	< 0.05			0.05	Pass	
Toxaphene	mg/kg	< 1			1	Pass	
Method Blank							
Ammonia (as N)	mg/kg	< 5			5	Pass	
Nitrate & Nitrite (as N)	mg/kg	< 5			5	Pass	
Total Kjeldahl Nitrogen (as N)	mg/kg	< 10			10	Pass	
Total Organic Carbon	%	< 0.1			0.1	Pass	
Method Blank							
Heavy Metals							
Aluminium	mg/kg	< 10			10	Pass	
Arsenic	mg/kg	< 2			2	Pass	
Barium	mg/kg	< 10			10	Pass	
Beryllium	mg/kg	< 2			2	Pass	
Boron	mg/kg	< 10			10	Pass	
Cadmium	mg/kg	< 0.4			0.4	Pass	
Chromium	mg/kg	< 5			5	Pass	
Cobalt	mg/kg	< 5			5	Pass	
Copper	mg/kg	< 5			5	Pass	
Iron	mg/kg	< 20			20	Pass	
Lead	mg/kg	< 5			5	Pass	
Manganese	mg/kg	< 5			5	Pass	
Mercury	mg/kg	< 0.1			0.1	Pass	
Molybdenum	mg/kg	< 5			5	Pass	
Nickel	mg/kg	< 5			5	Pass	
Selenium	mg/kg	< 2			2	Pass	
Silver	mg/kg	< 0.2			0.2	Pass	
Vanadium	mg/kg	< 10			10	Pass	
Zinc	mg/kg	< 5			5	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	%	100			70-130	Pass	
TRH C10-C14	%	71			70-130	Pass	
LCS - % Recovery							
BTEX							
Benzene	%	117			70-130	Pass	
Toluene	%	107			70-130	Pass	
Ethylbenzene	%	96			70-130	Pass	
m&p-Xylenes	%	89			70-130	Pass	
Xylenes - Total	%	90			70-130	Pass	
LCS - % Recovery							
Volatile Organics							
1.1-Dichloroethene	%	84			70-130	Pass	
1.1.1-Trichloroethane	%	110			70-130	Pass	
1.2-Dichlorobenzene	%	103			70-130	Pass	
1.2-Dichloroethane	%	111			70-130	Pass	
Trichloroethene	%	122			70-130	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
Naphthalene	%	114			70-130	Pass	
TRH C6-C10	%	98			70-130	Pass	
TRH >C10-C16	%	71			70-130	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
LCS - % Recovery							
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	%	80			70-130	Pass	
Acenaphthylene	%	79			70-130	Pass	
Anthracene	%	76			70-130	Pass	
Benz(a)anthracene	%	82			70-130	Pass	
Benzo(a)pyrene	%	82			70-130	Pass	
Benzo(b&j)fluoranthene	%	73			70-130	Pass	
Benzo(g.h.i)perylene	%	82			70-130	Pass	
Benzo(k)fluoranthene	%	83			70-130	Pass	
Chrysene	%	79			70-130	Pass	
Dibenz(a.h)anthracene	%	88			70-130	Pass	
Fluoranthene	%	70			70-130	Pass	
Fluorene	%	85			70-130	Pass	
Indeno(1.2.3-cd)pyrene	%	87			70-130	Pass	
Naphthalene	%	76			70-130	Pass	
Phenanthrene	%	90			70-130	Pass	
Pyrene	%	70			70-130	Pass	
LCS - % Recovery							
Organochlorine Pesticides							
4.4'-DDD	%	123			70-130	Pass	
4.4'-DDE	%	121			70-130	Pass	
4.4'-DDT	%	124			70-130	Pass	
a-BHC	%	109			70-130	Pass	
Aldrin	%	120			70-130	Pass	
b-BHC	%	106			70-130	Pass	
d-BHC	%	113			70-130	Pass	
Dieldrin	%	118			70-130	Pass	
Endosulfan I	%	118			70-130	Pass	
Endosulfan II	%	115			70-130	Pass	
Endosulfan sulphate	%	117			70-130	Pass	
Endrin	%	128			70-130	Pass	
Endrin aldehyde	%	116			70-130	Pass	
Endrin ketone	%	119			70-130	Pass	
g-BHC (Lindane)	%	111			70-130	Pass	
Heptachlor	%	119			70-130	Pass	
Heptachlor epoxide	%	120			70-130	Pass	
Hexachlorobenzene	%	106			70-130	Pass	
Methoxychlor	%	104			70-130	Pass	
LCS - % Recovery							
Total Kjeldahl Nitrogen (as N)	%	93			70-130	Pass	
Total Organic Carbon	%	96			70-130	Pass	
LCS - % Recovery							
Heavy Metals							
Arsenic	%	107			80-120	Pass	
Barium	%	117			80-120	Pass	
Beryllium	%	116			80-120	Pass	
Boron	%	115			80-120	Pass	
Cadmium	%	100			80-120	Pass	
Chromium	%	107			80-120	Pass	
Cobalt	%	109			80-120	Pass	
Copper	%	102			80-120	Pass	
Lead	%	102			80-120	Pass	
Manganese	%	110			80-120	Pass	

Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Mercury			%	88			75-125	Pass	
Molybdenum			%	106			80-120	Pass	
Nickel			%	104			80-120	Pass	
Selenium			%	103			80-120	Pass	
Silver			%	102			80-120	Pass	
Vanadium			%	104			80-120	Pass	
Zinc			%	106			80-120	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
				Result 1					
Total Kjeldahl Nitrogen (as N)	M18-My24390	NCP	%	103			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Arsenic	S18-My24527	CP	%	99			75-125	Pass	
Barium	S18-My24527	CP	%	101			75-125	Pass	
Beryllium	S18-My24527	CP	%	113			75-125	Pass	
Boron	S18-My24527	CP	%	104			75-125	Pass	
Cadmium	S18-My24527	CP	%	94			75-125	Pass	
Chromium	S18-My24527	CP	%	98			75-125	Pass	
Cobalt	S18-My24527	CP	%	100			75-125	Pass	
Copper	S18-My24527	CP	%	98			75-125	Pass	
Lead	S18-My24527	CP	%	96			75-125	Pass	
Manganese	S18-My24527	CP	%	104			75-125	Pass	
Mercury	S18-My24527	CP	%	86			70-130	Pass	
Molybdenum	S18-My24527	CP	%	101			75-125	Pass	
Nickel	S18-My24527	CP	%	99			75-125	Pass	
Selenium	S18-My24527	CP	%	95			75-125	Pass	
Silver	S18-My24527	CP	%	98			75-125	Pass	
Vanadium	S18-My24527	CP	%	97			75-125	Pass	
Zinc	S18-My24527	CP	%	101			75-125	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1					
TRH C6-C9	S18-My24532	CP	%	87			70-130	Pass	
TRH C10-C14	S18-My24532	CP	%	75			70-130	Pass	
Spike - % Recovery									
BTEX				Result 1					
Benzene	S18-My24532	CP	%	87			70-130	Pass	
Toluene	S18-My24532	CP	%	88			70-130	Pass	
Ethylbenzene	S18-My24532	CP	%	89			70-130	Pass	
m&p-Xylenes	S18-My24532	CP	%	84			70-130	Pass	
o-Xylene	S18-My24532	CP	%	87			70-130	Pass	
Xylenes - Total	S18-My24532	CP	%	85			70-130	Pass	
Spike - % Recovery									
Volatile Organics				Result 1					
1.1-Dichloroethene	S18-My24532	CP	%	71			70-130	Pass	
1.1.1-Trichloroethane	S18-My24532	CP	%	74			70-130	Pass	
1.2-Dichlorobenzene	S18-My24532	CP	%	80			70-130	Pass	
1.2-Dichloroethane	S18-My24532	CP	%	102			70-130	Pass	
Trichloroethene	S18-My24532	CP	%	86			70-130	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1					
Naphthalene	S18-My24532	CP	%	77			70-130	Pass	
TRH C6-C10	S18-My24532	CP	%	86			70-130	Pass	
TRH >C10-C16	S18-My24532	CP	%	71			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
Polycyclic Aromatic Hydrocarbons				Result 1					
Acenaphthene	S18-My24532	CP	%	94			70-130	Pass	
Acenaphthylene	S18-My24532	CP	%	96			70-130	Pass	
Anthracene	S18-My24532	CP	%	107			70-130	Pass	
Benz(a)anthracene	S18-My24532	CP	%	106			70-130	Pass	
Benzo(a)pyrene	S18-My24532	CP	%	99			70-130	Pass	
Benzo(b&j)fluoranthene	S18-My24532	CP	%	95			70-130	Pass	
Benzo(g.h.i)perylene	S18-My24532	CP	%	104			70-130	Pass	
Benzo(k)fluoranthene	S18-My24532	CP	%	92			70-130	Pass	
Chrysene	S18-My24532	CP	%	103			70-130	Pass	
Dibenz(a.h)anthracene	S18-My24532	CP	%	113			70-130	Pass	
Fluoranthene	S18-My24532	CP	%	86			70-130	Pass	
Fluorene	S18-My24532	CP	%	97			70-130	Pass	
Indeno(1.2.3-cd)pyrene	S18-My24532	CP	%	110			70-130	Pass	
Naphthalene	S18-My24532	CP	%	95			70-130	Pass	
Phenanthrene	S18-My24532	CP	%	107			70-130	Pass	
Pyrene	S18-My24532	CP	%	86			70-130	Pass	
Spike - % Recovery									
Organochlorine Pesticides				Result 1					
4.4'-DDD	S18-My24532	CP	%	126			70-130	Pass	
4.4'-DDE	S18-My24532	CP	%	118			70-130	Pass	
4.4'-DDT	S18-My24532	CP	%	112			70-130	Pass	
a-BHC	S18-My24532	CP	%	113			70-130	Pass	
Aldrin	S18-My24532	CP	%	128			70-130	Pass	
b-BHC	S18-My24532	CP	%	112			70-130	Pass	
d-BHC	S18-My24532	CP	%	125			70-130	Pass	
Dieldrin	S18-My24532	CP	%	130			70-130	Pass	
Endosulfan I	S18-My24532	CP	%	129			70-130	Pass	
Endosulfan II	S18-My24532	CP	%	125			70-130	Pass	
Endosulfan sulphate	S18-My24532	CP	%	125			70-130	Pass	
Endrin	S18-My24532	CP	%	126			70-130	Pass	
Endrin aldehyde	S18-My24532	CP	%	89			70-130	Pass	
Endrin ketone	S18-My24532	CP	%	112			70-130	Pass	
g-BHC (Lindane)	S18-My24532	CP	%	115			70-130	Pass	
Heptachlor	S18-My24532	CP	%	122			70-130	Pass	
Heptachlor epoxide	S18-My24532	CP	%	130			70-130	Pass	
Hexachlorobenzene	S18-My24532	CP	%	114			70-130	Pass	
Methoxychlor	S18-My24532	CP	%	127			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Arsenic	S18-My24537	CP	%	104			75-125	Pass	
Barium	S18-My24537	CP	%	110			75-125	Pass	
Beryllium	S18-My24537	CP	%	118			75-125	Pass	
Boron	S18-My24537	CP	%	113			75-125	Pass	
Cadmium	S18-My24537	CP	%	99			75-125	Pass	
Chromium	S18-My24537	CP	%	104			75-125	Pass	
Cobalt	S18-My24537	CP	%	105			75-125	Pass	
Copper	S18-My24537	CP	%	104			75-125	Pass	
Lead	S18-My24537	CP	%	99			75-125	Pass	
Manganese	S18-My24537	CP	%	114			75-125	Pass	
Mercury	S18-My24537	CP	%	85			70-130	Pass	
Molybdenum	S18-My24537	CP	%	105			75-125	Pass	
Nickel	S18-My24537	CP	%	103			75-125	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Selenium	S18-My24537	CP	%	101			75-125	Pass	
Silver	S18-My24537	CP	%	98			75-125	Pass	
Vanadium	S18-My24537	CP	%	102			75-125	Pass	
Zinc	S18-My24537	CP	%	107			75-125	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
Total Inorganic Carbon	S18-My24526	CP	%	0.2	0.1	6.2	30%	Pass	
Total Organic Carbon	S18-My24526	CP	%	4.6	4.8	3.9	30%	Pass	
Phosphorus	S18-My24526	CP	mg/kg	510	520	2.0	30%	Pass	
Sulphur	S18-My24526	CP	mg/kg	400	410	2.0	30%	Pass	
% Moisture	S18-My24526	CP	%	62	62	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium	S18-My24526	CP	mg/kg	21000	23000	7.0	30%	Pass	
Arsenic	S18-My24526	CP	mg/kg	9.2	9.6	4.0	30%	Pass	
Barium	S18-My24526	CP	mg/kg	180	190	6.0	30%	Pass	
Beryllium	S18-My24526	CP	mg/kg	< 2	< 2	<1	30%	Pass	
Boron	S18-My24526	CP	mg/kg	11	< 10	18	30%	Pass	
Cadmium	S18-My24526	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	S18-My24526	CP	mg/kg	42	46	8.0	30%	Pass	
Cobalt	S18-My24526	CP	mg/kg	12	13	7.0	30%	Pass	
Copper	S18-My24526	CP	mg/kg	57	61	8.0	30%	Pass	
Iron	S18-My24526	CP	mg/kg	24000	26000	6.0	30%	Pass	
Lead	S18-My24526	CP	mg/kg	26	27	4.0	30%	Pass	
Manganese	S18-My24526	CP	mg/kg	400	430	7.0	30%	Pass	
Mercury	S18-My24526	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Molybdenum	S18-My24526	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Nickel	S18-My24526	CP	mg/kg	48	51	6.0	30%	Pass	
Selenium	S18-My24526	CP	mg/kg	< 2	< 2	<1	30%	Pass	
Silver	S18-My24526	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Vanadium	S18-My24526	CP	mg/kg	28	30	6.0	30%	Pass	
Zinc	S18-My24526	CP	mg/kg	86	91	5.0	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1	Result 2	RPD			
TRH C6-C9	S18-My24527	CP	mg/kg	< 20	< 20	<1	30%	Pass	
TRH C10-C14	S18-My24527	CP	mg/kg	< 20	< 20	<1	30%	Pass	
TRH C15-C28	S18-My24527	CP	mg/kg	< 50	< 50	<1	30%	Pass	
TRH C29-C36	S18-My24527	CP	mg/kg	< 50	< 50	<1	30%	Pass	
Duplicate									
BTEX				Result 1	Result 2	RPD			
Benzene	S18-My24527	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Toluene	S18-My24527	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Ethylbenzene	S18-My24527	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
m&p-Xylenes	S18-My24527	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
o-Xylene	S18-My24527	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Xylenes - Total	S18-My24527	CP	mg/kg	< 0.3	< 0.3	<1	30%	Pass	
Duplicate									
Volatile Organics				Result 1	Result 2	RPD			
1.1-Dichloroethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
1.1-Dichloroethene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
1.1.1-Trichloroethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
1.1.1.2-Tetrachloroethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
1.1.2-Trichloroethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	

Duplicate									
Volatile Organics				Result 1	Result 2	RPD			
1.1.2.2-Tetrachloroethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
1.2-Dibromoethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
1.2-Dichlorobenzene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
1.2-Dichloroethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
1.2-Dichloropropane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
1.2.3-Trichloropropane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
1.2.4-Trimethylbenzene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
1.3-Dichlorobenzene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
1.3-Dichloropropane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
1.3.5-Trimethylbenzene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
1.4-Dichlorobenzene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
2-Butanone (MEK)	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
2-Propanone (Acetone)	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
4-Chlorotoluene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
4-Methyl-2-pentanone (MIBK)	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Allyl chloride	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Bromobenzene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Bromochloromethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Bromodichloromethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Bromoform	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Bromomethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Carbon disulfide	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Carbon Tetrachloride	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Chlorobenzene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Chloroethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Chloroform	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Chloromethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
cis-1.2-Dichloroethene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
cis-1.3-Dichloropropene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Dibromochloromethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Dibromomethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Dichlorodifluoromethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Iodomethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Isopropyl benzene (Cumene)	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Methylene Chloride	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Styrene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Tetrachloroethene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
trans-1.2-Dichloroethene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
trans-1.3-Dichloropropene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Trichloroethene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Trichlorofluoromethane	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Vinyl chloride	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1	Result 2	RPD			
Naphthalene	S18-My24527	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
TRH C6-C10	S18-My24527	CP	mg/kg	< 20	< 20	<1	30%	Pass	
TRH >C10-C16	S18-My24527	CP	mg/kg	< 50	< 50	<1	30%	Pass	
TRH >C16-C34	S18-My24527	CP	mg/kg	< 100	< 100	<1	30%	Pass	
TRH >C34-C40	S18-My24527	CP	mg/kg	< 100	< 100	<1	30%	Pass	

Duplicate									
Polycyclic Aromatic Hydrocarbons				Result 1	Result 2	RPD			
Acenaphthene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Acenaphthylene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Anthracene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benz(a)anthracene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(a)pyrene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(b&j)fluoranthene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(g.h.i)perylene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(k)fluoranthene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Chrysene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Dibenz(a.h)anthracene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Fluoranthene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Fluorene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Indeno(1.2.3-cd)pyrene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Naphthalene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Phenanthrene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Pyrene	M18-My24691	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Duplicate									
Organochlorine Pesticides				Result 1	Result 2	RPD			
Chlordanes - Total	S18-My24527	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
4.4'-DDD	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
4.4'-DDE	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
4.4'-DDT	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
a-BHC	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Aldrin	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
b-BHC	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
d-BHC	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Dieldrin	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endosulfan I	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endosulfan II	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endosulfan sulphate	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endrin	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endrin aldehyde	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Endrin ketone	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
g-BHC (Lindane)	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Heptachlor	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Heptachlor epoxide	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Hexachlorobenzene	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Methoxychlor	S18-My24527	CP	mg/kg	< 0.05	< 0.05	<1	30%	Pass	
Toxaphene	S18-My24527	CP	mg/kg	< 1	< 1	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium	S18-My24527	CP	mg/kg	20000	20000	<1	30%	Pass	
Arsenic	S18-My24527	CP	mg/kg	9.0	9.0	<1	30%	Pass	
Barium	S18-My24527	CP	mg/kg	180	180	1.0	30%	Pass	
Beryllium	S18-My24527	CP	mg/kg	< 2	< 2	<1	30%	Pass	
Boron	S18-My24527	CP	mg/kg	< 10	< 10	<1	30%	Pass	
Cadmium	S18-My24527	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	S18-My24527	CP	mg/kg	42	42	1.0	30%	Pass	
Cobalt	S18-My24527	CP	mg/kg	12	13	1.0	30%	Pass	
Copper	S18-My24527	CP	mg/kg	56	56	<1	30%	Pass	
Iron	S18-My24527	CP	mg/kg	24000	24000	1.0	30%	Pass	
Lead	S18-My24527	CP	mg/kg	25	25	<1	30%	Pass	
Manganese	S18-My24527	CP	mg/kg	400	400	1.0	30%	Pass	
Mercury	S18-My24527	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	

Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Molybdenum	S18-My24527	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Nickel	S18-My24527	CP	mg/kg	47	47	<1	30%	Pass	
Selenium	S18-My24527	CP	mg/kg	< 2	< 2	<1	30%	Pass	
Silver	S18-My24527	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Vanadium	S18-My24527	CP	mg/kg	28	28	2.0	30%	Pass	
Zinc	S18-My24527	CP	mg/kg	85	85	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Total Inorganic Carbon	S18-My24533	CP	%	0.1	0.1	2.4	30%	Pass	
Total Organic Carbon	S18-My24533	CP	%	4.9	4.9	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Phosphorus	S18-My24536	CP	mg/kg	440	410	9.0	30%	Pass	
Sulphur	S18-My24536	CP	mg/kg	350	340	5.0	30%	Pass	
% Moisture	S18-My24536	CP	%	59	58	1.0	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium	S18-My24536	CP	mg/kg	22000	20000	11	30%	Pass	
Arsenic	S18-My24536	CP	mg/kg	11	9.3	18	30%	Pass	
Barium	S18-My24536	CP	mg/kg	190	180	6.0	30%	Pass	
Beryllium	S18-My24536	CP	mg/kg	< 2	< 2	<1	30%	Pass	
Boron	S18-My24536	CP	mg/kg	< 10	< 10	<1	30%	Pass	
Cadmium	S18-My24536	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	S18-My24536	CP	mg/kg	51	44	14	30%	Pass	
Cobalt	S18-My24536	CP	mg/kg	14	13	11	30%	Pass	
Copper	S18-My24536	CP	mg/kg	73	64	12	30%	Pass	
Iron	S18-My24536	CP	mg/kg	27000	24000	13	30%	Pass	
Lead	S18-My24536	CP	mg/kg	28	25	14	30%	Pass	
Manganese	S18-My24536	CP	mg/kg	370	340	8.0	30%	Pass	
Mercury	S18-My24536	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Molybdenum	S18-My24536	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Nickel	S18-My24536	CP	mg/kg	57	49	15	30%	Pass	
Selenium	S18-My24536	CP	mg/kg	< 2	< 2	<1	30%	Pass	
Silver	S18-My24536	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Vanadium	S18-My24536	CP	mg/kg	32	29	10	30%	Pass	
Zinc	S18-My24536	CP	mg/kg	94	85	10	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium	S18-My24537	CP	mg/kg	21000	21000	<1	30%	Pass	
Arsenic	S18-My24537	CP	mg/kg	8.8	8.7	1.0	30%	Pass	
Barium	S18-My24537	CP	mg/kg	170	170	<1	30%	Pass	
Beryllium	S18-My24537	CP	mg/kg	< 2	< 2	<1	30%	Pass	
Boron	S18-My24537	CP	mg/kg	< 10	< 10	<1	30%	Pass	
Cadmium	S18-My24537	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	S18-My24537	CP	mg/kg	43	44	1.0	30%	Pass	
Cobalt	S18-My24537	CP	mg/kg	12	12	<1	30%	Pass	
Copper	S18-My24537	CP	mg/kg	60	59	1.0	30%	Pass	
Iron	S18-My24537	CP	mg/kg	24000	24000	<1	30%	Pass	
Lead	S18-My24537	CP	mg/kg	24	24	<1	30%	Pass	
Manganese	S18-My24537	CP	mg/kg	340	340	1.0	30%	Pass	
Mercury	S18-My24537	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Molybdenum	S18-My24537	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Nickel	S18-My24537	CP	mg/kg	48	48	<1	30%	Pass	
Selenium	S18-My24537	CP	mg/kg	< 2	< 2	<1	30%	Pass	

Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Silver	S18-My24537	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
Vanadium	S18-My24537	CP	mg/kg	28	28	1.0	30%	Pass	
Zinc	S18-My24537	CP	mg/kg	83	84	1.0	30%	Pass	

Comments

Particle size distribution analysed by: East West labs Tamworth, report reference EW181058.

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	No
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	Yes

Qualifier Codes/Comments

Code	Description
N01	F2 is determined by arithmetically subtracting the "naphthalene" value from the ">C10-C16" value. The naphthalene value used in this calculation is obtained from volatiles (Purge & Trap analysis).
N02	Where we have reported both volatile (P&T GCMS) and semivolatile (GCMS) naphthalene data, results may not be identical. Provided correct sample handling protocols have been followed, any observed differences in results are likely to be due to procedural differences within each methodology. Results determined by both techniques have passed all QAQC acceptance criteria, and are entirely technically valid.
N04	F1 is determined by arithmetically subtracting the "Total BTEX" value from the "C6-C10" value. The "Total BTEX" value is obtained by summing the concentrations of BTEX analytes. The "C6-C10" value is obtained by quantitating against a standard of mixed aromatic/aliphatic analytes.
N07	Please note:- These two PAH isomers closely co-elute using the most contemporary analytical methods and both the reported concentration (and the TEQ) apply specifically to the total of the two co-eluting PAHs

Authorised By

Nibha Vaidya	Analytical Services Manager
Alex Petridis	Senior Analyst-Metal (VIC)
Harry Bacalis	Senior Analyst-Volatile (VIC)
Joseph Edouard	Senior Analyst-Organic (VIC)
Michael Brancati	Senior Analyst-Inorganic (VIC)

Glenn Jackson

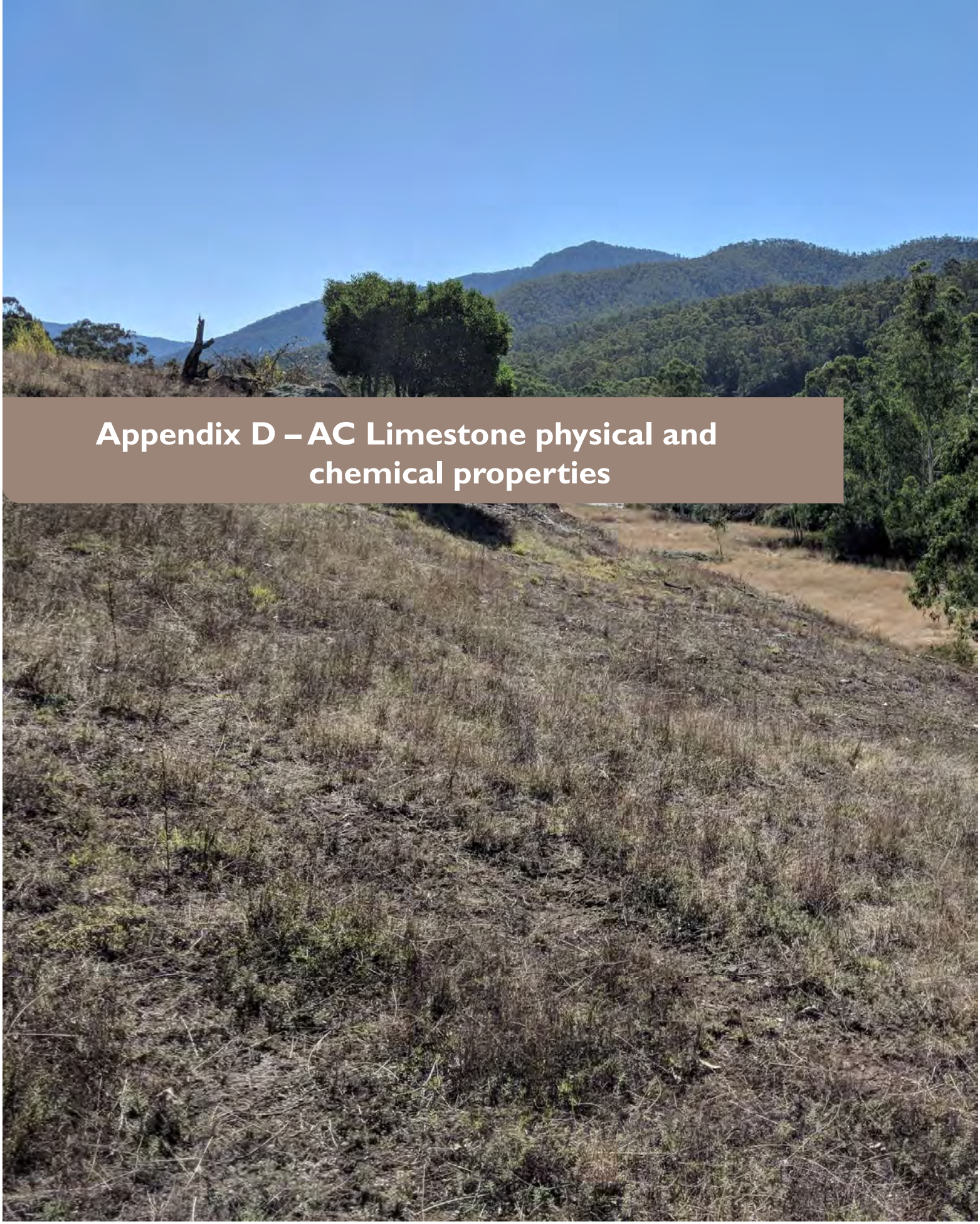
National Operations Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.



Appendix D – AC Limestone physical and chemical properties

Table 20 Typical AC limestone 8 mm minus particle size distribution

Particle size (mm)	Percentage retained
20.00	0.231
16.00	0.000
9.50	0.000
8.00	0.066
6.70	1.187
5.60	4.351
5.00	4.258
3.35	9.836
1.25	19.180
0.90	5.714
0.50	22.385
0.25	26.666
0.075	29.649
<0.075	21.297

Note: Supplied by Omya Australia Pty Limited

Table 21 Typical AC limestone geochemistry

Constituent	Chemical composition	Units	Concentration
Calcium carbonate	$CaCO_3$	%	95
Magnesium carbonate	$MgCO_3$	%	3.5
Quartz	SiO_2	%	1.2
Aluminium oxide	$Al2O_3$	%	0.1
Iron oxide	Fe_2O_3	%	0.1
Potassium	K_2O	Parts per million (ppm)	<10
Sodium	Na_2O	%	0.02
Sulfur	SO_3	ppm	<10
Cu	Cu	ppm	<1
Manganese	MnO	ppm	550
P	P_2O_5	%	0.015
Ni	Ni	ppm	<1
Cr	Cr	ppm	<2
Cobalt	Co	ppm	<1

Note: Supplied by Omya Australia Pty Limited

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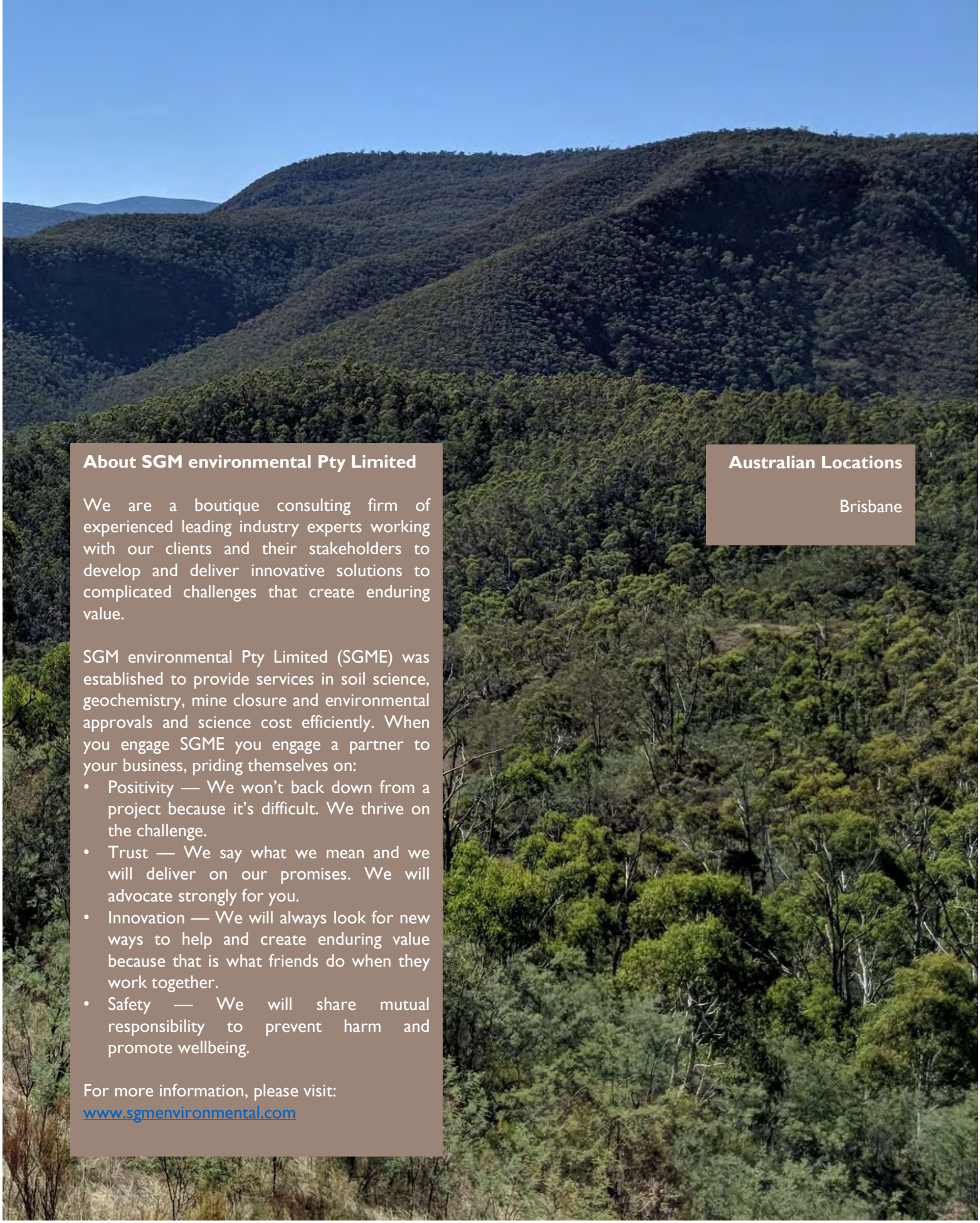

About SGM environmental Pty Limited

We are a boutique consulting firm of experienced leading industry experts working with our clients and their stakeholders to develop and deliver innovative solutions to complicated challenges that create enduring value.

SGM environmental Pty Limited (SGME) was established to provide services in soil science, geochemistry, mine closure and environmental approvals and science cost efficiently. When you engage SGME you engage a partner to your business, priding themselves on:

- Positivity — We won't back down from a project because it's difficult. We thrive on the challenge.
- Trust — We say what we mean and we will deliver on our promises. We will advocate strongly for you.
- Innovation — We will always look for new ways to help and create enduring value because that is what friends do when they work together.
- Safety — We will share mutual responsibility to prevent harm and promote wellbeing.

For more information, please visit:
www.sgmenvironmental.com

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