S2-FGJV-ENV-PLN-0026

GROUNDWATER MANAGEMENT PLAN

Approval Record			
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ABBREVIATIONS AND DEFINITIONS

Acronym	Definition
AFL	Agreement for Lease
AGMG	Australian Groundwater Modelling Guidelines
AHD	Australian Height Datum
AIP	*Aquifer Interference Policy 2012*
ANZECC	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
BCD	Biodiversity and Conservation Division (now part of Department of Planning, Industry and Environment)`
BoM	Bureau of Meteorology
CoA	Conditions of Approval
CSSI	Critical State Significant Infrastructure
DoI Water	NSW Department of Industry Water
DPIE	NSW Department of Planning, Industry and Environment (formerly DPE)
DPI	NSW Department of Industry - Fisheries
ESCP	Erosion and Sediment Control Plan
EIS	*Environmental Impact Statement Exploratory Works for Snowy 2.0*
EMS	Environmental Management Strategy
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPA	NSW Environment Protection Authority
EPL	Environment Protection Licence
ESCP	Erosion and Sediment Control Plan
EWAR	Exploratory Works Access Roads
Future Generation/ FGJV	Future Generation Joint Venture
Future Generation-PMS	Project Management System
GDE	Groundwater dependant ecosystem
GMP	Groundwater Monitoring Program
GWA	Groundwater Assessment (EIS Appendix N)
GWMP	Groundwater Management Plan (this Plan)
ISO	International Standards Organisation
KNP	Kosciuszko National Park
Leed	Leed Engineering
MDB	Murray Darling Basin
NATA	National Association of Testing Authorities
NEPC	National Environmental Protection Council
NEPM	National Environmental Protection Measure
NERDDC	National Energy Research Development and Demonstration Council

Acronym	Definition
NOW	NSW Office of Water
NPWS	National Park and Wildlife Service
NRMMC	Natural Resource Management Ministerial Council
NRAR	Natural Resources Access Regulator
PEP	Project Execution Plan
PCT	Plant community type
PESCP	Progressive erosion and sediment control plan
PIRMP	Pollution Incident Response Management Plan
PMS	Project Management System
POEO Act	*Protection of the Environment Operations Act 1997*
POEO Regulation	*Protection of the Environment Operations (General) Regulation 2009*
QMP	Quality Management Plan
REMM	Revised Environmental Management Measures
SHC Act	*Snowy Hydro Corporatisation Act 1997*
SHL	Snowy Hydro Limited
SPAL	Specific Purpose Access Licence
SSI	State Significant Infrastructure
SSTV	Site Specific Trigger Value
Submissions Report or RTS	*Response to Submissions Exploratory Works for Snowy 2.0*
SWMP	Surface Water Management Plan
TARP	Trigger Action Response Plan
TBM	Tunnel Boring Machine
WAL	Water Access Licence
WM Act	*Water Management Act 2000*
WMA Act	*Water Management Amendment Act 2014*
WMP	Water Management Plan
WSP	Water Sharing Plans
WM Regulation	*Water Management (General) Regulation 2011*
WMS	Work Method Statement

1. INTRODUCTION

Salini Impregilo, Clough and Lane have formed the Future Generation Joint Venture (Future Generation) to provide the Civil Works Package for Snowy Hydro Limited (SHL) on the Snowy 2.0 Project (the Project).

The Project is a pumped hydro project that will increase the generation capacity of the Snowy Mountains Scheme by up to 2,000mW and at full capacity will provide approximately 350,000MW/h of energy storage. The project includes all activities associated with the civil works requirements for the Snowy 2.0 Pumped Hydro-electric Scheme.

Intake and outlet structures will be built at both Tantangara and Talbingo Reservoirs, which are in the Kosciusko National Park (KNP) in southern NSW. Approximately 27km of concrete-lined tunnels will be constructed to link the two reservoirs and a further 20km of tunnels will be required to support the facility. The power station complex will be located almost one kilometre underground.

The project will deliver one of the largest pumped hydro schemes in the world and underscores the importance of the Snowy Scheme's role in the National Electricity Market.

Future Generation was conceived to deliver an integrated engineering, procurement and construction management service for the project. The joint venture is backed by the combined experience of Salini Impregilo, Clough and Lane, through their experience in the infrastructure, mineral and oil and gas sectors throughout Australia and the world.

1.1. Purpose

This Groundwater Management Plan (GWMP or Plan) forms part of the Water Management Plan and Environmental Management Strategy (EMS) for Snowy 2.0 – Exploratory Works – Stage 2 (Exploratory Works – Stage 2). The Exploratory Works is the first phase of Snowy 2.0, a pumped hydro-electric storage and generation project which will increase the hydro-electric capacity within the existing Snowy Mountains Hydro-electric Scheme. The Main Works or second phase, will be subject to a separate Environmental Impact Statement (EIS) in 2019.

This GWMP has been prepared to address the requirements of:

- the Infrastructure Approval (SSI 9208) (Approval) issued for Snowy 2.0 Exploratory Works on 7 February 2019 and modified on 2 December 2019 and 27 March 2020;
- the *Environmental Impact Statement Exploratory Works for Snowy Hydro 2.0* (Exploratory Works EIS);
- the revised environmental management measures (REMMs) within the *Response to Submissions Exploratory Works for Snowy 2.0* (Submissions Report or RTS);
- the *Modification 1 Assessment Report - Exploratory Works for Snowy 2.0* (Modification 1)*;*
- the REMMs within the *Response to Submissions - Exploratory Works Modification 1* (Submissions Report for Modification 1);
- the Modification 2 Assessment Report - Exploratory Works for Snowy 2.0 (Modification 2); and
- the REMMs within the *Response to Submissions - Exploratory Works Modification 2* (Submissions Report for Modification 2).

The Exploratory Work scope for Snowy 2.0 includes:

- an exploratory tunnel to the site of the underground power station for Snowy 2.0;

- horizontal and test drilling;
- a portal construction pad;
- an accommodation camp;
- road works and upgrades providing access and haulage routes;
- barge access infrastructure and dredge works*;
- excavated rock management, including subaqueous placement* within Talbingo Reservoir;
- services infrastructure; and
- post-construction revegetation and rehabilitation.

Note: these activities will not proceed unless the relevant management plans are approved by Department of Planning, Industry and Environment (DPIE).

Exploratory Works will be delivered in three distinct stages and these stages will be completed by two different contractors. Leed Engineering (Leed) is the contractor who will be carrying out the Snowy 2.0 Stage 1 work on behalf of SHL. Future Generation is the contractor who will be delivering the Snowy 2.0 Stage 2 works on behalf of SHL.

Works to be completed by Leed on behalf of SHL:

- **Stage 1a – Pre-construction Minor Works** - Stage 1a has been approved and commenced I the first quarter of 2019. The scope of pre-construction minor works includes dilapidation studies, survey work, borehole installation, site office establishment, minor access roads, installation of monitoring equipment, installation of erosion and sediment controls, and minor clearing. Works commenced in the quarter two (Q2) of 2019.
- **Stage 1b - Exploratory Works Access Roads (EWAR)** – Stage 1b has been approved and commenced in the second quarter of 2019. The scope includes roadworks and upgrades to enable access and haulage routes during Exploratory Works. This includes upgrades to 26 km of existing roads and creating about 2 km of new roads, two new bridge crossings and two temporary waterway crossings.

Works to be completed by Future Generation on behalf of SHL:

- **Stage 2 – Exploratory Works** – Stage 2 has been approved and works commenced October of 2019. The scope for Stage 2 Exploratory Works includes:
  - pre-construction minor activities including dilapidation studies, survey, investigations, access etc; and
  - construction works including exploratory tunnel, portal construction pad, accommodation camp, dredging, barge access infrastructure, excavated rock management and additional geotechnical investigation. This includes subaqueous emplacement within Talbingo Reservoir.

Further detail on construction activities and staging is presented in Section 1.7 and Figure 1-1.

This Plan identifies the project's environmental management measures in relation to groundwater management for the Exploratory Works – Stage 2. It has been specifically developed for the Exploratory Works – Stage 2.

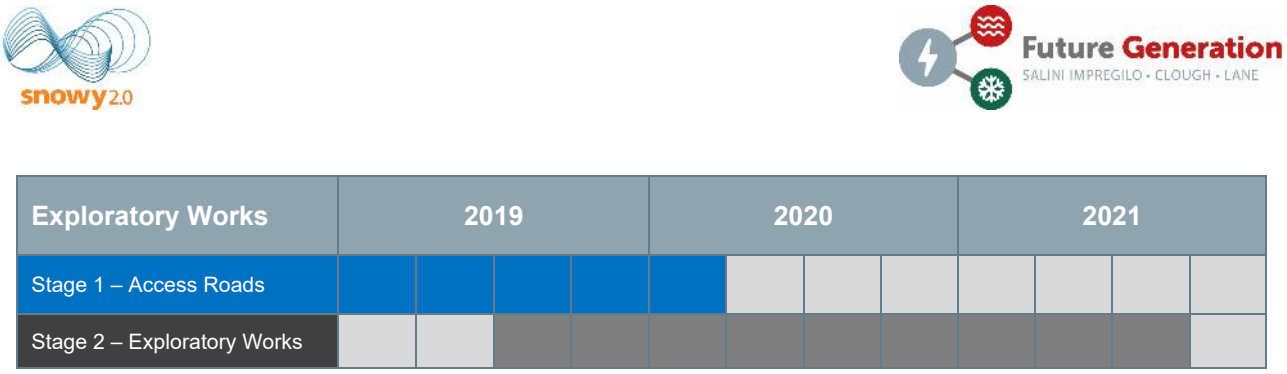


Figure 1-1: Timing of exploratory works stages

Stage 2 management plans have been revised from the corresponding Stage 1 management plan, as demonstrated in the document revision section of each Stage 2 plan. The intent of this arrangement is to ensure a consistent approach to managing environmental risk and regulatory requirements for the Exploratory Works project. In the event that both Exploratory Works Stages are undertaken concurrently, and / or in overlapping locations, the Stage 1 management plan will apply to the Stage 1 works, and the Stage 2 management plans will apply to the Stage 2 works. This arrangement would not affect management standards as all relevant measures from each management plan would continue to apply. As the proponent, Snowy Hydro will oversee both stages of the Exploratory Works project.

The timing of the preparation, consultation, submission and approval of this Plan, along with other management plans required by the Conditions of Approval (CoA), is shown within Table 3-1 and Figure 4.4 of the EMS.

Ongoing revisions to this Plan will occur in accordance with Section 2.6 of the EMS, and as required by condition 4 of schedule 4 of the Infrastructure Approval. Circumstances requiring a review, and if necessary, revision of this Plan include submission of incident reports or audit reports, approval of modifications to the CoA and directions of the Planning Secretary under condition 4 of schedule 2.

Table 1-1 presents the relationship of activities relating to water management with respect to this Plan and other management plans being prepared for the Project. Some distinct work activities which have the potential to impact on other water elements such as surface and dredging, require greater detail and therefore warrant separate plans.

Table 1-1: Relationship to other plans

Activities	Relevant plan	Timing of the plan*	
		Stage 1	Stage 2
General environmental compliance including inspection, monitoring and auditing.	Environmental Management Strategy	P	R
Road construction and tunnelling – general management of groundwater	This plan	P	R
Surface Water	Surface Water Management Plan	P	R
Erosion and sedimentation management	Surface Water Management Plan	P	R
Extracted tunnel groundwater processing within the process water system	Surface Water Management Plan		P
Excavated tunnel rock stockpiling	Excavated Material Management Plan	P	R
Geodiversity and karst features	Historic and Natural Heritage Management Plan	P	R

* P – prepare, R – revise

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

1.2. Background

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

Future Generation proposes to carry out the Exploratory Works – Stage 2 prior to the main construction works for the Project, to inform the detailed design and to reduce project risk. Exploratory Works are required to obtain detailed geological data for the location of the underground power station. An exploratory tunnel is to be constructed to gain this information. The Exploratory Works – Stage 2 will predominantly be in the Lobs Hole area of KNP. If the Exploratory Works are not undertaken, risks to the design and construct elements of the power station cavern are significantly increased.

The Exploratory Works EIS was prepared to assess the impact of these works on the environment, including an assessment of groundwater impacts within Chapters 5.4 and Appendix N.

The RTS included REMMs within Chapter 8. The management measures from that report have been addressed within this GWMP.

The Exploratory Works EIS found that the predicted peak annual groundwater take for the Exploratory Works is 340 ML/yr, and that there is sufficient groundwater entitlement within the Lachlan Fold Belt MDB (Fractured Rock Groundwater Source). Modelling undertaken as part of the EIS predicted localised drawdown in the vicinity of the tunnel alignment, primarily around the portal.

There are no identified High Priority Groundwater Dependant Ecosystems (GDEs) within the project area. Yarrangobilly Caves was the only High Priority GDE within the Lachlan Fold Belt and is approximately 8 km north of the Exploratory Works area. Modelling predicted a maximum lateral drawdown extent of 2 km from the Exploratory Works and therefore there were no predicted impacts on the Yarrangobilly Caves. Only minor impacts to the baseflow of the Yarrangobilly River and tributaries are expected during construction. Losses are predicted to increase post construction until a new equilibrium is reached.

1.2.1. Modification 1

In accordance with section 5.25 of the EP&A Act, the Infrastructure Approval issued for Exploratory Works was modified to:

- provide additional geotechnical information for the detailed design of the Snowy 2.0 power station and power waterway;
- provide a reliable long term source of construction power for the duration of Exploratory Works and will reduce the reliance on diesel generation and associated on-site storage and emissions;
- improve the efficiency of the Exploratory Works construction power;
- optimise the detailed design of construction areas and access roads; and

- improve worker safety during construction.

The Modification 1 Assessment Report was submitted to Department of Planning, Industry and Environment (DPIE) in June 2019, and was publicly exhibited between 26 June 2019 and 9 July 2019. A total of nine submissions were received, and following consideration, approval was granted by the Minister for Planning and Public Spaces on 2 December 2019.

Though Modification 1 included several changes, only the geotechnical investigations are relevant to the Stage 2 works and Future Generation's activities for the Exploratory Works project. This GWMP has therefore been revised to address the groundwater requirements and management measures from Modification 1 which are relevant to the geotechnical activities.

1.2.2. Modification 2

In accordance with section 5.25 of the EP&A Act, the Infrastructure Approval issued for Exploratory Works was modified to:

- revise the tunnelling method from drill and blast to predominantly tunnel boring machine (TBM);
- provide for road upgrades required to enable the transport and delivery of TBM equipment and materials required for tunnelling;
- include vegetation trimming, and selective tree lopping/removal on Lobs Hole Ravine Road (south) to provide adequate clearance for transport of the TBMs;
- improve access and egress to Lobs Hole via Lobs Hole Ravine Road (north);
- relocate the Middle Bay Barge ramp;
- increase the capacity of the Lobs Hole accommodation camp from 152 personnel to up to 250;
- provide for additional diesel storage capacity for the TBM until the Lobs Hole substation construction power is available;
- provide for the additional diesel generators required to provide power supply to the TBM prior to Lobs Hole substation commissioning; and
- revise the transport strategy to reduce the use of barging for delivery of materials to site.

The Modification 2 Assessment Report was submitted to Department of Planning, Industry and Environment (DPIE) in October 2019, and was publicly exhibited between 5 November 2019 and 21 November 2019. A total of twenty-five submissions were received, and following consideration, approval was granted by the Minister for Planning and Public Spaces in 27 March 2020.

This GWMP has been revised to address the changes which have occurred as a result of Modification 2.

1.3. Environmental Management System

The overall environmental management system for the Project is described in the EMS. This GWMP forms part of Future Generation's Environmental Management Framework for the Project as described in Section 4 of the EMS.

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

1.4. Relationship to Project Management System and Other Plans

It is a requirement of Volume 4 Employer's Requirements – Project Execution to develop and implement a number of project plans for the project. These plans are defined as deliverables. The GWMP is required to support the deliverable plans.

The Environmental Management Strategy (EMS) will form part of the Project Management System (Future Generation-PMS) and will include any requirements specified in the contract documents, where appropriate. All Future Generation-PMS procedures will support, interface or directly relate to the development and execution of the plan.

The Project Execution Plan (PEP) is the overarching document that outlines the minimum requirements for project management on the project. The PEP is not a standalone document and has been prepared with consideration to other project plan requirements. The PEP will also detail the interfaces between other project plans and provide information on the responsibility and management of the interfaces and project works.

All project plans are reviewed by the Quality Manager and/or Systems Manager to ensure consistency with the Quality Management Plan (QMP) and Future Generation-PMS.

1.5. Purpose and Objectives

The purpose of this Plan is to describe how the Project proposes to minimise and manage construction impacts on groundwater during construction of the Project.

The key objective of the GWMP is to describe the management measures that are to be implemented to ensure that impacts to groundwater are minimised and within the scope permitted by the Project CoA. To achieve this, SHL and Future Generation will:

- ensure appropriate controls and procedures are implemented during construction to avoid or minimise groundwater impacts and potential adverse impact
- ensure appropriate measures are implemented to address the relevant CoA and the REMMs listed within the Submissions Report and Modification 1 Response to Submissions Report, as detailed within Table 2-1 and Table 2-2 of this Plan; and
- establish a groundwater monitoring program to assess impacts on the surrounding environment.

1.6. Plan Preparation

In accordance with the requirements of Schedule 3 Condition 34 of the Infrastructure Approval this plan has been prepared by Roisin Batch of WolfPeak, John Wright of TREES and Hilary Chapman of Seran whose appointment, on behalf of Future Generation, has been approved by the Secretary of Department of Planning and Environment on 31 May 2019.

1.7. Consultation

In accordance with Schedule 3, Condition 34 of the Infrastructure Approval dated 7th February 2019, this Plan is to be prepared as part of the Water Management Plan (WMP). The WMP is to be prepared in consultation with the NSW Environment Protection Agency (EPA), National Parks and Wildlife Service (NPWS), Department of Industry – Water (DoI Water) and Department of Primary Industries – Fisheries (DPI Fisheries). The WMP must be prepared to the satisfaction of the Planning Secretary.

On 20 May 2019, the Plan was issued to Stakeholder agencies for review and comment. Comments from consultation have been incorporated into this Plan where appropriate. Response

to the comments have been provided back to the Stakeholder Agencies. Comments are summarised in Table 1-2.

A separate document titled Agency Consultation Evidence Report has been prepared detailing the consultation process and Future Generation's responses. This report has been provided to DPIE.

Table 1-2: Stage 2 consultation with stakeholder agencies summary

Date	Consultation	Outcomes
Stage 2 Consultation – First round		
27 May 2019	Management Plan submitted to EPA, NPWS, DoI Water and DoI Fisheries	-
5 June 2019	Agency briefing meeting held with EPA, NPWS, DoI Fisheries, DoI Water & SHL	-
11 June 2019	NPWS	Comments received on management plan. Management plan updated to reflect comments.
12 June 2019	Department of Industry – Water	Comments received on management plan. Management plan updated to reflect comments.
9 July 2019	EPA	Comments received from EPA; no specific comments received regarding GWMP.

Revision 1 of the GWMP (prepared in response to Modification 1 of the Infrastructure Approval), was issued to the following agencies for consultation:

- NPWS on 10 October 2019; and
- EPA on 24 October 2019.

NPWS recommended that the plan be issued to EPA and EPA advised that they had no comments.

Revision 4 of this plan (prepared in response to Modification 2 consolidation approval conditions) was issued to NPWS and EPA for consultation on 6 April 2020. No comments were provided by either NPWS or EPA.

1.8. Construction Activities

This Plan relates to Stage 2 works. Stage 2 will include the following:

- pre-construction minor works (not construction activities) including:
  - building/road dilapidation studies;
  - survey works;
  - installing groundwater bores in the Ravine beds on site for water supply;
  - establishing a temporary site office;
  - minor access roads to facilitate the pre-construction minor works;
- installation of environmental impact mitigation measures, including the installation of monitoring equipment, erosion and sediment controls, and fencing;

- minor clearing or translocation of native vegetation within the approved disturbance footprint for the pre-construction minor works;
- the exploratory tunnel which is approximately 3.1 km long and will lead to the site of the underground power station. Excavation of the tunnel will occur through a method of both drill and blast and TBM;
- road upgrades for transport and delivery of the TBM and TBM equipment (undertaken by SHL or their contractors);
- a turnaround area on Link Road (undertaken by SHL or their contractors) for transportation of the TBM equipment and materials to the construction areas at Lobs Hole and to facilitate set down and turn-back of oversize and overmass (OSOM) deliveries;
- 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;
- borehole drilling and geophysical surveys for further geotechnical investigation of the Snowy 2.0 power station and power waterway at Marica, Talbingo and Tantangara;
- ongoing groundwater monitoring using existing boreholes and access tracks within KNP;
- ongoing maintenance and rehabilitation of existing access tracks required for groundwater monitoring and geotechnical investigations within KNP;
- additional geotechnical drilling is proposed to enable investigation and detailed design of critical bridge works (Nungar Creek bridge) on Tantangara Road;
- additional laydown areas at Talbingo north for the transfer of plant and materials are proposed within Modification 1 to improve constructability;
- a portal construction pad for the exploratory tunnel. This will provide the entrance structure to the tunnel and an area for infrastructure and equipment needed to support tunnelling activities;
- an accommodation camp for the Exploratory Works construction workforce;
- barge access infrastructure including one new barge ramp at Middle Bay near Lobs Hole at the southern part of Talbingo Reservoir;
- excavated rock management, including subaqueous placement within Talbingo Reservoir*. Up to 750,000 m3 of excavated rock will need to be tested for its geochemical properties (i.e. whether the rock is reactive or non-reactive) before being managed by a combination of the following options:
    - re-use – suitable material can be used as construction materials for roads or similar. Some materials will be provided to NPWS for use in road maintenance and upgrades in other areas of KNP;
    - on land placement – material will be placed in one of two on land emplacement areas. The eastern emplacement area has been designed to safely treat reactive material during temporary storage. The western emplacement area will be used for temporary storage of materials for re-use or offsite disposal (Note: no material is to remain at any emplacement area and must be either sub-aqueously placed at Talbingo Reservoir or removed to a suitable place outside of KNP within three years of completion of the Exploratory Works (should Snowy 2.0 Main Works not proceed));

- subaqueous placement within Talbingo Reservoir* – suitable material will be placed at a suitable location within Talbingo Reservoir, subject to a number of water quality controls and monitoring; and

- services infrastructure such as diesel-generated power, water and communication;
- post-construction revegetation and rehabilitation, management and monitoring.

Note: these activities will not proceed unless the relevant management plans are approved by DPIE.

1.8.1. Works approved through Modification 1

The Exploratory Works - Modification 1 works scope is included in Table 1-3. For clarity this has been divided between Stage 1 and Stage 2 works.

The revised project boundary (disturbance footprint) for the project, as approved through Modification 1 of the Infrastructure Approval, has been included in Appendix E of the Water Management Plan.

Table 1-3: Exploratory Works - Modification 1 works scope (Stage 1 and Stage 2)

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

Lobs Hill Ravine Road and Construction Boundary Changes	Minor changes to the project boundary identified through detailed design including: • revised road upgrade for Lobs Hole/Ravine Road to improve access, drainage and safety; • minor additions to construction areas for design optimisation. • removal of dangerous trees on Lobs Hole Ravine Road. This will involve either complete or partial removal of up to 91 trees that have been identified to pose a safety risk to road users on Lobs Hole Ravine Road and Mine Trail Road; (Illustrated in Appendix E of the Water Management Plan, Figures 1b to 1f and Figure 1i).
Operating Hours	Modify operating hours for the use of Upper Lobs Hole Ravine Road from 7 am to 6pm to sunrise to sunset.
Miscellaneous	Continued use of existing communications towers within KNP that were previously approved by the NPWS under a separate review of environmental factors (REF R – Wallaces Creek Geotechnical drilling) environmental impact assessment carried out under the NSW National Parks and Wildlife Act 1974 (NPW Act) and its regulation for the geotechnical investigation program; and Increase in peak traffic volumes. Additional vehicles will be required to access the site to facilitate construction of Exploratory Works, however no change in impacts to the road network are expected. (The location of the communications towers are illustrated in Appendix E of the Water Management Plan, Figures 1a, 1f and 1l).
Stage 2	
Activity	**Description**
Borehole drilling and geophysical surveys	This includes: • borehole drilling and geophysical surveys for further geotechnical investigation of the Snowy 2.0 power station and power waterway at Marica, Talbingo and Tantangara; • clearing of up to 2.79 hectares (ha) of additional vegetation for access tracks and drilling pads. About 1.33 ha within Smokey Mouse potential habitat; • trimming of overhanging dangerous branches on adjacent trees (these trees will not require removal); • mulching of trees and vegetation; • establishment of an additional 1 km of access tracks (4 m wide), including minor earthworks; • placement of geofabric (as required) and import of stabilised material; • establishment of eight drilling pads and boreholes at top of the cavern area, with an area of 900 m2 per pad, including minor earthworks, placement of geofabric (as required) and import of stabilised material (as required); • undertaking geophysical surveys near Talbingo and Tantangara reservoirs; • establishment of two drilling pads and boreholes at both Tantangara and Talbingo with an area of 900 m2 per pad, including approximately 400 m of additional access tracks and minor earthworks (as required); • establishment of in-reservoir boreholes including one in Talbingo Reservoir and two in Tantangara Reservoir; • drilling of additional nested vertical boreholes at each of the drilling pads up to a depth of 1,100 m; • conversion of the investigation boreholes into monitoring bores; • undertaking geophysical surveys; • rehabilitation of the drilling pads and access tracks following completion of works; • ongoing maintenance of existing access tracks required for geotechnical investigations within KNP. (Illustrated in Appendix E of the Water Management Plan, Figures 1j, 1k, 1l, 1m and 1n).
Talbingo Laydown	Outside of KNP, SHL is proposing to add four laydown locations to facilitate the construction of the communications cable linking Lobs Hole with the Tumut 3 Power Station. These are proposed on existing hardstand areas along the northern foreshore of Talbingo

	Reservoir within Snowy Hydro owned land. Additional widening of Spillway Road for accessibility is required. (Illustrated in Appendix E of the Water Management Plan, Figure 1o).
Tantangara Access	Two additional geotechnical boreholes are required to facilitate the detailed design of cuttings, bridge foundations, retaining wall foundations, and drainage structures near Nungar Creek. (Illustrated in Appendix E of the Water Management Plan, Figure 1m).
Operating Hours	Modify operating hours for the use of Upper Lobs Hole Ravine Road from 7 am to 6pm to sunrise to sunset.

1.8.2. Works approved through Modification 2

The Exploratory Works - Modification 2 scope for Stage 2 works is included in Table 1-4.

The revised project boundary (disturbance footprint) for the project, as approved through Modification 2 of the Infrastructure Approval, has been included in Appendix E of the Water Management Plan.

Table 1-4: Exploratory Works - Modification 2 works scope (Stage 2)

Modification 2 - Stage 2 works	
Activity	**Description**
Tunnelling	The tunnelling methodology has been revised and include the following: • TBM method will used to excavate the exploratory tunnel. The TBMs will be fully equipped to perform the excavation, ventilation, lining, and removal of excavated material; • the TBMs will be engineered to facilitate dismantling operations. This will avoid the need to excavate a preliminary dismantling chamber and allow the TBMs to be retrieved from the tunnel, thereby reducing the amount of excavated rock material; • the TBM will be equipped with devices to perform the following surveys: – geophysical seismic reflection surveys; – geoelectrical surveys; and – systematic probe core retrieval ahead of the advancing tunnel face; • the probing results will also be used to determine the presence of potentially acid forming (PAF) and naturally occurring asbestos (NOA) material; • the TBMs will be equipped with drilling machines to drill drainage holes with pipes to relieve groundwater pressures. If required, pre-excavation grouting will also be used to seal-off groundwater inflow and to improve the stability of the excavation face; • post-excavation grouting from the segmental lining may also be used to further consolidate the surrounding rock and/or prevent water ingress if required. (Illustrated in Appendix E of WMP).
Design	Detailed design and geotechnical investigations have been optimised. The project optimisation is expected to reduce the exploratory tunnel length by approximately 600 m and reduce the volume of excavated material by approximately 65,000 m^3. (Illustrated in Appendix E of WMP).
Road upgrades (undertaken by Future Generation and SHL or their contractors)	Minor road upgrade works will be undertaken to enable transport of TBM equipment and materials required for tunnelling. The road upgrades have been designed to avoid additionally impacting any areas of geodiversity significance including the boulder streams, karst and fossil features on Lobs Hole Ravine Road. (Illustrated in Appendix E of WMP).
Vegetation Clearing (undertaken by Future Generation and SHL or their contractors)	The additional clearing will include approximately 2.78 ha of vegetation to establish road upgrades on Lobs Hole Ravine Road (south), Lobs Hole Ravine Road (north) and Link Road. (Illustrated in Appendix E of WMP).

Modification 2 - Stage 2 works	
Activity	**Description**
Transport Strategy	Modification 2 proposes to revise the transport strategy so that materials and equipment required for Exploratory Works will be delivered using Lobs Hole Ravine Road (south) as the primary access road. (Illustrated in Appendix E of WMP).
Link Road Turnaround Area (undertaken by SHL or their contractors)	A turnaround area will be established on Link Road for safe transportation of the TBM equipment and materials to the construction areas at Lobs Hole. The turnaround area will facilitate set down and turn-back of oversize and overmass deliveries. (Illustrated in Appendix E of WMP).
Lobs Hole Ravine Road (south) (undertaken by SHL or their contractors)	Minor upgrade works will be undertaken on sections Lobs Hole Ravine Road (south) to enable the transport of the TBM equipment. (Illustrated in Appendix E of WMP).
Lobs Hole Ravine Road (north)	Roadworks will be conducted at Lobs Hole Ravine Road (North) to provide improved access and egress to Lobs Hole. Road works will include road upgrade and widening in several sections suitable for passing bays as well as regular maintenance of the existing roadway. (Illustrated in Appendix E of WMP).
Middle Bay Barge Ramp	The location of the Middle Bay barge ramp was revised as part of further refinement to the construction methodology. An alternative location for the Middle Bay barge ramp was identified to the west of the approved barge ramp location. A key benefit of the new barge ramp location is that it minimises the requirement for dredging as part of the barge ramp construction. (Illustrated in Appendix E of WMP).
Accommodation Camp	Lobs Hole accommodation camp will increase capacity to provide beds for up to 250 personnel. The additional accommodation will be created through an additional storey to the Lobs Hole accommodation camp using modular and stackable accommodation units that will allow the expansion to be entirely within the existing disturbance footprint.
Power Supply	Additional power supply capacity is required to enable TBM tunnelling for Exploratory Works. The Lobs Hole substation proposed under Modification 1 is scheduled to be online from approximately October 2020 and will provide the power supply required for operation of the TBM. It is currently planned to commence tunnelling with the TBM from August 2020. In the period prior to the Lobs Hole substation commissioning the additional power supply required for TBM tunnelling will be provided by additional diesel generator sets. Diesel generator sets with a total capacity of 20 MVa as well as an additional three 65 kL diesel storage tanks will be installed at the portal construction pad. (Illustrated in Appendix E of WMP).

2. ENVIRONMENTAL REQUIREMENTS

2.1. Legislation

Legislation relevant to groundwater management includes:

- *Environmental Planning and Assessment Act 1979* (EP&A Act);
- *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation);
- *Protection of the Environment Operations Act 1997* (POEO Act);
- *Protection of the Environment Operations (General) Regulation 2009* (as amended) (POEO Regulation);

- *Water Management Act 2000* (WM Act);
- *Water Management Amendment Act 2014* (WMA Act);
- *Water Management (General) Regulation 2011* (WM Regulation);
- *Aquifer Interference Regulation 2011*;
- *Snowy Hydro Corporatisation Act 1997* (SHC Act);
- Water Sharing Plan for the Murrumbidgee unregulated and alluvial water source 2012 (unregulated WSP);
- Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011; and
- Water Sharing Plan for the South Coast Groundwater Sources 2016.

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

2.2. Conditions of Approval

Table 2-1 details all conditions from the Infrastructure Approval (SSI 9208) relevant to management of impacts on groundwater.

Table 2-1: Conditions of approval relevant to groundwater management

Condition	Requirement	Where addressed
Sch 3, Cond 31	The Proponent must ensure that it has sufficient water for all stages of the development; and if necessary, stage the development to match its available water supply. *Note: Under the Water Management Act 2000, the Proponent must obtain the necessary water licences for the development.*	Section 5
Sch 3, Cond 32	Unless an environment protection licence authorises otherwise, the Proponent must comply with Section 120 of the POEO Act. *Note: Section 120 of the POEO Act makes it an offence to pollute any waters.*	Section 5
Sch 3, Cond 34	Prior to carrying out any construction, unless the Planning Secretary agrees otherwise, the Proponent must prepare a Water Management Plan for the development to the satisfaction of the Planning Secretary. The plan must: (e) include a Groundwater Management Plan with:	This Plan
	• detailed baseline data on groundwater levels, yield and quality on the aquifers that could be affected by the development;	Section 3 and Section 6
	• a program to augment the baseline data during the development;	Section 6
	• groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts;	Section 6
	• a description of the measures that would be implemented to minimise the groundwater impacts of the development	Table 5-1
	• a program to monitor and report on:	Section 6
	○ groundwater inflows to the tunnel, including inflows to relevant water sources;	Section 3 Section 6
	○ groundwater take from the groundwater bores;	Section 3.4 Section 6

Condition	Requirement	Where addressed
	○ the impacts of the development on:	
	- regional and local (including alluvial) aquifers;	Section 3
	- groundwater dependent ecosystems, stygofauna and riparian vegetation; and	Section 3
	- base flow to surface water sources;	Section 3 Section 5
	• a plan to response to any exceedances of the trigger levels and/or assessment criteria and mitigate and/or offset any adverse groundwater impacts of the development.	Section 7

2.3. Revised Environmental Management Measures

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

The environmental management measures relevant to this Plan are listed in Table 2-2 below. If additional measures are cross-referenced from another section of the EIS or Submissions Report, these measures are also included. The revised environmental management measures from Modification 1 have also been incorporated into Table 2-2.

Table 2-2: Revised environmental management measures relevant to groundwater

Impact	Reference	Requirement	Where addressed
Leaching/ running into groundwater/ creeks	WAT01	Management measures will be implemented to minimise potential environmental impacts to water and soil from hydrocarbon and chemical spills and leaks including: • minimizing direct access to the river by construction vehicles and mechanical plant; • regular inspection of construction vehicles and mechanical plant for leakage of fuel and /or oils; • establishing a bunded area for storage of fuel and oils; • refueling and maintenance of vehicles and mechanical plant at least 50 m from watercourses; • avoiding as far as possible re-fueling, washing and maintenance of land-based vehicles and plant within 50 m of watercourses; • reporting spillages to the appropriate officer and immediately deploying spill containment and / or absorption kits as required to restrict its spread; • vehicles, vessels and plant would be properly maintained and regularly inspected for fluid leaks; • emergency spill kits will be kept onsite, at refueling areas and on all vessels at all times during the Exploratory Works. The spill kit will be appropriately sized for the volume of substances on the vessel. All staff would be made aware of the location of the spill kit and trained in its use; • if any hydrocarbon spills were to occur during soil stripping, the impact will be isolated and clean-up procedures implemented; • areas to be used for long-term storage and	WMP – Appendix A Surface Water Management Plan and Spill Response Procedure Appendix and Section 5 of this Plan

Impact	Reference	Requirement	Where addressed
		handling of hydrocarbons and chemicals will be enclosed with concrete bunds; • chemicals will be handled and stored as per manufacturer's instructions; and • below ground, refueling will be undertaken in dry, enclosed, bunded areas;	
Surface and groundwater	WAT02	A Surface and Groundwater Monitoring Program will be developed and implemented to monitor the effectiveness of water quality controls. The program will include:	Section 6 of this Plan for Groundwater monitoring program and WMP - Appendix A Surface Water Management Plan
		• establish monitoring locations to provide suitable baseline and detection monitoring of surface and groundwater parameters;	Section 6 of this Plan for Groundwater monitoring program and WMP - Appendix A Surface Water Management Plan
		• monitor groundwater inflows indirectly through the process water system and groundwater levels as well as groundwater quality during construction; and	Section 6 And WMP - Appendix A Surface Water Management Plan
		• set out annual monitoring requirements for Yarrangobilly Caves and plant community types potentially reliant on groundwater.	Section 6
	WAT03	Areas of groundwater inflow will be shotcreted or sealed by other methods to minimise further ingress.	Table 5-1
		If groundwater is intercepted and reductions to groundwater inflows to watercourses predicted, then groundwater should be discharged to waterways. This would occur following appropriate treatment of discharge water.	Table 5-1and Section 7
Borehole drilling	M1.6	During borehole drilling slurries used will be of appropriate grade and composition such that it poses no threat to groundwater quality should it infiltrate intersected aquifers.	Table 5-1

2.4. Guidelines and Standards

The main guidelines, specifications and policy documents relevant to this Plan include:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000);
- *Australian Drinking Water Guidelines* (Natural Resource Management Ministerial Council (NRMMC), 2011);
- Groundwater Dependent Ecosystems Risk Assessment Guidelines (NOW 2012d);
- NSW State Groundwater Quantity Management Policy (2001 (unpublished));
- NSW State Groundwater Quality Protection Policy (DLWC 1998);
- NSW State Groundwater Dependent Ecosystem Policy (DLWC 2002);
- Australian Groundwater Modelling Guidelines (National Water Commission 2012);

- National Water Quality Management Strategy Guidelines for Groundwater Quality Protection in Australia (NWQMS 2013);
- Department of Primary Industries Guidelines for Controlled Activities (2012);
- *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* – March 2004.

2.5. Licences and Permits

For the Stage 2 work scope SHL is required to licence groundwater extraction in accordance with the Aquifer Interference Policy 2012 (AIP) requiring a bore extraction licence, the WM Act requiring a water access licence (WAL), and the relevant statutory Water Sharing Plans (WSPs) (refer to Section 3.1). Sufficient water entitlement in the relevant groundwater or source will be held by SHL and linked to the project via a dealing prior to that water take occurring. Where water is to be obtained via an existing licensed user or water supplier, an agreement will be put in place to ensure the necessary volumes can be obtained when required.

During Stage 2 construction water will be sourced predominantly from the groundwater extraction from bores within Lobs Hole and the harvesting of water from the site erosion and sediment control basins. Consultation with DoI Water will continue in finalising licensing requirements.

Section 5.23 of the EP&A Act provides that a water use approval under section 80; a water management work approval under section 90; or an activity approval (other than an aquifer interference approval) under section 91 of the WM Act are not required for Critical State Significant Infrastructure (CSSI).

Environment Protection Licence (EPL) (No 21266) has been issued for the Project for the scheduled activity of land based extractive activities. The EPL details conditions which must be complied with when undertaking the extractive activities works.

The EPL includes requirements for groundwater monitoring for Snowy 2.0 Exploratory Works. At times, the groundwater monitoring requirements of the EPL may differ to that detailed within this plan, particularly in the event of variations to the EPL. Differences may include changes to the monitoring locations; changes to the frequency of monitoring; or changes to the parameters which are required to be monitored.

Should differences arise, the monitoring requirements of the EPL will take precedence. This will occur until such time that the revised GWMP is updated and approved. Responsibility for monitoring will be either that of SHL or Future Generation as detailed within Section 6.2.1.

An Agreement for Lease (AFL) with NPWS, with an accompanying Works Access Licence, is required to be established in order to carry out the relevant Stage 2 Exploratory Works in accordance with the Exploratory Works EIS, CSSI 9208 and the approved Management Plans.

2.5.1. Water Access Licence

The extraction of water from Talbingo Reservoir is proposed to be untaken via a Specific Purpose Access Licence (SPAL), which is currently being considered and in final stages of approval by the NSW Government. Once the SPAL is approved, a Miscellaneous Work approval will be issued by NRAR and then Water NSW will approve the nomination (link) between the SPAL and the miscellaneous Work Approval. SHL will not require a water use approval as the project is designated CSSI. Section 5.23 of the EP&A Act provides that the following approvals are not required - a water use approval under section 89; a water management work approval under section 90; or an activity approval under section 91 of the WM Act (it is noted that the provisions for granting Aquifer Interference Approvals under the WM Act are yet to be 'switched on', and therefore this approval is not yet available).

To obtain the required water for Stage 1 SHL are investigating both supply from Talbingo under the above SPAL, and supply from the Lachlan Fold Belt Groundwater Source via water supply bores in the Lobs Hole Ravine area. Piezometers are currently being constructed to consider the viability of groundwater in this area and each piezometer will be fitted with automated data-loggers and programmed to log groundwater levels every six hours. Once piezometers are established and a sustainable groundwater supply is confirmed Snowy Hydro will seek to 'nominate' their existing Water Access Licence (obtained under the controlled allocation release), with the water supply bores (via a miscellaneous Work approval for the water supply bores).

The AIP requires SHL to hold sufficient water licence to account for water take (either direct take for water supply or indirect take from tunnel inflow). As such licences will be held to account for all water take for water supply from relevant water sources (i.e. Talbingo Reservoir via the SPAL, and the Lachlan Fold Belt via the WAL granted under the controlled allocation). Associated approvals are largely exempt, but do require Miscellaneous Work approvals granted, and associated 'nominations' of licences to these works.

This will then provide for SHL to be compliant with the AIP, the WM Act, and the relevant statutory WSPs (refer to Section 2.1).

Consultation with relevant agencies including but not limited to DoI Water will continue in finalising licensing requirements.

3. EXISTING ENVIRONMENT

The following section summarises existing groundwater conditions within and adjacent to the Project based on the information provided within the EIS. The EIS includes, in Appendix N, a Groundwater Assessment (GWA) which was prepared by EMM Consulting Pty Ltd. The following information has been extracted from the GWA where relevant.

3.1. Geology

The Exploratory Works project area is within a steeply incised ravine, along the western fringe of the Long Plains fault escarpment. Elevations typically range from around 550 to 1,400 metres Australian Height Datum (AHD). Most of the project area is characterised by deep gorges and steep sloping ridges, the product of incision from watercourse flow and historic glaciation.

Two distinct geological terrains ('Incised Ravine Area' and the 'Plateau Area') are within the broader Snowy 2.0 project area, separated by an escarpment caused by movement on the Long Plain Fault. The Exploratory Works project is situated on the western side of this fault structure, in the Incised Ravine Area.

The area is dominated by sedimentary and igneous rock of Silurian to Devonian age. The Silurian aged Ravine Beds, composed of stratified altered siltstone, sandstone and limestone, provide the structural framework and topographic control for this area. The Ravine Beds are overlain in areas, typically along the escarpment, by younger volcanic rock.

The Yarrangobilly Caves, a karstic limestone, is approximately 8 km north of the project. The caves will not be intercepted by the exploratory tunnel, as demonstrated through geotechnical drilling. Details of the existing environment including topography and soil types are detailed in Section 4 of the WMP.

In summary, the EIS Appendix N Groundwater Assessment (GWA) identifies the Project area sits upon the Long Plain Fault 'Incised Ravine Area' shown in Figure 3-1. This Incised Ravine Area is typified by Silurian age igneous rock (stratified altered siltstone, sandstone and limestone). This is evident by the Yarrangobilly karstic limestone caves that are approximately eight (8) kilometres north of the Project. Above the igneous rock are interspersed occurrences of volcanic rock.

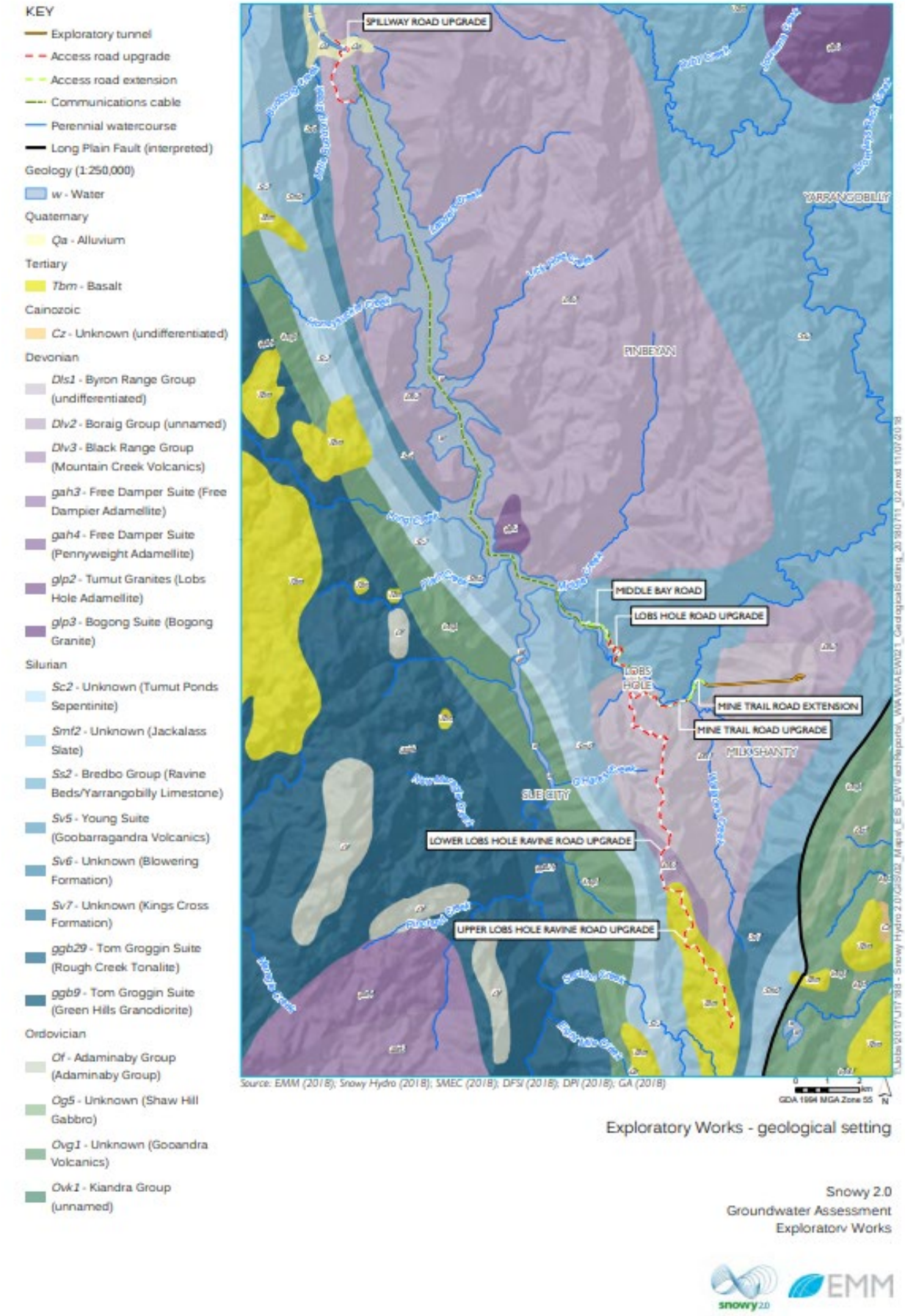


Figure 3-1: Local geology (EIS Appendix N Groundwater Assessment)

3.2. Hydrogeological Units

The groundwater units within the area are defined as:

- localised unconsolidated shallow Quaternary gravels episodically recharged through rainfall/flooding events;
- shallow groundwater associated with weathered fractured rock (between 5 and 30 metres below ground level); and
- deep groundwater associated with deeper fractured rock (i.e. the Ravine Beds).

3.3. Groundwater Recharge and Discharge

The EIS GWA advised of two primary sources of groundwater recharge:

- rainfall recharge (dominant recharge source) - estimated to be up to 10% within the Ravine region;
- direct leakage from rivers and storages (secondary recharge source).

Given the prominence of groundwater springs across the Project area, it is likely that the water table is locally elevated. The shallow water table is likely to be contributing to local drainage lines 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.

The discharge area from the conceptualised groundwater systems is likely to be the Talbingo Reservoir. Locally, the Yarrangobilly River is also likely to gain from shallow groundwaters.

3.4. Groundwater Levels and Flow

The main groundwater flow direction in the Project area is regionally from areas of higher elevation in the east towards the west.

Groundwater levels are monitored at two monitoring sites (TMB01 and TMB05) adjacent to the proposed exploratory tunnel (Table 6-1) during Stage 1 works. Groundwater levels have shown little fluctuation since monitoring commenced in mid-March 2018. These two locations will be used for the construction monitoring program.

3.5. Groundwater Quality

A summary of the groundwater quality monitoring results to date are included in Appendix A of this plan.

The groundwater quality results are comparable and typical for the different formations across the larger Snowy 2.0 project area. Within the Exploratory Works area, pH is slightly alkaline, averaging 7.5, while salinity is observed to be marginal (780 µS/cm). Concentrations of most dissolved metals are typically low, with many measurements below detection limits. This is typical of groundwaters with reasonably neutral pH and in alpine areas where the groundwater is readily recharged via rainfall and snow melt.

3.6. Ecosystems that rely on Groundwater

An assessment of ecosystem groundwater reliance is described in Appendix F of the EIS which contains the Biodiversity Assessment.

The Yarrangobilly Caves are listed as the only high priority GDE in the Fractured Rock WSP within a 50 km radius of the Exploratory Works project area. The Yarrangobilly Caves have an entirely

obligate dependence on groundwater. Their formation over time and current structure is maintained by groundwater levels, flow, and quality. EIS geotechnical drilling shows that the Yarrangobilly Caves groundwater will not be intercepted by the exploratory tunnel construction.

Three native vegetation types were identified to occur at locations where groundwater is less than 5 m deep, and therefore have potential to access groundwater sporadically. These terrestrial plant community types include:

- Broad-leaved Sally grass – sedge woodland on valley flats and swamps;
- Brittle Gum peppermint open forest of the Woomargama to Tumut region; and
- Riparian Blakeley's Red Gum Woodland Broad-leaved Sally woodland, tea-tree, bottlebrush, wattle shrubland wetland.

These terrestrial ecosystems are not highly dependent or entirely dependent on groundwater and therefore there is a low risk that they will be material impact to these communities.

3.7. Extractive Water Users

There are no registered groundwater users within the project area or within 20 km of the Project area boundary.

4. ENVIRONMENTAL ASPECTS, IMPACTS AND RISKS

4.1. Environmental Aspects and Impacts

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

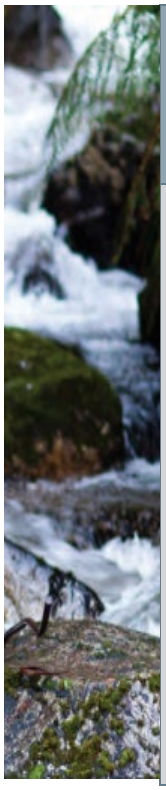
Key aspects during Stage 2 of the Project that could result in groundwater impacts are identified in Table 4-1(Column 1). The extent of these impacts will depend on the nature, extent and magnitude of construction activities and their interaction with the natural environment (Column 2). This is further exacerbated by environmental factors (Column 3).

The EIS indicated that the construction of the exploratory tunnel would draw up to a maximum of 354 megalitres per year (ML/year) of groundwater from the Ravine Beds. The assessment, indicated that extraction of water at this rate would not have an impact on the local environment, including the local groundwater source, groundwater users, baseflows to nearby rivers, tributaries and GDEs. The EIS found that there will be some localised drawdown of groundwater due to tunnelling, but this will not adversely impact local ecosystems or vegetation.

Groundwater extraction for construction purposes would be undertaken prior to tunnelling works in existing disturbed areas of Lobs Hole. The amount of groundwater extracted for construction purposes prior to tunnelling would be limited to less than 219 ML at peak construction demand, and therefore will not exceed the maximum of 354 ML/yr modelled in the EIS GWA. Groundwater impacts associated with the construction and operation of a bore for the purposes of water supply for pre-construction and construction purposes would not have an impact on the local environment.

In terms of groundwater quality, the potential for groundwater contamination is greatest adjacent to excavated rock emplacement areas, given the areas proximity to the highly porous, unconsolidated colluvium. Potential impacts and management measures associated with the rock emplacement areas are discussed in the Surface Water Management Plan and the Excavated Material Management Plan. Appropriate engineering controls will be implemented during construction to minimise the likelihood of impact on shallow groundwater.

Table 4-1: Projects aspects and impacts relevant to groundwater

	**Environmental Aspects** (Construction activities likely to cause groundwater impacts)	**Environmental Impacts**	**Environmental Factors (Conditions)**
	Water use and extraction Dewatering Refuelling and chemical handling Drilling and piling Excavations intercepting the groundwater table Tunnelling	Reduction in groundwater levels Groundwater contamination Reduction in baseflow from groundwater into waterways	Existing groundwater levels and inflows – groundwater inflows will be influenced by the existing groundwater level and groundwater pressure. Existing baseflow dependency – some waterways are not reliant on groundwater to contribute to baseflow conditions. Geology type – rock and soil types can impact the flow of groundwater into excavations. Seasonal fluctuations – waterways may be more reliant on groundwater inflows during periods of dryer weather. Existing groundwater quality – Existing groundwater quality in the Lobs Hole Mine area, mainly around the Eastern Emplacement due to mine workings and waste and to a lesser degree the Western Emplacement.

4.2. Environmental Risk Assessment

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

5. ENVIRONMENTAL MANAGEMENT MEASURES

5.1. Management Measures

Table 5-1 lists the management control measures that will be implemented during the Project to minimise construction impacts to groundwater. These management measures will be implemented to minimise impacts to groundwater aligned with the CoAs and REMMs:

- provide quality training and education;
- monitor groundwater quality and levels and modify work program where affect can be attributed to construction;
- minimise intrusion and contamination of groundwater from tunnelling and construction activities involving leachable chemicals
- inspect regularly and maintain controls in working order;
- prepare and maintain documents;
- report outcomes and impacts.

Table 5-1: Groundwater management and mitigation measures

ID	Measures/Requirements	Stage applicable	When to implement	Responsibility	Reference
General					
GW01	Training will be provided to all project personnel, including relevant sub-contractors on groundwater management through inductions, toolboxes and targeted training.	All	Pre-construction / Construction	Contractor	Schedule 3 Condition 34
GW02	Groundwater management measures from this plan will be included in relevant Work Method Statements (WMS) and/or Erosion and Sediment Control Plans (ESCPs).	All	Pre-construction / Construction	Contractor	Good practice
Procedures and plans					
GW03	Spills and emergency response will be managed in accordance with the Emergency spill response procedure included in the WMP Appendix A - SWMP.	All	Construction	Contractor	REMM WAT01 WMP Appendix A SWMP
Groundwater management					
GW04	Groundwater discharged to water courses will be within the agreed receiving water quality criteria and unless an environmental protection licence authorises otherwise, in compliance with Section 120 of the POEO Act.	All	Construction	Contractor	REMM WAT03 Schedule 3 Condition 32
GW05	Where reasonable and feasible, sites used for batch plants, refuelling and chemical storage will be managed to minimise the potential for groundwater intrusion.	All	Construction	Contractor	REMM WAT01 WMP Appendix A SWMP
GW06	Areas of groundwater inflow will be shotcreted or sealed by other methods to minimise further ingress including the exploratory tunnel.	Stage 2	Tunnelling	Contractor	REMM WAT03.1
GW07	If groundwater is intercepted by the tunnel and unacceptable reductions to groundwater inflows to watercourses occurs (or is predicted), then groundwater should be discharged to waterways.	Stage 2	Tunnelling	Contractor	REMM WAT03.2
Groundwater contamination					
GW08	Emergency spill kits will be readily available at key construction sites across the project and workers trained in their use.	All	Construction	Contractor	REMM WAT01 WMP Appendix A SWMP
GW09	At surface refuelling is to be undertaken away from waterways.	All	Construction	Contractor	REMM WAT01 WMP Appendix A SWMP

ID	Measures/Requirements	Stage applicable	When to implement	Responsibility	Reference
GW10	Storage and handling of chemicals, fuels and oils will be as per manufacturer's instructions in bunded, storage areas.	All	Construction	Contractor	REMM WAT01 WMP Appendix A SWMP
GW11	In the event of existing, non-construction contaminated groundwater being identified during Construction the source of the contamination will be investigated and monitoring continue.	All	Construction	Contractor	Good Practice
GW12	During borehole drilling slurries used will be of appropriate grade and composition such that it poses no threat to groundwater quality should it infiltrate intersected aquifers.	Stage 2	Construction	Contractor	REMM M1.6
Monitoring and model validation					
GW13	Groundwater monitoring (including further baseline monitoring and monitoring shallow groundwater) will be undertaken in accordance with the Groundwater Monitoring Program in Section 6	All	Pre-construction and construction	Snowy Hydro / Contractor	Schedule 3 Condition 34 REMM WAT02
GW14	Groundwater extraction will be monitored in accordance with the Ground Water Monitoring Program in Section 6. The data will be used to confirm water use.	All	Construction	Contractor	Schedule 3 Condition 34
GW15	Groundwater level monitoring will be undertaken in accordance with the Groundwater Monitoring Program in Section 6 of this Plan, to provide early warning for impacts beyond those assessed for: • baseflow connected waterways; • the local groundwater flow system; • local depressurisation of groundwater resources; • groundwater dependant ecosystems.	All	Construction	Contractor	REMM WAT02 Schedule 3 Condition 34
GW16	Adaptive management will be implemented for groundwater monitoring including review, analysis and modification of mitigation measures if they are shown to be ineffective.	All	Construction	Contractor	Schedule 3 Condition 34

5.2. Model Validation

Groundwater modelling for the EIS included an assessment of two predictive scenarios:

- a steady state simulation was produced to predict maximum impacts on baseflow to the Yarrangobilly River and drawdown at the water table across the model domain; and
- a transient simulation. This was undertaken because an aquifer access licence will be required for the maximum annual tunnel inflow, which will occur during tunnelling, a transient simulation was also constructed to identify likely tunnel inflow during tunnelling, not just after the groundwater system has re-equilibrated.

Prior to and during construction, the groundwater model predictions from the scenarios above will be validated regularly as new monitoring data and new monitoring sites become available. Significant deviations from the predicted impacts will be analysed and investigated by Snowy Hydro.

Further detail relating to groundwater monitoring is included in Section 6.

6. COMPLIANCE MANAGEMENT

This groundwater monitoring program will be implemented during Stage 1 of Exploratory Works and continue throughout Stage 2 works. The program is an extension of the EIS GWA baseline monitoring, the pre-construction monitoring, and the monitoring undertaken during Stage 1 works. This collective monitoring is referred to as the 'baseline' monitoring relative to Stage 2 works.

Additional or varied monitoring locations may be warranted following detailed design and during construction. Changes to the monitoring locations would be approved by SHL prior to relocation or addition of monitoring locations and updated in subsequent revisions of the water quality monitoring program.

6.1. Groundwater Monitoring Program Objectives

The groundwater monitoring program will be implemented during Stage 2 of Exploratory Works.

The primary objectives of the Program are to:

- assess and modify where required the effectiveness of water quality mitigation measures;
- identify and quantify groundwater quality;
- identify and quantify groundwater levels
- provide the actions required in the event of trigger value exceedances; and
- assess compliance with relevant consent and license conditions and other monitoring requirements including prescribed targets for the Project.

6.2. Monitoring and Inspection

6.2.1. Responsibilities

During Stage 2 Exploratory Works, sampling and testing will be coordinated by Snowy Hydro. Sample data collected by Snowy Hydro will provide data to the Contractor for analysis, investigation and reporting as described in Section 7 of this Plan. At all times during construction the Contractor will be responsible for initiation of the Trigger Action Response Plan (TARP).

A Groundwater Monitoring Program (Program), in accordance with Schedule 3 Condition 34(e) of the Infrastructure Approval, will be implemented during Stage 2 of Exploratory Works. Prior to

Stage 1 commencement Snowy Hydro continued to undertake groundwater monitoring of the EIS Baseline monitoring. The Stage 2 program is an extension of the baseline monitoring program undertaken by Snowy Hydro as well as data collected during Stage 1 works.

The ongoing development and expansion of the monitoring network will occur in consultation with DoI Water and WaterNSW prior to Stage 2 (tunnelling).

6.2.2. Monitoring Locations

Stage 1 propose to install additional shallow groundwater bores prior to tunnelling in order to collect further water quality data and confirm groundwater levels around Lick Hole Gully, the south adit and tunnel portal. Once available, the data collected from Stage 1 shallow bore monitoring will be used to refine the groundwater model and will be included in an update to Stage 2 monitoring program.

Proposed monitoring locations for Stage 1 and Stage 2 are shown in Table 6-1 and Figure 6-1.

At the time of writing, a drilling program to explore groundwater in the Ravine area as a potential source of construction water for Stage 1 Exploratory Works is being completed. If exploratory boreholes are converted to Exploratory Works Production Bores, they will be monitored as detailed in Table 6-1 for Stage 2. For exploratory boreholes that are not converted to production bores, boreholes will be backfilled to the first water strike and converted into Ravine Shallow Monitoring Bores to monitor the shallow groundwater system in the Ravine. Shallow monitoring bores will be monitored as detailed in Table 6-1. Both production and/or shallow monitoring bores will be used to monitor groundwater in the Ravine/Lick Hole areas.

Existing monitoring bore BH8108 was drilled upgradient and BH8101 has been drilled downgradient of the proposed portal and adit areas. These monitoring bores will be used as baseline monitoring bores for Stage 2 Exploratory Works.

Available groundwater level hydrographs for TMB01A, TMB01B, TMB05A, TMB05B, PB05 and YC05 are illustrated Appendix A. Monitoring results will be stored electronically on the project document control system (Aconex).

Table 6-1: Groundwater monitoring locations

Site ID	EPA Identification no.	Details	Type	Details							Monitored parameters	Sampling frequency
				Easting	Northing	Ground level (m AHD)	Total depth (m BGL)	Screen interval (m BGL)	Apparent yield (L/sec)	Monitored formation		
TMB01A		Previous monitoring location that has been removed as impacted by works. Replaced by RSMB6	Impact – monitoring bore	627670	6038074	581.2	15	11-14	0.10	Boraig Group	Water quality (pH, EC, T, DO, ORP, Nutrients, Dissolved Metals) Groundwater level (pressure transducer)	Monthly water quality 6 hourly groundwater level monitoring
TMB01B		Previous monitoring location that has been removed as impacted by works. Replaced by RSMB7	Impact – monitoring bore	627670	6038074	581.8	72	63-69	0.50 – 3.00	Ravine Formation		
RSMB2	TBA	TBA	Impact – monitoring bore	TBA	TBA	TBA	TBA	TBA	TBA	Ravine Formation		
RSMB6	1	Updated as per EPL, replaced TMB01A	Impact – monitoring bore	627718	6038191	TBA	TBA	TBA	TBA	Ravine Formation		
RSMB7	2	Updated as per EPL, replaced TMB01B	Impact – monitoring bore	627719	6038196	TBA	TBA	TBA	TBA	Ravine Formation		
RSMB9	4	Updated as per EPL, replaced BH8108	Impact – monitoring bore	627887	6038630	TBA	TBA	TBA	TBA	Ravine Formation		
BH8101	3		Impact – monitoring bore	627907	6038287	610.0	69	53-65	No data	Ravine Formation		
RSMB8	25	Updated as per EPL	Impact – monitoring bore	627893	6038637	TBA	TBA	TBA	TBA	Ravine Formation		
PB05	N/A	Additional reference bore not included in EPL.	Reference – monitoring bore	624,500	6,040,714	614.3	100	50-100	0.01	Ravine Formation		
YC05	N/A		Reference – Cave pool depth	634324	6045941	884.2	NA	NA	NA	Yarrangobilly caves	Pool depth (pressure transducer)	Continuous
Groundwater extraction from Exploratory Works Production Bores*	N/A		Impact – Production bore	TBA	TBA	TBA	TBA	TBA	TBA	Ravine Formation	Volume - Measured extraction volume Water quality (pH, EC, T, DO, ORP, Nutrients, Dissolved Metals) Manual groundwater level measurement	Weekly volume Monthly manual groundwater level and water quality

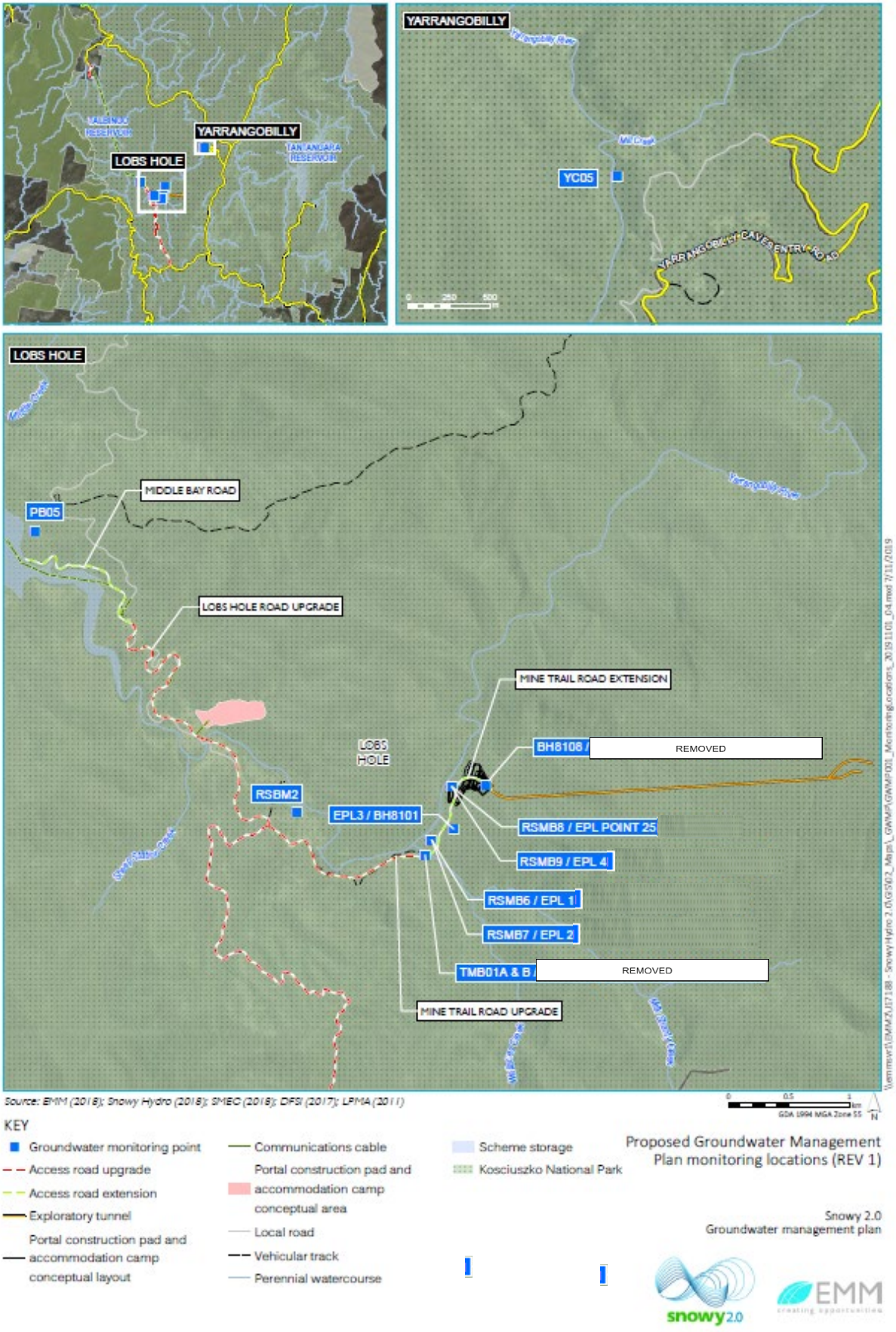


Figure 6-1: Stage 1 and 2 groundwater monitoring locations

6.2.3. Trigger Levels and Methodology

TMB01A, TMB01B, BH8101, BH8108, TMB05A and TMB05B have been designated as impact monitoring bores. Bores RSMB6, RSMB7 and RSMB9 are proposed to replace TMB01A, TMB01B and BH8108 as detailed within Table 6-1. PB05 and YC05 have been designated reference monitoring sites due to their distance away from the proposed Stage 2 impact/work area. Data from transducer YC05 in Yarrangobilly Caves will be collected monthly to ensure trends are consistent with historical and climatic data.

All pre-Stage 2 groundwater data will be used as reference baseline data against which to compare monitoring data collected during Stage 2 construction works at all locations detailed in Figure 6-1.

6.2.4. Groundwater Quality Triggers

The ANZECC trigger values have been used to determine appropriate water quality targets to be applied to groundwater during construction. The proposed target values are shown Table 6-2 and these will be used as the initial baseline to confirm the water quality within groundwater at nominated sampling locations.

The following ANZECC trigger values have been used to determine water quality targets,

- default trigger values that were sourced from relevant sections of ANZECC (2000) for south-east Australia (upland rivers), where applicable; and
- trigger values for the protection of 99% of species (freshwater), that are reported in Table 3.4.1 of ANZECC/ARMCANZ (2000), where applicable.

These default trigger values were also applied in the EIS during assessment of baseline groundwater quality, where relevant.

Should consistent exceedances be observed, a revision of this GWMP will be completed and Site Specific Trigger Values (SSTV's) established. If the exceedances are believed to be related to exploratory works, investigation into the exceedances are required as per Section 7.

Table 6-2: Groundwater quality trigger value

Category	Proposed sampling analytes	Unit	Analytical method	Water quality target
Physiochemical Properties (Basic)	pH	-	Field analysis	6.5 – 8.5
	Electrical conductivity (EC)	µS/cm		30 – 350
	Dissolved Oxygen	%/ppm		-
	Redox Potential (Eh)	mV		-
	Temperature	℃		-
	Turbidity	NTU		2-25
Nutrients	Total nitrogen (TN)	mg/l	NATA laboratory analysis	0.25
	Reactive phosphorus	mg/l		0.015
Metals (dissolved)	Aluminium (Al)	mg/l	NATA laboratory analysis	0.027
	Copper (Cu)	mg/l		0.0004
	Iron (Fe)	mg/l		0.3
	Lead (Pb)	mg/l		0.001

Category	Proposed sampling analytes	Unit	Analytical method	Water quality target
	Manganese (Mn)	mg/l		1.2
	Nickel (Ni)	mg/l		0.008
	Silver (As)	mg/l		0.00002
	Zinc (Zn)	mg/l		0.0024

6.2.5. Monitoring and Inspections

Inspection of groundwater levels and quality will be undertaken during sampling events. The groundwater monitoring is to be undertaken as prescribed in Table 6-3 and in accordance with the parameters and locations in EPL 21266. The water quality sampling suite will mimic the analytes sampled for during EIS GWA baseline monitoring.

The ANZECC trigger values have been used to determine appropriate water quality targets to be applied to groundwater during construction (Table 6-2 of this Plan). The proposed target values are based on EIS and pre-construction baseline data provided in Appendix A. This data will be used as the initial baseline for Stage 2 works to confirm the water quality within groundwater at nominated sampling locations.

While the ANZECC/ARMCANZ guidelines are not specifically ‘groundwater criteria’, they apply at the point of use or exposure and are therefore relevant where an aquatic ecosystem is partially or wholly dependent on groundwater, or where groundwater supply supports primary industry. Should sufficient data be obtained prior to and during construction site specific water quality targets will be established in consultation with EPA and DoI Water.

Shallow Ravine bore hole monitoring is addressed by new boreholes RSMB2, RSMB6, RSMB7, RESMB8 and RSMB9.

Monitoring outcomes which exceed certain thresholds will be subject to the implementation of the TARP detailed in Section 7.2 of this Plan.

Table 6-3: Groundwater monitoring

Characteristics	Proposed sampling	Frequency of sampling
Groundwater quality - general	Water quality lab samples from the suite described in Table 6-2 of this Plan	Monthly
Groundwater level	Groundwater Level - Direct-read data loggers	Every 6 hours
Ravine Cave (Yarrangobilly Cave)	Level fluctuations - Pressure transducer	Continuous
Compliance with bore groundwater extraction licence approval	Volume - Measured extraction volume	Daily or as required by the extraction licence
Tunnel inflow monitoring	Inflow volume measurements calculated over 1km flow rate /sample	Dependent on tunnelling; every kilometre

6.2.6. Groundwater Level Triggers

Initial groundwater level triggers assigned for Stage 1 monitoring bores were calculated using baseline data collected since late March 2018 (Appendix A). Groundwater level triggers presented in Table 6-4 have been calculated using the 20th percentile minus two (2) standard deviations.

Over extraction of groundwater in the Ravine Beds (from proposed Exploratory Works Production Bores currently being drilled) have the potential to draw down the natural groundwater table presenting a risk to groundwater dependent plants and/or ecosystems known within the area. As such, only lower limit groundwater level triggers have been calculated.

Table 6-4: Groundwater level triggers

Bore ID	Type	Data range	Mean (mAHD)	Median (mAHD)	20th percentile (mAHD)	Standard Deviation (mAHD)	Trigger level (mAHD)*
TMB01A	Impact	27/03/18 – 1/02/19	575.902	575.906	575.855	0.053	575.749
TMB01B	Impact	27/03/18 – 1/02/19	575.749	575.713	575.629	0.135	575.360
BH8101[1]	Impact	tba	tba	tba	tba	tba	tba
RSMB2[1]	Impact	tba	tba	tba	tba	tba	tba
RSMB6[1]	Impact	tba	tba	tba	tba	tba	tba
RSMB7[1]	Impact	tba	tba	tba	tba	tba	tba
RSMB8[1]	Impact	tba	tba	tba	tba	tba	tba
RSMB9[1]	Impact	tba	tba	tba	tba	tba	tba

Note: Exploratory Works Production Bores not included for groundwater level triggers because they will be pumped for water supply;
* Trigger level – 20th percentile minus 2 x standard deviations, [1] Will be updated in later GWMP revisions as baseline data is therefore required to be obtained.

Level triggers are an evolving mechanism that will be updated with the collection of new data to account for seasonal and/or climatic related fluctuations and will be updated with the collection of Stage 1 data as baseline for Stage 2, and during Stage 2 construction activities.

Groundwater level triggers will be updated to the date of the previous months collected data. If the 7 day moving average of the recently collected data exceeds the previous months trigger level for more than 30 days, an exceedance has occurred and investigation into the exceedance to discern whether it is a natural, anthropogenic or Exploratory Works related exceedance is required. If the exceedance is deemed to be seasonal and/or climatically driven, the recently collected data will be incorporated into the data set and the water level triggers updated for comparison for the following monitoring event. If the exceedance is deemed to be related to exploratory works, the groundwater level trigger is set at the previous months trigger level to assess the extent of impacts thereafter.

With reference to GDEs, over abstraction of groundwater in the Ravine Beds has the potential to draw down the natural groundwater table presenting a risk to groundwater dependent plants and/or ecosystems known within the area (Section 3). As such, only lower limit groundwater level triggers have been calculated in Table 6-4.

6.3. Groundwater Dependent Ecosystem Monitoring

Figure 6-2 illustrates the locations and extent of groundwater dependent community types within the Exploratory Works area.

6.3.1. Groundwater Dependent Plant Communities

An annual assessment of the Brittle Gum Peppermint Open Forest, White Box Yellow Box Blakeley's Red Gum Woodland, and Broad-leaved Sally grass-sedge, woodland and wetland ecosystem health will be undertaken using the Rapid Appraisal of Riparian Condition guidelines.

6.3.2. Yarrangobilly Caves

An annual visual inspection of Yarrangobilly caves will be undertaken to confirm that there have been no groundwater related impacts that have affected the cave groundwater system.

6.3.3. Stygofauna

One stygofauna assessment will be completed prior to the commencement of Stage 2 exploratory works on bores that have not previously been assessed for stygofauna. Hereafter, one stygofauna assessment will be completed annually on monitoring bores identified in Table 6-1 and where stygofauna is identified until Stage 2 Exploratory Works are completed.

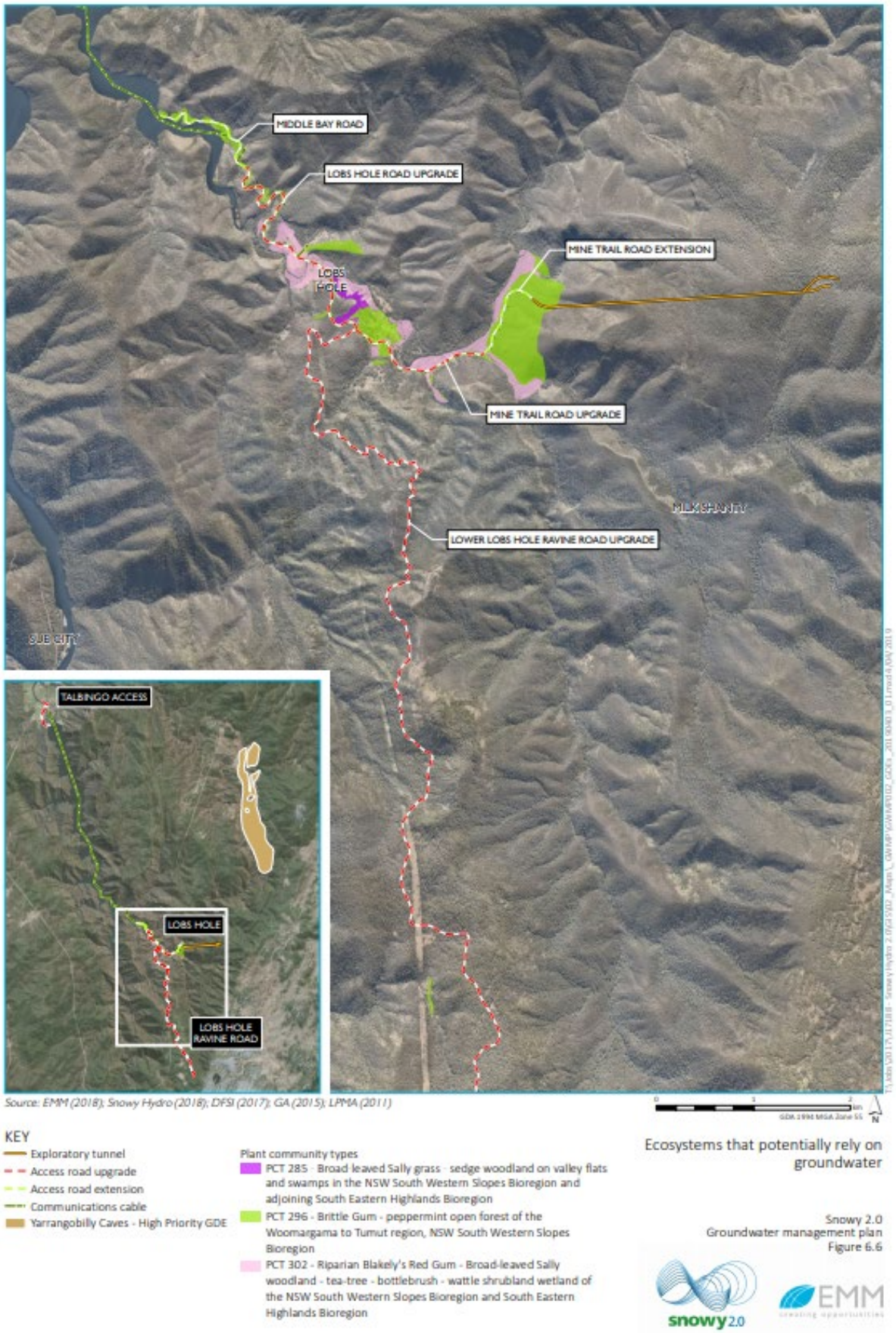


Figure 6-2: Groundwater dependent ecosystems

6.3.4. Groundwater Extraction

Groundwater extracted through proposed Exploratory Works Production Bores will be monitored to confirm that these remain below licensed extraction limits. Volumes will be recorded weekly and a record maintained on the project website.

6.3.5. Review and Response

Monitoring outcomes which exceed certain thresholds will be subject to the implementation of a TARPs. They allow prompt identification of unpredicted impacts and guide the implementation of additional management measures and corrective actions should certain unacceptable conditions arise. Mitigation measures will be adopted on a case by case basis, determined by the result of the investigation detailed in the TARP.

The TARPs will be is to be progressively updated with site specifics garnered from the monitoring program and management actions during the construction stage. A monthly monitoring data review and 6 monthly TARP review will be completed to ensure the TARP is consistent with the requirements of the groundwater monitoring program and works being completed.

Trigger Action Response Plans associated with groundwater are included in Section 7.2.

7. REVIEW AND RESPONSE PROCESS

This section details the Trigger Action Response Plan that has been developed for appropriate groundwater variation response. TARPs allow for prompt identification of unpredicted impacts and guide the implementation additional management measures and corrective actions should adverse conditions arise attributable to construction.

Monitoring will be undertaken using a combination of methods and will require varying levels of processing and review before it can be used to inform assessment and decision making.

7.1. Adaptive Management

Monitoring results obtained during construction will be subject to monitoring, analysis of results, review of mitigation measures (where exceedances are identified) and updates to measures and trigger values where required.

7.2. Trigger Action Response Plan

7.2.1. Purpose

The purpose of the TARP is to detail a standardised, response procedure in the event that trigger value banding is exceeded during a monitoring event for groundwater quality and availability (level) monitoring. The TARP applies to all current and future groundwater quality monitoring locations.

7.2.2. Objective

The objectives of the TARP are as follows:

- undertake supplementary monitoring to try and determine the extent of water quality variation;
- identify the potential cause of the water quality variation, if possible;
- identify and implement potential mitigation measures to minimise continuation of the water quality variation, if possible;
- perform due diligence when variation is identified; and

- meet CoA and REMMs requirements for trigger response.

7.2.3. Response Process

Where monitoring results exceed the trigger range for each water quality analyte, a site inspection will be undertaken to attempt to identify the cause of the variation. Table 7-1 summarises the groundwater monitoring TARP responses.

Table 7-1: Overview of trigger action response plans

Performance measure	Monitoring sites	Frequency	Trigger compliance	Objectives	Management Measures
Groundwater quality monitoring.	• BH8101 • RSMB2 • RSMB6 • RSMB7 • RSMB8 • RSMB9 • Production bores*	Monthly groundwater quality sampling	If a parameter exceeds one or more of the nominated water quality triggers for two consecutive monitoring events.	To identify (where possible) if the exceedance is naturally occurring or due to Exploratory Works	Implement TARP.
Groundwater level monitoring.	• BH8101 • RSMB2 • RSMB6 • RSMB7 • RSMB8 • RSMB9 • YC05 • Shallow Monitoring Bores*	Daily – 6 hourly (collected monthly during water quality sampling events)	If the 7 day moving average exceeds the previous months established trigger level for more than 30 days.		
Groundwater inflow rate monitoring	At 1km intervals within the tunnel	Every 1km	Review tunnel lining and waterproofing and segregation methods of tunnel sumps/process water system to asses ingress flow rate (GW06)	To limit the volume of water transferred from groundwater into surface water	

* Exploratory Works Production bores not included for groundwater level triggers because they will be pumped for water supply.
[1] Proposed to be removed and replaced with RSM bores.

Where a **groundwater quality** trigger value range (detailed in Table 6-2 of this Plan) is exceeded for two consecutive monitoring events, the following TARP process will be undertaken:

1. If the exceedance **is representative** of known EIS baseline/ pre-Stage 2 construction exceedances of the ANZECC/AMRCANZ 99% freshwater species protection, then the residual TARP process is not required and continue to monitor at the nominated frequency in Table 6-4
2. If the exceedance **is not representative** of known EIS baseline/ pre-Stage 2 construction exceedances of the ANZECC/AMRCANZ 99% freshwater species protection, then complete Steps 3 – 5 of the TARP process;

3. Undertake an inspection of the monitoring location, its surroundings in an attempt to identify the source of the variation;
    - If the exceedance **can be identified as attributable to non-Stage 2 works** then record the exceedance with justification and re-establish the trigger value for proceeding monitoring events;
    - if the cause of the exceedance **cannot be identified,** then undertake Steps 4 – 5 of the TARP process.
4. Undertake an inspection of any Stage 2 construction activities within the vicinity of the monitoring location with relevant construction personnel and attempt to identify the source of the variation.
    - check for climate related impacts or similar impacts at reference sites;
    - if the exceedance **cannot be attributed to construction activities**, then proceed to monitor the exceeded analyte at an increased frequency to the monthly sampling and repeat Steps 1 – 4 of the TARP process until the variation is stabilised or other resolution is met. Consider engaging a Hydrogeologist to provide an opinion on the exceedance;
    - if the exceedance **can be attributed to construction activities** then meet with relevant personnel, develop corrective actions with assigned timeframes and implement. Undertake monitoring of the exceeded analyte at an increased frequency to the monthly sampling and repeat Steps 1 – 4 of the TARP process until the variation is stabilised or other resolution is met.
5. Record any observations and a summary of the TARP process followed as well as summation of the cause of the variation, actions implemented and resolution.

Where a **groundwater level** trigger value tolerance is exceeded (detailed in Table 6-4 of this Plan) for longer than 7 consecutive days, the following TARP process will be undertaken:

1. Use the previous monthly data as an ‘interim groundwater level trigger’;

    Note: this is required due to the limited duration of previous groundwater monitoring, limiting the ability to analyse and identify long-term seasonal/climactic variation.

2. Continue to sample at the 6 hourly frequency and analyse the data weekly for the next 4 weeks;
3. If the 7 day rolling average over the next 4 weeks does not exceed the interim groundwater level an exceedance has not occurred, and monitoring should continue as per normal monitoring regime;
4. If the 7 day rolling average over the next 4 weeks exceeds the interim groundwater level, then an exceedance has occurred and needs to be investigated (Step 5 of the TARP process);
5. Undertake an inspection of the monitoring location, its surroundings in an attempt to identify the source of the variation;
    - Check for climate related impacts or similar impacts at reference sites;
    - If the exceedance can be identified **as attributable to factors other than Stage 2 works,** then record the exceedance with justification and use the recently collected data to re-establish the trigger value for proceeding monitoring events. Report on the findings. Consider engaging a Hydrogeologist to provide an opinion on the exceedance;

- If the exceedance **can be identified as attributable to Stage 2 works**, the groundwater level trigger is set to assess the extent of impacts thereafter. Assessment of impacts can involve meeting with relevant personnel, developing corrective actions with assigned timeframes and implementing including consideration of:
    - using captured and treated groundwater (i.e. from the tunnel) to replenish groundwater levels through waterways;
    - reviewing tunnel lining and waterproofing and segregation methods of tunnel sumps/process water system to asses ingress flow rate.

Response to incidents will be undertaken as described in Section 7 of the EMS and in accordance with the Pollution Incident Response Management Plan (PIRMP) required by the EPL.

7.2.4. Limitations

The following limitations apply for the TARP:

- response to quality sampling cannot be undertaken immediately due to the delay in laboratory testing. Therefore, response timeframes when sampling is undertaken is expected to be a minimum of two weeks;
- as discussed in Section 6.2.3, recorded baseline data trigger values are based on ANZECC values. The baseline data has been sampled in a short period and therefore there is potential for non-construction exceedances of trigger values during wet weather conditions or other influences attributed to non-construction sources.

7.3. Incident Management

Incidents are managed in accordance with the Section 7 of the EMS and the Pollution Incident Response Management Plan (PIRMP). The investigation will include a review of events leading up to the incident and implement improved practices as required.

In the event of the occurrence of an incident, the Future Generation Environment Manager will immediately inform SHL who will contact Department of Planning, Industry and Environment in accordance with the requirements of Schedule 4, Condition 5 of the Infrastructure Approval.

Corrective actions will be implemented to reflect the root cause of the event. This may include:

- additional spill response training;
- installation of physical barriers or diversions;
- monitoring groundwater and/ or nearby surface waters for possible contamination.

In accordance with Part 5.7 the *Protection of the Environment Operations Act 1997*, the Environment Manager or Project Director will enact the Pollution Incident Response Management Plan (PIRMP) should the incident be deemed to have:

- resulted in actual or potential for material environmental harm, or
- the associated clean-up costs exceed $10,000

7.4. Auditing

Audits of this Plan and appendices will be undertaken to assess compliance against the requirements assigned to this Plan at the frequency detailed in the EMS Section 8.

7.5. Reporting

Reporting will include monthly internal project reports and six-monthly compliance reports as required by the CoA. The six-monthly reports will track compliance against the CoAs and REMMs Reporting requirements. Responsibilities for these tasks are documented in Section 8 of the EMS.

Other reporting will be undertaken as prescribed by a relevant water licence (EPL or Extraction licence).

A monthly ground water quality report will be prepared by Snowy Hydro that presents:

- the locations and description of monitoring undertaken;
- a tabulation of results (e.g. groundwater levels and water quality results);
- summary of any measurements exceeding the nominated criteria;
- detail of any corrective actions and confirmation of their successful implementation.

Response to incidents will be undertaken in accordance with the Environmental Incident Procedure and the Pollution Incident Response Management Plan as described in the EMS.

7.6. Training

All site personnel will undergo site induction training relating to groundwater management issues, including:

- existence and requirements of this GWMP;
- relevant legislation;
- roles and responsibilities for groundwater management;
- groundwater mitigation and management measures; and
- procedures to be implemented in the event of an incident.

Targeted training in the form of toolbox talks or specific training will also be provided to personnel with a key role in groundwater management. Examples of training topics include:

- spill response and the location of spill kits on site;
- storage and handling of fuels, oils and hazardous chemicals; and
- plant refuelling procedures including those undertaken below grounds.

Further details regarding the staff induction and training are outlined in Section 5 of the EMS.

7.7. Groundwater Modelling

The groundwater model will be reviewed and/or updated every six months with the availability of new data. The revised model will be submitted to the relevant agencies on completion.

APPENDIX A – BASELINE GROUNDWATER QUALITY AND LEVEL DATA

Table A 1: Mean groundwater quality results (February 2018 – February 2020)

Analyte	Units	ANZECC 99% protection	TMB05A[2]	TMB05B[2]	TMB01A	TMB01B
Formation			Ravine Beds (w)[1]	Ravine Beds	Boraig Group	Ravine Beds
Field analytes						
pH	-	6.5-8	7.39	8.89	6.31	7.54
Electrical conductivity (EC)	µS/cm	30-350	532	689	306.9	2338
Temperature	ºC	-	13.64	14.49	14.55	14.7
Dissolved oxygen	mg/L	-	0.18	1.254	0.845	0.435
Turbidity	NTU	10-20	22.08	0.96	84.5	5.16
Oxidation Reduction Potential	millivolts	-	97	84.6	20.15	-125.33
Metals						
Aluminium (dissolved)	mg/L	0.055[3]	0.006	0.038	0.019	0.0055
Copper (dissolved)	mg/L	0.001	0.00072	0.00051	0.0011	0.0008
Iron (dissolved)	mg/L	ID[4]	0.166	0.026	0.389	0.1631
Lead (dissolved)	mg/L	0.001	0.00028	0.00028	0.00026	0.0002
Manganese (dissolved)	mg/L	1.2	0.072	0.0064	0.0275	0.1279
Mercury (dissolved)	mg/L	0.00006	0.00004	0.00004	0.00004	0.00004
Nickel (dissolved)	mg/L	0.008	0.0005	0.00079	0.0007	0.0018
Silver (dissolved)	mg/L	0.000002	0.00029	0.00026	0.00018	0.00001
Zinc (dissolved)	mg/L	0.0024	0.002	0.0034	0.0038	0.0073
Nutrients						
Nitrogen (Total)	mg/L	0.25	0.267	0.259	0.033	0.214
Reactive phosphorous	mg/L	0.015	0.005	0.108	0.006	0.027

Notes: For data received which was less than the limit of reporting (LOR), a value equal to half of the LOR was applied. Therefore if the result was <0.001 (as the LOR), the value applied is 0.0005.
1. (w) = weathered.
2. Data from February 2018 to November 2019 only.
3. ANZECC section 8.3.7 moderate reliability trigger level when pH>6.5.
4. ID = Insufficient data reported in ANZECC section 8.3.7.

Table A 2: Groundwater level summary (mAHD)

	TMB01A			TMB01B			TMB05A			TMB05B		
Month	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**
March 2018	576.040	575.978	575.935	575.547	575.591	575.527	598.221	598.822	598.727	598.373	598.111	598.004
April 2018	575.962	575.912	575.870	575.566	575.545	575.512	599.265	598.776	598.683	598.413	597.983	597.849
May 2018	575.944	575.822	575.763	575.618	575.599	575.578	599.031	598.932	598.766	598.420	598.322	597.963
June 2018	575.990	575.876	575.762	575.699	575.637	575.593	599.268	599.069	598.906	598.764	598.542	598.357
July 2018	576.053	575.969	575.891	575.751	575.676	575.600	599.269	599.172	599.070	598.798	598.619	598.385
August 2018	576.582	576.372	575.995	575.076	575.922	575.658	599.626	599.435	599.133	598.936	598.784	598.413
September 2018	576.636	576.464	576.331	575.051	575.939	575.810	599.622	599.487	599.358	599.161	598.996	598.840
October 2018	576.337	576.259	576.166	575.824	575.758	575.692	599.401	599.270	599.147	599.153	598.980	598.825
November 2018	576.422	576.269	576.144	575.802	575.726	575.597	599.293	599.201	599.085	598.941	598.860	598.758
December 2018	576.594	576.346	576.187	575.961	575.831	575.723	599.63	599.45	599.24	599.47	599.22	598.93
January 2019	576.305	576.199	576.134	575.740	575.668	575.609	599.44	599.25	599.08	599.28	599.03	598.81
February 2019	576.19	576.11	576.00	575.64	575.59	575.51	599.09	599.01	598.93	598.82	598.72	598.63
March 2019	576.16	576.00	575.94	575.70	575.55	575.50	599.10	598.92	598.85	598.65	598.61	598.55
April 2019	576.16	576.05	575.99	575.70	575.60	575.51	599.14	599.07	599.01	598.81	598.79	598.72
May 2019	575.99	576.14	576.39	575.92	575.69	575.57	599.53	599.27	599.03	599.27	599.01	598.79
June 2019	576.46	576.37	576.31	575.92	575.83	575.72	599.60	599.51	599.41	599.53	599.42	598.74
July 2019	576.86	576.59	576.39	576.19	575.98	575.83	599.90	599.72	599.59	599.93	599.74	599.52
August 2019	576.75	576.55	576.35	576.18	576.06	576.06	599.89	599.73	599.56	599.96	599.78	599.58
September 2019	576.75	576.68	576.49	575.84	575.92	575.95	599.67	599.57	599.50	599.57	599.57	599.49
October 2019	576.67	576.61	576.54	575.89	575.83	575.76	599.54	599.38	599.29	599.50	599.38	599.26
November 2019	576.794	576.542	576.394	575.98	575.89	575.74	599.39	599.30	599.16	599.37	599.29	599.14
December 2019	576.544	576.448	576.379	575.80	575.67	575.59	599.17	599.16	599.14	599.18	599.17	599.16
January 2020	576.84	576.55	576.35	575.92	575.70	575.57	NA	NA	NA	NA	NA	NA
February 2020	576.68	576.65	576.64	575.82	575.81	575.81	NA	NA	NA	NA	NA	NA
All periods	**576.86**	**576.40**	**575.94**	**576.19**	**575.75**	**575.5**	**599.9**	**599.25**	**598.68**	**599.96**	**598.95**	**597.84**

Note: NA - Data not available at time of writing

Table A 3: Lobs Hole shallow bore yield monitoring data summary

Site/ Bore ID	Date	Time	Yield (L/s)
EWPB1	20/03/19	09:30	1.4
		09:40	1.33
		09:50	1.14
		10:00	1.14
		10:10	1.14
		10:20	1.18
		10:30	1.14
		10:40	1.08
		10:50	1.08
		11:00	1.08
Site 2	02/04/19	12:45	0.1
		12:55	0.1
		13:05	0.1
EWPB3	29/04/19	13:10	5.00
		13:20	5.00
		13:30	5.00
		13:40	5.00
		13:50	5.00
		14:00	5.00
		14:10	5.00
		14:20	5.00
Site 4	28/03/19	11:25	2.66
		11:35	2.00
		11:45	1.43
		11:55	1.33
		12:05	1.33
		12:15	1.33
		12:25	1.33
		12:35	1.17
		12:45	1.17
		12:55	1.33
		13:05	1.33
		13:15	1.17
		13:25	1.17
Site 5	-	-	Low yield <0.5
Site 6	-	-	Low yield <0.5

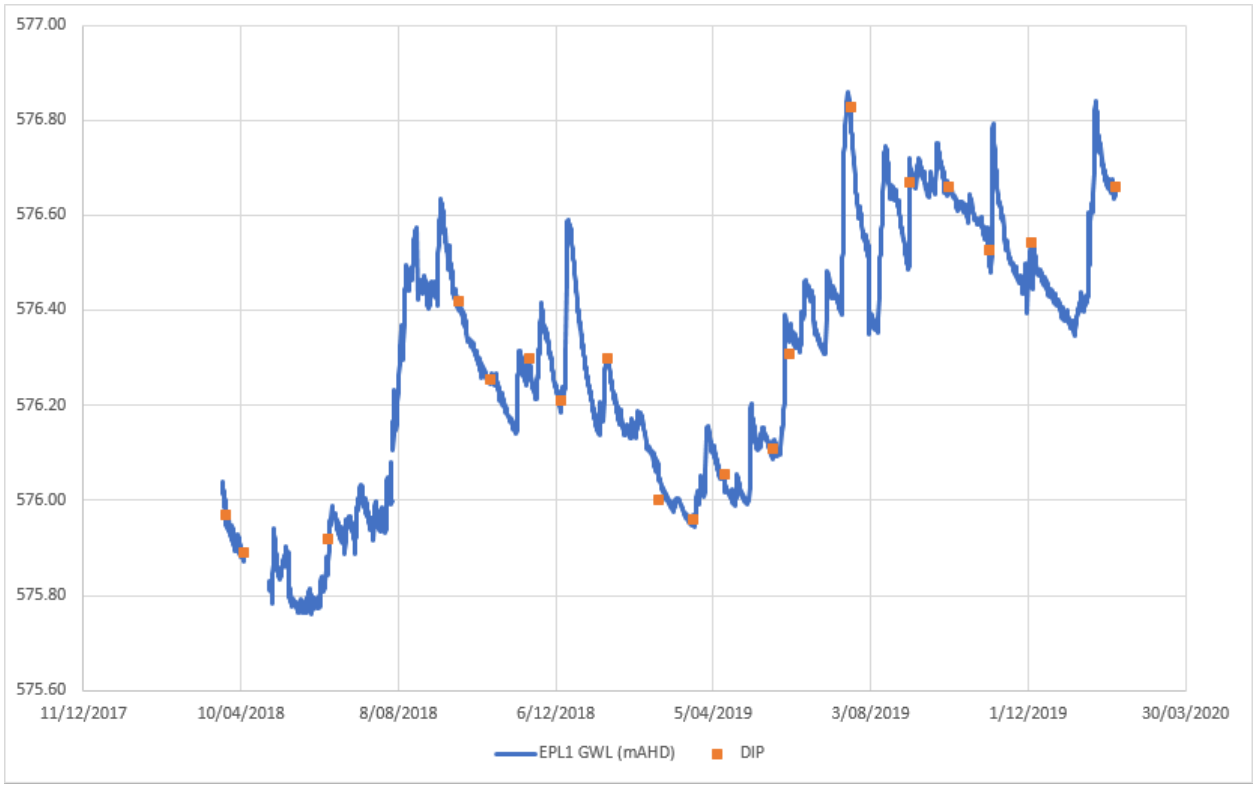


Figure A 1: TMB01A (EPL 1) groundwater level hydrograph

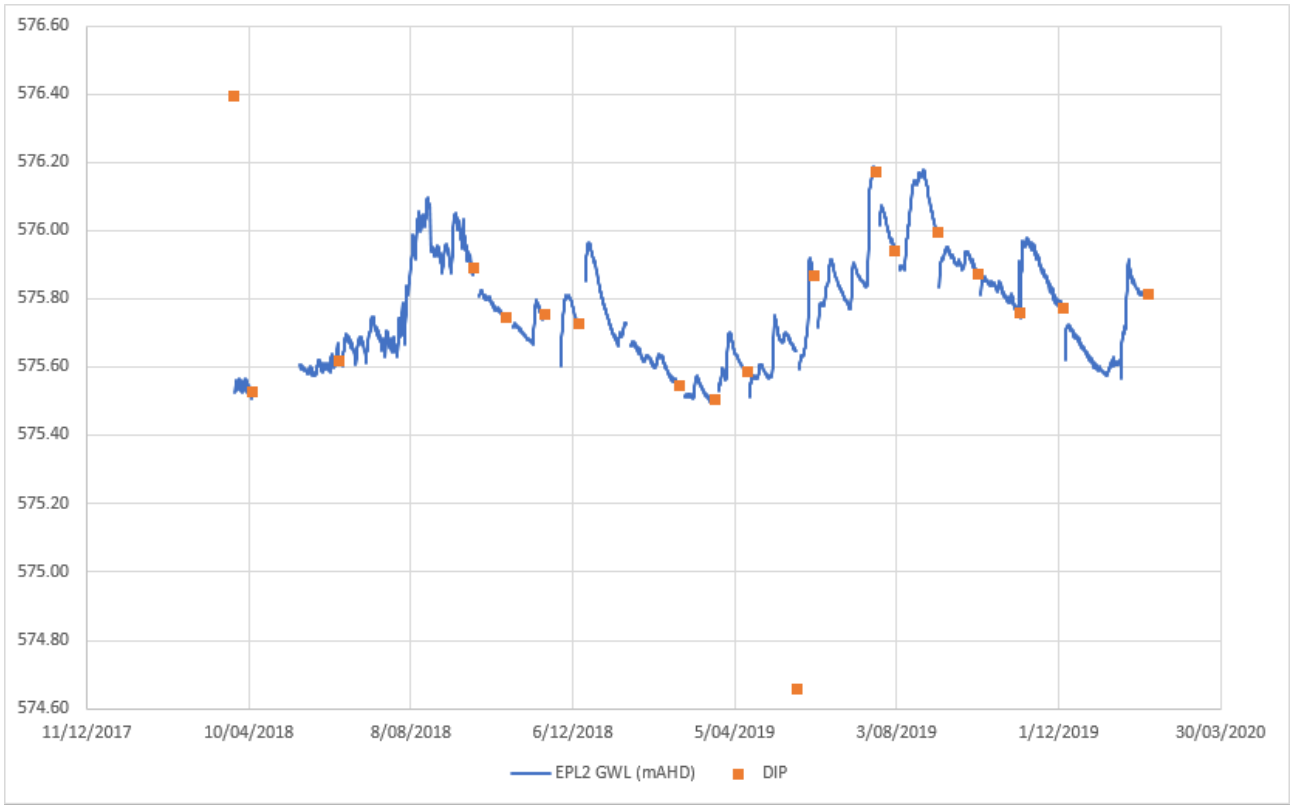


Figure A 2: TMB01B (EPL 2) groundwater level hydrograph

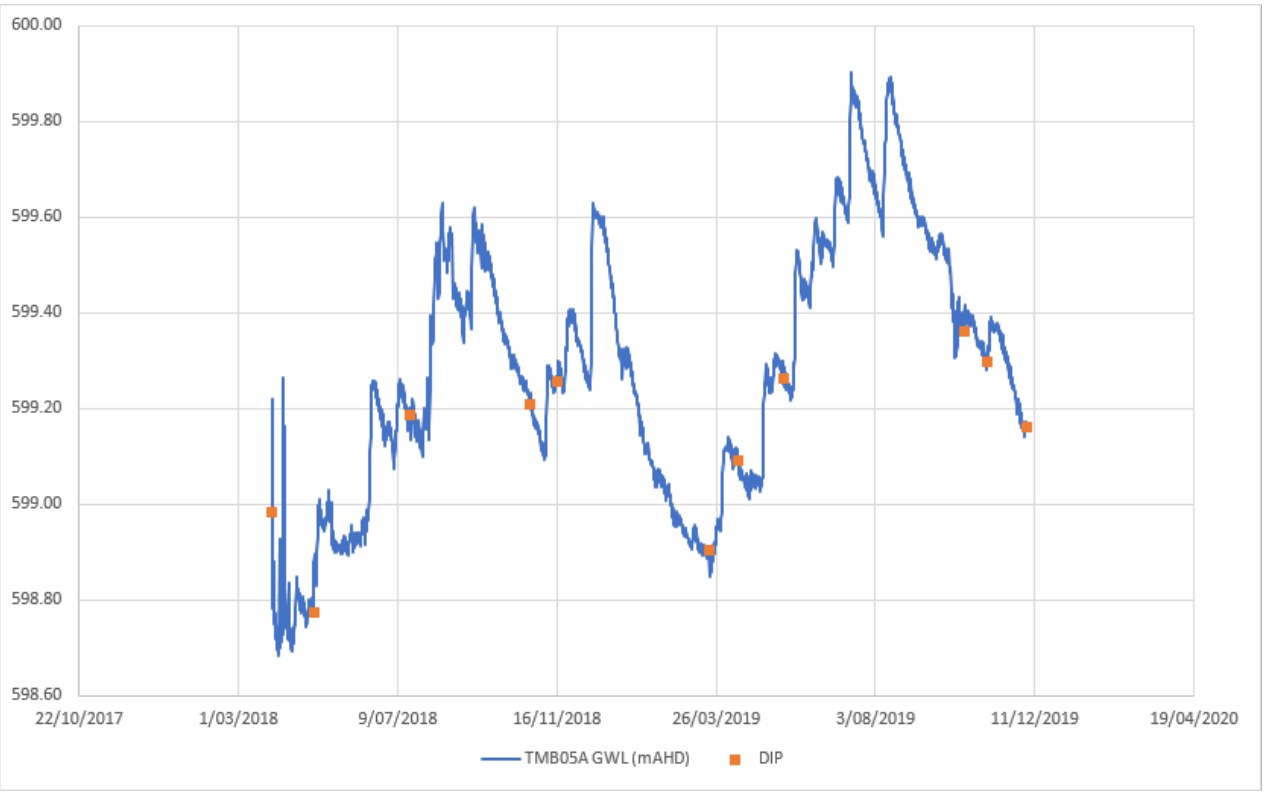


Figure A 3: TMB05A groundwater level hydrograph

Figure A 4: TMB05B groundwater level hydrograph

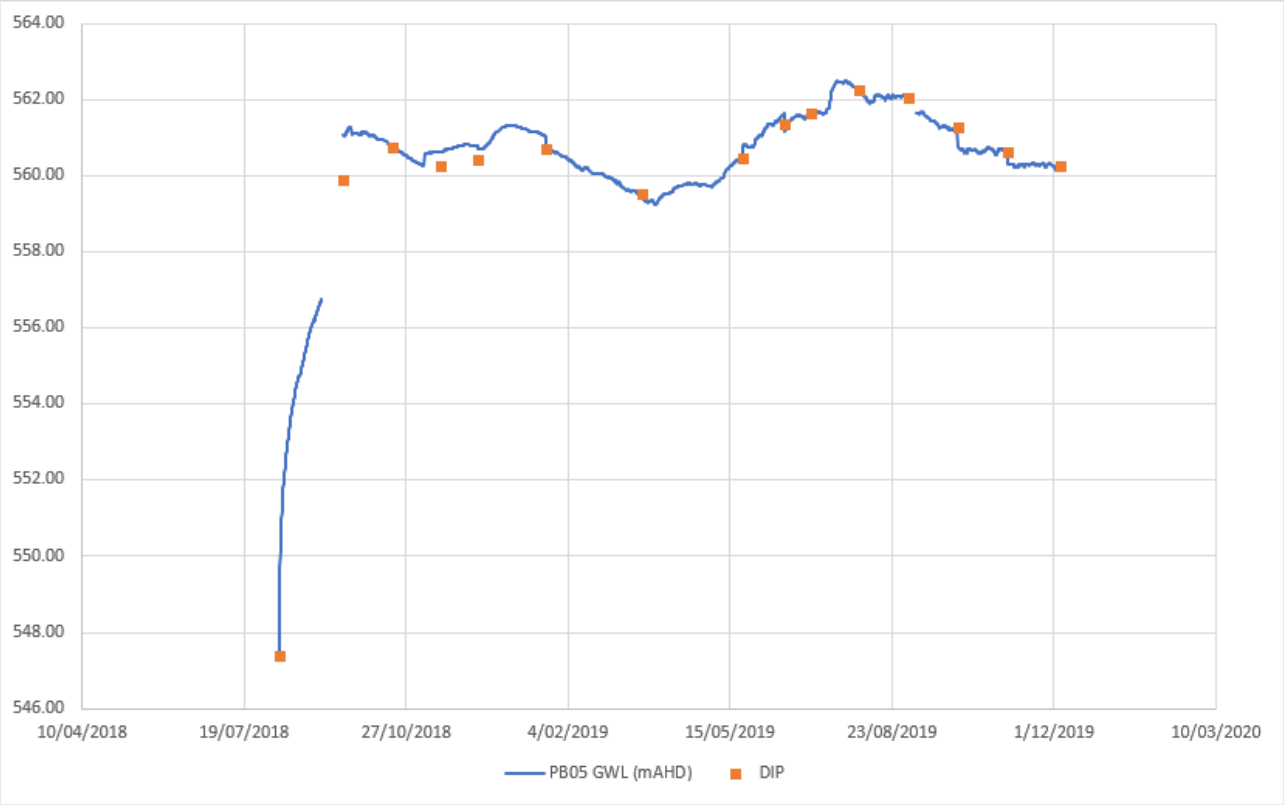


Figure A 5: PB05 groundwater level hydrograph

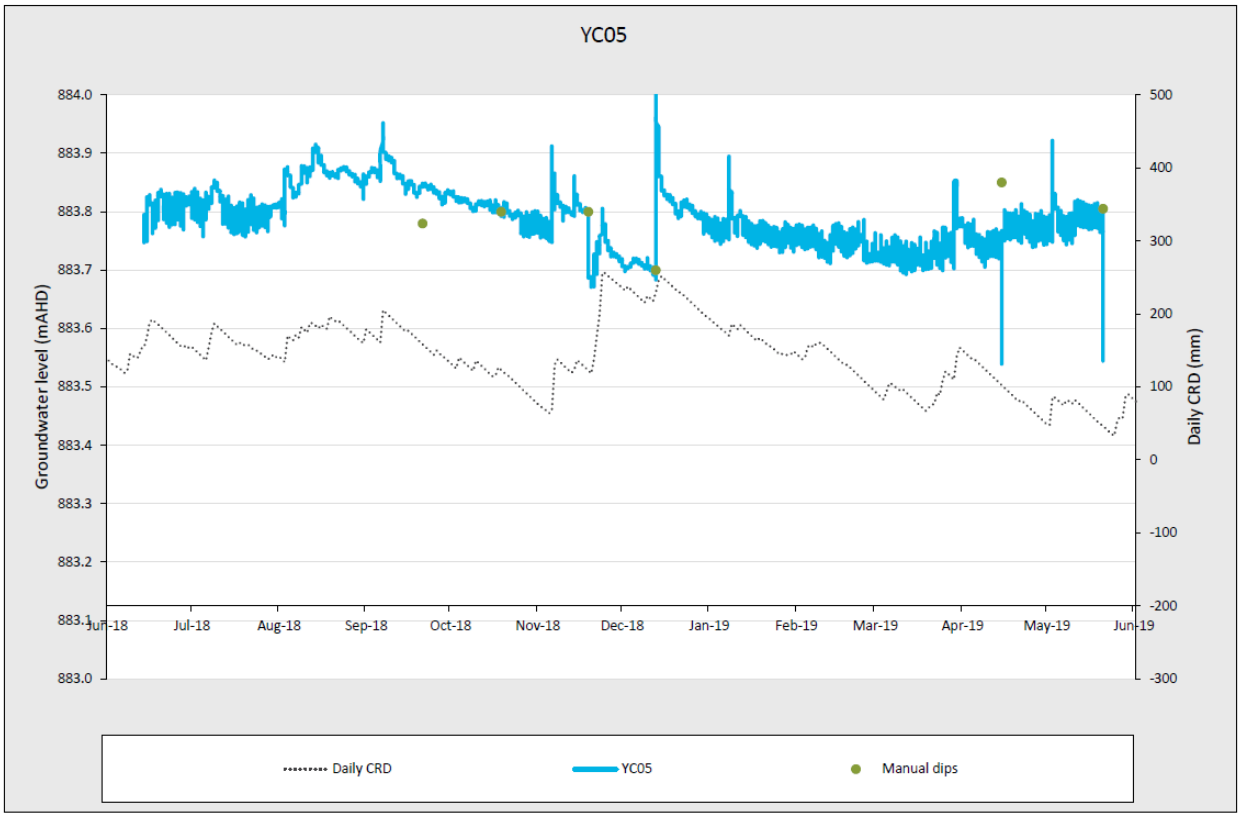


Figure A 6: YC05 pool depth level hydrograph