



Site	Russell Vale Colliery	DOC ID	RVE EC PLN 010
Type	Plan	Date Published	19/11/2021
Doc Title	Extraction Plan		

APPENDIX F: PUBLIC SAFETY MANAGEMENT PLAN



Site	Russell Vale Colliery	DOC ID	RVC EC PLN 009
Type	Management Plan	Date Published	18/11/2021
Doc Title	PUBLIC SAFETY MANAGEMENT PLAN		

RUSSELL VALE COLLIERY RUSSELL VALE REVISED UNDERGROUND EXPANSION PROJECT

PUBLIC SAFETY MANAGEMENT PLAN RVC EC PLN 009

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 009
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Revisions

Version	Date reviewed	Review team (consultation)	Nature of the amendment
1	03/08/2021	WCL	Draft document for consult
2	07/10/2021	WCL	Final draft for submission to DPIE
3	18/11/2021	WCL	Final version following response to regulators
4			

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1 INTRODUCTION

1.1 Overview

Wollongong Coal Limited (WCL) operates the Russell Vale Colliery (RVC) (formerly the NRE No.1 Colliery) located in the Southern Coalfield of New South Wales (NSW). The mine is located at Russell Vale, approximately 8 km north of Wollongong and 70 km south of Sydney, within the local government areas (LGAs) of Wollongong and Wollondilly in the Illawarra region of NSW (

Figure 1).

This Public Safety Management Plan (PSMP) has been prepared in support of an Extraction Plan (EP), as required by Condition 10 (g)(vii) of Development Consent MP09_0013 (the Development Consent). A Plan showing the extraction plan area (EP Area) with the proposed workings is depicted in **Figure 2**.

1.2 Project Background

RVC operates under the current Development Consent granted by the NSW Independent Planning Commission (IPC) on 8 December 2020. The Development Consent, known as the Underground Expansion Project (UEP), is based on the Revised Preferred Project Report (RPPR) and Response to Second PAC Review by Umwelt Environmental and Social Consultants Pty Ltd (Umwelt) dated July 2019. Under the Development Consent WCL may:

- extract 1.2 Mt of Run of Mine (ROM) coal per annum, with a maximum of 1 Mt of ROM coal being processed from site in a calendar year
- undertake mining operations for a period of five years from the date of commencement of mining operations.

The approved workings are contained within Consolidated Coal Lease 745 (CCL 745) and Mining Lease 1575 (ML 1575). In accordance with Condition C10(g)(vii) of the Development Consent, this PSMP has been prepared as a component of the RVC EP to manage the potential consequences of the second workings to ensure public safety and manage access across the EP area. The PSMP covers the area relating to PC07, PC08 and PC 21 to PC25. PC07, PC08 and PC 21 to PC25 are situated to the west and south-east of the previously mined Longwall 6 (

Figure 1).

The remaining pillars approved under the Development Consent will be mined in a staged approach and will therefore be subject to future EPs.

Section 2 of the main EP, 'Project Description', provides a full summary of the project, including details on the:

- mine planning and design
- mining methodologies
- phasing of the surface infrastructure relating to the project over 2 stages, which are both wholly covered under the EP
- staging of second workings
- stage 1(a) – PC21 to PC25



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- stage 1(b) – PC07 and PC08.

1.3 Public Safety Features Covered by this Plan

The purpose of this PSMP is to document the potential risks to public safety associated with the UEP in the Russell Vale, Wonga West Areas, and detail any measures to manage these risks.

This PSMP addresses the potential risks to public safety posed by the following hazards:

- potential impacts of subsidence on built features
- potential instability of steep slopes resulting from subsidence
- deformation or fracturing of land due to subsidence.

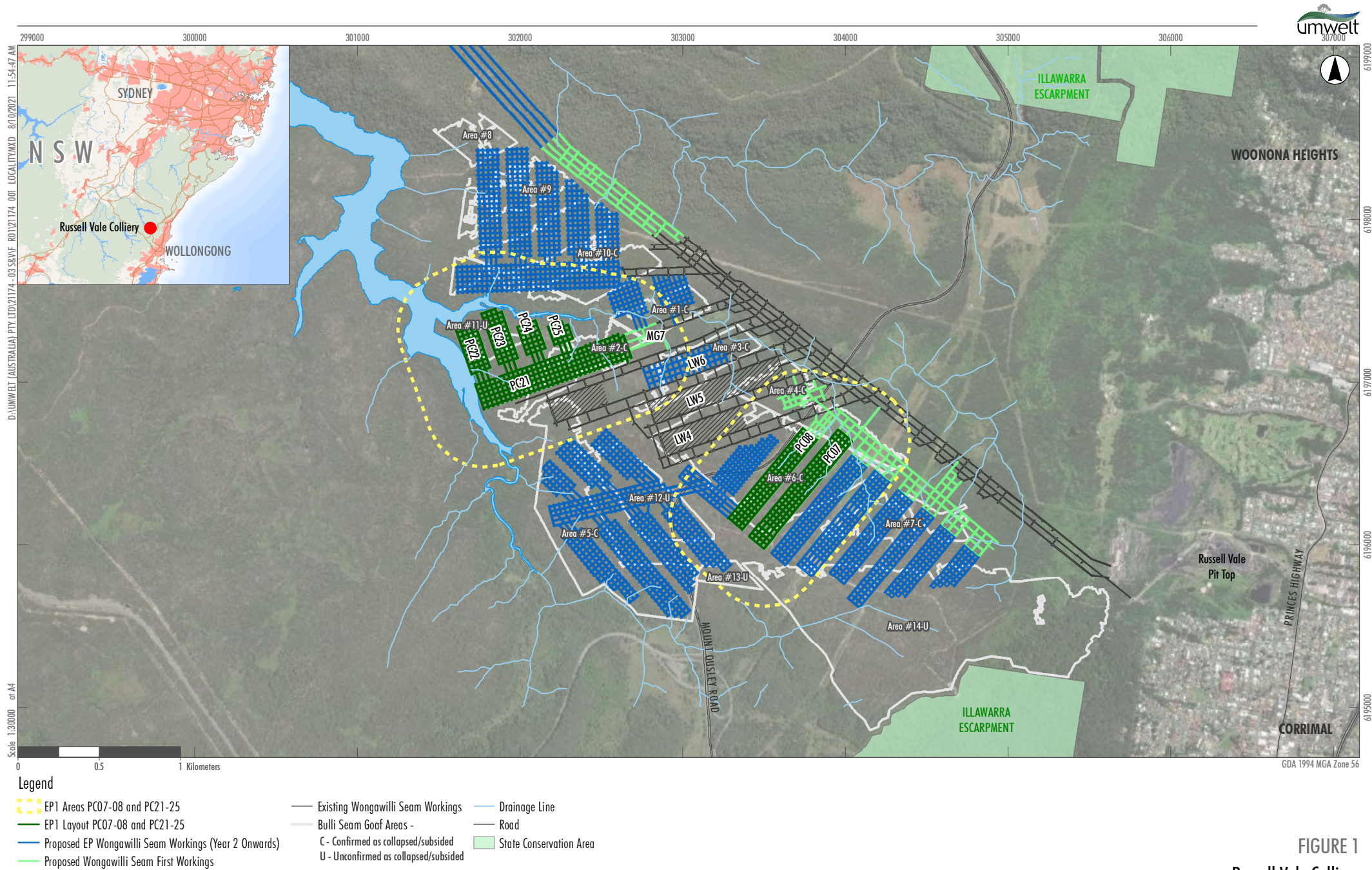
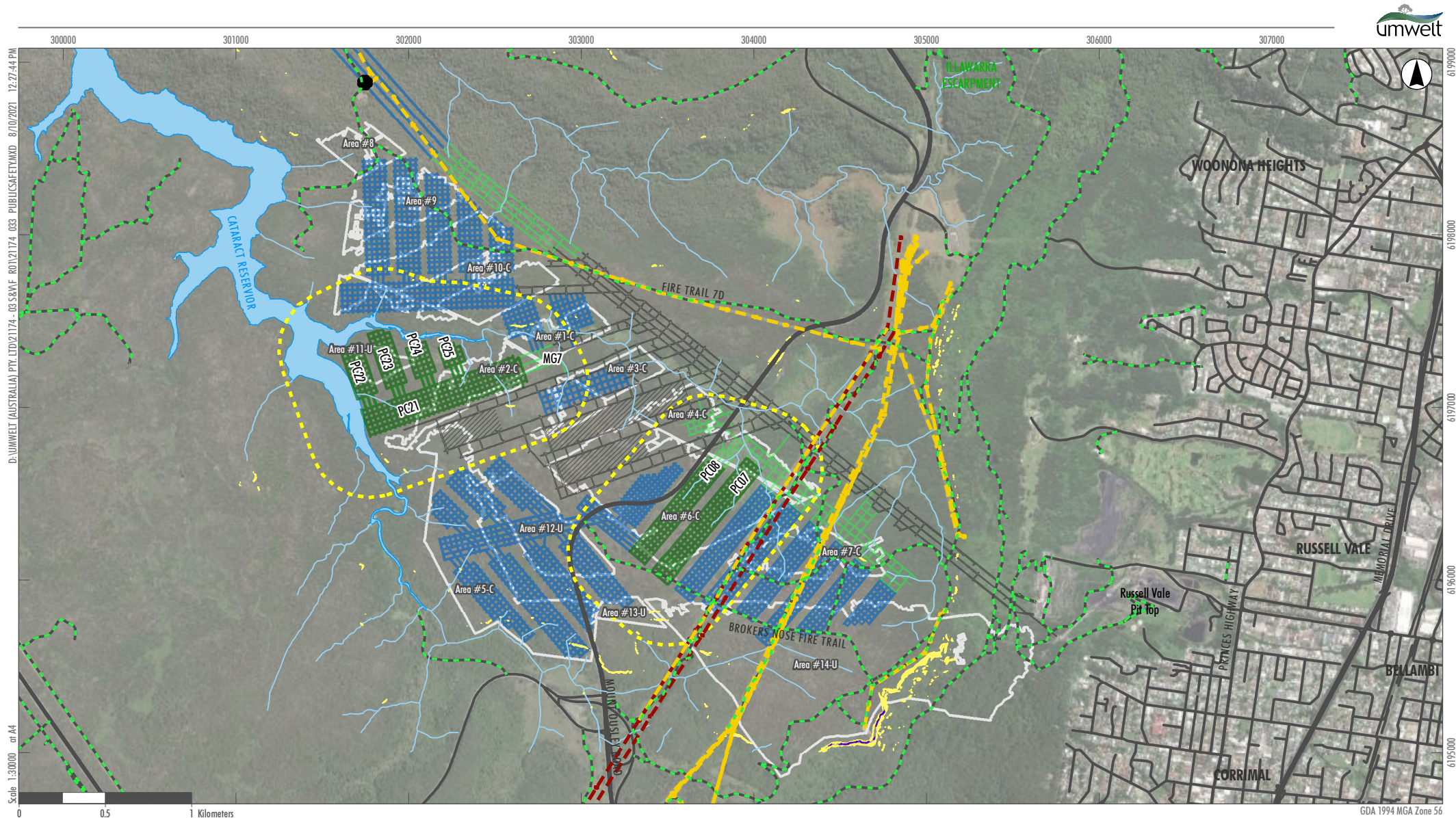


FIGURE 1
Russell Vale Colliery
Locality Plan



Legend

- EP1 Areas PC07-08 and PC21-25
- Proposed Wongawilli Seam 1st Workings
- Proposed EP Wongawilli Seam Workings (Year 2 Onwards)
- EP1 Layout PC07-08 and PC21-25
- Existing Wongawilli Seam Workings
- Bull's Seam Goaf Areas -
- C - Confirmed as collapsed/subsided
- U - Unconfirmed as collapsed/subsided
- Unsealed Access Roads and Fire Trails
- Power Line
- Transmission Tower Power Line
- Substation
- Cliffs (rock faces > 10 m high)
- Steep slopes (extended slopes > 1V:1H)
- Drainage Line
- Road

FIGURE 2
Public Safety Features

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2 STATUTORY REQUIREMENTS

2.1 Development Consent

Condition 10 (vii) of the Development Consent requires the preparation of a PSMP as a component of an EP.

Table 1 summarises the Development Consent conditions relevant to the PSMP.

In accordance with Condition C10 of the Development Consent, WCL will ensure implementation of this management plan upon approval by the Secretary.

Table 1 Extraction Plan Requirements

Condition	Condition Requirement	Section Addressed
C10. (g) (vii)	Prepare a Public Safety Management Plan which has been prepared in consultation with RR and WaterNSW, which ensures public safety and manages access on the site;	This PSMP Section 2.3

2.2 Leases, Licences and Permits

In addition to the requirements of the Development Consent, all activities at or in association with the Russell Vale Colliery are undertaken in accordance with the relevant conditions outlined within the licences, permits and leases in **Table 2**.

Table 2 Licences, Permits and Leases

Licence and/or Approval	Document Number	Issue Date	Expiry Date
Consolidated Coal Lease (CCL)	745	27/12/1990	30/12/2023
Mining Purposes Lease (MPL)	271	09/05/1991	09/05/2033
Mining Lease (ML)	1575	22/03/2012	22/03/2029
Environmental Protection Licence	12040	19 May 2004	-
EPBC Approval	2020/8702	31 August 2021	31 December 2067
Water Access License (WAL)	WAL36488	20/02/2017	-
Special Area Consent	F2020/3092	04 March 2021	03 March 2026

2.3 Consultation

2.3.1 Consultation During the Environmental Assessment Process

Extensive community and government consultation has been carried out prior to and during the preparation of the original environmental assessment, the RPPR, the Submissions Report and other project-related assessment documentation. The primary objective of consultation was to keep the community, government agencies and other stakeholders informed and involved during project development process.

Community engagement was carried out in two phases and is summarised in Section 4.1.2 and Section 4.1.3 of the RPPR.

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A complete summary of previous and ongoing government agency and stakeholder consultation is provided in Table 4.5 of the RPPR. Consulted parties of relevance to this PSMP included:

- the Department of Planning, Industry and Environment (DPIE)
- DPIE Mining Resources Regulator (NSW RR)
- DPIE Water
- NSW Environment Protection Authority (EPA)
- Wollongong City Council (WCC)
- WaterNSW
- Biodiversity Conservation Department
- NSW Heritage.

2.3.2 Consultation During the Preparation of the Management Plan

In accordance with Condition C10 (g) (vii) of the Development Consent, this PSMP has been prepared in consultation with the NSW RR and WaterNSW.

The consultation undertaken as part of the preparation of the management plan is included in **Table 3**.

Table 3 Consultation Undertaken as Part of the Preparation of this Management Plan

Agency name	Issue	Where issue is addressed in Management Plan
DPIE	This table to be completed on finalisation of Management Plan	Comments will be included in Appendix B of the main EP.
WaterNSW	<p>a. Section 2.3 Table 3 must list the Special Area Consent (Consent No. F2020/3092; commenced on 4th March 2021 and valid until 3rd March 2026) – Issued by WaterNSW under Division 1 of Part 3 of the Water NSW Regulation 2020.</p> <p>b. Section 6.1.3 - WCL is responsible for any damage caused to fire trails due to its surface activities and must have mitigation and contingency measures in place to ensure all WaterNSW fire trails are safe, serviceable and repaired as soon as practical.</p> <p>c. Section 7.1 Para 4 – reference to WaterNSW Standard Conditions must be deleted. Applicable conditions and requirements are listed in WCL's Special Areas Consent (F2020/3092) and in any approvals including specific activity approvals issued by WaterNSW under Part 5 of the EP&A Act.</p> <p>d. Section 7.3.1 – WaterNSW Special Areas: Reference to WaterNSW track maintenance guidelines (including the Track Stabilisation and Control Manual) needs to be deleted as it is no longer used by WaterNSW. Recommended guidelines are specified in Schedule 5 of WCL's Special Areas Access Consent. Schedule 7 of</p>	<p>a. Section 2.2 Table 2</p> <p>b. Section 6.1.3</p> <p>c. Section 7.1</p> <p>d. Section 7.3.1</p>

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	WCL's Access Consent also specifies WaterNSW's road and fire trail rules and Schedule 4 specifies roads and fire trails WCL can access within the Metropolitan Special Areas. A list of the most relevant ones overlying the Russell Vale Colliery proposed extraction area must be listed here that will be utilized, monitored and maintained.	
NSW Resources Regulator	No response supplied	N/A

Consultation is presented in **Appendix B**.

2.4 Report Structure

The remainder of this PSMP is structured as follows:

Section 2: Outlines the statutory requirements applicable to the Plan.

Section 3: Outlines the baseline data and impact assessments undertaken which support this PSMP.

Section 4: Describes the predicted subsidence applicable to public safety features.

Section 5: Details the performance measures and indicators that will be used to assess the Project.

Section 6: Describes the monitoring program and reporting requirements.

Section 7: Describes the management, remediation and mitigation measures that will be implemented to reduce potential impacts as well as the contingency plan to manage any unpredicted impacts and their consequences.

Section 8: Describes the protocols for the handling of incidents, complaints and non-compliances.

Section 9: Details the plan administration requirements

Section 10: Details how the Plan will be implemented, managed, reviewed and updated.

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3 BASELINE

This section is based on the subsidence assessment (SCT, 2019) conducted for the RPPR and the associated environmental assessment reports, and the updated subsidence report (SCT, 2021) as prepared in accordance with the Condition C10(e) of the Development Consent.

3.1 Site Description

The EP Area is located entirely within the 'Metropolitan Special Area' managed by WaterNSW. The Metropolitan Special Area is a restricted area and cannot be accessed by the public, except with the consent of WaterNSW. This area is accessed by WCL personnel and contractors for monitoring activities. The Metropolitan Special Area is also accessed by WaterNSW personnel. Mount Ousley Road is a public road that passes through the Metropolitan Special Area.

Known natural surface features in the EP Area that have the potential to affect public safety include steep slopes and these are managed within the LMP. Hazards associated with the following built surface features are possible, however are expected to be minor and manageable with the appropriate risk control measures (refer to section 4 of the BFMP):

- Mount Ousley Road (now M1 Princes Motorway)
- Picton Road Interchange
- high voltage electricity transmission lines east of Mount Ousley Road
- mine infrastructure (exploration boreholes, electricity lines, and ventilation shafts)
- other roads (dirt roads and fire trails).

Locations of these surface features are shown in Figure 2.

Mount Ousley Road (now M1 Princes Motorway) runs in a north-easterly direction over the previous mining leases. The interchange with Picton Road is located at the southern boundary and includes a concrete bridge and several drainage culverts. These assets are administered by Transport for NSW and are addressed within the Built Features Management Plan (BFMP) a sub plan to the main EP.

Located to the east of Mount Ousley Road is a 330 kV transmission line owned by TransGrid, a 132 kV transmission line and two single pole 33 kV transmission lines owned by Endeavour Energy.

A telecommunications installation is located adjacent the Illawarra Escarpment at Brokers Nose, approximately 600 m from the nearest proposed second workings.

Management of the built features assets as outlined above is outlined in the BFMP.

There are no known public amenities, agricultural lands, industrial/commercial establishments, or residential properties within the EP Area. The EP Area is not in a Subsidence Advisory NSW Mine Subsidence District.



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4 PREDICTED SUBSIDENCE IMPACTS

SCT have completed the Russell Vale Colliery: Subsidence Assessment for PC07-08 and PC21-25 Extraction Plan (2021). The Subsidence Assessment determined that the mine design is not considered to have any potential to perceptibly impact on public safety.

Planned mining is not expected to cause perceptible subsidence effects or impacts to the powerlines, so no additional risk to public safety is expected. However, monitoring of the powerlines during the period of active mining is considered an appropriate risk control measure for this infrastructure and is presented within the Built Features Management Plan (BFMP).

Any potential impacts to Mount Ousley Road and the associated risk to public safety will also be managed within the BFMP which has been developed in consultation with Transport for NSW. The BFMP also presents proposed monitoring for any potential impacts from previous longwall mining in the Wongawilli Seam.

Any potential impacts to steep slopes and the associated risk to public safety are managed within the Land Management Plan (RVC EC PLN 035). It is noted, however that the mine design is not considered to have any potential to perceptibly impact on natural surface features including steep slopes, however it should be recognised that there is always potential for rock falls to occur naturally as part of the ongoing erosion process. Proposed mining is not expected to increase this potential.

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5 PERFORMANCE MEASURES AND CRITERIA

5.1 Performance Measures

Performance measures for the management of public safety are set out in Table 6 of Condition C7 of the Development Consent and are reproduced here in **Table 4**.

Table 4 Subsidence Impact Performance Measures

Feature	Performance Measures	Performance Indicator	Monitoring
Public Safety			
Public Safety	Negligible additional risk	Change in safety risk	Global Navigation Satellite System (GNSS) Visual inspection Monitoring related to Mt Ousley Road and Transmission Lines

Public safety management will be undertaken in accordance with the process described in **Figure 3**.

To ensure that mining does not result in any additional risks to public safety, WCL has adopted the following performance objectives:

- no impacts affecting the trafficability of fire trails and access tracks
- management of risks associated with steep slopes
- no impacts on public roads that would affect the safety of motorists.

5.2 Adaptive Management

Where investigations triggered by the Performance Measure TARPS indicate that the changed conditions of sites have been, or are likely to have been, caused by mining operations, the response to these impacts include adaptive management measures to ensure further impacts to the site will not occur or be mitigated or that impacts to future sites do not occur in the future. Due to the nature of the proposed mining and low likelihood of underground mining resulting in any impacts to the site provided subsidence impacts remain within predictions, these adaptive management measures that will be implemented, will be considered in the investigation process. Adaptive management measures to be implemented in the event of a clear linkage between the mining authorised under the development consent and Public Safety Management items will include a review of the design and layout of future mining within areas that may potentially impact on such items to avoid a recurrence of any such impacts. These adaptive management measures include:

- stop mining and investigate causes of the exceeding of subsidence predictions.
- undertake a review of the panel design parameters in consultation with the resource regulator.

The Contingency Planning process set out in **Section 7.3** also covers this process.



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The purpose of this adaptive management measures are to implement additional measures where necessary to:

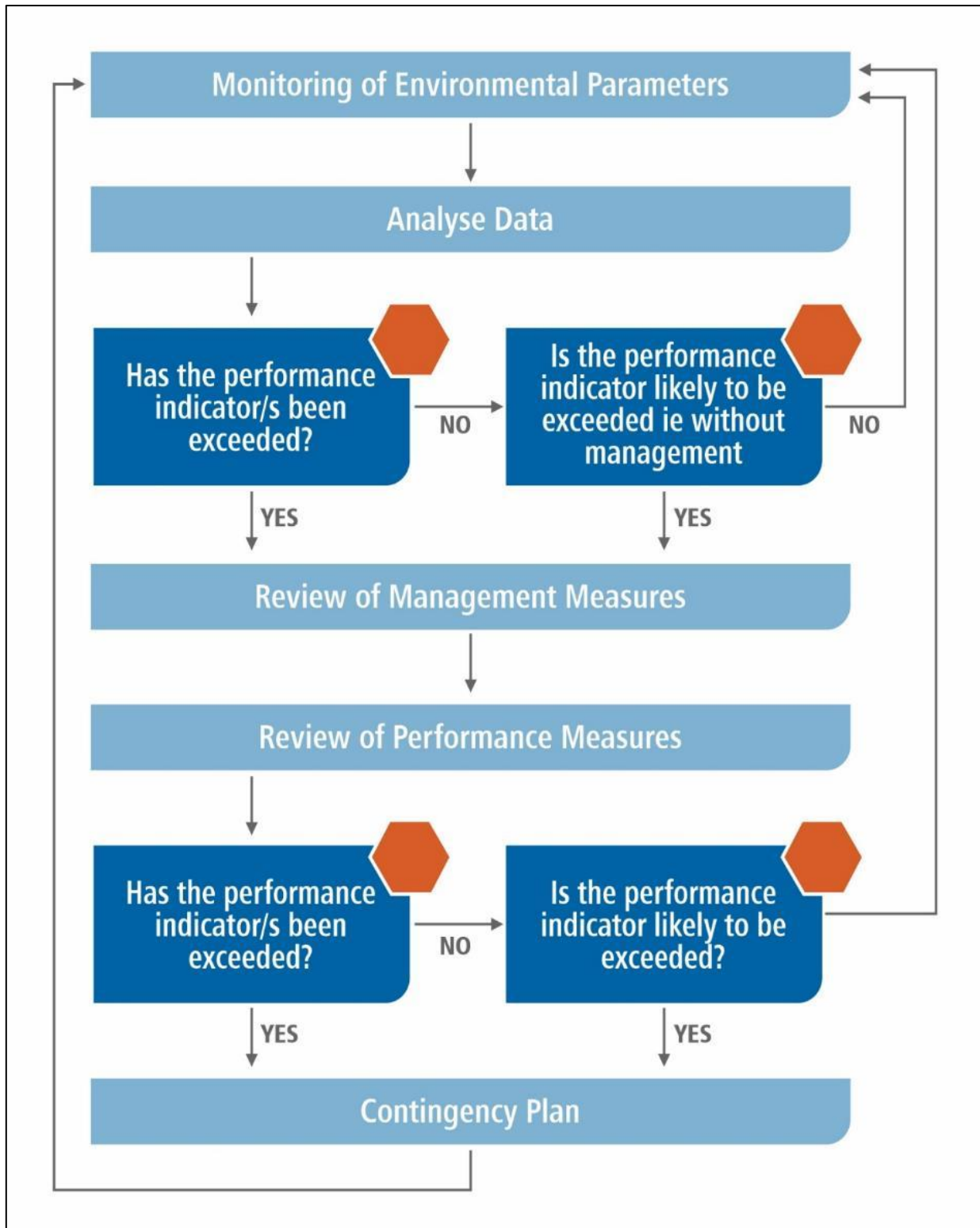
- enable potential impacts associated with higher than predicted subsidence impacts to be monitored; and/or
- the implementation of changes in mining operations to prevent performance criteria from being exceeded.

WCL will assess and manage development-related risks to ensure that there are no exceedances of the criteria and/or performance measures in this consent in accordance with Development Consent condition **F4**. Any exceedance of the Subsidence criteria and/or performance measures constitutes a breach of this consent and may be subject to penalty or offence provisions under the EP&A Act or EP&A Regulation, notwithstanding offsetting actions taken. Where any exceedance of these criteria and/or performance measures has occurred, WCL will at the earliest opportunity:

- take all reasonable and feasible steps to ensure the exceedance ceases and does not re-occur;
- consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action;
- within 14 days of the exceedance occurring, submit a report to the Secretary describing these remediation options and any preferred remediation measures or other course of action; and
- implement remediation measures as directed by the Planning Secretary,

to the satisfaction of the Secretary.

Figure 3 Adaptive Management Process



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6 MONITORING AND REPORTING

6.1 Monitoring

The monitoring activities that will be undertaken to identify and manage risks to public safety are outlined in this section.

6.1.1 Transport for NSW Infrastructure

Monitoring of Mount Ousley Road and other road infrastructure will be undertaken as described in the BFMP. This includes monitoring of the road pavement and other associated infrastructure, including bridges, culverts, cuttings and embankments.

6.1.2 Electrical Transmission Lines

Monitoring of electrical transmission lines and associated towers will be undertaken as described in detail in the BFMP. This includes the monitoring of the 330 kV transmission lines owned by TransGrid and the 132 kV and 33 kV owned by Endeavour Energy.

6.1.3 Unsealed Access Roads and Fire Trails

The unsealed access roads and trails within the EP Area are not likely to experience cracking due to the proposed mining. The monitoring regime for these unsealed roads is outlined in the Public Safety Trigger Response Action Plan (TARP) (attached as **Appendix A**). Visual inspections of the identified unsealed roads will be undertaken fortnightly during the second workings extraction and monthly for a period of six months after mining. If cracks larger than 10 mm are identified, WCL will notify DPIE, WaterNSW, and any other relevant agencies and prepare a remediation plan within one week.

Where cracking as a result of mining is observed on fire trails, WCL will be responsible for necessary repairs to ensure that fire trails are safe.

6.2 Reporting

The reporting framework set out in Section 7 of the EP will apply to the implementation of this PSMP. This reporting framework includes:

- incident reporting
- six monthly reporting
- impact reporting (in the event of an observed impact associated with the development covered by the EP)
- Annual Review reporting requirements.

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7 MITIGATION AND MANAGEMENT STRATEGIES

7.1 General

The portion of the EP Area to the east of Mount Ousley Road consists predominantly of WaterNSW managed land, with small areas of private land. Access to this land is restricted. Due to the restricted access to the land within the EP Area, subsidence is not predicted to pose a significant risk to the general public. Nevertheless, WCL will implement several management measures to prevent, mitigate and promptly remediate hazards within the EP Area.

The portion of the EP Area to the west of Mount Ousley Road is within the Metropolitan Special Area. The general public is not permitted to enter the Metropolitan Special Area (unless authorised by the WaterNSW). Signage installed at the entries to the WaterNSW Special Areas clearly stipulate that public access is restricted.

All WCL staff and contractors will be required to hold current WCL and WaterNSW inductions and are trained in personal safety requirements before accessing these lands. WCL personnel and contractors are required to wear the appropriate personal protective equipment (PPE) when working within the restricted area. The necessary PPE includes hard hat, protective boots, gloves, safety glasses, long-sleeved shirt and trousers.

WCL abide by the Special Area Consent F2020/3092 including those detailed in the WNSW WCL Access Agreements, as well as Part 5 of the Environmental Planning and Assessment (EP&A) Act at all times while working in and accessing the Metropolitan Special Area.

Such conditions include:

- abiding by speed restrictions (40 km/h)
- driving only on designated access tracks
- locking all gates after entering and leaving the area (to prevent public access)
- abiding by access restrictions (e.g. wet weather, total fire ban etc.)
- provision of appropriate documentation to WaterNSW prior to the commencement of works (including obtaining all relevant approvals and inductions)
- provision of emergency contact numbers.

WCL personnel and contractors will access these restricted areas to conduct monitoring activities. These areas may also be accessed by WaterNSW staff and other persons with permission from WaterNSW (e.g. asset owners such as TransGrid and Endeavour Energy). Therefore, such persons may be exposed to subsidence related risks in the unlikely event that the activities covered by the EP cause subsidence impacts which may affect public safety.

7.2 Trigger Action Response Plan (TARP)

In accordance with Condition C10(g)(viii) of the Development Consent, the Extraction Plan and associated sub plans will identify TARPs to be implemented to manage potential impacts associated with underground mining.

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These TARPs include the following:

- monitoring requirements (may include different locations);
- trigger levels that indicate a potential non-compliance or flag implementation of contingency measures;
- management and contingency actions (i.e. corrective and preventative actions) and reporting requirements;
- responsibilities; and
- timing.

These TARPs detail how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements. They also form the framework for and contingency actions.

The Trigger Action Response Plan (TARP), as presented in **Appendix A**, has been designed specifically for this PSMP to illustrate how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for adaptive management and contingency actions.

The TARP system provides a simple, transparent and useable record of the monitoring of environmental performance and the implementation of management and/or contingency measures. Due to the nature of predicted impacts associated with the proposed second workings, Performance Measure TARPs have been established.

If monitoring indicates a Level 2 or 3 trigger has been reached, an investigation will occur in all circumstances. The nature of the investigation will depend on the feature being monitored, the location of the trigger exceedance and Trigger level exceeded among other matters. Different investigation options are discussed in detail in the management plans specific to the feature being monitored.

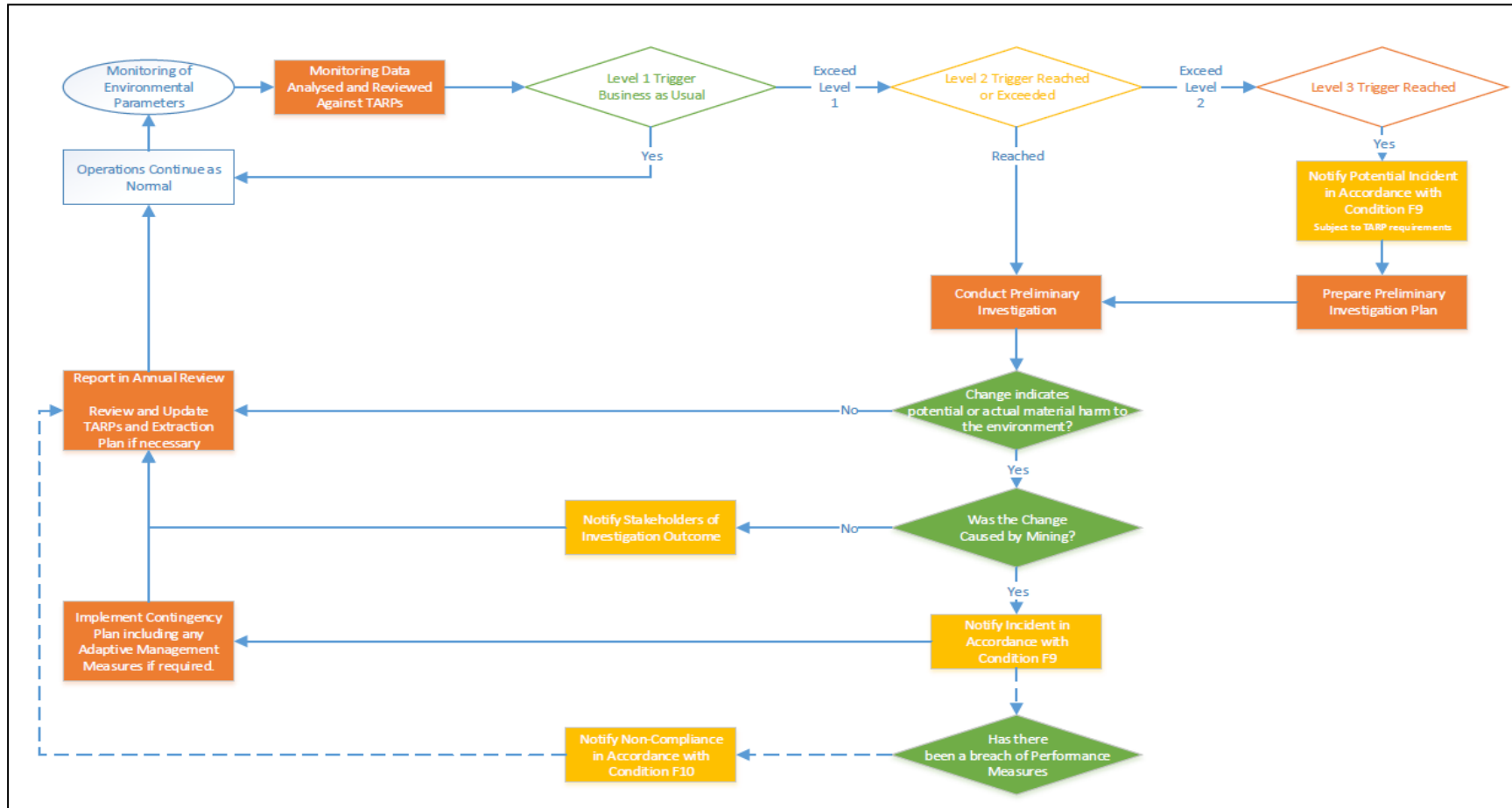
Note: Level 3 Performance Measure TARP triggers do not, of themselves, constitute an incident or non-compliance under the Development Consent. Investigations following a Level 3 trigger will determine whether an exceedance or non-compliance of the performance measures or Development Consent conditions is likely or has occurred.

In the unlikely event that investigations of Level 3 Performance Measure TARP trigger exceedances determine that material harm has occurred *and* is attributable to the development approved under the Development Consent, the contingency plan and adaptive management measures outlined within **Section 5.2** will be implemented. In certain cases, management measures may be implemented in the absence of any clear link between the approved development and the observed impact to mitigate adverse environmental outcomes. Response to matters which are identified as Incidents or Non-Compliances will be implemented in consultation.

Figure 4 below provides a flow chart covering the TARP Process.

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Figure 4 TARP Process



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7.3 Contingency Plan

In the event that the observed parameters or impacts exceed or are considered likely to exceed the performance measures detailed in the BFMP and in Section 5 of this PSMP, WCL will implement the following contingency plan:

- All reasonable measures will be taken to reduce any impact to public safety in a timely manner.
- The observation will be reported to the Group Environmental Manager as soon as possible.
- The observation will be recorded.
- An investigation will be undertaken to identify the cause of the observed impacts (noting that the proposed Development is not anticipated to have any more than negligible impacts on public safety values).
- WCL will report any exceedances of the performance measure DPIE and other relevant stakeholders as soon as practicable after WCL becomes aware of the exceedances.
- WCL will assess the exceedances referred to in the TARP (outlined in Section 7.2) and where appropriate, implement safety measures in accordance with the appropriate Management Plans.
- The Group Environmental Manager will investigate any potential contributing factors and identify an appropriate action plan to manage the identified impacts, in consultation with specialists and/or relevant agencies if necessary.
- WCL will identify an appropriate action plan to manage the identified impacts, in consultation with other specialists and/or key stakeholders.
- WCL will submit the proposed course of action to DPIE for approval.
- WCL will implement the approved course of action to the satisfaction of DPIE.
- WCL will continue to monitor performance with the new action plan in place and, if successful will formalise these actions as part of this Plan.

Contingency measures will be developed in consideration of the specific circumstances of the issue and the assessment of consequences.

The following outlines general contingency measures that may be implemented in the event of subsidence related impacts that may impact on public safety.

7.3.1 WaterNSW Special Areas

If significant surface cracks are identified along access roads and fire trails, remediation will be undertaken in consultation with WaterNSW and would be undertaken in accordance with Schedule 5 of WCL Special Areas Consent F2020/3092. Surface cracks will generally be remediated by in-filling. The WaterNSW road and fire trail rules are outlined in Schedule 7, along with Schedule 4, which specifies which roads and fire trails WCL can access within the Metropolitan Special Area. Surface cracking of access roads and fire trails is not expected.

Those identified fire trails and access roads include:

- Brokers Nose Fire Trail
- Fire Trail 7d.

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7.3.2 Built Features

Public roads and electricity transmission lines are not expected to be significantly impacted by the proposed second workings mining. If WCL or the asset owner considers that the integrity of the asset and/or public safety has been compromised as a result of subsidence, remediation works and/or contingency measures will be implemented in accordance with the relevant management plan or as otherwise agreed with the asset owner.

Risks to public safety as a result of impacts on road infrastructure or impacts on transmission lines will be managed in accordance with the BFMP.

7.3.3 Steep Slopes

The steep slopes that may be impacted by subsidence are located within the Metropolitan Special Area and are therefore not accessible to the public. To ensure the safety of personnel that have authority to access the area, the following safety measures will be implemented:

- Signs shall be prominently displayed at any area that has been identified as potentially being susceptible to failure. Signposts will warn specifically of the danger. Signposts that are to be installed on private or public property will be installed in agreement with the relevant authority.
- The location of all signs, fences, and other remedial or warning provisions established will be marked on a Plan. This Plan will be maintained as a record of any remedial measures instituted during mining.
- Any potentially unstable rock structures will be assessed and secured (if safe and practicable to do so). Methods used to secure unstable rock structures will be determined on a case-by-case basis and may include rock bolting or grouting of rock fractures. If required, measures to stabilise rock formations will be developed in consultation with the relevant regulatory agencies.

7.4 Potential Incident Notifications

Level 3 TARP are set at a level that may indicate more than trivial environmental harm. Where monitoring indicates a Level 3 TARP trigger has been exceeded but the cause of the trigger being exceeded is unclear, DPIE (and other relevant stakeholders) will be notified of a *potential* Incident. The notification will include the same matters required to be included in an incident notification as required by Condition F9 of the Development Consent, including the development (including the development application number and name) and set out the location and nature of the potential incident.

Unless the cause of the exceedance is clearly identifiable at the time the exceedance, the first step will be to investigate the likely cause or causes of the exceedance. A preliminary investigation plan will be developed to guide this investigation process and a copy provided to DPIE and other relevant stakeholders. This is discussed further in **Section 8**.

The investigation process will also consider any remedial action that may be required.

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8 INCIDENTS, COMPLAINTS AND NON-COMPLIANCES

8.1 Incidents

According to the Development Consent:

- An 'incident' is defined as "an occurrence or a set of circumstances that causes or threatens to cause material harm and which may or not be or cause a non-compliance". Examples may include a breach of specific development consent criteria or performance measure.
- An 'exceedance' or 'non-compliance' is defined as "an occurrence, set of circumstances or development that is a breach of this consent".

In both circumstances, an Incident or Non-Compliance must be attributable to the development approved under the development consent.

Material harm is defined in the Development Consent as:

"harm to the environment that:

- *involves actual or potential harm to the health or safety of human beings or to the environment that is not trivial, or*
- *results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding \$10,000 (such loss includes the reasonable costs and expenses that would be incurred in taking all reasonable costs and expenses that would be incurred in taking all reasonable and practical measures to prevent, mitigate or make good harm to the environmental)."*

This definition excludes "harm" that is authorised under either this consent or any other consent.

The proposed 'second workings' which trigger the requirement for this EP are long term stable bord and pillar workings which are predicted to have only negligible subsidence effects. Incidents and associated reporting requirements will be managed through established procedures set out in Section 7.2 of the EP. The relevant authority will be notified of an incident with public safety implications immediately upon detection of the incident. In the event of a public safety incident related to road infrastructure, the incident will be reported to Transport for NSW. Public safety incidents involving electrical transmission lines would be reported to TransGrid or Endeavour Energy. Notification requirements for these built features can be found in the BFMP. Public safety incidents involving natural features and unsealed access roads and fire trails will be reported to the Department of Agriculture, Water and Environment (DAWE), as per the EPBC approval, as well as WaterNSW and DPIE.

8.2 Complaints Handling

Complaints will be managed through established WCL procedures developed in accordance with Condition F5(h) of the Development Consent by where a copy of a complaints register (updated on a monthly basis) will be kept on the WCL website. A summary of complaints will be available to regulatory authorities, community consultative committee (CCC), and interested persons upon request and provided in the Annual Reviews.

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9 PLAN ADMINISTRATION

9.1 Roles and Responsibilities

Environment and community management is regarded as part of the responsibilities of all Colliery personnel. The roles and function of the main personnel responsible for the implementation of environmental and community management including the plans, procedures and action plans contained in this LMP are outlined in WCL's Management Operating System.

9.2 Resources Required

In accordance with the WCL SYS POL 003 Environmental Policy, Management shall ensure that the appropriate resources are made available to achieve the implementation of this PSMP.

It is the role of the Group Environment Manager to ensure that these requirements are communicated to WCL Management.

9.3 Training

Staff training will consist of three levels of applicable to different types of staff:

- Level 1 – High level training on environmental legislative requirements (management staff)
- Level 2 – Operational level training (project managers, supervisors, surface personnel, control room operators)
- Level 3 – Basic awareness of environmental management (underground staff, all personnel).

Targeted environmental awareness training relative to the risks associated with their works (e.g. air quality, noise, traffic, waste management) will be provided to individuals or groups of workers with a specific authority or responsibility for operational environmental management, or those undertaking an activity with a high risk of potential environmental impacts. Training will be provided as deemed necessary to contractors to provide them with the knowledge, skills and awareness to minimise environmental impacts and conditions of consent relevant to their activities in accordance with Condition A28 of the Development Consent. At a minimum this will include:

- contractors whose activities are not directly supervised by Colliery personnel
- contractors whose activities are ongoing and have the potential to result in an environmental incident (e.g. truck drivers, stockpile contractors).

The Environment Manager/Site Environment Representative and Mine Training Manager will review the training program and monitor its implementation.

9.4 Inductions

All personnel, including contractors, sub-contractors and staff, are required to attend a compulsory site induction that includes an environmental component prior to commencement on site. The Environment Manager or delegate, will conduct the environmental component of the site induction.



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The environmental component will include an overview of:

- relevant details of this Management Plan, including purpose and objectives
- key environmental issues
- conditions of environmental licences, permits and approvals
- mitigation measures for environmental issues
- incident response and reporting requirements.

A record of all environmental training and inductions will be maintained and kept on site. The Environmental Manager may authorise amendments to the induction where required to address project modifications, legislative changes or amendments to this Management Plan or related documentation.

The Environment Manager/Site Environment Representative will review and endorse the induction program and monitor its implementation.

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10 AUDIT AND REVIEW

10.1 Annual Review

In accordance with Condition F11 of the Development Consent, an Annual Review of the environmental performance of the project is prepared.

The Annual Review will:

- describe the development (including rehabilitation) that was carried out in the previous calendar year and the development that is proposed to be carried out over the current year
- include a comprehensive review of the monitoring results and complaints records of the development over the previous calendar year, including a comparison of these results against the:
 - relevant statutory requirements, limits or performance measures/criteria
 - requirements of any plan or program required under this consent
 - monitoring results of previous years
 - relevant predictions in the EA documents listed in the approval condition A2(c)
- identify any non-compliance or incidence which occurred in the previous calendar year, and describe what actions were (or are being) taken to ensure compliance and avoid recurrence
- evaluate and report on compliance with the performance measures, criteria, and operating conditions of the development
- identify any trends in the monitoring data over the life of the development
- identify any discrepancies between the predicted and actual impacts of the development and analyse the potential cause of any significant discrepancies
- describe what measures will be implemented over the next calendar year to improve the environmental performance of the development.

10.2 Auditing

In accordance with Condition F13 of the Development Consent, an Independent Environmental Audit will be undertaken by a suitably qualified auditor and include experts in any field specified by the Secretary within 12 months of the approval and every three years after that.

This audit must:

- be prepared in accordance with the Independent Audit Post Approval Requirements (DPIE 2020 or as updated)
- be led and conducted by a suitably qualified, experienced and independent auditor whose appointment has been endorsed by the Planning Secretary
- be conducted by a suitably qualified, experienced and independent team of experts (including any expert in field/s specified by the Planning Secretary) whose appointment has been endorsed by the Planning Secretary
- include consultation with the relevant agencies and the CCC

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- assess the environmental performance of the development and whether it is complying with the relevant requirements in the approval water licences and mining leases for the development (including any assessment, strategy, plan or program required under these approvals)
- review the adequacy of any approved strategy, plan or program required under the abovementioned approvals
- recommend appropriate measures or actions to improve the environmental performance of the development, and/or any assessment strategy, plan or program required under these approvals
- be conducted and reported to the satisfaction of the Planning Secretary.

In accordance with Condition F14 of the Development Consent WCL would submit a copy of the audit report, along with responses to any recommendations contained within the report to the Planning Secretary. The audit and response to recommendations would be submitted within three months of the completion of the audit unless otherwise agreed by the Planning Secretary.

10.3 Plan Revision

In accordance with Condition F7 of the Development Consent, this PSMP will be reviewed within three months of:

- the submission of an incident report as per Condition F9
- the submission of an annual review under Condition F11
- the submission of an Independent Environmental Audit under Condition F13
- any modification to the conditions of approval (unless the conditions require otherwise or as otherwise agreed with DPIE).

The revision status of this PSMP is indicated in the footer of each copy. Revisions to any documents listed within this PSMP will not necessarily constitute a revision of this document.

Where revisions are required, the document would be submitted to DPIE within six weeks of the review.



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11 REFERENCES

DPIE, 2020. Independent Audit Post Approval Requirements, <https://www.planning.nsw.gov.au/-/media/Files/DPE/Other/Assess-and-regulate/About-Compliance/independent-audit-post-approval-requirements-2020-05-19.pdf>

The Independent Planning Commission of NSW Development Consent Russell Vale Revised Preferred Underground Expansion Project MP09_0013.

SCT Operations (2014), *Update of Subsidence Assessment for Wollongong Coal Preferred Project Report Russell Vale No. 1 Colliery*.

SCT, 2019. Russell Vale Colliery: Subsidence Assessment for Proposed Workings in Wongawilli Seam at Russell Vale East. SCT report number: UMW4609.

SCT Operations, 2021. Russell Vale Colliery: Subsidence Assessment for PC07-08 and PC21-25 Extraction Plan.

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12 GLOSSARY OF TERMS AND ABBREVIATIONS

Abbreviations	
CCC	Community consultative committee
DPIE	Department of Planning, Industry and Environment
EP	Extraction Plan
LGA	Local Government Area
MSB	Mine Subsidence Board
IPC	Independent Planning Commission
PSMP	Public Safety Management Plan
RMS	Roads and Maritime Services (formerly the Roads and Traffic Authority)
ROM	Run of Mine
RPPR	Revised Preferred Project Report
RR	Resource Regulator
TARP	Trigger Action Response Plan
UEP	Underground Expansion Project
WNSW	Water NSW
WCL	Wollongong Coal Limited

Terms	
Baseline data	Monitoring conducted over time to collect a body of information to define specific characteristics of an area (e.g. species occurrence or noise levels) prior to commencement of a specific activity.
Bord and pillar	Mining method comprising of a series of self-supporting roadways (or bords) within the coal seam leaving a grid of pillars of unmined coal which are designed to be stable in the long term.
Built Features	Included any building or work erected or constructed on land, and included swellings and infrastructure such as any formed road, street, path walk, or driveway; any pipeline, water, sewer, telephone, gas or other service main.
Development Consent (the approval)	Russell Vale Revised Underground Expansion Project MP09-0013
Driveage	A horizontal or inclined heading or roadway in the process of construction. The roadway will be used to access a new mining area within the lease.
Dyke	A sheet like vertical intrusion of igneous rock cutting across the strata of older rocks.
Ecosystem	An interacting system of animals, plants, other organisms and non-living parts of the environment.
Fault	Major fracture of the earth's crust caused by the relative movement of the rock masses on either side.
First Workings	Involves the development headings or roadways which will provide access to the coal resource. They are developed using continuous miners with integrated roof and rib bolting rigs. First workings leave the coal pillars intact and the overlying strata fully supported

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Terms	
Goaf (or goafing)	The space left following extraction of the coal seam where the roof material is allowed to collapse.
Habitat	The particular local environment occupied by an organism.
Incident	An occurrence or set of circumstances that cause or threaten to cause material harm and which may or may not be or cause a non-compliance
Infrastructure	The supporting installations and services that supply the needs of the Project.
Land	Has the same meaning as the definition of the term in section 1.4 the EP&A Act, except for where the term is used in the noise and air quality conditions in PART B of this consent where it is defined to mean a whole of a lot, or contiguous lots owned by the same landowner, in a current plan registered at the Land Titles Office at the date of the development consent.
Longwall	A secondary extraction method of mining coal that continuously removes the coal from the working face onto a series of conveyors that transfer the coal to the surface. As the coal is cut away (a 'shear'), both the longwall machine (known as a 'shearer') and the hydraulic roof supports advance forward ready for the next shear.
Material Harm	Is harm to the environment that: <ul style="list-style-type: none"> Involves actual or potential harm to the health or safety of human beings or to the environment that is not trivial, or Results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding \$10,000 (such loss includes the reasonable cost and expenses that would be incurred in taking all reasonable and practicable measures to prevent, mitigate or make good harm to the environment)
Mine Operations	The carrying out of mining, including the extraction, processing, stockpiling and transportation of coal on the site and the associated removal, storage and/or emplacement of vegetation, topsoil, overburden and reject material.
Non-compliance	An occurrence, set of circumstances or development that is a breach of the development consent.
Pillar Extraction	A continuous miner system of mining whereby coal pillars are systematically extracted.
Pillar Run	A large scale progressive collapse of coal pillars in a short period of time.
Privately-owned Land	Land that is not owned by a public agency or a mining, petroleum or extractive industry company (or its subsidiary or related party).
Project Approval	Russell Vale Revised Underground Expansion Project MP09-0013
Public infrastructure	Linear and related infrastructure and the like that provides services to the general public, such as roads, railways, water supply, drainage, sewage, gas supply, electricity, telephone, telecommunications etc.
Rehabilitation	The restoration of a landscape and especially the vegetation following its disturbance.
Second Workings	Extraction of coal from bord and pillar workings
Strain	The change in the horizontal distance between two points divided by the original horizontal distance between the points.
Subsidence	The totality of subsidence effects, subsidence impacts and environmental consequences of subsidence impacts
Subsidence effects	Deformation of the ground mass due to mining, including all mining-induced ground movements, such a vertical and horizontal displacement, tilt, strain and curvature.
Subsidence impacts	Physical changes to the ground and its surface caused by subsidence effects, including tensile and shear cracking of the rock mass, localised buckling of strata caused by valley closure and upsidence and surface depressions or troughs.



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Terms	
Tilt	The difference in subsidence between two points divided by the horizontal distance between the points.
Upsidence	Relative upward movement, or uplift, created by the horizontal compression and buckling behaviour of the rock strata in the vicinity of a valley floor
Valley closure	A phenomenon whereby one or both sides of a valley move horizontally towards the valley centreline, due to changed stress conditions beneath the valley and its confining land masses

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APPENDIX A – TRIGGER ACTION RESPONSE PLAN

Aspect	Monitoring				Trigger			
	Location	Parameters	Frequency/timing	Purpose	Level	Action/Reporting	Report Timing	Responsibility
Public Safety Features	All public safety features present within the PRP Application Area as outlined within the PSMP.	Visual Monitoring of EP Area	Monitoring of key landscape features prior to, during and post mining for any potential impacts will be undertaken to confirm that the mine design measures to prevent such impact are adequate and in accordance with the Development Consent.	To determine if subsidence effects resulting from bord and pillar mining system result in impacts to public safety.	Within prediction (Level 1): No change in condition of features observed.	Continue monitoring. Report negligible impact in six monthly reports.	Six monthly reporting in accordance with Extraction Plan approval.	Russell Vale Colliery (Environmental Manager)
					Within prediction (Level 2): Change in features condition is predicted to occur. No change to the condition of features is observed.	Continue monitoring. Inform DPIE and WaterNSW of potential impact. Undertake site inspection to document and photograph any observed changes/ impacts. Report potential impacts in six monthly reports.	DPIE and WaterNSW informed within one week. Six monthly reporting in accordance with Extraction Plan approval.	Russell Vale Colliery (Environmental Manager)

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Aspect	Monitoring				Trigger			
	Location	Parameters	Frequency/timing	Purpose	Level	Action/Reporting	Report Timing	Responsibility
					Exceeding prediction (Level 3): Change in features condition is observed, and impact greater than predicted occurs.	Make area safe as soon as practicable. Continue monitoring. Inform DPIE and WaterNSW of potential impact. Undertake site inspection to document and photograph any observed changes/impacts. Discussion of potential remediation/mitigation. Consultation with relevant stakeholders will be required if remediation or mitigation measures are required. Use appropriate specialists to undertake physical remediation activities. Report potential impacts in six monthly reports.	DPIE and WaterNSW and informed within one week. Commence preparation of mitigation/action and monitoring plan within one week (if required). Six monthly reporting in accordance with Extraction Plan approval.	Russell Vale Colliery (Environmental Manager)



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APPENDIX B – CONSULTATION

Trescinda Brown

From: Richard Sheehan <richard.sheehan@wcl.net.au>
Sent: Tuesday, 10 August 2021 2:21 PM
To: Trescinda Brown
Cc: Luke Bettridge
Subject: FW: Submission of RVC Extraction Plan_Land Management Plan and Public Safety Plan for WNSW review
Attachments: fig2_21174_003_30K_Natural_Features_rev1.pdf; RVC EC PLN 009_Public Safety Management Plan _Rev 3_Draft.docx; 21174_Russell Vale UEP Land Management Plan_V2_Draft.docx

From: Richard Sheehan <richard.sheehan@wcl.net.au>
Sent: Tuesday, 3 August 2021 9:21 PM
To: 'Jessie Evans' <Jessie.Evans@waternsw.com.au>
Cc: 'Ravi Sundaram' <ravi.sundaram@waternsw.com.au>; 'Devendra Vyas' <DVyas2@wcl.net.au>
Subject: RE: Submission of RVC Extraction Plan_Land Management Plan and Public Safety Plan for WNSW review

Good evening Jessie and Ravi,

Further to our correspondence as attached please see for your information and review the WCL Extraction Plan Land Management Plan and Public Safety Plan in draft form.

To support the review of the Land Management Plan please also see the Figure 4 showing the identified natural features.

If you have any questions or comments on the attached please contact me at your convenience.

Regards

Richard Sheehan
Group Environmental & Approvals Manager



Wollongong Coal Limited
Russell Vale Colliery
7 Princes Highway, Corrimal NSW 2518
PO Box 281, Fairy Meadow NSW 2519
☎ Mob: 0404 972 746
✉ Email: Richard.sheehan@wcl.net.au

From: Richard Sheehan <richard.sheehan@wcl.net.au>
Sent: Thursday, 17 June 2021 10:28 PM
To: 'Jessie Evans' <Jessie.Evans@waternsw.com.au>
Cc: 'Ravi Sundaram' <ravi.sundaram@waternsw.com.au>
Subject: RE: Management plans

Thanks Jessie

Apologies as we had suggested we might have been able to meet to discuss last Friday as there are overlapping requirements with regard to the Land Management Plan, Public Safety Plan, and the Built Features Plan if we consider the high water line of the dam as that defining line for the asset being the dam catchment. I will take the points raised and get back to you on the specifics of a response including which document will address this requirement.

In addition we have consult with WNSW for comment via the DPIE portal, specifically reference PAE-20016268 and (MP09_0013-PA-19) being the UEP Extraction Plan Water Management Plan.

We are looking to complete the consultation phase of this management plan in the coming days so we can move towards finalisation and submission to DPIE next week in association with the Draft Extraction Plan. As such it would be greatly appreciated if you were able to provide comment early in the new week.

Regards

Richard Sheehan
Group Environmental & Approvals Manager



Wollongong Coal Limited
Russell Vale Colliery
7 Princes Highway, Corrimal NSW 2518
PO Box 281, Fairy Meadow NSW 2519
☎ Mob: 0404 972 746
✉ Email: Richard.sheehan@wcl.net.au

From: Jessie Evans <Jessie.Evans@waternsw.com.au>
Sent: Monday, 7 June 2021 9:53 AM
To: Richard Sheehan <richard.sheehan@wcl.net.au>
Cc: Ravi Sundaram <ravi.sundaram@waternsw.com.au>
Subject: Management plans

Hi Richard,

At the TWG we discussed getting together to work out what it include in the management plans Wollongong Coal is required to prepare. Having reviewed the conditions, I don't think we necessarily need to meet but Kel and I have put together some points for you to consider below. I strongly recommend having a look at Metropolitan Coal's management plans (available on their website) as they have similar requirements.

Management plans should look at the following, in particular,

- Roads - damage to roads from mining subsidence and overuse is a water quality and management issue. Long term use of roads and tracks and who pays for ongoing maintenance including cleaning out culverts and drains and repairs after heavy rain. What tracks are WCL going to manage?
- Infrastructure – Any WNSW assets needs to have a dilapidation survey to note current condition and recognise any damage from mining.
- Swamps – Access to piezometers in the middle of swamps needs to be minimised so that broad access ways are not made, minimal disturbance.
- Gates and fences need to be maintained in their current condition, no additional locks to maintain security.

I hope that helps.

Thanks

Jessie Evans

Mining Manager, Catchment Protection

For noting: *I am currently working remotely.
Please reach me via email or on my mobile*



Level 14, 169 Macquarie Street

PO Box 398

Parramatta NSW 2150

M: 0436 861 165

jessie.evans@waternsw.com.au

www.waternsw.com.au

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Consent: F2020/3092

Wollongong Coal Limited
PO Box 281
FAIRY MEADOW NSW 2519

ACN: 111 244 896

Attention: Mr Richard Sheehan, Group Environmental & Approvals Manager

Email: richard.sheehan@wcl.net.au

Special Area Consent – Issued under Division 1 of Part 3 of the Water NSW Regulation 2020

CONSENT SUMMARY

Consent No:

F2020/3092

Name of Consent Holder:

Wollongong Coal Limited

Address of Consent Holder:

7 Princes Highway, CORRIMAL NSW 2518

Commencement date:

4 March 2021

Expiry date:

3 March 2026

Hours of Operation

24 hours per day, 7 days per week unless otherwise specified in EP&A Act approval to a specific Permitted Activity

Contacts

Water NSW Incident Notification Number:

Ph: 1800 061 069

Operational issues:

Water NSW Catchment Assets Manager

Ph: 02 4886 9416

Material changes to Statutory Approvals:

Water NSW Mining Manager

Ph: 0436 861 165

Standard Conditions

1 Grant of Consent

1.1 Consent

- 1.1.1 In accordance with the provisions of Division 1 of Part 3 of the Water NSW Regulation 2020, Water NSW grants to the Consent Holder, Consent to enter upon and to pass and repass through the Special Area to enter and remain on the Designated Area for the purpose of undertaking the Permitted Activity in accordance with the conditions of this Consent.
- 1.1.2 The Consent Holder does not commit an offence under Part 3 of the Water NSW Regulation 2020 by reason of anything done in accordance with a Statutory Approval.
- 1.1.3 The Consent Holder must not undertake any activity in the Designated Area other than the Permitted Activity.
- 1.1.4 The employees, consultants and contractors of the Consent Holder who enter the Designated Area on behalf of the Consent Holder must comply with the Conditions on this Consent.
- 1.1.5 This Consent also extends to stakeholders of the Consent Holder as long as they are accompanied by an employee, consultant or contractor of the Consent Holder, on the condition that the Water NSW Catchment Assets Manager is informed 48 hours prior to entering the Designated Area, via the special_area_access@waternsw.com.au email address.

1.2 Term of Consent

The Consent is granted to the Consent Holder up until the Expiry Date or until such time as the Consent Holder ceases undertaking the Permitted Activity, whichever occurs first.

1.3 Responsibility for other persons

The Consent Holder must ensure that all persons carrying out the Permitted Activity in the Designated Areas are familiar with the terms of this Consent, including the requirement to comply with the conditions of this Consent.

1.4 Reservation of Rights by Water NSW

This Consent does not limit the statutory powers of Water NSW under the *Water NSW Act 2014* or the Water NSW Regulation 2020 or any other law.

1.5 No assignment

Subject to Condition 1.1.1, this Consent is personal to the Consent Holder and the Consent Holder may not assign, transfer, charge or otherwise deal with or dispose of its interest in this Consent.

2 Regulatory Conditions

2.1 Access to Information

The Consent Holder must notify the Water NSW Mining Manager, in writing, as soon as practical when there is a material change to any Statutory Approval.

2.2 Compliance with Statutory Requirements

The Consent Holder must comply with the Statutory Approvals in undertaking the Permitted Activity.

2.3 Consent Fee and Cost Recovery

2.3.1 The Consent Holder must pay to Water NSW the Consent Fee, if required, in the manner set out in Item 8 of the Reference Schedule (Schedule 1).

2.3.2 The Consent Holder must pay to Water NSW all reasonable costs incurred by Water NSW to engage suitably qualified and independent experts to review and advise for the purpose of determining:

- (a) the adequacy of any plans or monitoring programs reasonably required as a condition of this Consent; and
- (b) whether the Consent Holder has complied with the conditions of this Consent.

2.3.3 The Consent Holder must pay to Water NSW all rehabilitation and compliance costs incurred by Water NSW by reason of the breach of this Consent by the Consent Holder. Where possible Water NSW will consult with the Consent Holder in determining the value of these costs.

2.4 Goods and Services Tax

All sums payable under this Consent are exclusive of GST. Where those payments are consideration for a taxable supply, or adjustments to the consideration of a taxable supply, the amount payable will be increased by a sum equal to the amount of the payment multiplied by the then current rate of GST.

3 Operating Conditions

3.1 General

3.1.1 Subject to the terms of the Statutory Approvals, the Consent Holder is permitted to access the Designated Area during the Hours of Operation as set out in Item 6 of the Reference Schedule (Schedule 1).

3.1.2 Water NSW may restrict access to the Designated Area in accordance with the Water NSW Regulation 2020 at any time due to weather or fire conditions or any other operational and/or safety reason.

3.1.3 The Consent Holder must ensure all employees, contractors and consultants undertake any Designated Area inductions and training sessions reasonably required by Water NSW prior to their first entry onto the Designated Area and from time to time as required during the term of the Consent.

3.1.4 The on-site supervisor while conducting the Permitted Activity, must have in their possession a copy of this Consent, any environmental assessments, Statutory Approvals and associated Conditions of Approval, any related environmental management plan, rehabilitation plan, revegetation plan, soil and water management plan, water monitoring plan, the Safe Work Plan and a copy of all licences, permits and other approvals that are required in relation to the Consent Holder's activities in the Designated Area, available for reference purposes.

- 3.1.5 Waste as defined under the *Protection of the Environment Operations Act 1997* must not be brought into the Special Area.
- 3.1.6 Any imported fill material to be used in the Designated Area must be restricted to 'Virgin Excavated Natural Material' (VENM) that is not mixed with any other waste.
- 3.1.7 Prior to entry, all vehicles, machinery, and equipment to be used in the Special Area must be washed down, free of weeds, seeds, and soil.
- 3.1.8 Activities conducted under this Consent that are likely to cause a fire or create a fire hazard are not permitted without prior written approval from Water NSW.
- 3.1.9 All vehicles, machinery and equipment used by the Consent Holder in the Designated Area must be maintained in proper and efficient condition, be without risks to the health and safety of persons and must be operated in a safe, proper, and efficient manner.
- 3.1.10 Wet weather access must be in accordance with the approved *Special Area Wet Weather Management Plan* and *Special Area Wet Weather Trigger Action Response Plan* (Schedule 8).
- 3.1.11 The employees, consultants, and contractors of the Consent Holder:
 - a) may not access the Designated Area or any Water NSW water storages, rivers, lakes or other watercourses within the Designated Area by boat unless the Consent Holder obtains prior written approval from Water NSW and complies with the current version, as amended from time to time, of Water NSW's Safe Use of Watercraft Procedure, which is attached to this Consent; and
 - b) when working in or near water, as defined by Water NSW's Working in or Near Water Procedure which is attached to this Consent, must comply with Water NSW's Working in or Near Water Procedure.
- 3.1.12 Storage of fuels, oils or chemicals is not permitted in the Designated Area unless the Consent Holder obtains prior written approval from Water NSW or unless permitted by a Statutory Approval.
- 3.1.13 Appropriate and effective erosion and sediment controls must be designed, installed and maintained for areas disturbed as a result of the Permitted Activity, in accordance with *Landcom's Managing Urban Stormwater – Soils and Construction – Volume 1, 4th Edition 2004* (the 'Blue Book') until disturbed areas are stabilised.

3.2 Notification of Intent to Enter

- 3.2.1 Notification of the details of the employees, consultants and contractors of the Consent Holder involved in the Permitted Activity must be provided to Water NSW prior to their entry on the Designated Area.
- 3.2.2 The Consent Holder must notify Water NSW in relation to entry under this Consent at least two (2) business days prior to any inspection work and at least one (1) week prior to commencing works.
- 3.2.3 Notification must be through the special_area_access@waternsw.com.au email address. The notification must include the Consent reference number (**F2020/3092**), the specific location, dates of entry, description of work, vehicle types and registration numbers, and at least one contact telephone number of personnel conducting the works onsite.

3.3 Roads and Fire Trails

- 3.3.1 The Consent Holder must comply with the Water NSW's Road and Fire Trail Rules listed in Schedule 7.
- 3.3.2 The Consent Holder may utilise Water NSW roads and fire trails listed in Schedule 4.
- 3.3.3 The roads and fire trails that are the sole responsibility of the Consent Holder to maintain and repair are indicated in Schedule 4.
- 3.3.4 The Consent Holder must maintain and repair the roads and fire trails listed in Schedule 4 in accordance with the documents: *Managing Urban Stormwater – Soils and Construction – Volume 2C – Unsealed Roads* (Department of Environment & Climate Change NSW, 2008) and *NSW Rural Fire Service Fire Trail Design, Construction and Maintenance Manual* (Soil Conservation Service, 2017) (Schedule 5).

3.4 Security

- 3.4.1 When entering or exiting the Designated Area the Consent Holder must ensure that all site entry points including gates and barriers remain closed, locked or otherwise secured to prevent unauthorised entry to the Designated Area.
- 3.4.2 Any damaged gates or barriers must be temporarily secured by the Consent Holder and reported immediately to the Water NSW Incident Notification Number as shown in the Consent Summary.
- 3.4.3 The employees, contractors and consultants of the Consent Holder must:
 - (a) carry photographic identification which must always include the name and address of their employer when they are in the Designated Area; and
 - (b) produce the photographic identification if requested by an Authorised Officer of Water NSW.
- 3.4.4 Where short term or one-off access is required by contractors or consultants, they do not require photographic identification, provided they are accompanied by the Consent Holder who has photographic identification as required by 3.4.3(a).
- 3.4.5 Water NSW keys are issued to the Consent Holder for use by employees, contractors, and consultants of the Consent Holder. Water NSW keys are issued subject to the following conditions:
 - (a) Water NSW keys must only be used to access the Designated Area in accordance with the conditions of this Consent.
 - (b) keys are issued to the Consent Holder and must not be transferred.
 - (c) if the Consent Holder no longer requires access to the Designated Area to conduct the Permitted Activity or when this Consent expires, the Consent Holder must return all Water NSW issued keys to Water NSW.
 - (d) if a key is lost, the Consent Holder must notify Water NSW within 24 hours of becoming aware that the key has been lost. Notification must be made in writing to the Water NSW Catchment Assets Manager via the special_area_access@waternsw.com.au email address;

- (e) new keys will not be issued by Water NSW without a written request which provides detailed reasons why a new key is required. The Consent Holder will bear any costs incurred by Water NSW to issue new keys.
- (f) the Consent Holder agrees that all keys remain Water NSW property and undertakes to return keys from a key holder as soon as the valid need for access ceases; and
- (g) the Consent Holder agrees, if requested, to pay a bond of \$150.00 per key issued.

- 3.4.6 The Consent Holder must not place its own locks on gates in or to the Designated Area unless it obtains the prior written approval of Water NSW.
- 3.4.7 The Consent Holder must maintain a current list of all employees and contractors who have a Water NSW key in their possession and make that record available to Water NSW on request.
- 3.4.8 The Consent Holder must maintain a log of all persons entering the Designated Area under this Consent which includes details of the time of entry and exit on each day.

3.5 Waste Management

- 3.5.1 The Consent Holder must provide and maintain toilet facilities on the site where two or more persons are working in one location for a period of two days or more, and all site personnel must use and be instructed to use such facilities.
- 3.5.2 Where toilet facilities are not required by the Consent, human organic waste must be buried to a depth of no less than 150 millimetres and not within 100 metres of stored waters, creeks or drainage lines.

3.6 Work Health & Safety

- 3.6.1 All activities under this consent must be carried out in accordance with the duties under Work Health and Safety legislation.
- 3.6.2 Persons entering the Special Area must take reasonable care for his or her own health and safety and take reasonable care that his or her acts or omissions do not adversely affect the health and safety of other persons.
- 3.6.3 All activities under this consent must be carried out in accordance with an appropriate, relevant and specific Safe Work Plan (SWP), which has been approved or endorsed by the Consent Holder.
- 3.6.4 The employees, consultants, and contractors of the Consent Holder, when entering the Designated Area, must have suitable communications in place for reliable and effective use in remote areas, and have suitable arrangements in place to ensure safe egress from these areas.

4 Reporting Conditions

4.1 Incident Management

- 4.1.1 The Consent Holder must make each of its employees, consultants and contractors aware of the need to report and provide information via the **Water NSW Incident Notification Number (1800 061 069)** of any reportable designated incidents or events which are specified in Conditions 4.1.2, 4.1.3 and 4.1.4.

- 4.1.2 If the Consent Holder is required to report an incident or non-compliance under a Statutory Approval, the Consent Holder must also report that incident to Water NSW as soon as reasonably possible after becoming aware of that incident.
- 4.1.3 If a pollution incident occurs in the course of the Permitted Activity in the Designated Area so that material harm is caused or threatened to the environment as defined in section 147(1) of the *Protection of the Environment Operations Act 1997* the Consent Holder must notify Water NSW immediately of the incident and provide all relevant information.
- 4.1.4 If any Aboriginal or European cultural heritage site or artefact (as defined by the *National Parks and Wildlife Act 1974* or *Heritage Act 1977*) is identified during the Permitted Activity and does not already have an appropriate heritage plan that is being implemented, the Consent Holder's employees, consultants and/or contractors must **Stop Work immediately** at the location and ensure no further harm to the object. The Consent Holder must immediately report the find to Water NSW, and report to the regulator in accordance with legislation. The Permitted Activity must not commence in the vicinity of the find until any required approvals have been granted by the regulator. In the event that skeletal remains are encountered, the area must be secured to prevent unauthorised access and the Consent Holder must immediately contact NSW Police and Water NSW.

4.2 Non-Compliance

- 4.2.1 If the Consent Holder fails to comply with any condition of this Consent, the Consent Holder must notify Water NSW immediately upon becoming aware of the breach through the **Water NSW Incident Notification Number (1800 061 069)**. The Consent Holder must also provide Water NSW with a comprehensive written report in relation to the non-compliance within 14 days of first becoming aware of the non-compliance. The following must be addressed in the written report:
- (a) Consent reference and Condition number not complied with.
 - (b) Summary of particulars of non-compliance (no more than 50 words).
 - (c) Dates when the non-compliance occurred.
 - (d) Precise location where the non-compliance occurred (attach a map or diagram).
 - (e) Cause of Non-compliance.
 - (f) Action taken to mitigate any adverse of the non-compliance.
 - (g) Action taken to prevent a recurrence of the non-compliance.
- 4.2.2 The Consent Holder's compliance with the conditions of this Consent may be the subject of monitoring or audit by Water NSW from time to time. The Consent Holder must fully cooperate in the compliance monitoring or audit process.

4.3 Annual Statement of Compliance

The Consent Holder must provide Water NSW with a signed copy of the Russell Vale Colliery and Wongawilli Colliery Annual Environmental Management Report (AEMR), required under the mining leases outlined in Schedule 1 Item 2, containing an 'Annual Statement of Compliance with Consent Conditions' which is consistent with the form set out in Schedule 6. The annual statement of compliance will indicate compliance or otherwise with the conditions in this Consent for each 12 month reporting period (being 1 July to 30 June) with the reports due annually by 30 September, in line with the AEMR reporting period. The Consent Holder must sign and endorse the AEMR and submit it to Water NSW via email to compliance@waternsw.com.au.

5 General Conditions

5.1 Release

By accessing the Designated Area, the Consent Holder agrees to exercise the rights granted by Water NSW at its own risk and to release to the full extent permitted by law, Water NSW, its employees, agents and contractors, in the absence of any negligence on their part from all suits, actions, demands and claims of every kind resulting from any damage or destruction to any property (both real and personal) and injury suffered or sustained by any persons (including death) arising out of or in connection with the Permitted Activity.

5.2 Indemnity

- 5.2.1 By accessing the Designated Area, from the date of the consent, the Consent Holder agrees to indemnify and keep indemnified, Water NSW, its employees, agents and contractors in the absence of any negligence on their part from and against all its actions, demands, claims, proceedings, losses, damages, costs (including legal costs), charges or expenses incurred by Water NSW or for which Water NSW may become liable resulting from any damage or destruction to any property (both real and personal) and injury suffered or sustained by any persons arising out of or in connection with the Permitted Activity.

5.3 Warranty

Water NSW provides no warranty that the Designated Area is suitable for the Permitted Activity.

5.4 Insurance

- 5.4.1 The Consent Holder must, prior to accessing the Designated Area, provide Water NSW with a certificate of currency for Public Liability Insurance for the amount specified in Item 7 of the Reference Schedule covering property, injury or death arising from the Consent Holder undertaking the Permitted Activity in the Designated Area.
- 5.4.2 The policy must note the insurable interest of Water NSW.

5.5 Additional conditions

The Consent Holder must comply with the additional conditions contained in Schedule 2. To the extent that there is any inconsistency between the standard conditions of this Consent and the additional conditions in Schedule 2, the additional conditions take preference to the standard conditions in this Consent, to the extent necessary to resolve the inconsistency.

5.6 Definitions

- 5.6.1 In this Consent unless the contrary intention appears:
- a) **Authorised Officer** means a member of staff, and includes any class of persons prescribed by the regulations, who is designated by Water NSW as an authorised officer whose official duties are concerned with the enforcement of the *Water NSW Act 2014* and the *Protection of the Environment Operations Act 1997* or their regulations or with the investigation or prosecution of offences or alleged offences against these Acts or the regulations.

- b) **Authority** means any government or any governmental, semi-governmental, quasi-governmental, administrative, or judicial body, department, commission, authority, tribunal, or entity which has power to provide a Statutory Approval.
- c) **Commencement Date** means the commencement date of the Consent set out at Item 3 of the Reference Schedule.
- d) **Consent** means this document and all schedules to it.
- e) **Consent Holder** means the party identified at Item 1 of the Reference Schedule.
- f) **Consent Holder's Equipment** means all the equipment brought onto the Designated Area by the Consent Holder, its employees, contractors, and consultants.
- g) **Consent Fee** means the amount payable by the Consent Holder in accordance with Condition 2.3 and set out in Item 8 of the Reference Schedule.
- h) **Designated Area** means that part of Water NSW land described in Item 2 of the Reference Schedule.
- i) **EP&A Act** means the *Environmental Planning and Assessment Act 1979*.
- j) **Expiry Date** means the date of the Consent will expire as set out at Item 4 of the Reference Schedule.
- k) **Hours of Operation** means times at which the Consent Holder is permitted to access the Designated Area for the purpose of the Permitted Activity. Hours of Operation are outlined in the Consent Summary and Item 6 of the Reference Schedule.
- l) **Permitted Activity** means the activity for which the Consent is required as described in Item 5 of Reference Schedule.
- m) **Reference Schedule** means Schedule 1 of this Consent.
- n) **Statutory Approval** means any licence, approval or consent issued by any Authority permitting the Consent Holder to undertake the Permitted Activities in the Designated Area.
- o) **Water NSW Act** means *Water NSW Act 2014*.
- p) **Water NSW Regulation** means *Water NSW Regulation 2020*.
- q) **Water NSW Road and Fire Trail Rules** means the rules set out in Schedule 7.



Fiona Smith
Executive Manager Water and Catchment Protection
Water NSW

DATE: 3 March 2021

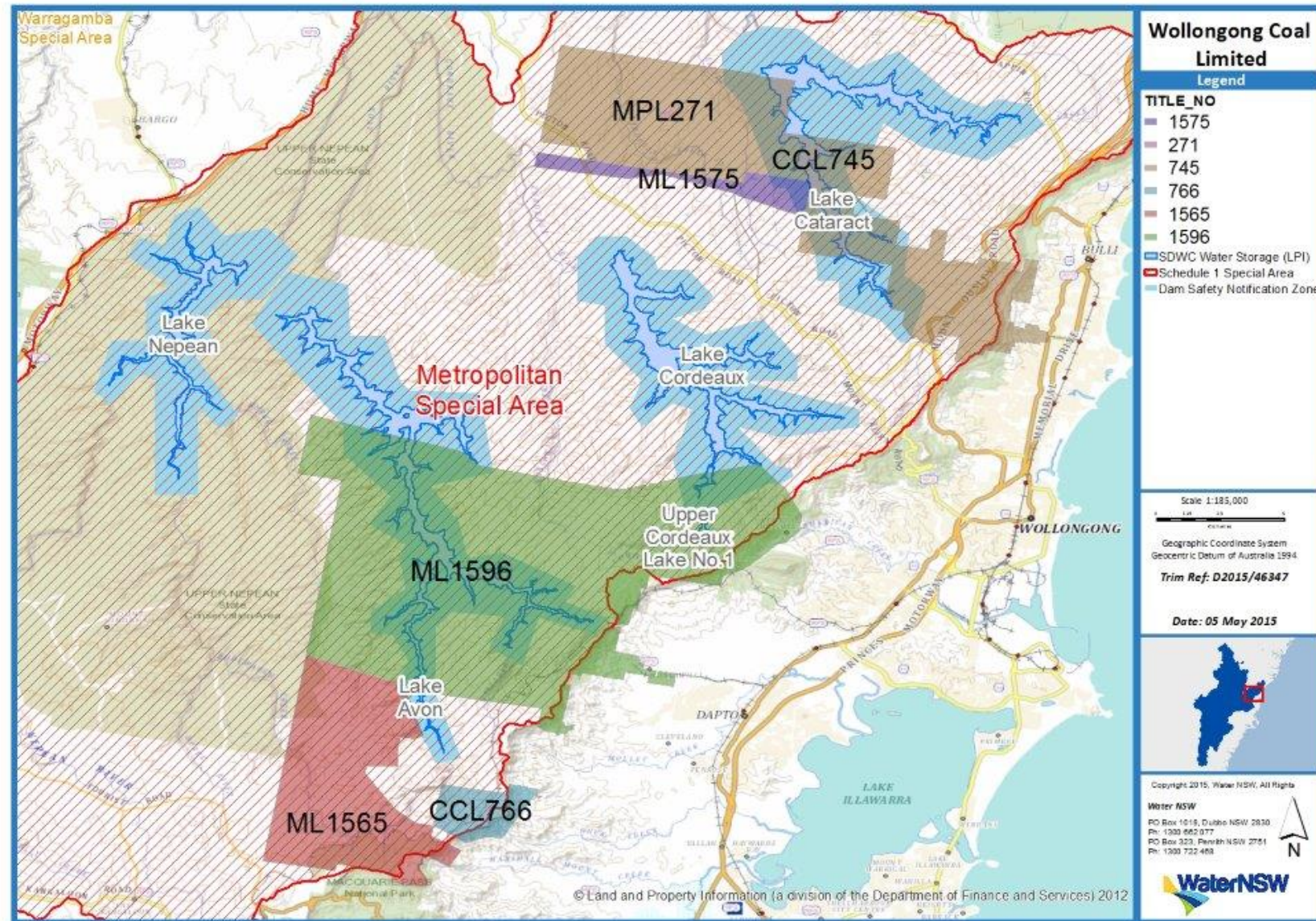
Schedule 1 – Reference Schedule

Item 1	Consent Holder:	Wollongong Coal Limited
Item 2	Designated Area:	The surface area of the Metropolitan Special Area associated with ML1565, ML1575, ML1596, MPL271, CCL745 & CCL766 as required to be accessed in accordance with a Statutory Approval as detailed in the map provided at Schedule 3.
Item 3	Commencement Date:	4 March 2021
Item 4	Expiry Date:	3 March 2026
Item 5	Permitted Activity:	To enter and remain on Special Area land and carry out activities that are otherwise prohibited by the Water NSW Regulation 2020 to the extent necessary to carry out the requirements of any Statutory Approval.
Item 6	Hours of Operation:	24 hours per day, 7 days per week unless otherwise specified in EP&A Act approval to a specific Permitted Activity.
Item 7	Insurance	Public Liability Insurance of up to \$25M for any one occurrence unlimited to the number of occurrences in any one policy year.
Item 8	Consent Fee	Not used.

Schedule 2 – Additional Conditions

Not Applicable.

Schedule 3 – Map showing location of ML1565, ML1575, ML1596, MPL271, CCL745 and CCL766



Schedule 4 – List of Fire Trails as at 3 March 2021

List of Water NSW roads and fire trails which may be utilised under this Consent:

1
1F
6A
6D
6F
6G
7
7C
7D
7J
7L
7M
8
8A*
8C*
8H
9G*
12
12B
15
15A
15E
15F
15G
15H
15I
15J
15M

** indicates the roads and fire trails that are the sole responsibility of the Consent Holder to maintain and repair in accordance with Schedule 5, except where damage is caused by another user

Schedule 5 – Managing Urban Stormwater – Soils and Construction – Volume 2C – Unsealed Roads, and NSW Rural Fire Service Fire Trail Design, Construction and Maintenance Manual

Managing Urban Stormwater – Soils and Construction – Volume 2C – Unsealed Roads (Department of Environment & Climate Change NSW, 2008)

NSW Rural Fire Service Fire Trail Design, Construction and Maintenance Manual (Soil Conservation Service, 2017)

Schedule 6 – Annual Statement of Compliance with Consent Conditions

Consent Holder

Wollongong Coal Limited

Consent Number

F2020/3092

Reporting Period

{insert dates}

Compliance with Consent Conditions

1. Were all the following documents complied with during the reporting period? (tick a box)

Consent/Approval	Yes	No
a. Conditions of this Consent;		
b. All Statutory Approvals;		
c. Any environmental management plans, rehabilitation plans, revegetation plans, soil and water management plans, water monitoring plans or other plans required by Water NSW.		

2. If you answered “No” to any part of question 1, please supply the name of the non-compliance/incident and the date the written report was provided to Water NSW, in the table below:

Non Compliance / Incident (one line)	Date written report provided to Water NSW	Relevant section of Annual Review (if applicable)

3. How many pages have you attached?
(Each attached page must be initialled by the person(s) who signs Section 4 of this Statement of Compliance)

4. Signature and Certification

The Statement of Compliance must only be signed by a person(s) with legal authority to sign it as set out below:

- By affixing the Common Seal in accordance with *Corporations Act 2001*, or
- By 2 Directors, or
- By a Director and a Company Secretary, or
- By a person delegated to sign on the company's behalf in accordance with the *Corporations Act 2001* and approved in writing by Water NSW to sign on the company's behalf.

Signature:

Name:

(printed)

Position

Date:

Signature:

Name:

(printed)

Position

Date:

SEAL (if signing under Seal)

The Consent Holder can request Water NSW approval for the compliance requirements of this Consent to be linked to and built into other compliance reporting that may be required under approvals issued under the EP&A Act.

Schedule 7 – Water NSW Road and Fire Trail Rules

1. The driver of any vehicle must hold a current driver's licence and obey all speed advisory and warning signs. Vehicle speed must not exceed **40 km/h** on public access roads at WaterNSW owned sites such as picnic grounds unless otherwise signposted and **60 km/h** for all other Water NSW roads and fire trails unless otherwise signposted.
2. Any motor vehicle used to travel on any surface within the Designated Area must be registered and suitable for the purpose for which it is being used. The minimum vehicle standard for use in the non-publicly accessible areas within the Designated Area is a vehicle with All Wheel Drive or Four-Wheel Drive capabilities.
3. All vehicles must carry appropriate safety and recovery gear consistent with the Consent Holder's Safe Work Plan or other Work Health and Safety requirements.
4. All drivers of vehicles must be competent to operate or drive, and be appropriately licensed, for the type of vehicle in use.
5. The Consent Holder must not drive or use any road or fire trail in the Designated Area if the road or fire trail is not suitable for type of vehicle in use, or if driving or using any road or fire trail will result or is likely to result in damage to the road or fire trail or damage to the surrounding catchment area.
6. Vehicles must not be driven on the roads or fire trails in the Designated Area if they have been closed by Water NSW for any reason, unless permitted by this Consent.
7. Vehicles may only be driven on formed fire trails in the Designated Area, unless permitted by the Statutory Approvals.
8. Vehicles must not be driven around fallen branches and trees on any road in the Designated Area. The Consent Holder must remove any items obstructing the road or report their location to Water NSW. Vehicles must not progress along a road unless the obstruction has been removed first.
9. Entry is restricted to vehicles essential to undertake the Permitted Activity and vehicle movements must be kept to a minimum.
10. For this section, the term "vehicles" includes all vehicles including cars, trucks and any machinery driven on roads and fire trails.

Schedule 8 – Special Area Wet Weather Management Plan and Trigger Action Response Plan

WaterNSW Special Areas Wet Weather Management Plan dated 30 September 2020 (Wollongong Coal DOC ID: WCL EC PLN 004) – WaterNSW Reference number: D2021/9895

Wet Weather – Trigger Action Response Plan (TARP) dated 30 September 2020 (Wollongong Coal DOC ID: WCL EC TARP 001) – Water NSW Reference number: D2021/9897

Richard Sheehan

From: Ravi Sundaram <ravi.sundaram@waterNSW.com.au> on behalf of Ravi Sundaram
Sent: Tuesday, 24 August 2021 3:02 PM
To: Richard Sheehan; Jessie Evans
Cc: Devendra Vyas
Subject: RE: RE: Submission of RVC Extraction Plan_Land Management Plan and Public Safety Plan for WNSW review

Hi Richard

Thank you for providing WaterNSW to review draft versions of the above plans. WaterNSW has reviewed the plans and has the following comments/suggestions for your consideration.

Public Safety Management Plan (PSMP)

Special Area Access Consent

Majority of the surface land overlying the proposed extraction area lies within WaterNSW land declared as a Special Area (specifically the Metropolitan Special Area) owned and managed by WaterNSW and provisions of the *WaterNSW Act 2013* and *WaterNSW Regulation 2020* apply. Maintaining the ecological integrity of the Special Areas is important and a key consideration of WaterNSW Mining Principles.

Section 2.3 Table 3 must list the Special Area Consent (Consent No. F2020/3092; commenced on 4th March 2021 and valid until 3rd March 2026) – Issued by WaterNSW under Division 1 of Part 3 of the *Water NSW Regulation 2020*.

Unsealed access roads and Fire trails (Section 6.1.3)

Fire trails within the Metropolitan Special Area and overlying the mining area have a low potential to be impacted by subsidence due to the mining method adopted. However, they can be directly impacted on the surface by WCL activities in relation to exploration and environmental monitoring. A list of Water NSW roads and fire trails which may be utilised by WCL are listed in Schedule 4 of the Consent. WCL is responsible for any damage caused to fire trails due to its surface activities and must have mitigation and contingency measures in place to ensure all WaterNSW fire trails are safe, serviceable and repaired as soon as practical.

Schedules in the WCL Special Area Consent detail necessary aspects in relation to maintenance of fire trails including:

- Schedule 5 – Guidelines
 - Managing Urban Stormwater – Soils and Construction – Volume 2C – Unsealed Roads, and
 - NSW Rural Fire Service Fire Trail Design, Construction and Maintenance Manual
- Schedule 7 - WaterNSW Road and Fire Trail Rules
- Schedule 8 – Special Area Wet Weather Management Plan and Trigger Action Response Plan

Section 7.1 Para 4 – reference to WaterNSW Standard Conditions must be deleted. Applicable conditions and requirements are listed in WCL's Special Areas Consent (F2020/3092) and in any approvals including specific activity approvals issued by WaterNSW under Part 5 of the EP&A Act. Section 7.3.1 – WaterNSW Special Areas: Reference to WaterNSW track maintenance guidelines (including the Track Stabilisation and Control Manual) needs to be deleted as it is no longer used by WaterNSW. Recommended guidelines are specified in Schedule 5 of WCL's Special Areas Access Consent. Schedule 7 of WCL's Access Consent also specifies WaterNSW's road and fire trail rules and Schedule 4 specifies roads and fire trails WCL can access within the Metropolitan Special Areas. A list of the most relevant ones overlying the Russell Vale Colliery proposed extraction area must be listed here that will be utilized, monitored and maintained.

Land Management Plan

Majority of the surface land overlying the proposed extraction area lies within WaterNSW land declared as a Special Area owned and managed by WaterNSW and provisions of the WaterNSW Act 2013 and WaterNSW Regulation 2020 apply. Maintaining the ecological integrity of the Special Areas is important and a key consideration of WaterNSW Mining Principles. Section 1.5 Natural Features must acknowledge this.

Section 2.3 Leases, Licences and Permits must list the Special Area Consent (Consent No. - F2020/3092; commenced on 4th March 2021 and valid until 3rd March 2026) – Issued by WaterNSW under Division 1 of Part 3 of the Water NSW Regulation 2020.

Please feel free to contact me if you need to clarify any information regarding the above.

Regards

Ravi

Ravi Sundaram
Mining Catchment Specialist



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Note: Please contact me by email or on my mobile until further notice as I may be working remotely.

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From: Richard Sheehan <richard.sheehan@wcl.net.au>

Sent: Tuesday, 3 August 2021 9:21 PM

To: Jessie Evans <Jessie.Evans@waterNSW.com.au>

Cc: Ravi Sundaram <ravi.sundaram@waterNSW.com.au>; Devendra Vyas <DVyas2@wcl.net.au>

Subject: ARK: RE: Submission of RVC Extraction Plan_Land Management Plan and Public Safety Plan for WNSW review

Good evening Jessie and Ravi,

Further to our correspondence as attached please see for your information and review the WCL Extraction Plan Land Management Plan and Public Safety Plan in draft form.

To support the review of the Land Management Plan please also see the Figure 4 showing the identified natural features.

If you have any questions or comments on the attached please contact me at your convenience.

Regards

Richard Sheehan

Group Environmental & Approvals Manager



Wollongong Coal Limited

Russell Vale Colliery

7 Princes Highway, Corrimal NSW 2518

PO Box 281, Fairy Meadow NSW 2519

☎ Mob: 0404 972 746

✉ Email: Richard.sheehan@wcl.net.au



Site	Russell Vale Colliery	DOC ID	RVE EC PLN 010
Type	Plan	Date Published	19/11/2021
Doc Title	Extraction Plan		

APPENDIX G: WATER MANAGEMENT PLAN



Site	Russell Vale Colliery	DOC ID	RVC EC PLN 009
Type	Management Plan	Date Published	18/11/2021
Doc Title	PUBLIC SAFETY MANAGEMENT PLAN		

RUSSELL VALE COLLIERY RUSSELL VALE REVISED UNDERGROUND EXPANSION PROJECT

PUBLIC SAFETY MANAGEMENT PLAN RVC EC PLN 009

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 009
Type	Management Plan	Date Published	18/11/2021
Doc Title	PUBLIC SAFETY MANAGEMENT PLAN		

Revision history

Property	Value
Approved by	Group Environment Manager
Document Owner	Group Environment Coordinator
Effective Date	

Revisions

Version	Date reviewed	Review team (consultation)	Nature of the amendment
1	03/08/2021	WCL	Draft document for consult
2	07/10/2021	WCL	Final draft for submission to DPIE
3	18/11/2021	WCL	Final version following response to regulators
4			

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 009
Type	Management Plan	Date Published	18/11/2021
Doc Title	PUBLIC SAFETY MANAGEMENT PLAN		

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1 INTRODUCTION

1.1 Overview

Wollongong Coal Limited (WCL) operates the Russell Vale Colliery (RVC) (formerly the NRE No.1 Colliery) located in the Southern Coalfield of New South Wales (NSW). The mine is located at Russell Vale, approximately 8 km north of Wollongong and 70 km south of Sydney, within the local government areas (LGAs) of Wollongong and Wollondilly in the Illawarra region of NSW (

Figure 1).

This Public Safety Management Plan (PSMP) has been prepared in support of an Extraction Plan (EP), as required by Condition 10 (g)(vii) of Development Consent MP09_0013 (the Development Consent). A Plan showing the extraction plan area (EP Area) with the proposed workings is depicted in **Figure 2**.

1.2 Project Background

RVC operates under the current Development Consent granted by the NSW Independent Planning Commission (IPC) on 8 December 2020. The Development Consent, known as the Underground Expansion Project (UEP), is based on the Revised Preferred Project Report (RPPR) and Response to Second PAC Review by Umwelt Environmental and Social Consultants Pty Ltd (Umwelt) dated July 2019. Under the Development Consent WCL may:

- extract 1.2 Mt of Run of Mine (ROM) coal per annum, with a maximum of 1 Mt of ROM coal being processed from site in a calendar year
- undertake mining operations for a period of five years from the date of commencement of mining operations.

The approved workings are contained within Consolidated Coal Lease 745 (CCL 745) and Mining Lease 1575 (ML 1575). In accordance with Condition C10(g)(vii) of the Development Consent, this PSMP has been prepared as a component of the RVC EP to manage the potential consequences of the second workings to ensure public safety and manage access across the EP area. The PSMP covers the area relating to PC07, PC08 and PC 21 to PC25. PC07, PC08 and PC 21 to PC25 are situated to the west and south-east of the previously mined Longwall 6 (

Figure 1).

The remaining pillars approved under the Development Consent will be mined in a staged approach and will therefore be subject to future EPs.

Section 2 of the main EP, 'Project Description', provides a full summary of the project, including details on the:

- mine planning and design
- mining methodologies
- phasing of the surface infrastructure relating to the project over 2 stages, which are both wholly covered under the EP
- staging of second workings
- stage 1(a) – PC21 to PC25



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- stage 1(b) – PC07 and PC08.

1.3 Public Safety Features Covered by this Plan

The purpose of this PSMP is to document the potential risks to public safety associated with the UEP in the Russell Vale, Wonga West Areas, and detail any measures to manage these risks.

This PSMP addresses the potential risks to public safety posed by the following hazards:

- potential impacts of subsidence on built features
- potential instability of steep slopes resulting from subsidence
- deformation or fracturing of land due to subsidence.

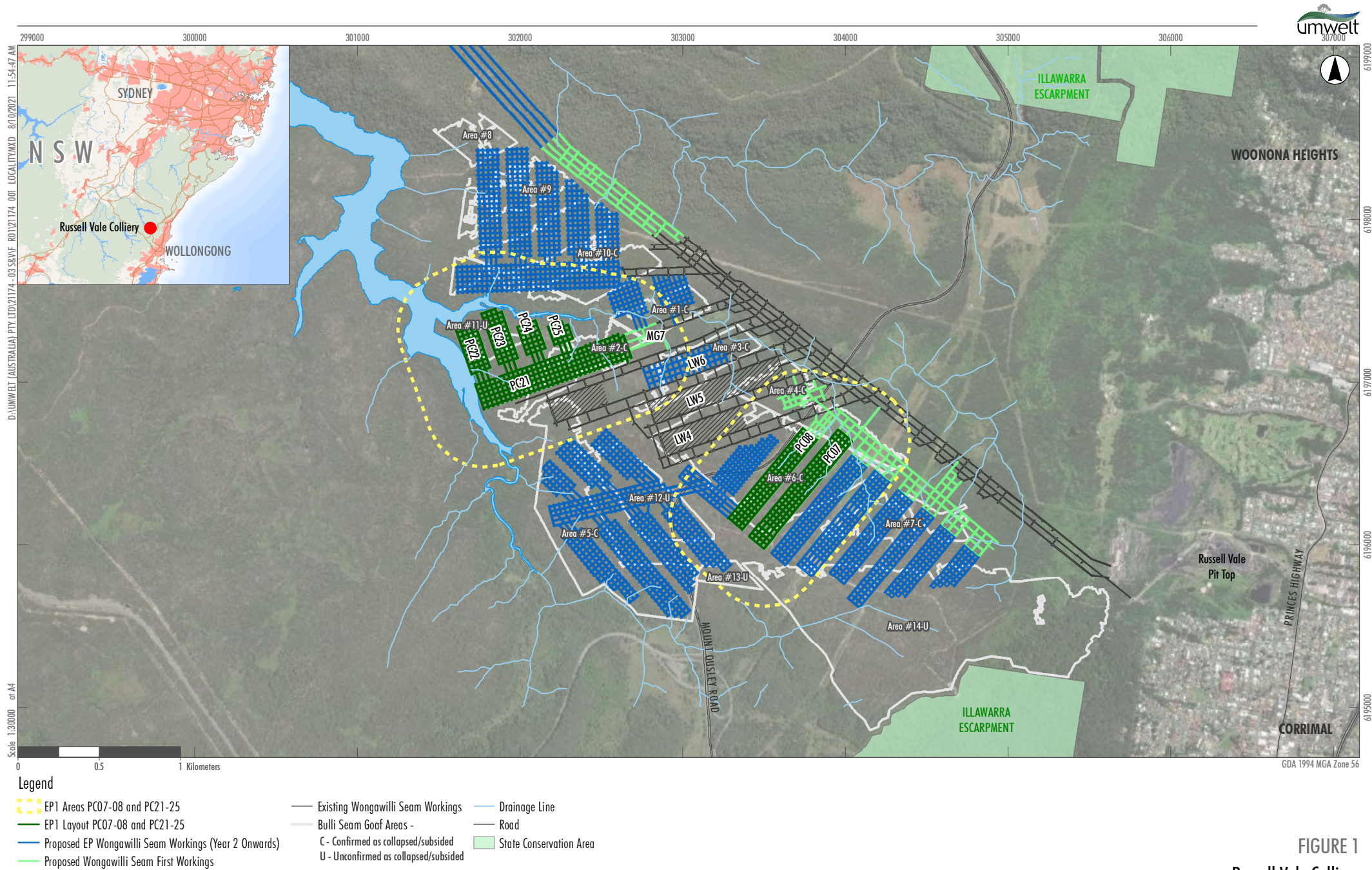
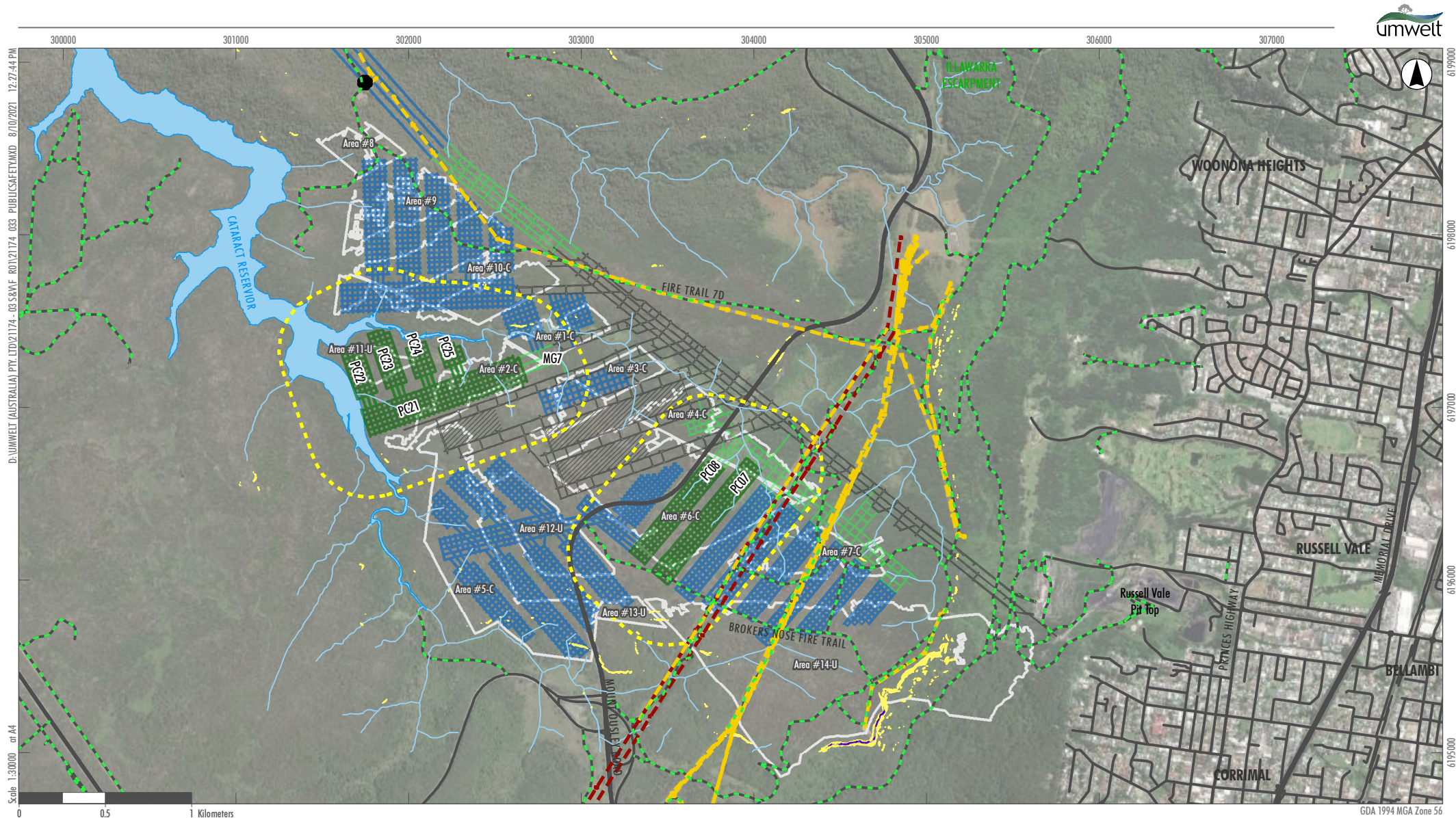


FIGURE 1
Russell Vale Colliery
Locality Plan



Legend

- EP1 Areas PC07-08 and PC21-25
- Proposed Wongawilli Seam 1st Workings
- Proposed EP Wongawilli Seam Workings (Year 2 Onwards)
- EP1 Layout PC07-08 and PC21-25
- Existing Wongawilli Seam Workings
- Bull's Seam Goaf Areas -
- C - Confirmed as collapsed/subsided
- U - Unconfirmed as collapsed/subsided
- Unsealed Access Roads and Fire Trails
- Power Line
- Transmission Tower Power Line
- Substation
- Cliffs (rock faces > 10 m high)
- Steep slopes (extended slopes > 1V:1H)
- Drainage Line
- Road

FIGURE 2
Public Safety Features

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2 STATUTORY REQUIREMENTS

2.1 Development Consent

Condition 10 (vii) of the Development Consent requires the preparation of a PSMP as a component of an EP.

Table 1 summarises the Development Consent conditions relevant to the PSMP.

In accordance with Condition C10 of the Development Consent, WCL will ensure implementation of this management plan upon approval by the Secretary.

Table 1 Extraction Plan Requirements

Condition	Condition Requirement	Section Addressed
C10. (g) (vii)	Prepare a Public Safety Management Plan which has been prepared in consultation with RR and WaterNSW, which ensures public safety and manages access on the site;	This PSMP Section 2.3

2.2 Leases, Licences and Permits

In addition to the requirements of the Development Consent, all activities at or in association with the Russell Vale Colliery are undertaken in accordance with the relevant conditions outlined within the licences, permits and leases in **Table 2**.

Table 2 Licences, Permits and Leases

Licence and/or Approval	Document Number	Issue Date	Expiry Date
Consolidated Coal Lease (CCL)	745	27/12/1990	30/12/2023
Mining Purposes Lease (MPL)	271	09/05/1991	09/05/2033
Mining Lease (ML)	1575	22/03/2012	22/03/2029
Environmental Protection Licence	12040	19 May 2004	-
EPBC Approval	2020/8702	31 August 2021	31 December 2067
Water Access License (WAL)	WAL36488	20/02/2017	-
Special Area Consent	F2020/3092	04 March 2021	03 March 2026

2.3 Consultation

2.3.1 Consultation During the Environmental Assessment Process

Extensive community and government consultation has been carried out prior to and during the preparation of the original environmental assessment, the RPPR, the Submissions Report and other project-related assessment documentation. The primary objective of consultation was to keep the community, government agencies and other stakeholders informed and involved during project development process.

Community engagement was carried out in two phases and is summarised in Section 4.1.2 and Section 4.1.3 of the RPPR.

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A complete summary of previous and ongoing government agency and stakeholder consultation is provided in Table 4.5 of the RPPR. Consulted parties of relevance to this PSMP included:

- the Department of Planning, Industry and Environment (DPIE)
- DPIE Mining Resources Regulator (NSW RR)
- DPIE Water
- NSW Environment Protection Authority (EPA)
- Wollongong City Council (WCC)
- WaterNSW
- Biodiversity Conservation Department
- NSW Heritage.

2.3.2 Consultation During the Preparation of the Management Plan

In accordance with Condition C10 (g) (vii) of the Development Consent, this PSMP has been prepared in consultation with the NSW RR and WaterNSW.

The consultation undertaken as part of the preparation of the management plan is included in **Table 3**.

Table 3 Consultation Undertaken as Part of the Preparation of this Management Plan

Agency name	Issue	Where issue is addressed in Management Plan
DPIE	This table to be completed on finalisation of Management Plan	Comments will be included in Appendix B of the main EP.
WaterNSW	<p>a. Section 2.3 Table 3 must list the Special Area Consent (Consent No. F2020/3092; commenced on 4th March 2021 and valid until 3rd March 2026) – Issued by WaterNSW under Division 1 of Part 3 of the Water NSW Regulation 2020.</p> <p>b. Section 6.1.3 - WCL is responsible for any damage caused to fire trails due to its surface activities and must have mitigation and contingency measures in place to ensure all WaterNSW fire trails are safe, serviceable and repaired as soon as practical.</p> <p>c. Section 7.1 Para 4 – reference to WaterNSW Standard Conditions must be deleted. Applicable conditions and requirements are listed in WCL's Special Areas Consent (F2020/3092) and in any approvals including specific activity approvals issued by WaterNSW under Part 5 of the EP&A Act.</p> <p>d. Section 7.3.1 – WaterNSW Special Areas: Reference to WaterNSW track maintenance guidelines (including the Track Stabilisation and Control Manual) needs to be deleted as it is no longer used by WaterNSW. Recommended guidelines are specified in Schedule 5 of WCL's Special Areas Access Consent. Schedule 7 of</p>	<p>a. Section 2.2 Table 2</p> <p>b. Section 6.1.3</p> <p>c. Section 7.1</p> <p>d. Section 7.3.1</p>

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	WCL's Access Consent also specifies WaterNSW's road and fire trail rules and Schedule 4 specifies roads and fire trails WCL can access within the Metropolitan Special Areas. A list of the most relevant ones overlying the Russell Vale Colliery proposed extraction area must be listed here that will be utilized, monitored and maintained.	
NSW Resources Regulator	No response supplied	N/A

Consultation is presented in **Appendix B**.

2.4 Report Structure

The remainder of this PSMP is structured as follows:

Section 2: Outlines the statutory requirements applicable to the Plan.

Section 3: Outlines the baseline data and impact assessments undertaken which support this PSMP.

Section 4: Describes the predicted subsidence applicable to public safety features.

Section 5: Details the performance measures and indicators that will be used to assess the Project.

Section 6: Describes the monitoring program and reporting requirements.

Section 7: Describes the management, remediation and mitigation measures that will be implemented to reduce potential impacts as well as the contingency plan to manage any unpredicted impacts and their consequences.

Section 8: Describes the protocols for the handling of incidents, complaints and non-compliances.

Section 9: Details the plan administration requirements

Section 10: Details how the Plan will be implemented, managed, reviewed and updated.

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3 BASELINE

This section is based on the subsidence assessment (SCT, 2019) conducted for the RPPR and the associated environmental assessment reports, and the updated subsidence report (SCT, 2021) as prepared in accordance with the Condition C10(e) of the Development Consent.

3.1 Site Description

The EP Area is located entirely within the 'Metropolitan Special Area' managed by WaterNSW. The Metropolitan Special Area is a restricted area and cannot be accessed by the public, except with the consent of WaterNSW. This area is accessed by WCL personnel and contractors for monitoring activities. The Metropolitan Special Area is also accessed by WaterNSW personnel. Mount Ousley Road is a public road that passes through the Metropolitan Special Area.

Known natural surface features in the EP Area that have the potential to affect public safety include steep slopes and these are managed within the LMP. Hazards associated with the following built surface features are possible, however are expected to be minor and manageable with the appropriate risk control measures (refer to section 4 of the BFMP):

- Mount Ousley Road (now M1 Princes Motorway)
- Picton Road Interchange
- high voltage electricity transmission lines east of Mount Ousley Road
- mine infrastructure (exploration boreholes, electricity lines, and ventilation shafts)
- other roads (dirt roads and fire trails).

Locations of these surface features are shown in Figure 2.

Mount Ousley Road (now M1 Princes Motorway) runs in a north-easterly direction over the previous mining leases. The interchange with Picton Road is located at the southern boundary and includes a concrete bridge and several drainage culverts. These assets are administered by Transport for NSW and are addressed within the Built Features Management Plan (BFMP) a sub plan to the main EP.

Located to the east of Mount Ousley Road is a 330 kV transmission line owned by TransGrid, a 132 kV transmission line and two single pole 33 kV transmission lines owned by Endeavour Energy.

A telecommunications installation is located adjacent the Illawarra Escarpment at Brokers Nose, approximately 600 m from the nearest proposed second workings.

Management of the built features assets as outlined above is outlined in the BFMP.

There are no known public amenities, agricultural lands, industrial/commercial establishments, or residential properties within the EP Area. The EP Area is not in a Subsidence Advisory NSW Mine Subsidence District.



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4 PREDICTED SUBSIDENCE IMPACTS

SCT have completed the Russell Vale Colliery: Subsidence Assessment for PC07-08 and PC21-25 Extraction Plan (2021). The Subsidence Assessment determined that the mine design is not considered to have any potential to perceptibly impact on public safety.

Planned mining is not expected to cause perceptible subsidence effects or impacts to the powerlines, so no additional risk to public safety is expected. However, monitoring of the powerlines during the period of active mining is considered an appropriate risk control measure for this infrastructure and is presented within the Built Features Management Plan (BFMP).

Any potential impacts to Mount Ousley Road and the associated risk to public safety will also be managed within the BFMP which has been developed in consultation with Transport for NSW. The BFMP also presents proposed monitoring for any potential impacts from previous longwall mining in the Wongawilli Seam.

Any potential impacts to steep slopes and the associated risk to public safety are managed within the Land Management Plan (RVC EC PLN 035). It is noted, however that the mine design is not considered to have any potential to perceptibly impact on natural surface features including steep slopes, however it should be recognised that there is always potential for rock falls to occur naturally as part of the ongoing erosion process. Proposed mining is not expected to increase this potential.

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5 PERFORMANCE MEASURES AND CRITERIA

5.1 Performance Measures

Performance measures for the management of public safety are set out in Table 6 of Condition C7 of the Development Consent and are reproduced here in **Table 4**.

Table 4 Subsidence Impact Performance Measures

Feature	Performance Measures	Performance Indicator	Monitoring
Public Safety			
Public Safety	Negligible additional risk	Change in safety risk	Global Navigation Satellite System (GNSS) Visual inspection Monitoring related to Mt Ousley Road and Transmission Lines

Public safety management will be undertaken in accordance with the process described in **Figure 3**.

To ensure that mining does not result in any additional risks to public safety, WCL has adopted the following performance objectives:

- no impacts affecting the trafficability of fire trails and access tracks
- management of risks associated with steep slopes
- no impacts on public roads that would affect the safety of motorists.

5.2 Adaptive Management

Where investigations triggered by the Performance Measure TARPS indicate that the changed conditions of sites have been, or are likely to have been, caused by mining operations, the response to these impacts include adaptive management measures to ensure further impacts to the site will not occur or be mitigated or that impacts to future sites do not occur in the future. Due to the nature of the proposed mining and low likelihood of underground mining resulting in any impacts to the site provided subsidence impacts remain within predictions, these adaptive management measures that will be implemented, will be considered in the investigation process. Adaptive management measures to be implemented in the event of a clear linkage between the mining authorised under the development consent and Public Safety Management items will include a review of the design and layout of future mining within areas that may potentially impact on such items to avoid a recurrence of any such impacts. These adaptive management measures include:

- stop mining and investigate causes of the exceeding of subsidence predictions.
- undertake a review of the panel design parameters in consultation with the resource regulator.

The Contingency Planning process set out in **Section 7.3** also covers this process.



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The purpose of this adaptive management measures are to implement additional measures where necessary to:

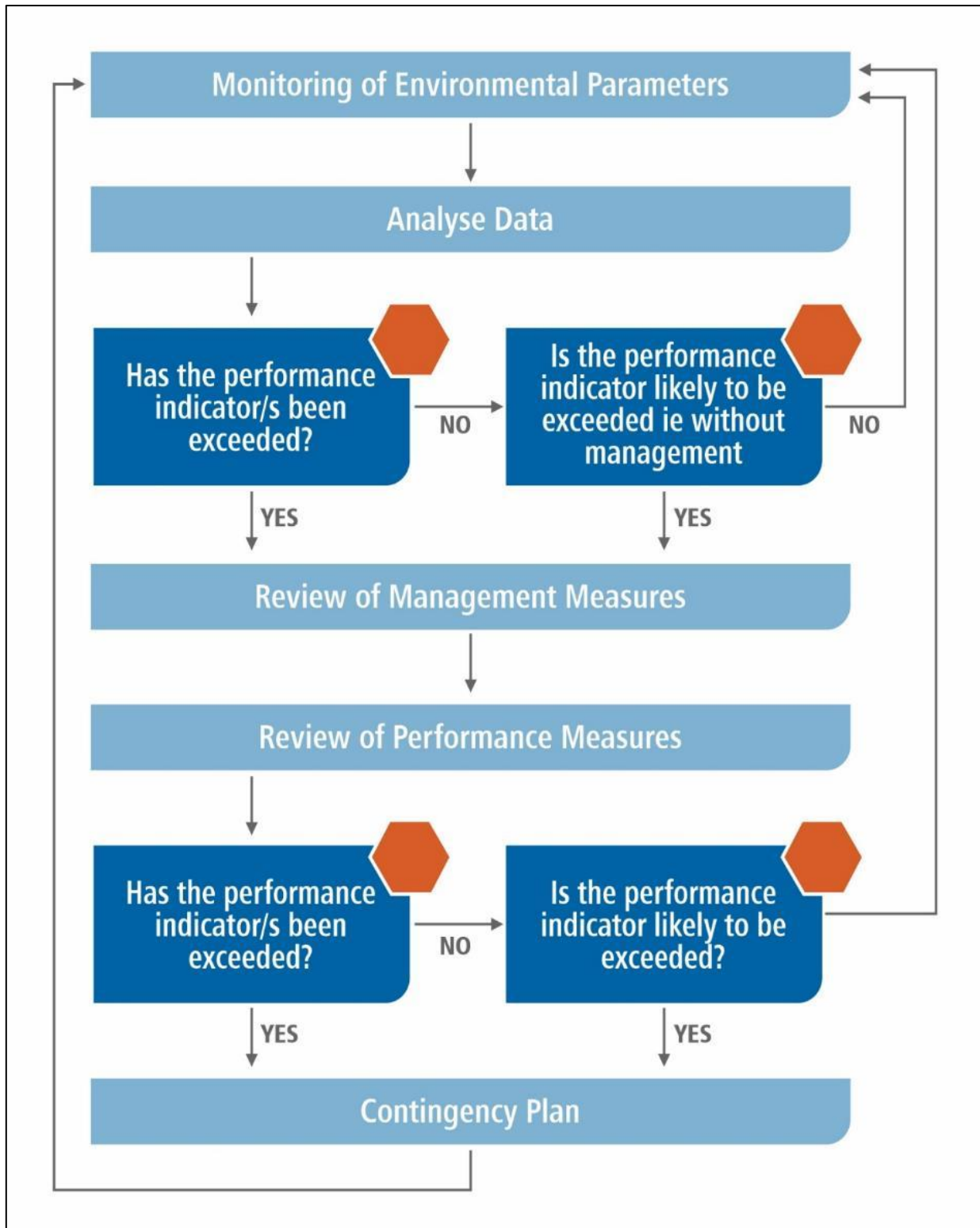
- enable potential impacts associated with higher than predicted subsidence impacts to be monitored; and/or
- the implementation of changes in mining operations to prevent performance criteria from being exceeded.

WCL will assess and manage development-related risks to ensure that there are no exceedances of the criteria and/or performance measures in this consent in accordance with Development Consent condition **F4**. Any exceedance of the Subsidence criteria and/or performance measures constitutes a breach of this consent and may be subject to penalty or offence provisions under the EP&A Act or EP&A Regulation, notwithstanding offsetting actions taken. Where any exceedance of these criteria and/or performance measures has occurred, WCL will at the earliest opportunity:

- take all reasonable and feasible steps to ensure the exceedance ceases and does not re-occur;
- consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action;
- within 14 days of the exceedance occurring, submit a report to the Secretary describing these remediation options and any preferred remediation measures or other course of action; and
- implement remediation measures as directed by the Planning Secretary,

to the satisfaction of the Secretary.

Figure 3 Adaptive Management Process



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6 MONITORING AND REPORTING

6.1 Monitoring

The monitoring activities that will be undertaken to identify and manage risks to public safety are outlined in this section.

6.1.1 Transport for NSW Infrastructure

Monitoring of Mount Ousley Road and other road infrastructure will be undertaken as described in the BFMP. This includes monitoring of the road pavement and other associated infrastructure, including bridges, culverts, cuttings and embankments.

6.1.2 Electrical Transmission Lines

Monitoring of electrical transmission lines and associated towers will be undertaken as described in detail in the BFMP. This includes the monitoring of the 330 kV transmission lines owned by TransGrid and the 132 kV and 33 kV owned by Endeavour Energy.

6.1.3 Unsealed Access Roads and Fire Trails

The unsealed access roads and trails within the EP Area are not likely to experience cracking due to the proposed mining. The monitoring regime for these unsealed roads is outlined in the Public Safety Trigger Response Action Plan (TARP) (attached as **Appendix A**). Visual inspections of the identified unsealed roads will be undertaken fortnightly during the second workings extraction and monthly for a period of six months after mining. If cracks larger than 10 mm are identified, WCL will notify DPIE, WaterNSW, and any other relevant agencies and prepare a remediation plan within one week.

Where cracking as a result of mining is observed on fire trails, WCL will be responsible for necessary repairs to ensure that fire trails are safe.

6.2 Reporting

The reporting framework set out in Section 7 of the EP will apply to the implementation of this PSMP. This reporting framework includes:

- incident reporting
- six monthly reporting
- impact reporting (in the event of an observed impact associated with the development covered by the EP)
- Annual Review reporting requirements.

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7 MITIGATION AND MANAGEMENT STRATEGIES

7.1 General

The portion of the EP Area to the east of Mount Ousley Road consists predominantly of WaterNSW managed land, with small areas of private land. Access to this land is restricted. Due to the restricted access to the land within the EP Area, subsidence is not predicted to pose a significant risk to the general public. Nevertheless, WCL will implement several management measures to prevent, mitigate and promptly remediate hazards within the EP Area.

The portion of the EP Area to the west of Mount Ousley Road is within the Metropolitan Special Area. The general public is not permitted to enter the Metropolitan Special Area (unless authorised by the WaterNSW). Signage installed at the entries to the WaterNSW Special Areas clearly stipulate that public access is restricted.

All WCL staff and contractors will be required to hold current WCL and WaterNSW inductions and are trained in personal safety requirements before accessing these lands. WCL personnel and contractors are required to wear the appropriate personal protective equipment (PPE) when working within the restricted area. The necessary PPE includes hard hat, protective boots, gloves, safety glasses, long-sleeved shirt and trousers.

WCL abide by the Special Area Consent F2020/3092 including those detailed in the WNSW WCL Access Agreements, as well as Part 5 of the Environmental Planning and Assessment (EP&A) Act at all times while working in and accessing the Metropolitan Special Area.

Such conditions include:

- abiding by speed restrictions (40 km/h)
- driving only on designated access tracks
- locking all gates after entering and leaving the area (to prevent public access)
- abiding by access restrictions (e.g. wet weather, total fire ban etc.)
- provision of appropriate documentation to WaterNSW prior to the commencement of works (including obtaining all relevant approvals and inductions)
- provision of emergency contact numbers.

WCL personnel and contractors will access these restricted areas to conduct monitoring activities. These areas may also be accessed by WaterNSW staff and other persons with permission from WaterNSW (e.g. asset owners such as TransGrid and Endeavour Energy). Therefore, such persons may be exposed to subsidence related risks in the unlikely event that the activities covered by the EP cause subsidence impacts which may affect public safety.

7.2 Trigger Action Response Plan (TARP)

In accordance with Condition C10(g)(viii) of the Development Consent, the Extraction Plan and associated sub plans will identify TARPs to be implemented to manage potential impacts associated with underground mining.

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These TARPs include the following:

- monitoring requirements (may include different locations);
- trigger levels that indicate a potential non-compliance or flag implementation of contingency measures;
- management and contingency actions (i.e. corrective and preventative actions) and reporting requirements;
- responsibilities; and
- timing.

These TARPs detail how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements. They also form the framework for and contingency actions.

The Trigger Action Response Plan (TARP), as presented in **Appendix A**, has been designed specifically for this PSMP to illustrate how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for adaptive management and contingency actions.

The TARP system provides a simple, transparent and useable record of the monitoring of environmental performance and the implementation of management and/or contingency measures. Due to the nature of predicted impacts associated with the proposed second workings, Performance Measure TARPs have been established.

If monitoring indicates a Level 2 or 3 trigger has been reached, an investigation will occur in all circumstances. The nature of the investigation will depend on the feature being monitored, the location of the trigger exceedance and Trigger level exceeded among other matters. Different investigation options are discussed in detail in the management plans specific to the feature being monitored.

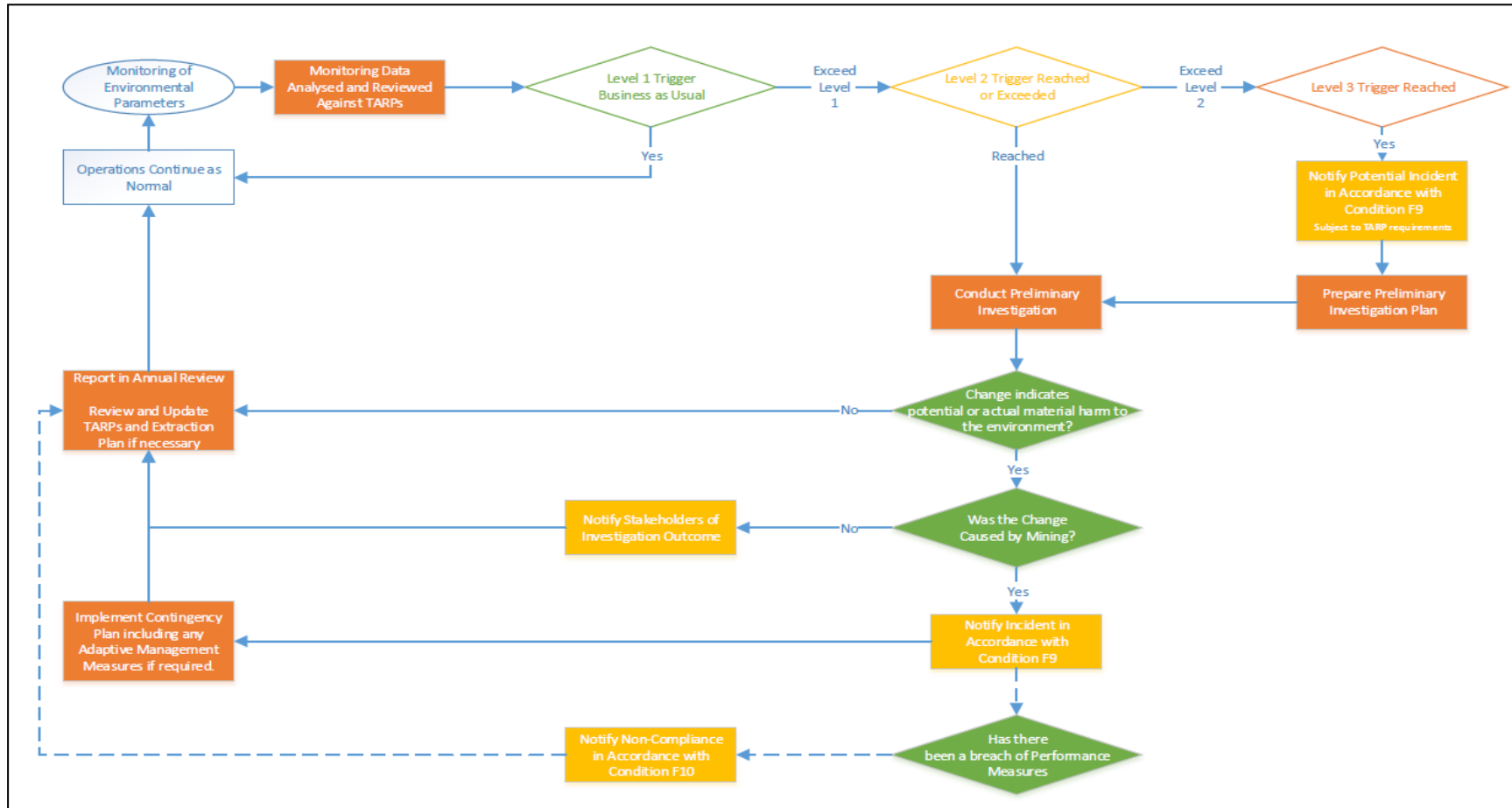
Note: Level 3 Performance Measure TARP triggers do not, of themselves, constitute an incident or non-compliance under the Development Consent. Investigations following a Level 3 trigger will determine whether an exceedance or non-compliance of the performance measures or Development Consent conditions is likely or has occurred.

In the unlikely event that investigations of Level 3 Performance Measure TARP trigger exceedances determine that material harm has occurred *and* is attributable to the development approved under the Development Consent, the contingency plan and adaptive management measures outlined within **Section 5.2** will be implemented. In certain cases, management measures may be implemented in the absence of any clear link between the approved development and the observed impact to mitigate adverse environmental outcomes. Response to matters which are identified as Incidents or Non-Compliances will be implemented in consultation.

Figure 4 below provides a flow chart covering the TARP Process.

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Figure 4 TARP Process



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7.3 Contingency Plan

In the event that the observed parameters or impacts exceed or are considered likely to exceed the performance measures detailed in the BFMP and in Section 5 of this PSMP, WCL will implement the following contingency plan:

- All reasonable measures will be taken to reduce any impact to public safety in a timely manner.
- The observation will be reported to the Group Environmental Manager as soon as possible.
- The observation will be recorded.
- An investigation will be undertaken to identify the cause of the observed impacts (noting that the proposed Development is not anticipated to have any more than negligible impacts on public safety values).
- WCL will report any exceedances of the performance measure DPIE and other relevant stakeholders as soon as practicable after WCL becomes aware of the exceedances.
- WCL will assess the exceedances referred to in the TARP (outlined in Section 7.2) and where appropriate, implement safety measures in accordance with the appropriate Management Plans.
- The Group Environmental Manager will investigate any potential contributing factors and identify an appropriate action plan to manage the identified impacts, in consultation with specialists and/or relevant agencies if necessary.
- WCL will identify an appropriate action plan to manage the identified impacts, in consultation with other specialists and/or key stakeholders.
- WCL will submit the proposed course of action to DPIE for approval.
- WCL will implement the approved course of action to the satisfaction of DPIE.
- WCL will continue to monitor performance with the new action plan in place and, if successful will formalise these actions as part of this Plan.

Contingency measures will be developed in consideration of the specific circumstances of the issue and the assessment of consequences.

The following outlines general contingency measures that may be implemented in the event of subsidence related impacts that may impact on public safety.

7.3.1 WaterNSW Special Areas

If significant surface cracks are identified along access roads and fire trails, remediation will be undertaken in consultation with WaterNSW and would be undertaken in accordance with Schedule 5 of WCL Special Areas Consent F2020/3092. Surface cracks will generally be remediated by in-filling. The WaterNSW road and fire trail rules are outlined in Schedule 7, along with Schedule 4, which specifies which roads and fire trails WCL can access within the Metropolitan Special Area. Surface cracking of access roads and fire trails is not expected.

Those identified fire trails and access roads include:

- Brokers Nose Fire Trail
- Fire Trail 7d.

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7.3.2 Built Features

Public roads and electricity transmission lines are not expected to be significantly impacted by the proposed second workings mining. If WCL or the asset owner considers that the integrity of the asset and/or public safety has been compromised as a result of subsidence, remediation works and/or contingency measures will be implemented in accordance with the relevant management plan or as otherwise agreed with the asset owner.

Risks to public safety as a result of impacts on road infrastructure or impacts on transmission lines will be managed in accordance with the BFMP.

7.3.3 Steep Slopes

The steep slopes that may be impacted by subsidence are located within the Metropolitan Special Area and are therefore not accessible to the public. To ensure the safety of personnel that have authority to access the area, the following safety measures will be implemented:

- Signs shall be prominently displayed at any area that has been identified as potentially being susceptible to failure. Signposts will warn specifically of the danger. Signposts that are to be installed on private or public property will be installed in agreement with the relevant authority.
- The location of all signs, fences, and other remedial or warning provisions established will be marked on a Plan. This Plan will be maintained as a record of any remedial measures instituted during mining.
- Any potentially unstable rock structures will be assessed and secured (if safe and practicable to do so). Methods used to secure unstable rock structures will be determined on a case-by-case basis and may include rock bolting or grouting of rock fractures. If required, measures to stabilise rock formations will be developed in consultation with the relevant regulatory agencies.

7.4 Potential Incident Notifications

Level 3 TARP are set at a level that may indicate more than trivial environmental harm. Where monitoring indicates a Level 3 TARP trigger has been exceeded but the cause of the trigger being exceeded is unclear, DPIE (and other relevant stakeholders) will be notified of a *potential* Incident. The notification will include the same matters required to be included in an incident notification as required by Condition F9 of the Development Consent, including the development (including the development application number and name) and set out the location and nature of the potential incident.

Unless the cause of the exceedance is clearly identifiable at the time the exceedance, the first step will be to investigate the likely cause or causes of the exceedance. A preliminary investigation plan will be developed to guide this investigation process and a copy provided to DPIE and other relevant stakeholders. This is discussed further in **Section 8**.

The investigation process will also consider any remedial action that may be required.

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8 INCIDENTS, COMPLAINTS AND NON-COMPLIANCES

8.1 Incidents

According to the Development Consent:

- An 'incident' is defined as "an occurrence or a set of circumstances that causes or threatens to cause material harm and which may or not be or cause a non-compliance". Examples may include a breach of specific development consent criteria or performance measure.
- An 'exceedance' or 'non-compliance' is defined as "an occurrence, set of circumstances or development that is a breach of this consent".

In both circumstances, an Incident or Non-Compliance must be attributable to the development approved under the development consent.

Material harm is defined in the Development Consent as:

"harm to the environment that:

- *involves actual or potential harm to the health or safety of human beings or to the environment that is not trivial, or*
- *results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding \$10,000 (such loss includes the reasonable costs and expenses that would be incurred in taking all reasonable costs and expenses that would be incurred in taking all reasonable and practical measures to prevent, mitigate or make good harm to the environmental)."*

This definition excludes "harm" that is authorised under either this consent or any other consent.

The proposed 'second workings' which trigger the requirement for this EP are long term stable bord and pillar workings which are predicted to have only negligible subsidence effects. Incidents and associated reporting requirements will be managed through established procedures set out in Section 7.2 of the EP. The relevant authority will be notified of an incident with public safety implications immediately upon detection of the incident. In the event of a public safety incident related to road infrastructure, the incident will be reported to Transport for NSW. Public safety incidents involving electrical transmission lines would be reported to TransGrid or Endeavour Energy. Notification requirements for these built features can be found in the BFMP. Public safety incidents involving natural features and unsealed access roads and fire trails will be reported to the Department of Agriculture, Water and Environment (DAWE), as per the EPBC approval, as well as WaterNSW and DPIE.

8.2 Complaints Handling

Complaints will be managed through established WCL procedures developed in accordance with Condition F5(h) of the Development Consent by where a copy of a complaints register (updated on a monthly basis) will be kept on the WCL website. A summary of complaints will be available to regulatory authorities, community consultative committee (CCC), and interested persons upon request and provided in the Annual Reviews.

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9 PLAN ADMINISTRATION

9.1 Roles and Responsibilities

Environment and community management is regarded as part of the responsibilities of all Colliery personnel. The roles and function of the main personnel responsible for the implementation of environmental and community management including the plans, procedures and action plans contained in this LMP are outlined in WCL's Management Operating System.

9.2 Resources Required

In accordance with the WCL SYS POL 003 Environmental Policy, Management shall ensure that the appropriate resources are made available to achieve the implementation of this PSMP.

It is the role of the Group Environment Manager to ensure that these requirements are communicated to WCL Management.

9.3 Training

Staff training will consist of three levels of applicable to different types of staff:

- Level 1 – High level training on environmental legislative requirements (management staff)
- Level 2 – Operational level training (project managers, supervisors, surface personnel, control room operators)
- Level 3 – Basic awareness of environmental management (underground staff, all personnel).

Targeted environmental awareness training relative to the risks associated with their works (e.g. air quality, noise, traffic, waste management) will be provided to individuals or groups of workers with a specific authority or responsibility for operational environmental management, or those undertaking an activity with a high risk of potential environmental impacts. Training will be provided as deemed necessary to contractors to provide them with the knowledge, skills and awareness to minimise environmental impacts and conditions of consent relevant to their activities in accordance with Condition A28 of the Development Consent. At a minimum this will include:

- contractors whose activities are not directly supervised by Colliery personnel
- contractors whose activities are ongoing and have the potential to result in an environmental incident (e.g. truck drivers, stockpile contractors).

The Environment Manager/Site Environment Representative and Mine Training Manager will review the training program and monitor its implementation.

9.4 Inductions

All personnel, including contractors, sub-contractors and staff, are required to attend a compulsory site induction that includes an environmental component prior to commencement on site. The Environment Manager or delegate, will conduct the environmental component of the site induction.



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The environmental component will include an overview of:

- relevant details of this Management Plan, including purpose and objectives
- key environmental issues
- conditions of environmental licences, permits and approvals
- mitigation measures for environmental issues
- incident response and reporting requirements.

A record of all environmental training and inductions will be maintained and kept on site. The Environmental Manager may authorise amendments to the induction where required to address project modifications, legislative changes or amendments to this Management Plan or related documentation.

The Environment Manager/Site Environment Representative will review and endorse the induction program and monitor its implementation.

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10 AUDIT AND REVIEW

10.1 Annual Review

In accordance with Condition F11 of the Development Consent, an Annual Review of the environmental performance of the project is prepared.

The Annual Review will:

- describe the development (including rehabilitation) that was carried out in the previous calendar year and the development that is proposed to be carried out over the current year
- include a comprehensive review of the monitoring results and complaints records of the development over the previous calendar year, including a comparison of these results against the:
 - relevant statutory requirements, limits or performance measures/criteria
 - requirements of any plan or program required under this consent
 - monitoring results of previous years
 - relevant predictions in the EA documents listed in the approval condition A2(c)
- identify any non-compliance or incidence which occurred in the previous calendar year, and describe what actions were (or are being) taken to ensure compliance and avoid recurrence
- evaluate and report on compliance with the performance measures, criteria, and operating conditions of the development
- identify any trends in the monitoring data over the life of the development
- identify any discrepancies between the predicted and actual impacts of the development and analyse the potential cause of any significant discrepancies
- describe what measures will be implemented over the next calendar year to improve the environmental performance of the development.

10.2 Auditing

In accordance with Condition F13 of the Development Consent, an Independent Environmental Audit will be undertaken by a suitably qualified auditor and include experts in any field specified by the Secretary within 12 months of the approval and every three years after that.

This audit must:

- be prepared in accordance with the Independent Audit Post Approval Requirements (DPIE 2020 or as updated)
- be led and conducted by a suitably qualified, experienced and independent auditor whose appointment has been endorsed by the Planning Secretary
- be conducted by a suitably qualified, experienced and independent team of experts (including any expert in field/s specified by the Planning Secretary) whose appointment has been endorsed by the Planning Secretary
- include consultation with the relevant agencies and the CCC

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- assess the environmental performance of the development and whether it is complying with the relevant requirements in the approval water licences and mining leases for the development (including any assessment, strategy, plan or program required under these approvals)
- review the adequacy of any approved strategy, plan or program required under the abovementioned approvals
- recommend appropriate measures or actions to improve the environmental performance of the development, and/or any assessment strategy, plan or program required under these approvals
- be conducted and reported to the satisfaction of the Planning Secretary.

In accordance with Condition F14 of the Development Consent WCL would submit a copy of the audit report, along with responses to any recommendations contained within the report to the Planning Secretary. The audit and response to recommendations would be submitted within three months of the completion of the audit unless otherwise agreed by the Planning Secretary.

10.3 Plan Revision

In accordance with Condition F7 of the Development Consent, this PSMP will be reviewed within three months of:

- the submission of an incident report as per Condition F9
- the submission of an annual review under Condition F11
- the submission of an Independent Environmental Audit under Condition F13
- any modification to the conditions of approval (unless the conditions require otherwise or as otherwise agreed with DPIE).

The revision status of this PSMP is indicated in the footer of each copy. Revisions to any documents listed within this PSMP will not necessarily constitute a revision of this document.

Where revisions are required, the document would be submitted to DPIE within six weeks of the review.



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11 REFERENCES

DPIE, 2020. Independent Audit Post Approval Requirements, <https://www.planning.nsw.gov.au/-/media/Files/DPE/Other/Assess-and-regulate/About-Compliance/independent-audit-post-approval-requirements-2020-05-19.pdf>

The Independent Planning Commission of NSW Development Consent Russell Vale Revised Preferred Underground Expansion Project MP09_0013.

SCT Operations (2014), *Update of Subsidence Assessment for Wollongong Coal Preferred Project Report Russell Vale No. 1 Colliery*.

SCT, 2019. Russell Vale Colliery: Subsidence Assessment for Proposed Workings in Wongawilli Seam at Russell Vale East. SCT report number: UMW4609.

SCT Operations, 2021. Russell Vale Colliery: Subsidence Assessment for PC07-08 and PC21-25 Extraction Plan.

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12 GLOSSARY OF TERMS AND ABBREVIATIONS

Abbreviations	
CCC	Community consultative committee
DPIE	Department of Planning, Industry and Environment
EP	Extraction Plan
LGA	Local Government Area
MSB	Mine Subsidence Board
IPC	Independent Planning Commission
PSMP	Public Safety Management Plan
RMS	Roads and Maritime Services (formerly the Roads and Traffic Authority)
ROM	Run of Mine
RPPR	Revised Preferred Project Report
RR	Resource Regulator
TARP	Trigger Action Response Plan
UEP	Underground Expansion Project
WNSW	Water NSW
WCL	Wollongong Coal Limited

Terms	
Baseline data	Monitoring conducted over time to collect a body of information to define specific characteristics of an area (e.g. species occurrence or noise levels) prior to commencement of a specific activity.
Bord and pillar	Mining method comprising of a series of self-supporting roadways (or bords) within the coal seam leaving a grid of pillars of unmined coal which are designed to be stable in the long term.
Built Features	Included any building or work erected or constructed on land, and included swellings and infrastructure such as any formed road, street, path walk, or driveway; any pipeline, water, sewer, telephone, gas or other service main.
Development Consent (the approval)	Russell Vale Revised Underground Expansion Project MP09-0013
Driveage	A horizontal or inclined heading or roadway in the process of construction. The roadway will be used to access a new mining area within the lease.
Dyke	A sheet like vertical intrusion of igneous rock cutting across the strata of older rocks.
Ecosystem	An interacting system of animals, plants, other organisms and non-living parts of the environment.
Fault	Major fracture of the earth's crust caused by the relative movement of the rock masses on either side.
First Workings	Involves the development headings or roadways which will provide access to the coal resource. They are developed using continuous miners with integrated roof and rib bolting rigs. First workings leave the coal pillars intact and the overlying strata fully supported

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Terms	
Goaf (or goafing)	The space left following extraction of the coal seam where the roof material is allowed to collapse.
Habitat	The particular local environment occupied by an organism.
Incident	An occurrence or set of circumstances that cause or threaten to cause material harm and which may or may not be or cause a non-compliance
Infrastructure	The supporting installations and services that supply the needs of the Project.
Land	Has the same meaning as the definition of the term in section 1.4 the EP&A Act, except for where the term is used in the noise and air quality conditions in PART B of this consent where it is defined to mean a whole of a lot, or contiguous lots owned by the same landowner, in a current plan registered at the Land Titles Office at the date of the development consent.
Longwall	A secondary extraction method of mining coal that continuously removes the coal from the working face onto a series of conveyors that transfer the coal to the surface. As the coal is cut away (a 'shear'), both the longwall machine (known as a 'shearer') and the hydraulic roof supports advance forward ready for the next shear.
Material Harm	Is harm to the environment that: <ul style="list-style-type: none"> Involves actual or potential harm to the health or safety of human beings or to the environment that is not trivial, or Results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding \$10,000 (such loss includes the reasonable cost and expenses that would be incurred in taking all reasonable and practicable measures to prevent, mitigate or make good harm to the environment)
Mine Operations	The carrying out of mining, including the extraction, processing, stockpiling and transportation of coal on the site and the associated removal, storage and/or emplacement of vegetation, topsoil, overburden and reject material.
Non-compliance	An occurrence, set of circumstances or development that is a breach of the development consent.
Pillar Extraction	A continuous miner system of mining whereby coal pillars are systematically extracted.
Pillar Run	A large scale progressive collapse of coal pillars in a short period of time.
Privately-owned Land	Land that is not owned by a public agency or a mining, petroleum or extractive industry company (or its subsidiary or related party).
Project Approval	Russell Vale Revised Underground Expansion Project MP09-0013
Public infrastructure	Linear and related infrastructure and the like that provides services to the general public, such as roads, railways, water supply, drainage, sewage, gas supply, electricity, telephone, telecommunications etc.
Rehabilitation	The restoration of a landscape and especially the vegetation following its disturbance.
Second Workings	Extraction of coal from bord and pillar workings
Strain	The change in the horizontal distance between two points divided by the original horizontal distance between the points.
Subsidence	The totality of subsidence effects, subsidence impacts and environmental consequences of subsidence impacts
Subsidence effects	Deformation of the ground mass due to mining, including all mining-induced ground movements, such a vertical and horizontal displacement, tilt, strain and curvature.
Subsidence impacts	Physical changes to the ground and its surface caused by subsidence effects, including tensile and shear cracking of the rock mass, localised buckling of strata caused by valley closure and upsidence and surface depressions or troughs.



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Terms	
Tilt	The difference in subsidence between two points divided by the horizontal distance between the points.
Upsidence	Relative upward movement, or uplift, created by the horizontal compression and buckling behaviour of the rock strata in the vicinity of a valley floor
Valley closure	A phenomenon whereby one or both sides of a valley move horizontally towards the valley centreline, due to changed stress conditions beneath the valley and its confining land masses

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APPENDIX A – TRIGGER ACTION RESPONSE PLAN

Aspect	Monitoring				Trigger			
	Location	Parameters	Frequency/timing	Purpose	Level	Action/Reporting	Report Timing	Responsibility
Public Safety Features	All public safety features present within the PRP Application Area as outlined within the PSMP.	Visual Monitoring of EP Area	Monitoring of key landscape features prior to, during and post mining for any potential impacts will be undertaken to confirm that the mine design measures to prevent such impact are adequate and in accordance with the Development Consent.	To determine if subsidence effects resulting from bord and pillar mining system result in impacts to public safety.	Within prediction (Level 1): No change in condition of features observed.	Continue monitoring. Report negligible impact in six monthly reports.	Six monthly reporting in accordance with Extraction Plan approval.	Russell Vale Colliery (Environmental Manager)
					Within prediction (Level 2): Change in features condition is predicted to occur. No change to the condition of features is observed.	Continue monitoring. Inform DPIE and WaterNSW of potential impact. Undertake site inspection to document and photograph any observed changes/ impacts. Report potential impacts in six monthly reports.	DPIE and WaterNSW informed within one week. Six monthly reporting in accordance with Extraction Plan approval.	Russell Vale Colliery (Environmental Manager)



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Aspect	Monitoring				Trigger			
	Location	Parameters	Frequency/timing	Purpose	Level	Action/Reporting	Report Timing	Responsibility
					Exceeding prediction (Level 3): Change in features condition is observed, and impact greater than predicted occurs.	Make area safe as soon as practicable. Continue monitoring. Inform DPIE and WaterNSW of potential impact. Undertake site inspection to document and photograph any observed changes/impacts. Discussion of potential remediation/mitigation. Consultation with relevant stakeholders will be required if remediation or mitigation measures are required. Use appropriate specialists to undertake physical remediation activities. Report potential impacts in six monthly reports.	DPIE and WaterNSW and informed within one week. Commence preparation of mitigation/action and monitoring plan within one week (if required). Six monthly reporting in accordance with Extraction Plan approval.	Russell Vale Colliery (Environmental Manager)



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APPENDIX B – CONSULTATION

Trescinda Brown

From: Richard Sheehan <richard.sheehan@wcl.net.au>
Sent: Tuesday, 10 August 2021 2:21 PM
To: Trescinda Brown
Cc: Luke Bettridge
Subject: FW: Submission of RVC Extraction Plan_Land Management Plan and Public Safety Plan for WNSW review
Attachments: fig2_21174_003_30K_Natural_Features_rev1.pdf; RVC EC PLN 009_Public Safety Management Plan _Rev 3_Draft.docx; 21174_Russell Vale UEP Land Management Plan_V2_Draft.docx

From: Richard Sheehan <richard.sheehan@wcl.net.au>
Sent: Tuesday, 3 August 2021 9:21 PM
To: 'Jessie Evans' <Jessie.Evans@waternsw.com.au>
Cc: 'Ravi Sundaram' <ravi.sundaram@waternsw.com.au>; 'Devendra Vyas' <DVyas2@wcl.net.au>
Subject: RE: Submission of RVC Extraction Plan_Land Management Plan and Public Safety Plan for WNSW review

Good evening Jessie and Ravi,

Further to our correspondence as attached please see for your information and review the WCL Extraction Plan Land Management Plan and Public Safety Plan in draft form.

To support the review of the Land Management Plan please also see the Figure 4 showing the identified natural features.

If you have any questions or comments on the attached please contact me at your convenience.

Regards

Richard Sheehan
Group Environmental & Approvals Manager



Wollongong Coal Limited
Russell Vale Colliery
7 Princes Highway, Corrimal NSW 2518
PO Box 281, Fairy Meadow NSW 2519
☎ Mob: 0404 972 746
✉ Email: Richard.sheehan@wcl.net.au

From: Richard Sheehan <richard.sheehan@wcl.net.au>
Sent: Thursday, 17 June 2021 10:28 PM
To: 'Jessie Evans' <Jessie.Evans@waternsw.com.au>
Cc: 'Ravi Sundaram' <ravi.sundaram@waternsw.com.au>
Subject: RE: Management plans

Thanks Jessie

Apologies as we had suggested we might have been able to meet to discuss last Friday as there are overlapping requirements with regard to the Land Management Plan, Public Safety Plan, and the Built Features Plan if we consider the high water line of the dam as that defining line for the asset being the dam catchment. I will take the points raised and get back to you on the specifics of a response including which document will address this requirement.

In addition we have consult with WNSW for comment via the DPIE portal, specifically reference PAE-20016268 and (MP09_0013-PA-19) being the UEP Extraction Plan Water Management Plan.

We are looking to complete the consultation phase of this management plan in the coming days so we can move towards finalisation and submission to DPIE next week in association with the Draft Extraction Plan. As such it would be greatly appreciated if you were able to provide comment early in the new week.

Regards

Richard Sheehan
Group Environmental & Approvals Manager



Wollongong Coal Limited
Russell Vale Colliery
7 Princes Highway, Corrimal NSW 2518
PO Box 281, Fairy Meadow NSW 2519
☎ Mob: 0404 972 746
✉ Email: Richard.sheehan@wcl.net.au

From: Jessie Evans <Jessie.Evans@waternsw.com.au>
Sent: Monday, 7 June 2021 9:53 AM
To: Richard Sheehan <richard.sheehan@wcl.net.au>
Cc: Ravi Sundaram <ravi.sundaram@waternsw.com.au>
Subject: Management plans

Hi Richard,

At the TWG we discussed getting together to work out what it include in the management plans Wollongong Coal is required to prepare. Having reviewed the conditions, I don't think we necessarily need to meet but Kel and I have put together some points for you to consider below. I strongly recommend having a look at Metropolitan Coal's management plans (available on their website) as they have similar requirements.

Management plans should look at the following, in particular,

- Roads - damage to roads from mining subsidence and overuse is a water quality and management issue. Long term use of roads and tracks and who pays for ongoing maintenance including cleaning out culverts and drains and repairs after heavy rain. What tracks are WCL going to manage?
- Infrastructure – Any WNSW assets needs to have a dilapidation survey to note current condition and recognise any damage from mining.
- Swamps – Access to piezometers in the middle of swamps needs to be minimised so that broad access ways are not made, minimal disturbance.
- Gates and fences need to be maintained in their current condition, no additional locks to maintain security.

I hope that helps.

Thanks

Jessie Evans

Mining Manager, Catchment Protection

For noting: *I am currently working remotely.
Please reach me via email or on my mobile*



Level 14, 169 Macquarie Street

PO Box 398

Parramatta NSW 2150

M: 0436 861 165

jessie.evans@waternsw.com.au

www.waternsw.com.au

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Consent: F2020/3092

Wollongong Coal Limited
PO Box 281
FAIRY MEADOW NSW 2519

ACN: 111 244 896

Attention: Mr Richard Sheehan, Group Environmental & Approvals Manager

Email: richard.sheehan@wcl.net.au

Special Area Consent – Issued under Division 1 of Part 3 of the Water NSW Regulation 2020

CONSENT SUMMARY

Consent No:

F2020/3092

Name of Consent Holder:

Wollongong Coal Limited

Address of Consent Holder:

7 Princes Highway, CORRIMAL NSW 2518

Commencement date:

4 March 2021

Expiry date:

3 March 2026

Hours of Operation

24 hours per day, 7 days per week unless otherwise specified in EP&A Act approval to a specific Permitted Activity

Contacts

Water NSW Incident Notification Number:

Ph: 1800 061 069

Operational issues:

Water NSW Catchment Assets Manager

Ph: 02 4886 9416

Material changes to Statutory Approvals:

Water NSW Mining Manager

Ph: 0436 861 165

Standard Conditions

1 Grant of Consent

1.1 Consent

- 1.1.1 In accordance with the provisions of Division 1 of Part 3 of the Water NSW Regulation 2020, Water NSW grants to the Consent Holder, Consent to enter upon and to pass and repass through the Special Area to enter and remain on the Designated Area for the purpose of undertaking the Permitted Activity in accordance with the conditions of this Consent.
- 1.1.2 The Consent Holder does not commit an offence under Part 3 of the Water NSW Regulation 2020 by reason of anything done in accordance with a Statutory Approval.
- 1.1.3 The Consent Holder must not undertake any activity in the Designated Area other than the Permitted Activity.
- 1.1.4 The employees, consultants and contractors of the Consent Holder who enter the Designated Area on behalf of the Consent Holder must comply with the Conditions on this Consent.
- 1.1.5 This Consent also extends to stakeholders of the Consent Holder as long as they are accompanied by an employee, consultant or contractor of the Consent Holder, on the condition that the Water NSW Catchment Assets Manager is informed 48 hours prior to entering the Designated Area, via the special_area_access@waternsw.com.au email address.

1.2 Term of Consent

The Consent is granted to the Consent Holder up until the Expiry Date or until such time as the Consent Holder ceases undertaking the Permitted Activity, whichever occurs first.

1.3 Responsibility for other persons

The Consent Holder must ensure that all persons carrying out the Permitted Activity in the Designated Areas are familiar with the terms of this Consent, including the requirement to comply with the conditions of this Consent.

1.4 Reservation of Rights by Water NSW

This Consent does not limit the statutory powers of Water NSW under the *Water NSW Act 2014* or the Water NSW Regulation 2020 or any other law.

1.5 No assignment

Subject to Condition 1.1.1, this Consent is personal to the Consent Holder and the Consent Holder may not assign, transfer, charge or otherwise deal with or dispose of its interest in this Consent.

2 Regulatory Conditions

2.1 Access to Information

The Consent Holder must notify the Water NSW Mining Manager, in writing, as soon as practical when there is a material change to any Statutory Approval.

2.2 Compliance with Statutory Requirements

The Consent Holder must comply with the Statutory Approvals in undertaking the Permitted Activity.

2.3 Consent Fee and Cost Recovery

2.3.1 The Consent Holder must pay to Water NSW the Consent Fee, if required, in the manner set out in Item 8 of the Reference Schedule (Schedule 1).

2.3.2 The Consent Holder must pay to Water NSW all reasonable costs incurred by Water NSW to engage suitably qualified and independent experts to review and advise for the purpose of determining:

- (a) the adequacy of any plans or monitoring programs reasonably required as a condition of this Consent; and
- (b) whether the Consent Holder has complied with the conditions of this Consent.

2.3.3 The Consent Holder must pay to Water NSW all rehabilitation and compliance costs incurred by Water NSW by reason of the breach of this Consent by the Consent Holder. Where possible Water NSW will consult with the Consent Holder in determining the value of these costs.

2.4 Goods and Services Tax

All sums payable under this Consent are exclusive of GST. Where those payments are consideration for a taxable supply, or adjustments to the consideration of a taxable supply, the amount payable will be increased by a sum equal to the amount of the payment multiplied by the then current rate of GST.

3 Operating Conditions

3.1 General

3.1.1 Subject to the terms of the Statutory Approvals, the Consent Holder is permitted to access the Designated Area during the Hours of Operation as set out in Item 6 of the Reference Schedule (Schedule 1).

3.1.2 Water NSW may restrict access to the Designated Area in accordance with the Water NSW Regulation 2020 at any time due to weather or fire conditions or any other operational and/or safety reason.

3.1.3 The Consent Holder must ensure all employees, contractors and consultants undertake any Designated Area inductions and training sessions reasonably required by Water NSW prior to their first entry onto the Designated Area and from time to time as required during the term of the Consent.

3.1.4 The on-site supervisor while conducting the Permitted Activity, must have in their possession a copy of this Consent, any environmental assessments, Statutory Approvals and associated Conditions of Approval, any related environmental management plan, rehabilitation plan, revegetation plan, soil and water management plan, water monitoring plan, the Safe Work Plan and a copy of all licences, permits and other approvals that are required in relation to the Consent Holder's activities in the Designated Area, available for reference purposes.

- 3.1.5 Waste as defined under the *Protection of the Environment Operations Act 1997* must not be brought into the Special Area.
- 3.1.6 Any imported fill material to be used in the Designated Area must be restricted to 'Virgin Excavated Natural Material' (VENM) that is not mixed with any other waste.
- 3.1.7 Prior to entry, all vehicles, machinery, and equipment to be used in the Special Area must be washed down, free of weeds, seeds, and soil.
- 3.1.8 Activities conducted under this Consent that are likely to cause a fire or create a fire hazard are not permitted without prior written approval from Water NSW.
- 3.1.9 All vehicles, machinery and equipment used by the Consent Holder in the Designated Area must be maintained in proper and efficient condition, be without risks to the health and safety of persons and must be operated in a safe, proper, and efficient manner.
- 3.1.10 Wet weather access must be in accordance with the approved *Special Area Wet Weather Management Plan* and *Special Area Wet Weather Trigger Action Response Plan* (Schedule 8).
- 3.1.11 The employees, consultants, and contractors of the Consent Holder:
- a) may not access the Designated Area or any Water NSW water storages, rivers, lakes or other watercourses within the Designated Area by boat unless the Consent Holder obtains prior written approval from Water NSW and complies with the current version, as amended from time to time, of Water NSW's Safe Use of Watercraft Procedure, which is attached to this Consent; and
 - b) when working in or near water, as defined by Water NSW's Working in or Near Water Procedure which is attached to this Consent, must comply with Water NSW's Working in or Near Water Procedure.
- 3.1.12 Storage of fuels, oils or chemicals is not permitted in the Designated Area unless the Consent Holder obtains prior written approval from Water NSW or unless permitted by a Statutory Approval.
- 3.1.13 Appropriate and effective erosion and sediment controls must be designed, installed and maintained for areas disturbed as a result of the Permitted Activity, in accordance with *Landcom's Managing Urban Stormwater – Soils and Construction – Volume 1, 4th Edition 2004* (the 'Blue Book') until disturbed areas are stabilised.

3.2 Notification of Intent to Enter

- 3.2.1 Notification of the details of the employees, consultants and contractors of the Consent Holder involved in the Permitted Activity must be provided to Water NSW prior to their entry on the Designated Area.
- 3.2.2 The Consent Holder must notify Water NSW in relation to entry under this Consent at least two (2) business days prior to any inspection work and at least one (1) week prior to commencing works.
- 3.2.3 Notification must be through the special_area_access@waternsw.com.au email address. The notification must include the Consent reference number (**F2020/3092**), the specific location, dates of entry, description of work, vehicle types and registration numbers, and at least one contact telephone number of personnel conducting the works onsite.

3.3 Roads and Fire Trails

- 3.3.1 The Consent Holder must comply with the Water NSW's Road and Fire Trail Rules listed in Schedule 7.
- 3.3.2 The Consent Holder may utilise Water NSW roads and fire trails listed in Schedule 4.
- 3.3.3 The roads and fire trails that are the sole responsibility of the Consent Holder to maintain and repair are indicated in Schedule 4.
- 3.3.4 The Consent Holder must maintain and repair the roads and fire trails listed in Schedule 4 in accordance with the documents: *Managing Urban Stormwater – Soils and Construction – Volume 2C – Unsealed Roads* (Department of Environment & Climate Change NSW, 2008) and *NSW Rural Fire Service Fire Trail Design, Construction and Maintenance Manual* (Soil Conservation Service, 2017) (Schedule 5).

3.4 Security

- 3.4.1 When entering or exiting the Designated Area the Consent Holder must ensure that all site entry points including gates and barriers remain closed, locked or otherwise secured to prevent unauthorised entry to the Designated Area.
- 3.4.2 Any damaged gates or barriers must be temporarily secured by the Consent Holder and reported immediately to the Water NSW Incident Notification Number as shown in the Consent Summary.
- 3.4.3 The employees, contractors and consultants of the Consent Holder must:
 - (a) carry photographic identification which must always include the name and address of their employer when they are in the Designated Area; and
 - (b) produce the photographic identification if requested by an Authorised Officer of Water NSW.
- 3.4.4 Where short term or one-off access is required by contractors or consultants, they do not require photographic identification, provided they are accompanied by the Consent Holder who has photographic identification as required by 3.4.3(a).
- 3.4.5 Water NSW keys are issued to the Consent Holder for use by employees, contractors, and consultants of the Consent Holder. Water NSW keys are issued subject to the following conditions:
 - (a) Water NSW keys must only be used to access the Designated Area in accordance with the conditions of this Consent.
 - (b) keys are issued to the Consent Holder and must not be transferred.
 - (c) if the Consent Holder no longer requires access to the Designated Area to conduct the Permitted Activity or when this Consent expires, the Consent Holder must return all Water NSW issued keys to Water NSW.
 - (d) if a key is lost, the Consent Holder must notify Water NSW within 24 hours of becoming aware that the key has been lost. Notification must be made in writing to the Water NSW Catchment Assets Manager via the special_area_access@waternsw.com.au email address;

- (e) new keys will not be issued by Water NSW without a written request which provides detailed reasons why a new key is required. The Consent Holder will bear any costs incurred by Water NSW to issue new keys.
- (f) the Consent Holder agrees that all keys remain Water NSW property and undertakes to return keys from a key holder as soon as the valid need for access ceases; and
- (g) the Consent Holder agrees, if requested, to pay a bond of \$150.00 per key issued.

- 3.4.6 The Consent Holder must not place its own locks on gates in or to the Designated Area unless it obtains the prior written approval of Water NSW.
- 3.4.7 The Consent Holder must maintain a current list of all employees and contractors who have a Water NSW key in their possession and make that record available to Water NSW on request.
- 3.4.8 The Consent Holder must maintain a log of all persons entering the Designated Area under this Consent which includes details of the time of entry and exit on each day.

3.5 Waste Management

- 3.5.1 The Consent Holder must provide and maintain toilet facilities on the site where two or more persons are working in one location for a period of two days or more, and all site personnel must use and be instructed to use such facilities.
- 3.5.2 Where toilet facilities are not required by the Consent, human organic waste must be buried to a depth of no less than 150 millimetres and not within 100 metres of stored waters, creeks or drainage lines.

3.6 Work Health & Safety

- 3.6.1 All activities under this consent must be carried out in accordance with the duties under Work Health and Safety legislation.
- 3.6.2 Persons entering the Special Area must take reasonable care for his or her own health and safety and take reasonable care that his or her acts or omissions do not adversely affect the health and safety of other persons.
- 3.6.3 All activities under this consent must be carried out in accordance with an appropriate, relevant and specific Safe Work Plan (SWP), which has been approved or endorsed by the Consent Holder.
- 3.6.4 The employees, consultants, and contractors of the Consent Holder, when entering the Designated Area, must have suitable communications in place for reliable and effective use in remote areas, and have suitable arrangements in place to ensure safe egress from these areas.

4 Reporting Conditions

4.1 Incident Management

- 4.1.1 The Consent Holder must make each of its employees, consultants and contractors aware of the need to report and provide information via the **Water NSW Incident Notification Number (1800 061 069)** of any reportable designated incidents or events which are specified in Conditions 4.1.2, 4.1.3 and 4.1.4.

- 4.1.2 If the Consent Holder is required to report an incident or non-compliance under a Statutory Approval, the Consent Holder must also report that incident to Water NSW as soon as reasonably possible after becoming aware of that incident.
- 4.1.3 If a pollution incident occurs in the course of the Permitted Activity in the Designated Area so that material harm is caused or threatened to the environment as defined in section 147(1) of the *Protection of the Environment Operations Act 1997* the Consent Holder must notify Water NSW immediately of the incident and provide all relevant information.
- 4.1.4 If any Aboriginal or European cultural heritage site or artefact (as defined by the *National Parks and Wildlife Act 1974* or *Heritage Act 1977*) is identified during the Permitted Activity and does not already have an appropriate heritage plan that is being implemented, the Consent Holder's employees, consultants and/or contractors must **Stop Work immediately** at the location and ensure no further harm to the object. The Consent Holder must immediately report the find to Water NSW, and report to the regulator in accordance with legislation. The Permitted Activity must not commence in the vicinity of the find until any required approvals have been granted by the regulator. In the event that skeletal remains are encountered, the area must be secured to prevent unauthorised access and the Consent Holder must immediately contact NSW Police and Water NSW.

4.2 Non-Compliance

- 4.2.1 If the Consent Holder fails to comply with any condition of this Consent, the Consent Holder must notify Water NSW immediately upon becoming aware of the breach through the **Water NSW Incident Notification Number (1800 061 069)**. The Consent Holder must also provide Water NSW with a comprehensive written report in relation to the non-compliance within 14 days of first becoming aware of the non-compliance. The following must be addressed in the written report:
- (a) Consent reference and Condition number not complied with.
 - (b) Summary of particulars of non-compliance (no more than 50 words).
 - (c) Dates when the non-compliance occurred.
 - (d) Precise location where the non-compliance occurred (attach a map or diagram).
 - (e) Cause of Non-compliance.
 - (f) Action taken to mitigate any adverse of the non-compliance.
 - (g) Action taken to prevent a recurrence of the non-compliance.
- 4.2.2 The Consent Holder's compliance with the conditions of this Consent may be the subject of monitoring or audit by Water NSW from time to time. The Consent Holder must fully cooperate in the compliance monitoring or audit process.

4.3 Annual Statement of Compliance

The Consent Holder must provide Water NSW with a signed copy of the Russell Vale Colliery and Wongawilli Colliery Annual Environmental Management Report (AEMR), required under the mining leases outlined in Schedule 1 Item 2, containing an 'Annual Statement of Compliance with Consent Conditions' which is consistent with the form set out in Schedule 6. The annual statement of compliance will indicate compliance or otherwise with the conditions in this Consent for each 12 month reporting period (being 1 July to 30 June) with the reports due annually by 30 September, in line with the AEMR reporting period. The Consent Holder must sign and endorse the AEMR and submit it to Water NSW via email to compliance@waternsw.com.au.

5 General Conditions

5.1 Release

By accessing the Designated Area, the Consent Holder agrees to exercise the rights granted by Water NSW at its own risk and to release to the full extent permitted by law, Water NSW, its employees, agents and contractors, in the absence of any negligence on their part from all suits, actions, demands and claims of every kind resulting from any damage or destruction to any property (both real and personal) and injury suffered or sustained by any persons (including death) arising out of or in connection with the Permitted Activity.

5.2 Indemnity

- 5.2.1 By accessing the Designated Area, from the date of the consent, the Consent Holder agrees to indemnify and keep indemnified, Water NSW, its employees, agents and contractors in the absence of any negligence on their part from and against all its actions, demands, claims, proceedings, losses, damages, costs (including legal costs), charges or expenses incurred by Water NSW or for which Water NSW may become liable resulting from any damage or destruction to any property (both real and personal) and injury suffered or sustained by any persons arising out of or in connection with the Permitted Activity.

5.3 Warranty

Water NSW provides no warranty that the Designated Area is suitable for the Permitted Activity.

5.4 Insurance

- 5.4.1 The Consent Holder must, prior to accessing the Designated Area, provide Water NSW with a certificate of currency for Public Liability Insurance for the amount specified in Item 7 of the Reference Schedule covering property, injury or death arising from the Consent Holder undertaking the Permitted Activity in the Designated Area.
- 5.4.2 The policy must note the insurable interest of Water NSW.

5.5 Additional conditions

The Consent Holder must comply with the additional conditions contained in Schedule 2. To the extent that there is any inconsistency between the standard conditions of this Consent and the additional conditions in Schedule 2, the additional conditions take preference to the standard conditions in this Consent, to the extent necessary to resolve the inconsistency.

5.6 Definitions

- 5.6.1 In this Consent unless the contrary intention appears:
- a) **Authorised Officer** means a member of staff, and includes any class of persons prescribed by the regulations, who is designated by Water NSW as an authorised officer whose official duties are concerned with the enforcement of the *Water NSW Act 2014* and the *Protection of the Environment Operations Act 1997* or their regulations or with the investigation or prosecution of offences or alleged offences against these Acts or the regulations.

- b) **Authority** means any government or any governmental, semi-governmental, quasi-governmental, administrative, or judicial body, department, commission, authority, tribunal, or entity which has power to provide a Statutory Approval.
- c) **Commencement Date** means the commencement date of the Consent set out at Item 3 of the Reference Schedule.
- d) **Consent** means this document and all schedules to it.
- e) **Consent Holder** means the party identified at Item 1 of the Reference Schedule.
- f) **Consent Holder's Equipment** means all the equipment brought onto the Designated Area by the Consent Holder, its employees, contractors, and consultants.
- g) **Consent Fee** means the amount payable by the Consent Holder in accordance with Condition 2.3 and set out in Item 8 of the Reference Schedule.
- h) **Designated Area** means that part of Water NSW land described in Item 2 of the Reference Schedule.
- i) **EP&A Act** means the *Environmental Planning and Assessment Act 1979*.
- j) **Expiry Date** means the date of the Consent will expire as set out at Item 4 of the Reference Schedule.
- k) **Hours of Operation** means times at which the Consent Holder is permitted to access the Designated Area for the purpose of the Permitted Activity. Hours of Operation are outlined in the Consent Summary and Item 6 of the Reference Schedule.
- l) **Permitted Activity** means the activity for which the Consent is required as described in Item 5 of Reference Schedule.
- m) **Reference Schedule** means Schedule 1 of this Consent.
- n) **Statutory Approval** means any licence, approval or consent issued by any Authority permitting the Consent Holder to undertake the Permitted Activities in the Designated Area.
- o) **Water NSW Act** means *Water NSW Act 2014*.
- p) **Water NSW Regulation** means *Water NSW Regulation 2020*.
- q) **Water NSW Road and Fire Trail Rules** means the rules set out in Schedule 7.



Fiona Smith
Executive Manager Water and Catchment Protection
Water NSW

DATE: 3 March 2021

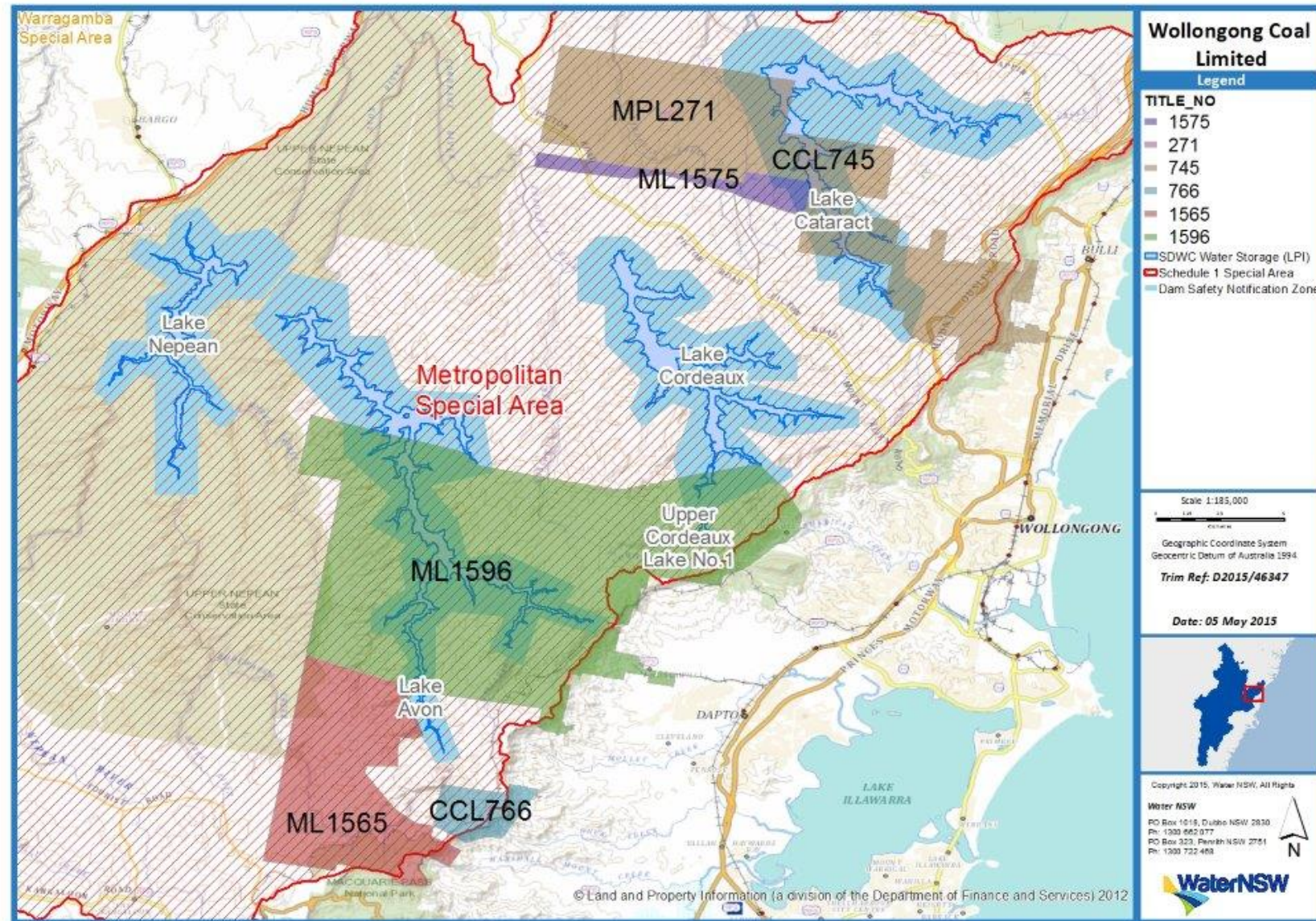
Schedule 1 – Reference Schedule

Item 1	Consent Holder:	Wollongong Coal Limited
Item 2	Designated Area:	The surface area of the Metropolitan Special Area associated with ML1565, ML1575, ML1596, MPL271, CCL745 & CCL766 as required to be accessed in accordance with a Statutory Approval as detailed in the map provided at Schedule 3.
Item 3	Commencement Date:	4 March 2021
Item 4	Expiry Date:	3 March 2026
Item 5	Permitted Activity:	To enter and remain on Special Area land and carry out activities that are otherwise prohibited by the Water NSW Regulation 2020 to the extent necessary to carry out the requirements of any Statutory Approval.
Item 6	Hours of Operation:	24 hours per day, 7 days per week unless otherwise specified in EP&A Act approval to a specific Permitted Activity.
Item 7	Insurance	Public Liability Insurance of up to \$25M for any one occurrence unlimited to the number of occurrences in any one policy year.
Item 8	Consent Fee	Not used.

Schedule 2 – Additional Conditions

Not Applicable.

Schedule 3 – Map showing location of ML1565, ML1575, ML1596, MPL271, CCL745 and CCL766



Schedule 4 – List of Fire Trails as at 3 March 2021

List of Water NSW roads and fire trails which may be utilised under this Consent:

1
1F
6A
6D
6F
6G
7
7C
7D
7J
7L
7M
8
8A*
8C*
8H
9G*
12
12B
15
15A
15E
15F
15G
15H
15I
15J
15M

** indicates the roads and fire trails that are the sole responsibility of the Consent Holder to maintain and repair in accordance with Schedule 5, except where damage is caused by another user

Schedule 5 – Managing Urban Stormwater – Soils and Construction – Volume 2C – Unsealed Roads, and NSW Rural Fire Service Fire Trail Design, Construction and Maintenance Manual

Managing Urban Stormwater – Soils and Construction – Volume 2C – Unsealed Roads (Department of Environment & Climate Change NSW, 2008)

NSW Rural Fire Service Fire Trail Design, Construction and Maintenance Manual (Soil Conservation Service, 2017)

Schedule 6 – Annual Statement of Compliance with Consent Conditions

Consent Holder

Wollongong Coal Limited

Consent Number

F2020/3092

Reporting Period

{insert dates}

Compliance with Consent Conditions

1. Were all the following documents complied with during the reporting period? (tick a box)

Consent/Approval	Yes	No
a. Conditions of this Consent;		
b. All Statutory Approvals;		
c. Any environmental management plans, rehabilitation plans, revegetation plans, soil and water management plans, water monitoring plans or other plans required by Water NSW.		

2. If you answered “No” to any part of question 1, please supply the name of the non-compliance/incident and the date the written report was provided to Water NSW, in the table below:

Non Compliance / Incident (one line)	Date written report provided to Water NSW	Relevant section of Annual Review (if applicable)

3. How many pages have you attached?
(Each attached page must be initialled by the person(s) who signs Section 4 of this Statement of Compliance)

4. Signature and Certification

The Statement of Compliance must only be signed by a person(s) with legal authority to sign it as set out below:

- By affixing the Common Seal in accordance with *Corporations Act 2001*, or
- By 2 Directors, or
- By a Director and a Company Secretary, or
- By a person delegated to sign on the company's behalf in accordance with the *Corporations Act 2001* and approved in writing by Water NSW to sign on the company's behalf.

Signature:

Name:

(printed)

Position

Date:

Signature:

Name:

(printed)

Position

Date:

SEAL (if signing under Seal)

The Consent Holder can request Water NSW approval for the compliance requirements of this Consent to be linked to and built into other compliance reporting that may be required under approvals issued under the EP&A Act.

Schedule 7 – Water NSW Road and Fire Trail Rules

1. The driver of any vehicle must hold a current driver's licence and obey all speed advisory and warning signs. Vehicle speed must not exceed **40 km/h** on public access roads at WaterNSW owned sites such as picnic grounds unless otherwise signposted and **60 km/h** for all other Water NSW roads and fire trails unless otherwise signposted.
2. Any motor vehicle used to travel on any surface within the Designated Area must be registered and suitable for the purpose for which it is being used. The minimum vehicle standard for use in the non-publicly accessible areas within the Designated Area is a vehicle with All Wheel Drive or Four-Wheel Drive capabilities.
3. All vehicles must carry appropriate safety and recovery gear consistent with the Consent Holder's Safe Work Plan or other Work Health and Safety requirements.
4. All drivers of vehicles must be competent to operate or drive, and be appropriately licensed, for the type of vehicle in use.
5. The Consent Holder must not drive or use any road or fire trail in the Designated Area if the road or fire trail is not suitable for type of vehicle in use, or if driving or using any road or fire trail will result or is likely to result in damage to the road or fire trail or damage to the surrounding catchment area.
6. Vehicles must not be driven on the roads or fire trails in the Designated Area if they have been closed by Water NSW for any reason, unless permitted by this Consent.
7. Vehicles may only be driven on formed fire trails in the Designated Area, unless permitted by the Statutory Approvals.
8. Vehicles must not be driven around fallen branches and trees on any road in the Designated Area. The Consent Holder must remove any items obstructing the road or report their location to Water NSW. Vehicles must not progress along a road unless the obstruction has been removed first.
9. Entry is restricted to vehicles essential to undertake the Permitted Activity and vehicle movements must be kept to a minimum.
10. For this section, the term "vehicles" includes all vehicles including cars, trucks and any machinery driven on roads and fire trails.

Schedule 8 – Special Area Wet Weather Management Plan and Trigger Action Response Plan

WaterNSW Special Areas Wet Weather Management Plan dated 30 September 2020 (Wollongong Coal DOC ID: WCL EC PLN 004) – WaterNSW Reference number: D2021/9895

Wet Weather – Trigger Action Response Plan (TARP) dated 30 September 2020 (Wollongong Coal DOC ID: WCL EC TARP 001) – Water NSW Reference number: D2021/9897

Richard Sheehan

From: Ravi Sundaram <ravi.sundaram@waternsw.com.au> on behalf of Ravi Sundaram
Sent: Tuesday, 24 August 2021 3:02 PM
To: Richard Sheehan; Jessie Evans
Cc: Devendra Vyas
Subject: RE: RE: Submission of RVC Extraction Plan_Land Management Plan and Public Safety Plan for WNSW review

Hi Richard

Thank you for providing WaterNSW to review draft versions of the above plans. WaterNSW has reviewed the plans and has the following comments/suggestions for your consideration.

Public Safety Management Plan (PSMP)

Special Area Access Consent

Majority of the surface land overlying the proposed extraction area lies within WaterNSW land declared as a Special Area (specifically the Metropolitan Special Area) owned and managed by WaterNSW and provisions of the *WaterNSW Act 2013* and *WaterNSW Regulation 2020* apply. Maintaining the ecological integrity of the Special Areas is important and a key consideration of WaterNSW Mining Principles.

Section 2.3 Table 3 must list the Special Area Consent (Consent No. F2020/3092; commenced on 4th March 2021 and valid until 3rd March 2026) – Issued by WaterNSW under Division 1 of Part 3 of the *Water NSW Regulation 2020*.

Unsealed access roads and Fire trails (Section 6.1.3)

Fire trails within the Metropolitan Special Area and overlying the mining area have a low potential to be impacted by subsidence due to the mining method adopted. However, they can be directly impacted on the surface by WCL activities in relation to exploration and environmental monitoring. A list of Water NSW roads and fire trails which may be utilised by WCL are listed in Schedule 4 of the Consent. WCL is responsible for any damage caused to fire trails due to its surface activities and must have mitigation and contingency measures in place to ensure all WaterNSW fire trails are safe, serviceable and repaired as soon as practical.

Schedules in the WCL Special Area Consent detail necessary aspects in relation to maintenance of fire trails including:

- Schedule 5 – Guidelines
 - Managing Urban Stormwater – Soils and Construction – Volume 2C – Unsealed Roads, and
 - NSW Rural Fire Service Fire Trail Design, Construction and Maintenance Manual
- Schedule 7 - WaterNSW Road and Fire Trail Rules
- Schedule 8 – Special Area Wet Weather Management Plan and Trigger Action Response Plan

Section 7.1 Para 4 – reference to WaterNSW Standard Conditions must be deleted. Applicable conditions and requirements are listed in WCL's Special Areas Consent (F2020/3092) and in any approvals including specific activity approvals issued by WaterNSW under Part 5 of the EP&A Act. Section 7.3.1 – WaterNSW Special Areas: Reference to WaterNSW track maintenance guidelines (including the Track Stabilisation and Control Manual) needs to be deleted as it is no longer used by WaterNSW. Recommended guidelines are specified in Schedule 5 of WCL's Special Areas Access Consent. Schedule 7 of WCL's Access Consent also specifies WaterNSW's road and fire trail rules and Schedule 4 specifies roads and fire trails WCL can access within the Metropolitan Special Areas. A list of the most relevant ones overlying the Russell Vale Colliery proposed extraction area must be listed here that will be utilized, monitored and maintained.

Land Management Plan

Majority of the surface land overlying the proposed extraction area lies within WaterNSW land declared as a Special Area owned and managed by WaterNSW and provisions of the WaterNSW Act 2013 and WaterNSW Regulation 2020 apply. Maintaining the ecological integrity of the Special Areas is important and a key consideration of WaterNSW Mining Principles. Section 1.5 Natural Features must acknowledge this.

Section 2.3 Leases, Licences and Permits must list the Special Area Consent (Consent No. - F2020/3092; commenced on 4th March 2021 and valid until 3rd March 2026) – Issued by WaterNSW under Division 1 of Part 3 of the Water NSW Regulation 2020.

Please feel free to contact me if you need to clarify any information regarding the above.

Regards

Ravi

Ravi Sundaram
Mining Catchment Specialist



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Note: Please contact me by email or on my mobile until further notice as I may be working remotely.

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From: Richard Sheehan <richard.sheehan@wcl.net.au>

Sent: Tuesday, 3 August 2021 9:21 PM

To: Jessie Evans <Jessie.Evans@waterNSW.com.au>

Cc: Ravi Sundaram <ravi.sundaram@waterNSW.com.au>; Devendra Vyas <DVyas2@wcl.net.au>

Subject: ARK: RE: Submission of RVC Extraction Plan_Land Management Plan and Public Safety Plan for WNSW review

Good evening Jessie and Ravi,

Further to our correspondence as attached please see for your information and review the WCL Extraction Plan Land Management Plan and Public Safety Plan in draft form.

To support the review of the Land Management Plan please also see the Figure 4 showing the identified natural features.

If you have any questions or comments on the attached please contact me at your convenience.

Regards

Richard Sheehan

Group Environmental & Approvals Manager



Wollongong Coal Limited

Russell Vale Colliery

7 Princes Highway, Corrimal NSW 2518

PO Box 281, Fairy Meadow NSW 2519

☎ Mob: 0404 972 746

✉ Email: Richard.sheehan@wcl.net.au



Site	Russell Vale Colliery	DOC ID	RVE EC PLN 010
Type	Plan	Date Published	19/11/2021
Doc Title	Extraction Plan		

APPENDIX H: GROUNDWATER MANAGEMENT PLAN

Russell Vale Colliery
Revised Underground Expansion Project

WATER MANAGEMENT PLAN
Groundwater Management Plan

RVC EC PLN 006

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Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
Type	Plan	Date Published	17/11/2021
Doc Title	GROUNDWATER MANAGEMENT PLAN		

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1. INTRODUCTION

1.1 Project Background

The Colliery is an underground coal mine located at Russell Vale, approximately 8 kilometres (km) north of Wollongong and 70 km south of Sydney, within the Wollongong and Wollondilly local government areas (LGAs), as shown in **Figure 1-1**. The Colliery is owned and operated by Wollongong Coal. Wollongong Coal is majority owned by Jindal Steel and Power Limited (JSPL).

Underground mining has been undertaken at Russell Vale Colliery since the 1880. Mining has occurred in three coal seams, the Bulli Seam, Balgownie Seam and the Wongawilli Seam. Mining is currently only undertaken in the Wongawilli Seam with the mining in this seam initially approved under a development consent (project approval 10_0046) for the Preliminary Works Project (PWP) granted by the Planning Assessment Commission (PAC) on 13 October 2011. The Preliminary Works Approval (as modified) approved mining in three longwall panels, LW4, LW 5 and LW6. Mining has been completed in LWs 4 and 5 and 25 metres of LW6 remains to be extracted to enable the removal of the longwall miner.

Development consent for the RVE UEP Revised Underground Expansion Project (UEP) (MP09_0013) was granted by the NSW Independent Planning Commission (IPC) on 8 December 2020 to allow:

- Extraction of the final 25 metres of LW6 and the removal of the longwall miner.
- Mining using first working mining techniques within the Russell Vale East (RVE UEP) area, with the workings targeting the Wongawilli Seam designed to be long-term stable with imperceptible subsidence impacts.
- Extraction of approximately 3.7 Million tonnes (Mt) of run-of-mine (ROM) coal over a period of five years at a rate not exceeding 1.2 Mt of ROM coal per year and a production rate not exceeding 1 Mt of product coal per year.

The location and layout of historical and future mine operations for the RVE UEP are shown in **Figure 1-1**. The figure also shows the Extraction Plan mine layout that covers the initial year of operation, and indicative areas for ongoing operations.

1.2 Purpose and Scope

This Groundwater Management Plan (GWMP) has been prepared to address the combined consolidated consent conditions relevant to RVE UEP workings and the Extraction Plan. The GWMP relates to the groundwater systems potentially impacted by the approved operations. This Plan was prepared as a part of the Water Management Plan (WMP) as required by **Condition B17** and the Extraction Plan Water Management Plan (EP WMP) as required by **Condition C10g (iii)**. The general conditions of consent and general information detailed in the overarching WMP **RVC EC PLN 019** (developed in fulfilment of **Condition B17**) also apply to this GWMP, as a sub plan of the overarching WMP, as outlined in Section 1.3 of **RVC EC PLN 019**. This GWMP provides the specific detail on the relevant water management practices and process in compliance with the relevant consent conditions detailed in **Section 2**. This plan applies to the following features overlying or adjacent to the proposed extraction areas:

- Cataract Reservoir;
- Cataract Creek;

- Bellambi Creek;
- Bellambi Gully;
- Upland swamps; and
- Groundwater resources including Hawkesbury Sandstone.

This Plan addresses:

- Monitoring;
- Reporting;
- Impact assessment;
- Trigger levels to initiate implementation of management, remedial or contingency measures;
- implementation of remedial or contingency measures to groundwater systems if adverse mining induced degradation is observed;
- Access to piezometers; and
- Rehabilitation of groundwater systems and access routes, if required.

The aim of the plan is to:

- Monitor groundwater and swamp levels and water quality within the potentially affected areas;
- Assess potential changes to swamps and groundwater systems before, during and after mining;
- Identify hydraulic characteristics of the groundwater systems within the vicinity of the proposed workings;
- Determine potential changes to groundwater systems due to coal extraction and mine dewatering operations; and
- Report on any groundwater impact simulation and validation studies.

This GWMP has been prepared on a staged basis, in accordance with **Condition A21**, consistent with the project description outlined in Section 2.2 of **RVC EC PLN 019**. This plan applies to the operations described in Stage 1 and Stage 2a of the project, where no coal rejects are generated. If the company determines that it is financially viable to install the Coal Processing Plant (CPP) in Stage 2b, and coal rejects are to be generated, this WMP will be updated as outlined in Appendix G of **RVC EC PLN 019**.

1.3 Plan Preparation and Consultation

1.3.1 Preparation of the Plan

In recognition of the requirements of **Condition B17(a)**, this GWMP has been Prepared by a suitably qualified and experienced person, Ms Claire Stephenson from Umwelt (Australia) Pty Limited (Umwelt). Claire has Bachelor's degrees in Science (Geology) and Forestry with a first class research honours, a Master of Business Administration and is a certified lead auditor in Environmental Management Systems (ISO 14001:2015) with Exemplar Global. Claire has over 14 years' experience in groundwater consulting across Australia, with prior experience working in agriculture and forestry. Claire has extensive experience managing complex groundwater projects to meet Local Government, State and Commonwealth regulatory requirements. Over her career Claire has developed diversified skills and experience, including field investigation programs and fieldwork involving contaminated site sampling (soil and water), bore installation for water supply and monitoring, surface water and groundwater sampling, stygofauna sampling and hydraulic testing. Along with groundwater management plans, seepage investigations, water supply studies, compliance reporting (i.e. annual reviews and trigger reviews), planning and approvals (i.e. groundwater impact assessments). As well as numerical groundwater modelling, peer review, expert advice and independent auditing.

Claire has worked extensively on projects across NSW and has a good understanding of the site groundwater regime and predicted impacts, having assisted on the groundwater components of the RVE UEP Public Environment Report.

1.3.2 Consultation during the environmental assessment process

Extensive community and government consultation has been carried out prior to and during the preparation of the original EA, the Revised Project Report, the Submissions Report and other project-related assessment documentation. The primary objective of consultation was to keep the community, government agencies and other stakeholders informed and involved during project development process.

Surface water impacts associated with the Colliery and Bellambi Gully Creek Diversion Works have been a key concern to the local community. Community engagement has been carried out over a number of years and is summarised in Section 4.1.2 and Section 4.1.3 of the Revised Project Report.

A complete summary of previous and ongoing government agency and stakeholder consultation is provided in Table 4.5 of the Revised Project Report. Consulted parties included the following State and local government agencies, and roads and utilities authorities:

- Department of Planning, Industry and Environment (DPIE);
- Department of Resources and Geosciences (DRG);
- Department of Environment and Energy (DoEE);
- NSW Environment Protection Authority (EPA);
- Wollongong City Council (WCC);
- WaterNSW;
- The former Office of Environment and Heritage (OEH) now DPIE Biodiversity Conservation Department BCD;
- Roads and Maritime Services (RMS);

- TransGrid;
- Endeavour Energy; and
- the Independent Expert Panel for Mining in the Catchment.

1.3.3 Consultation during the preparation of the Management Plan

This Plan is being prepared as a part of the WMP as required by condition B17 and the EP WMP as required by condition C10g (iii) in consultation with:

- Department of Planning, Industry and Environment – Water (DPIE Water);
- NSW EPA
- WaterNSW;
- Wollongong City Council (WCC).

Consultation records are included in WMP Appendix A, with feedback received addressed in S1.3 of the WMP.

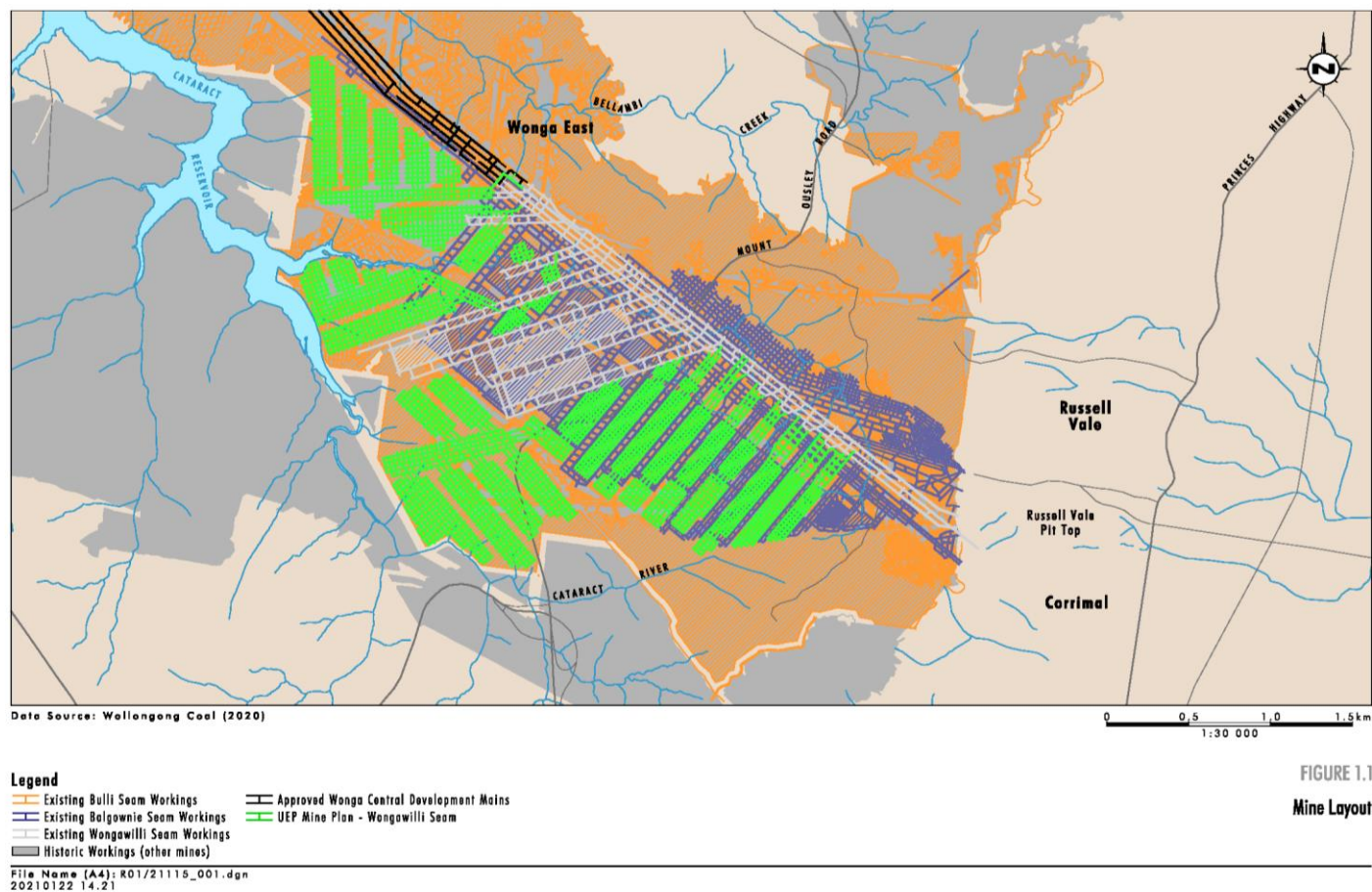
1.4 Distribution

In accordance with Condition F17 of the Project Approval, WCL will make this Plan publicly available on the WCL website and will be responsible for its maintenance. A hard copy will also be kept at the Russell Vale Colliery, 7 Princes Highway, Corrimal, NSW 2518.

Any revisions undertaken will be the responsibility of WCL and any notifications will be sent accordingly. WCL will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on WCL's computer system, website, and hard copy at the Russell Vale Colliery, 7 Princes Highway, Corrimal, NSW 2518.

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Figure 1-1 Mine Layout



2. STATUTORY REQUIREMENTS

2.1 Project Approval

The GWMP has been prepared in accordance with the development consent conditions for the WMP B17(v) for the GWMP. The relevant consent conditions are specified in **Table 1**, with reference to where each component of the condition is addressed within this Plan. This plan also covers groundwater specific requirements under condition C10 (g) (iii) EP WMP however specific management of groundwater monitoring and TARPs related to potential impacts from subsidence related effects on groundwater features are contained within the specific Extraction Plans (EPs) developed under condition C10. Matters covered by the GWMP which are relevant to the management of groundwater features regulated by Condition C10 are detailed in **Table 2**.

Table 1 Groundwater Management Plan Consent Conditions B17

Project Approval Condition	Where addressed in this Plan
A1 - OBLIGATION TO MINIMISE HARM TO THE ENVIRONMENT In addition to meeting the specific performance measures and criteria established under this approval, the Applicant must implement all reasonable and feasible measures to prevent, and if prevention is not reasonable and feasible, minimise, any material harm to the environment that may result from the construction and operation of the project, and any rehabilitation required under this consent.	This document and other associated management plans, including WMP, EP WMP, Subsidence Monitoring Plan, Biodiversity Management Plan and Upland Swamp Ecological Monitoring Plan
B17 (v) Groundwater Management Plan	
Detailed baseline data of groundwater levels, yield and quality for groundwater resources potentially impacted by the development;	Section 4 and Section 5
Detailed description of the groundwater management system	Section 8.2
Groundwater performance criteria, including trigger levels for identifying and investigating any potentially adverse groundwater impacts associated with the development, on: <ul style="list-style-type: none"> regional and local aquifers (alluvial and hard rock); and groundwater supply for other water users such as licensed privately-owned groundwater bores; 	Section 8.4
A program to monitor and evaluate: <ul style="list-style-type: none"> compliance with the relevant performance measures listed in Table 3 and the performance criteria in this plan; water loss/seepage from water storages into the groundwater system groundwater inflows, outflows and storage volumes, to inform the Site Water Balance; the hydrogeological setting of any nearby alluvial aquifers and the likelihood of any indirect impacts from the development; and the effectiveness of the groundwater management system. 	Section 7 and Appendix F
Reporting procedures for the results of the monitoring program, including notifying other water users of any elevated results.	Sections 7 and 9.3

Project Approval Condition	Where addressed in this Plan
Trigger action response plan to respond to any exceedances of the groundwater performance criteria, and repair, mitigate and/or offset any adverse groundwater impacts of the development.	Section 8 and Appendix G and Appendix H
Program to periodically validate the groundwater model for the development, including an independent review of the model every 3 years, and a comparison of monitoring results with modelled predictions.	Section 7.5

Table 2 Groundwater Management Plan Consent Conditions – C10g (iii) Extraction Plan Water Management Plan

Project Approval Condition	Where addressed in this Plan
Water Management Plan (WMP) which has been prepared in consultation with WCC, EPA, DPIE Water and WaterNSW, which provides for the management of potential impacts and/or environmental consequences of the proposed underground workings on watercourses and aquifers, including: <ul style="list-style-type: none"> detailed baseline data on: <ul style="list-style-type: none"> surface water flows and quality in water bodies that could be affected by subsidence, including Cataract River, Cataract Creek and all major associated tributaries; groundwater levels, yield and quality in the region; 	Section 3.5, Section 4 and Section 5 for groundwater. Refer EP WMP for surface water.
<ul style="list-style-type: none"> surface and groundwater impact assessment criteria, including trigger levels for investigating any potentially adverse impacts on water resources or water quality; 	Section 6, Section 8, Appendix F, Appendix G and Appendix H. Refer EP WMP for surface water.
<ul style="list-style-type: none"> a surface water monitoring program to monitor and report on: <ul style="list-style-type: none"> stream flows and quality; stream and riparian vegetation health; and channel and bank stability; 	Refer EP WMP for surface water.
<ul style="list-style-type: none"> a groundwater monitoring program to monitor and report on: <ul style="list-style-type: none"> springs, their discharge quantity and quality, as well as associated groundwater dependent ecosystems; groundwater inflows to the underground mining operations; the height of groundwater depressurization; background changes in groundwater yield/quality against mine-induced changes, in particular, on groundwater bore users in the vicinity of the site; permeability, hydraulic gradient, flow direction and connectivity of the deep and shallow groundwater aquifers; and impacts of the project on upland swamps (refer to condition C10(v) below) and other groundwater dependent ecosystems; 	Section 7
<ul style="list-style-type: none"> a description of any adaptive management practices implemented to guide future mining activities in the event of greater than predicted impacts on aquatic habitat; 	Section 8 and refer to EP WMP

Project Approval Condition	Where addressed in this Plan
<ul style="list-style-type: none"> a program to validate the surface water and groundwater models for the project, and compare monitoring results with modelled predictions; and 	Section 7 and refer to EP WMP
<ul style="list-style-type: none"> a plan to respond to any exceedances of the surface water and groundwater assessment criteria; 	Section 8 and Appendix F . Refer EP WMP for surface water.

2.2 Statement of Commitment

The following statements of commitment as outlined in Table 3

Table 3 Groundwater Management – Statements of Commitment

Project Approval Condition	Timing	Where addressed in this Plan
The existing Russell Vale East WMP will be reviewed and updated in consultation with DPIE-Water, WaterNSW and DPIE-Planning and the updated plan will be implemented for the Revised Preferred Project. The updated plan will include the proposed approach to the updating of the groundwater model for use in the verification of monitoring.	Within 3 months of approval and ongoing	Refer to EP WMP
The existing groundwater monitoring network will continue to be utilised to monitor impacts associated with the Revised Preferred Project. The existing groundwater monitoring program will be reviewed and updated to reflect the Revised Preferred Project as part of an update to the existing Russell Vale East WMP. The groundwater monitoring program will include monitoring of groundwater levels, water quality, mine water inflows, pumping volumes and stream flows. The ongoing collection and interpretation of the data will be used to update the TARP trigger levels and the groundwater model as required.	Within 3 months of approval and ongoing	Section 7
Existing monitoring and management measures associated with the mining of longwalls 4 to 6, as set out in the existing Russell Vale East WMP and LW5 WMP will remain in place.	Ongoing, with regular review of the results, effectiveness and ongoing need for monitoring as set out in the WMP	Captured within this document
WCL will obtain WALs, or alternative mechanisms agreed in consultation with the Natural Resources Access Regulator, for all groundwater or surface water take in the course of mining.	Ongoing	Refer EP WMP

2.3 Relevant Legislation

The legislation relevant to this GWMP is consistent with that included in the EP WMP.

2.3.1 Water Management Act 2000

Water take associated with the RVE UEP is required to be licensed under the NSW *Water Management Act 2000*. Wollongong Coal holds a current Water Access Licence (WAL36488) for 515ML (units) per year within the Sydney Basin Nepean Groundwater Source - Nepean Management Zone 2 and were successful in a bid for a further allocation of 100 units within this groundwater source in early 2020. Wollongong Coal therefore holds sufficient allocation to account for the predicted maximum groundwater inflows to Russell Vale Colliery workings of 288ML/year (refer **Section 6**).

As discussed later in **Section 6**, the peak reduction in baseflow for Cataract River, Cataract Creek and Bellambi Creek combined is predicted to be very small, with the volume apportioned to the RVE UEP being between 2.3ML/year and 6ML/year.

Wollongong Coal currently holds sufficient licences to account for the volume of predicted water take at Russell Vale Colliery. These licences are however held in the water sharing plan relevant to groundwater sources only.

Full details on water licensing is included in the EP WMP.

2.4 Guidelines and Policies

This plan has been prepared with reference to the following documents:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000);
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Water Quality Framework (ANZG 2018);
- Approved Methods for Sampling and Analysis of Water Pollutants in New South Wales (DEC, 2004);
- Australian Standard/New Zealand Standard (AS/NZS) 5667:1998 Parts 1, 4 and 6;
- Barnett B., Townley L.R., Post V., Evans R.E., Hunt R.J., Peeters L., Richardson S., Werner A.D., Knapton A., Boronkay A. (2012), *Australian groundwater modelling guidelines: Waterlines report*, National Water Commission, Canberra;
- Groundwater Monitoring and Modelling Plans – Introduction for prospective mining and petroleum activities (NSW Department of Industry, Water (DPIE Water) 2014);
- National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ARMCANZ/ANZECC);
- National Water Quality Management Strategy (Department of Environment and Energy (DoEE) 2015);
- NSW State Groundwater Policy Framework Document (NSW Department of Land and Water Conservation [DLWC]);

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- NSW State Groundwater Quality Protection Policy (DLWC);
- NSW State Groundwater Quantity Management Policy (DLWC) Draft;
- NSW Groundwater Dependent Ecosystem Policy (DLWC); and
- Murray-Darling Basin Commission Groundwater Quality Sampling Guidelines Technical Report No 3 (MDBC).

3. GENERAL INFORMATION

3.1 Previous Mining

RVC is one of a number of underground coal mines within the Southern Coalfield. Other mining operations include Appin, West Cliff, North Cliff, Metropolitan, Tahmoor and Dendrobium mines. Regionally, the closest active mining operations include the Appin Mine located approximately 13 km to the north west, operating in the Bulli Seam, and Dendrobium Colliery located approximately 12 km south west, operating in the Wongawilli Seam.

Underground mining has been undertaken at RVC since the 1880s, with extraction having occurred in the Bulli, Balgownie and Wongawilli Seams. These coal seams were accessed directly from the Illawarra escarpment via adit entries directly into the target coal seams. There are 24 known adits or portals into the Illawarra escarpment at RVC associated with historical mining activities. Three of these adit entries are associated with the mining of the Wongawilli Seam and will be utilised in future operations.

Within the Bulli Seam, bord and pillar mining, pillar extraction and numerous longwall panels have largely exhausted the Bulli Seam resource in the eastern part of the colliery lease holding. Bulli Seam mining in the RVE UEP area was effectively finished by the 1950s. Eleven longwall panels were mined in the Balgownie Seam between 1970 and 1982. Three short longwall panels (**Figure 1-1**) were mined in the Wongawilli Seam between 2012 and 2015 in the RVE UEP area. The effects of historical mining have therefore been experienced across the RVE UEP area over a long period of time.

Figure 1-1 shows the previous mining areas within and in the vicinity of the RVE UEP area. The primary historical longwall mining related impacts are associated with subsidence and groundwater.

3.2 Climate

RVC operates an Automated Weather Station (AWS) at the RVC Pit Top (**Figure 1-1**) for the purpose of collecting meteorological data and informing environmental management activities at the Pit Top.

Rainfall data at site has been monitored since November 2013 to present. **Table 4** includes a summary of site rainfall data and monthly rainfall trends are shown in **Figure 3-1**. Site rainfall monitoring indicates that the annual rainfall at RVC has varied from 866 mm (2019) to 1,756 mm (2015), with an average annual rainfall of 1,222.90 mm/year. Average monthly rainfall at site is around 59.83 mm to 157.75 mm; however, this can vary between 20 mm/month to 202 mm/month (10th and 90th percentile range).

Longer term rainfall data is also available from the Scientific Information for Land Owners (SILO) database of historical climate records for Australia (Queensland Government 2020). SILO interpolates rainfall records from available stations for an area within 100 km of the coordinates Latitude -34.35/Longitude 150.85. The historical average monthly rainfall data collected by SILO between 01/01/1900 to 01/01/2021 is shown in **Table 4**. The table shows the historical regional data has an average annual rainfall of 1,385.20 mm/year.

Table 4 Long Term Average and 2020 Climate Data

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Historical Average (Site)	86.85	107.84	157.75	150.13	97.15	144.87	71.5	133.75	59.83	75.59	65.36	72.28	1222.90
2020 Rainfall (Site)	133.84	340.56	71.26	44.96	93.21	15.67	182.48	162.49	26.44	104.77	104.23	39.05	1318.96
Historical Average (SILO)	141.15	162.81	149.20	126.51	118.67	124.92	95.22	79.42	71.83	93.79	108.49	113.19	1385.20
2020 Rainfall (SILO)	80.10	325.40	113.30	43.40	102.00	25.20	215.60	133.00	26.20	118.70	70.00	128.10	1381.00

On average, February is the wettest month and September is the driest month. Regionally, January is typically the warmest month, with July the coolest. SILO historical regional data has an average annual pan evaporation of 1,365 mm/year (Queensland Government 2020).

The cumulative rainfall departure (CRD) has been calculated for site data and the longer term SILO data, as presented in **Figure 3-1** and **Figure 3-2**. CRD graphically shows trends in recorded rainfall compared to long-term averages and provides a historical record of relatively wet and dry periods. A rising trend in slope in the CRD graph indicates periods of above average rainfall, a declining slope indicates periods when rainfall is below average, and a level slope indicates average rainfall conditions. As shown in **Figure 3-1**, based on the short term site data, the area experienced below average rainfall from around 2016 to 2018, after which time the site experienced variable rainfall. When comparing to longer term trends (**Figure 3-2**) the data shows a more prolonged period of below average rainfall has been experienced in the region since 1990.

Figure 3-1 Cumulative Rainfall Departure (Site)

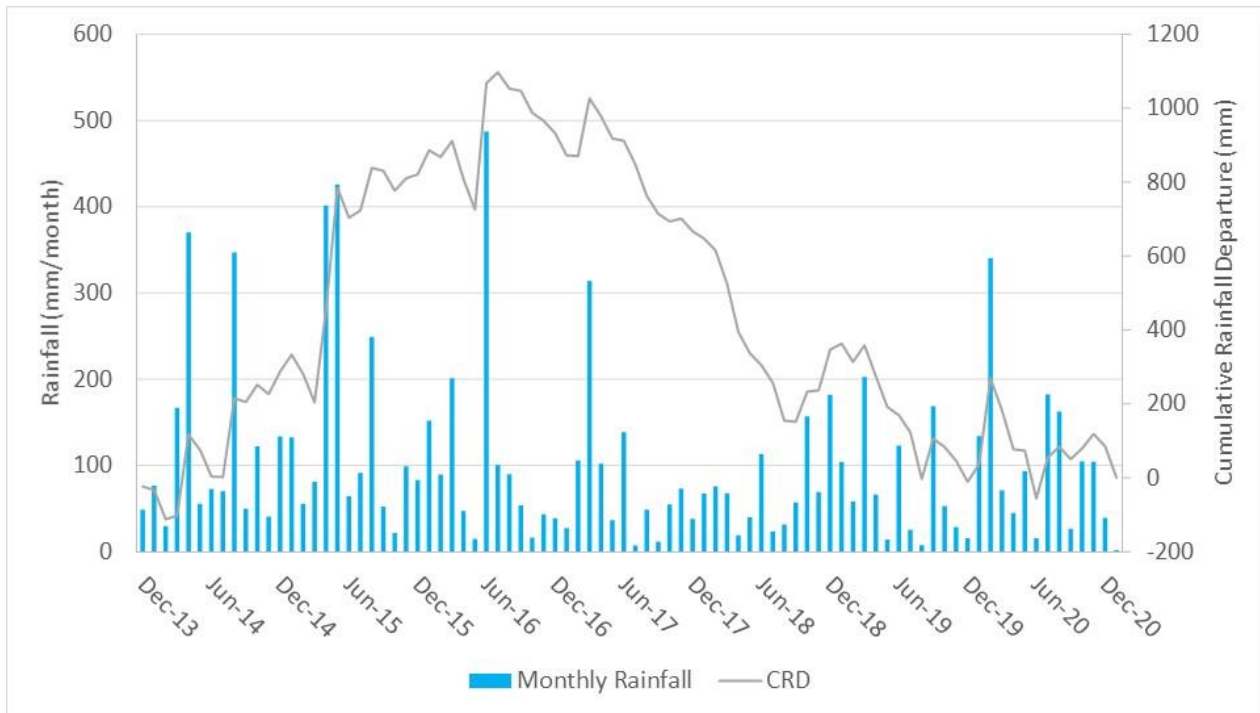
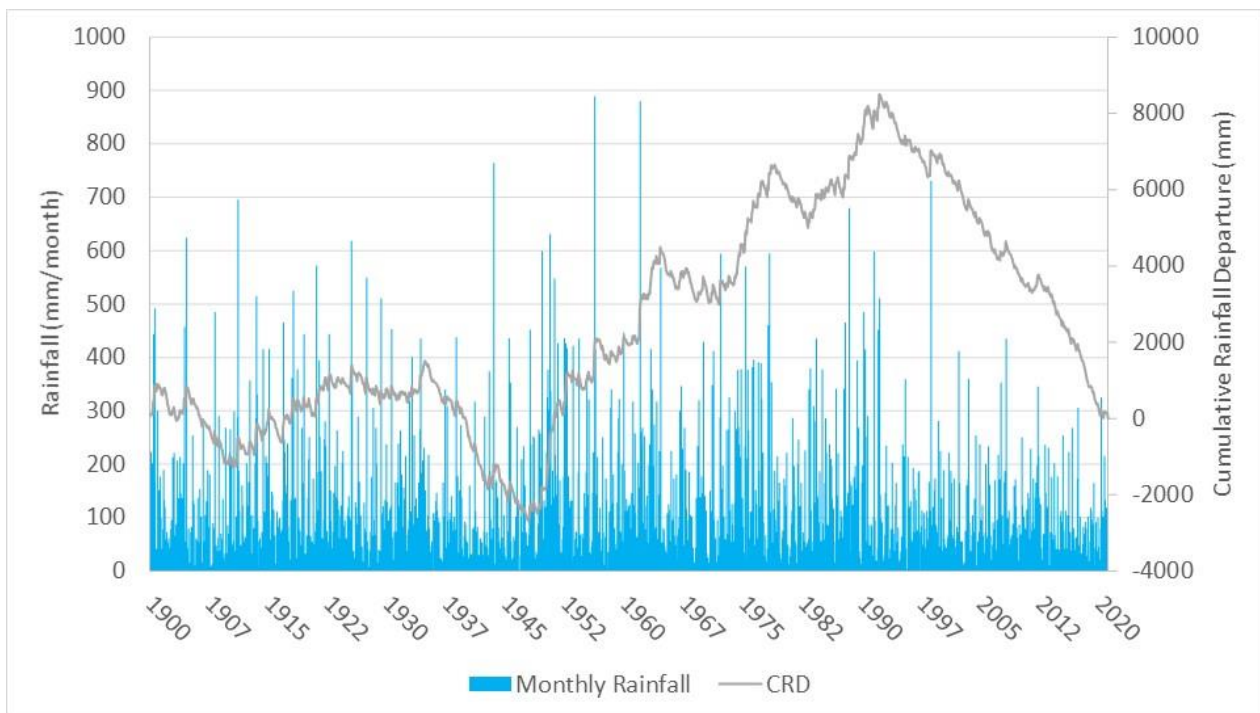


Figure 3-2 Cumulative Rainfall Departure (SILO)



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3.3 Hydrology

RVE UEP is located within the Upper Nepean Catchment declared Metropolitan Special Area under the Water NSW Act, which forms part of Greater Sydney's drinking water supply catchment. The main drainage lines within and downstream of RVE UEP are Cataract Creek, Cataract River and Bellambi Creek (refer **Figure 1-1**). Bellambi Gully is also present at the base of the escarpment and flows to the ocean to the east. These streams are ephemeral and intermittent, only flowing for short periods following rain. The upper reaches occur on the sandstone benches and upper ridges before passing through steep slopes and into the main channels of the corresponding creeks. Due to the topography, these tributaries do not tend to support pools.

RVE UEP is situated within the upper catchment of the Cataract Reservoir, beyond the full supply level of the reservoir. The reservoir is an artificial storage formed by Cataract Dam and has a maximum capacity of 97,190 ML. Cataract Reservoir has a total catchment area of approximately 127.8 km². Full details on the surface water conditions relevant to RVE UEP are outlined within the EP WMP.

3.4 Geology

3.4.1 Regional geology

RVE UEP is located in the southern extent of the Permo-Triassic Sydney Basin. Within RVE UEP, the strata dip at between 1 in 25 and 1 in 30 to the west-north-west from its outcrop on the Illawarra Escarpment. A summary of the geological units within the RVE UEP is provided in **Table 5** and mapped surface geology shown in **Figure 3-3**.

As shown in **Figure 3-3**, Triassic age Hawkesbury Sandstone is present on the surface over most of RVE UEP. The Bald Hill Claystone that underlies the Hawkesbury Sandstone outcrops in Cataract Creek and its tributaries. The Bulgo Sandstone that underlies the Bald Hill Claystone outcrops along the main channel of Cataract Creek on both sides of Mount Ousley Road (SCT 2019).

The Pit Top Area occurs at the base of the Illawarra Escarpment, below the outcrop of the Bulli Seam and Wongawilli Seam. According to the Wollongong 1:50k geology mapping, the geology at surface across the Pit Top Area comprises the Permian aged Woonona Coal Member (Piy) overlying the Erins Vale Formation (Pie) and Unanderra Coal Member (Pip). The Woonona Coal Member comprises interbedded coal, carbonaceous siltstone, claystone and tuffaceous claystone that dips to the north-west. The 1:50k geology mapping indicates Quaternary alluvium is present over 800 m east of the site along the coastline. Local site geotechnical assessment by Terra Insight (2020) indicates the potential for alluvium or colluvium localised along Bellambi Gully, unconformably overlying the Permian coal measures. Drill hole BH201 indicated the presence of silty sandy clay and clayey gravel down to 5 m depth beneath fill material and overlying weathered Permian coal measures (Terra Insight, 2020).

3.4.2 Structural geology

Regional mapping of faults, folds and dykes based on the Southern Coalfields 1:100k mapping and site-specific mapping is shown in **Figure 3-3**.

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Igneous intrusions are present across the RVE UEP including a series of dykes and a large sill (Bulli Sill Complex) to the east and north of Wonga East (refer **Figure 3-3**) (NRE 2014). The main structural features are the South Bulli Syncline and the Corrimal Fault south of the RVE UEP. As reported by GeoTerra/GES (2020), the Corrimal Fault has a 1.3 to 3.0 m displacement in the vicinity of the workings within the Bulli Seam and a maximum recorded displacement of 28.7 m within a 20 m wide faulted zone. The Corrimal Fault trends in a south-east north-west direction and is located to the west of LW4 and LW5 but passes through LW6 (approximately 340 m) then phases out to the north of LW6. The fault is not interpreted to be present between the proposed bord and pillar workings and Cataract Reservoir (SCT 2019).

A north-west south-east trending splay off the Corrimal Fault (associated with Dyke D5) and a south-west north-east fault (associated with Dyke D6) are also located to the south of the eastern block of workings, with the D6 fault crossing under Cataract River, to the west of the proposed eastern block (GeoTerra/GES 2020). No known or observed groundwater inflows have been associated with any faults intersected by the workings at Wonga East in the Bulli, Balgownie or Wongawilli Seams (SCT 2019).

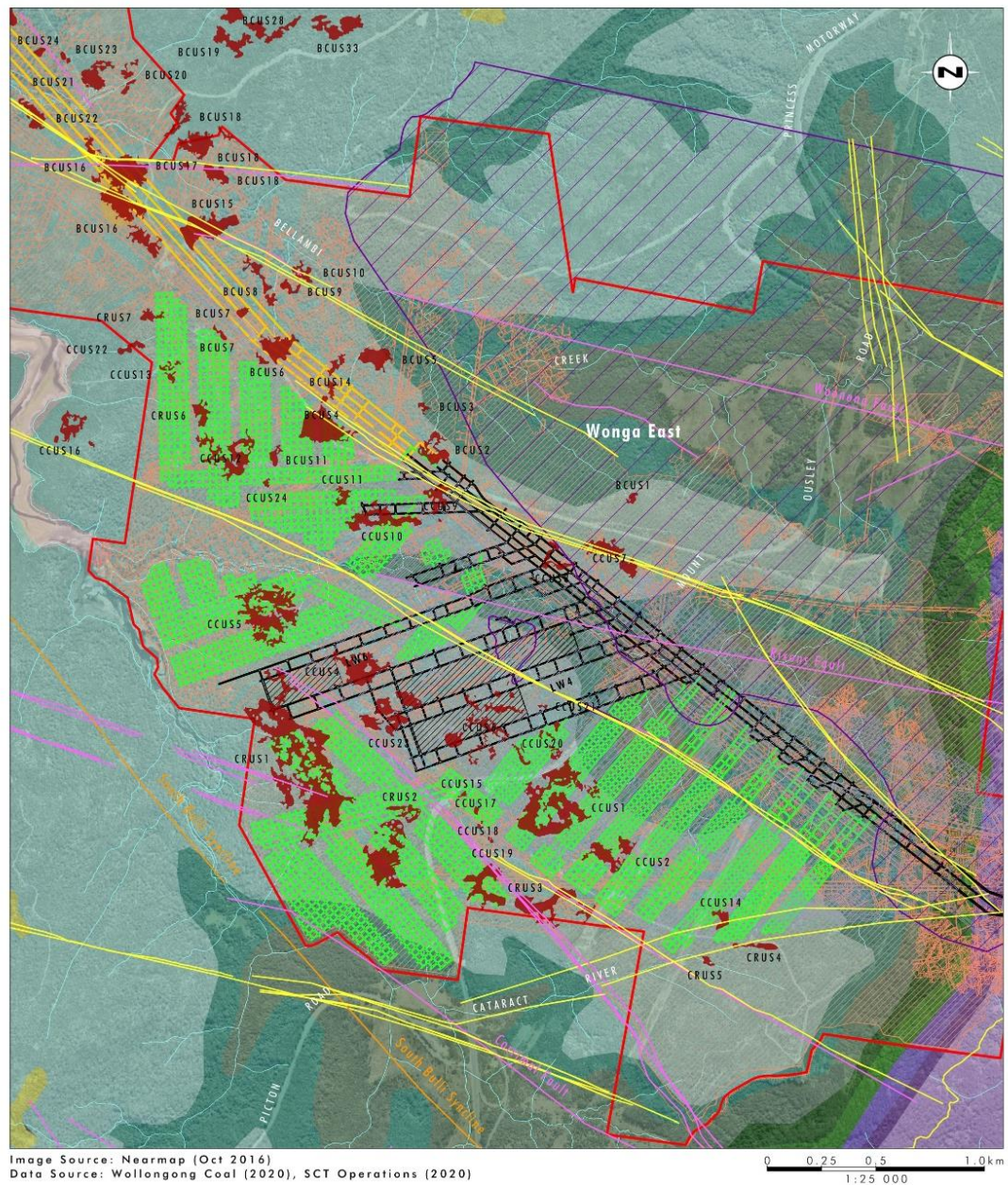
The north-west south-east trending Rixon's Pass Fault is shown at surface on the 1:100,000 geological map to be sub-parallel to Cataract Creek (refer **Figure 3-3**); however, no trace of it has been identified in the Bulli or Balgownie workings.

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Table 5 Site Geology

Age	Formation	Group	Lithology	Thickness in Project area
Quaternary		Swamps	Upland swamps comprise sandy and silty sediments transported by overland flow from the weathered Triassic sandstones. The swamps generally comprise a basal layer of yellow or grey mineral sandy loams overlain by an organic horizon to highly organic spongy black peats.	A few cm up to 2 m in RVE UEP
		Alluvium/ Colluvium	Localised along some creeks, gullies. Within the Pit Top Area it can comprise silty sandy clay and clayey gravel.	Up to 5 m deep
Triassic	Hawkesbury Formation		The bedded to massive quartzose sandstone with grey shale lenses up to several metres thick is uppermost in the stratigraphic sequence in the western extent of RVE UEP. It can contain up to 4% manganiferous siderite and up to 0.5% of iron sulfide (principally marcasite) with minor solid solution incorporation of nickel, zinc and manganese sulfides.	absent to 181 m thick
	Narrabeen Group	Newport and Garie Formations	The Newport and Garie Formations are exposed in reaches of Cataract Creek and localised areas on the eastern extent of RVE UEP. The Newport Formation has interbedded grey shales and sandstones and has a variable thickness across RVE UEP. The Garie Formation is generally around 3m thick and contains cream to brown, massive, characteristically oolitic claystone with a relatively constant thickness across RVE UEP.	4.6 – 36 m thick
		Bald Hill Claystone	Present at surface in localised areas on the eastern extent of RVE UEP. Typically chocolate brown to red brown kaolinitic marker bed claystone with silty and sandy grey and mottled grey - brown zones with a relatively constant thickness over the Application Area. It predominantly consists of 50 - 75% kaolinite with hematite and siderite as accessories.	17 – 42 m thick
		Bulgo Sandstone	Present at surface in localised areas on the eastern extent of RVE UEP. Thickly bedded, medium to coarse grained lithic sandstone with occasional conglomerate and shale.	113 – 154 m thick
		Stanwell Park Claystone	Greenish-grey mudstone and sandstone, with a general thickening of the claystone to the north west.	15 – 26 m thick
		Scarborough Sandstone	Thickly bedded sandstone with shale and sandy shale lenses up to several metres thick.	16 – 31 m thick
		Wombarra Claystone	Has a similar lithology to the Stanwell Park Claystone and generally thickens to the south east.	35 – 61 m thick
		Coal Cliff Sandstone	Shales and mudstones contiguous with the underlying Bulli seam and varies from a quartzose sandstone in the east to a more shale/mudstone dominated unit in the west.	8 – 13 m thick
Permian	Illawarra Coal Measures		The Illawarra Coal Measures consist of interbedded shales, mudstones, lithic sandstones and coal seams, including the Bulli Seam, Loddon Sandstone, Balgownie Seam, Lawrence Sandstone, Eckersley Formation, Wongawilli Seam and Kembla Sandstone.	~ 200 m thick

Figure 3-3 Surface Geology



Legend

- | | |
|---|--|
| <ul style="list-style-type: none"> Existing Bulli Seam Workings Existing Balgownie Seam Workings UEP Mine Plan Approved Wonga Central Development Mains Existing Wongawilli Seam Workings Upland Swamps Sill Fold Dyke Fault Drainage Line | <p>Surface Geology:</p> <ul style="list-style-type: none"> Qs - Swamp sediments TRh - Hawkesbury Sandstone TRnz - Bald Hill Claystone TRnbu - Bulgo Sandstone TRnsp - Stanwell Park Claystone TRnc - Coal Cliff Sandstone Pis - Sydney Group |
|---|--|

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FIGURE 3.3
Surface Geology

3.5 Hydrogeology

3.5.1 Hydrogeology Summary

The main hydrogeological units within the RVE UEP area include:

- Quaternary alluvium and colluvium
- Quaternary swamps including upland swamps and headwater swamps
- Hawkesbury Sandstone:
 - Shallow weathered Hawkesbury Sandstone
 - Deeper Hawkesbury Sandstone
- Narrabeen Group
- Illawarra Coal Measures, including the Bulli Seam and Balgownie Seam previously mined, and Wongawilli Seam that was mined in LW4 to LW6 and is the target seam for future operations at RVE UEP
- Basement - sedimentary sequence underlying the Wongawilli Seam.

Discussion on each of the groundwater bearing units is summarised below. Knowledge of the groundwater systems is provided by a network of shallow Open Standpipes (OSPs) and Vibrating Wire Piezometers (VWPs) across the RVE UEP.

Quaternary Alluvium and Colluvium

At the top of the escarpment, due to the steep topography and limited alluvium within the Cataract Reservoir storage, there is no notable groundwater bearing stream-based alluvium within the RVE UEP.

Alluvial and colluvial deposits may also occur along Bellambi Gully in the Pit Top area. Drill hole data (BH201) collected by Terra Insight (2020) indicates the presence of silty sandy clay overlying extremely weathered Permian coal measures. Drill holes across the Pit Top area outside of the creek alignment indicate the presence of clay-rich residual soil to around 3 m to 4 m depth, overlying weathered Permian coal measures (siltstone and shale).

Within the Pit Top Area a shallow water table was intercepted around 4 m below ground within the fill material, sediments and weathered Permian coal measures (Terra Insight, 2020). The dominance of clays and lack of registered groundwater bores within the alluvium along Bellambi Gully indicates limited groundwater occurrence and yields.

No water quality data was collected at the time of drilling; however it is anticipated the water would exhibit similar water quality to the Permian coal measures.

Quaternary Swamps

Quaternary unconsolidated alluvial and colluvial sediments are present within both valley fill and headwater upland swamps (refer **Figure 3-3**).

The existing site monitoring network includes piezometers within the swamp deposits across RVE UEP. Based on drill data collected at site from the swamp piezometers, the swamps within the RVE UEP comprise humic sands and clayey sands generally less than 2 m thick, overlying weathered Hawkesbury Sandstone.

Hawkesbury Sandstone

The Hawkesbury Sandstone outcrops over most of the lease area although it has been partially eroded in the central valley of Cataract Creek where the upper Bulgo Sandstone is exposed.

The Hawkesbury Sandstone is the main aquifer in RVE UEP along with the coal seams. The low groundwater flow rates within the Hawkesbury Sandstone are primarily horizontal, with minor vertical leakage due to the dominant horizontal bedding planes and bedding discontinuities interspersed with generally poorly connected vertical joints.

Narrabeen Group

The Triassic aged Narrabeen Group underlies the Hawkesbury Sandstone and occurs at surface in localised areas along the escarpment and in localised areas where the Hawkesbury Sandstone has been eroded away near Cataract River, Cataract Creek and Bellambi Creek.

The Narrabeen Group includes sandstone units (i.e. Bulgo Sandstone, Scarborough Sandstone and Coal Cliff Sandstone) interbedded with low permeability claystones (i.e. Bald Hill Claystone, Stanwell Park Claystone and Wombarra Claystone). The Narrabeen Group lithologies have significantly lower yielding aquifers compared to the Hawkesbury Sandstone, with very minor productive supplies obtained in the Southern Coalfield due to its generally deeper elevation below surface and its very low permeability.

Within the RVE UEP area, the lower portions of the Narrabeen Group have already been locally fractured and depressurised above the existing Wongawilli, Bulli and Balgownie seam workings. Previous investigations into the goaf effects have been conducted across the site and surrounding mines. As reported by GeoTerra (2012), packer testing was conducted at the site monitoring locations and showed a reduction in permeability with depth. The Stanwell Park Claystone also recorded a lower permeability compared to the sandstone units despite goaf effects within the area.

Illawarra Coal Measures

The Illawarra Coal Measures are the primary economic sequence of interest in the Sydney Basin, and consist of interbedded sandstones, shale and coal seams. Within the RVE UEP area, historical mining targeted the Bulli Seam and Balgownie Seam, with more recent longwall mining within the Wongawilli Seam (LW 4-6).

The coal seams outcrop to the east of the RVE UEP along the base of the escarpment, and dip approximately 2° towards the north-west. There are three main coal seams within the RVE UEP area:

1. The Bulli Seam is around 2 to 4.7 m thick and occurs around 205 m to 290 m below surface within the RVE UEP. The Bulli Seam has historically been extensively worked by longwall and bord and pillar methods within the region. The Bulli Seam overlies the Loddon Sandstone that is 5.5 to 13.6 m thick and in turn overlies the Balgownie Seam.
2. The Balgownie Seam is around 0.8 to 1.5 m thick and has some localised longwall extraction within the RVE UEP. The Balgownie Seam is separated from the underlying Wongawilli Seam by around 10.6 to 24.7 m of interburden (sandstone/siltstone).

3. The Wongawilli Seam is around 6.2 to 10.5 m thick based on the combined thickness across multiple seam splits. The Wongawilli Seam has been mined at LW4-6 within the RVE UEP. The seam is around 250 to 380 m below surface and around 24 to 36 m below the Bulli Seam. The Wongawilli Seam is the target seam for the proposed bord and pillar workings with a proposed mining height of 2.4 m in the basal section of the Wongawilli Seam.

The coal seams are the main groundwater bearing unit within the Illawarra Coal Measures, due to secondary porosity associated with fractures and cleats. The interburden material (siltstone, sandstones and shale) generally exhibits low permeability. The permeability of the coal seams has been assessed at site and within the region and has been found to vary spatially and with depth.

The permeability of the Permian strata is also influenced by goaf effects and natural fracturing and faulting. The Bulli, Balgownie and Wongawilli seams have been fractured and depressurised to varying degrees by the existing workings.

3.5.2 Groundwater Users

The RVE UEP is located within the Metropolitan Special Area and forms part of the Sydney drinking water supply catchment. There are no private water supply works located within the Cataract Reservoir catchment or along Bellambi Gully.

3.5.3 Groundwater Dependent Ecosystems

Biosis (2020) undertook an assessment of the potential for the study area to support groundwater dependent ecosystems (GDEs), using the Australian Government's Bureau of Meteorology, Groundwater Dependent Ecosystems Atlas (GDE Atlas) (BOM 2018), a download of metadata from State of NSW, and the NSW Office of Water Risk Assessment guidelines for groundwater dependent ecosystems (Serov *et al.* 2012). No areas reliant on the surface expression of groundwater are mapped within the study area according to the GDE Atlas or metadata (DPI Water 2016). Water Observations from Space mapping was also reviewed (**Figure 4-1**), which shows a low occurrence of water at surface (percentage of observations with water present at surface, based on satellite imagery since 1987).

Some small areas of mapped plant communities have been mapped within RVE UEP as having moderate to high GDE potential, as shown in **Figure 4-1**. Each of the plant communities occur on Hawkesbury Sandstone, or Bulgo Sandstone where it occurs at surface. Areas of shallow water table are potentially accessible by the roots of the vegetation. Areas of water table more than 10 m below the surface are generally considered to be inaccessible to all but the deepest rooted vegetation. Discussion on the shallow water table and the monitoring program targeting the potential GDE areas is included in **Section 5**.

Upland swamp communities have also been identified within the RVE UEP area (refer **Figure 4-1**). Discussion on the swamp stratigraphy and monitoring program are included in **Section 3** and **Section 4**, respectively. Details on the swamp ecology are included within the Biodiversity Management Plan.

The Hawkesbury Sandstone also provides baseflow contributions to surface water features where gradients enable this. Details on the surface water baseline data and monitoring program are included within the EP WMP.

3.6 Ecohydrological Model

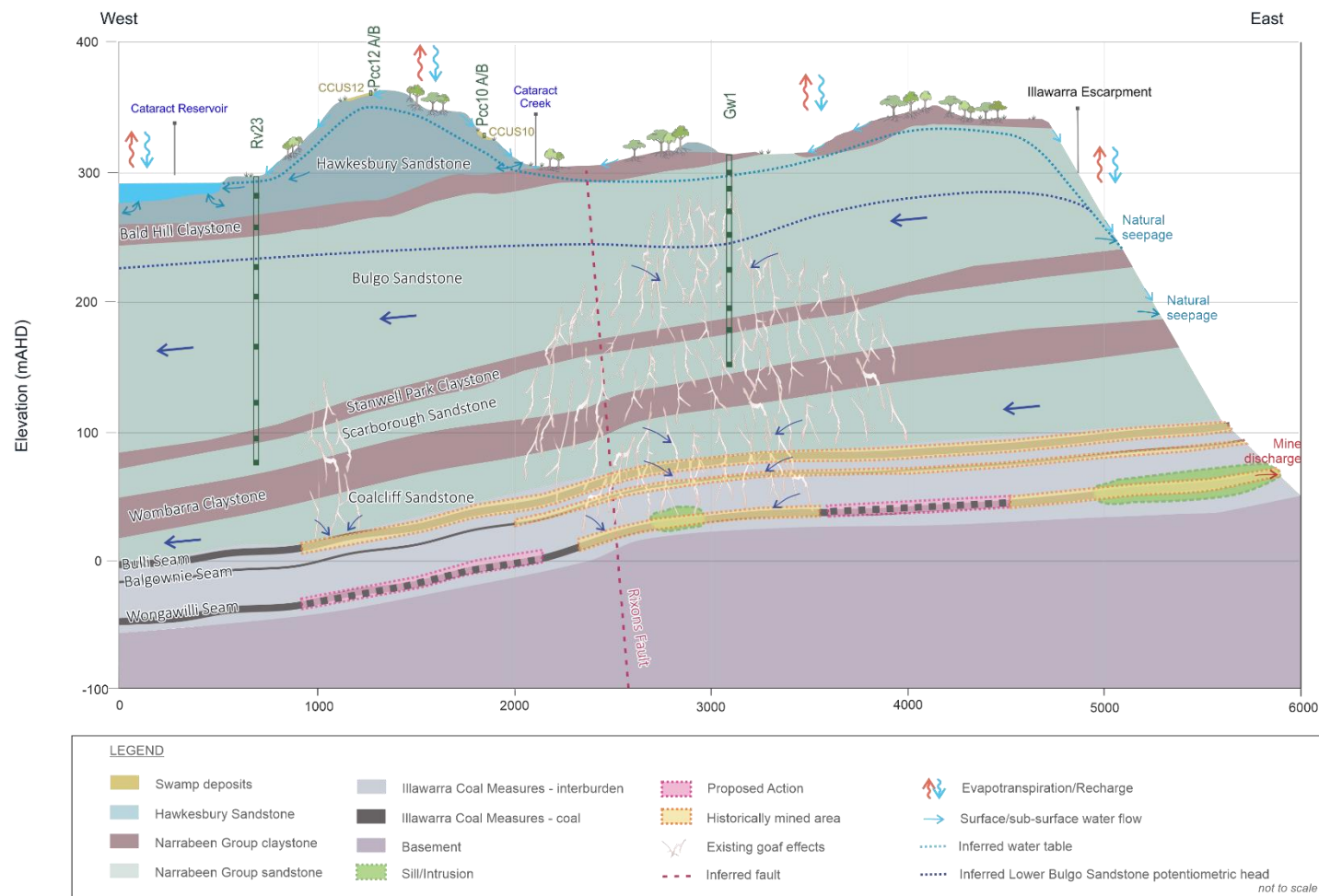
The conceptual ecohydrological model for RVE UEP was prepared based on previous studies conducted at the site including the groundwater impact assessment (GeoTerra/GES 2020), surface water assessment (Umwelt 2019) and ecological assessment (Biosis 2020). The conceptual model has been represented for RVE UEP in **Figure 3-4**. The figure shows the main stratigraphic units, recharge and discharge processes, ecological receptors and inferred groundwater conditions during mining and post closure.

The main ecohydrological features relevant to RVE UEP include:

- Creeks overlying and in vicinity of RVE UEP:
 - Cataract Creek - a fourth order stream associated with Cataract Reservoir. Channel invert elevations for Cataract Creek fall from approximately 340 to 285 mAHD. The creek is incised into the Hawkesbury Sandstone that contributes baseflow where hydraulic gradients enable this.
 - Cataract River - a regulated fourth order stream under the NSW Water Management Act 2000. It has a length of approximately 6.7 km from its headwaters to the full supply level of Cataract Reservoir. Channel invert elevations fall from approximately 430 to 285 mAHD. The creek is incised into the Hawkesbury Sandstone that contributes baseflow where hydraulic gradients enable this. Future bord and pillar do not underlie the Cataract River.
 - Bellambi Creek - a third order stream upstream for the first 5.5 km, then fourth order draining to the Cataract Reservoir. The creek is approximately 6.4 km long from its headwaters to the full supply level of Cataract Reservoir and has a catchment area of 9.3 km². Channel invert elevations fall from approximately 453 to 286 mAHD. The creek is incised into the Hawkesbury Sandstone that contributes baseflow where hydraulic gradients enable this. RVE UEP workings do not underlie or interact with the main Bellambi Creek stream channel.
 - Bellambi Gully - occurs on the lower slopes of the Illawarra Escarpment and flows east towards the Pacific Ocean. The gully has an elevation of 400 mAHD along the escarpment, declining down to 30 mAHD to the east around Corrimal where it flows past residential, recreational, commercial and light industrial facilities. Geology along the gully is mapped as the Sydney Group and Erins Vale Formation that underlie the Illawarra Coal Measures. Quaternary alluvium is mapped along the creek further to the east, outside of the mine lease area.
- Alluvium, colluvium and regolith – within the Pit Top Area, recent geotechnical drilling identified the presence of clayey gravels along the alignment of Bellambi Gully. Elsewhere across the site, drilling identified the presence of fill material and clay-rich residual soil overlying weathered Permian coal measures (siltstone and shale). Groundwater was detected in the shallow water table within the sediments and weathered Permian coal measures. Based on the site geology and historical land use, it is anticipated that the groundwater exhibits similar water quality to the Permian coal measures. No impacts to groundwater have been previously identified for the approved operations. The RVE UEP will involve upgrades to surface infrastructure around the Pit Top Area. However, no new activities that could interfere with the shallow water table (i.e. excavation or water storage) will be undertaken at site.

- Swamps – shallow upland swamps in the RVE UEP area extend to approximately 2 m depth and overly weathered Hawkesbury Sandstone. The swamps are recharged from rainfall and shallow flow, with trends influenced by climatic conditions and potentially by surface subsidence impacts from historical longwall mining. The swamps at site are generally hydraulically separated from the lower Hawkesbury Sandstone regional water table. Depressurisation due to first workings or the future RVE UEP bord and pillar is not predicted to cause additional impacts to swamp water conditions.
- Hardrock Aquifer systems:
 - Hawkesbury Sandstone – main aquifer in the region that provides baseflow contributions where incised along creeks and reservoirs. Groundwater flow is generally to the north, but with localised flow towards the escarpment and towards incised creeks. The Hawkesbury Sandstone is hydraulically separated from the underlying Bulgo Sandstone and deeper lithologies by the Bald Hill Claystone, except where the claystone is fractured by subsidence or eroded away in the channel of Cataract Creek. Localised drawdown within the Hawkesbury Sandstone has been observed associated with historical and existing mining at site.
 - Narrabeen Group – interbedded sandstones and low permeability claystones that inhibit downward seepage. Drawdown is observed within the RVE UEP area within the sandstone units (i.e. Bulgo Sandstone) in response to current and historical mining. This is due to goaf effects from longwall mining that resulted in increased permeability of overlying strata.
 - Permian Coal Measures – groundwater occurrence largely associated with the coal seams via secondary porosity. Groundwater within the coal measures is expected to be extensively depressurised by historical operations. Water quality within the coal seams is generally alkaline with fresh to brackish water quality and some trace metals.

Figure 3-4 Ecohydrological Model



4. SWAMP BASELINE DATA

4.1 Swamp Monitoring Network

Swamps are present at surface across the RVE UEP area, as presented on **Figure 4-1**. The swamps relevant to the RVE UEP are BCUS4, BCUS111, CCUS1, CCUS6, CCUS10, CCUS11, CCUS12, CCUS4, CCUS5, CRUS1, CRUS3, CCUS14, CCUS20, CCUS21, CRUS2 and CRUS6. Of these, swamps CRUS1, BCUS4, CCUS5 and CRUS1 are present above the Extraction Plan area.

The existing swamp monitoring network across RVE UEP has been progressively installed since 2012 and covers the nine swamps within RVE UEP (BCUS4, CCUS2, CCUS3, CCUS4, CCUS5, CCUS6, CCUS10, CCUS12 and CRUS1). The network comprises:

- 7 monitoring locations equipped with soil moisture probes
- 16 locations equipped with soil moisture probes and shallow piezometers
- 2 locations near swamps equipped with shallow piezometers

Details on the swamp monitoring network are shown in **Table 6** and locations are shown in **Figure 4-1**. **Table 6** includes details on the relevant swamp site, intake lithology and type of monitoring point.

Figure 4-1 presents the monitoring locations and swamps relative to historical mine operations and approved future bord and pillar. As shown in **Figure 4-1**, swamps CRUS1, CCUS3, CCUS4 and CCUS6 occur within proximity to the completed longwall mining (LW4 to LW6) that experienced subsidence impacts. Negligible subsidence impacts are predicted as part of future approved bord and pillar within the Wongawilli Seam at RVE UEP.

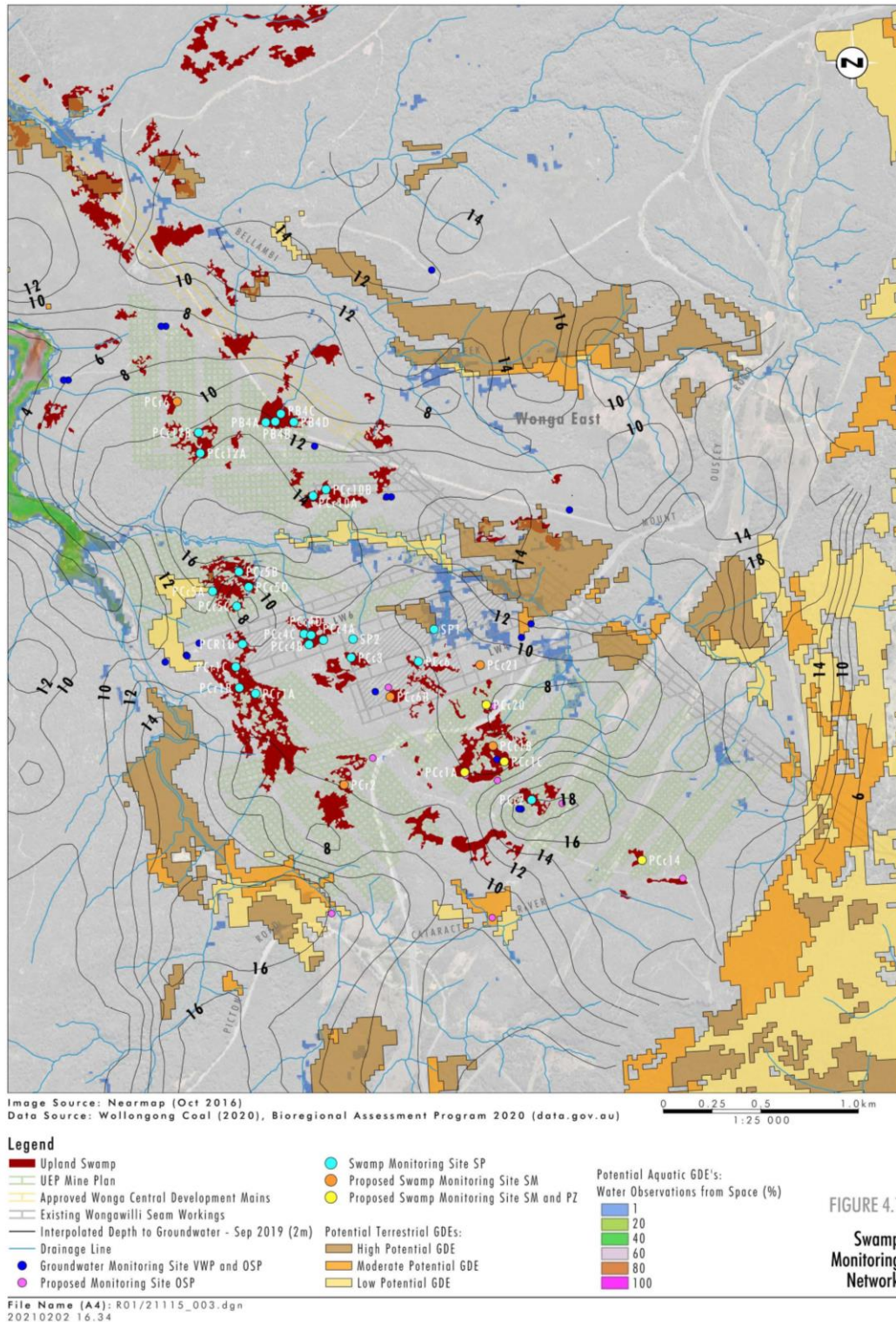
Table 6 Water Monitoring Network for Swamps

Site ID	Swamp Site	Installed	Easting GDA94 Z56	Northing GDA94 Z56	Ground Level mAH ¹	TOC magl ²	Screen mbgl ³	Intake Lithology ⁴	Type ⁵
PB4A	BCUS4	Nov-14	302382	6198016	340.8	1.35	1.17 – 1.59	HC / WS	SM and PZ
PB4B	BCUS4	Nov-14	302431	6198020	337.0	1.56	0.35 – 0.77	HC / WS	SM and PZ
PB4C	BCUS4	May-12	302460	6198060	333.0	1.22	0.25 – 0.63	HSC / WS	PZ
PB4D	BCUS4	Nov-14	302526	6198018	333.6	1.45	0.35 – 0.60	HSC / WS	SM and PZ
PCc10A	CCUS10	Nov-14	302625	6197639	329.1	1.62	0.30 – 0.59	HSC / WS	SM and PZ
PCc10B	CCUS10	Nov-14	302691	6197672	337.4	1.57	0.48 – 0.98	HSC / WS	SM and PZ
PCc12A	CCUS12	Nov-14	302047	6197858	361.6	1.65	0.27 – 0.72	CS / WS	SM and PZ
PCc12B	CCUS12	Nov-14	302038	6197964	366.5	1.59	0.11 – 0.27	WS	SM and PZ
PCc2	CCUS2	May-12	303745	6196080	371.4	0.96	1.10 – 1.63	HSC / WS	PZ
PCc3	CCUS3	May-12	302820	6196810	351.9	1.26	0.70 – 1.12	SC / WS	PZ
PCc4A	CCUS4	Oct-14	302678	6196900	342.4	1.35	1.11 – 1.62	HSC / WS	PZ
PCc4B	CCUS4	Oct-14	302604	6196877	342.1	1.04	1.34 – 1.95	HSC / WS	SM and PZ
PCc4C	CCUS4	Oct-14	302579	6196931	340.1	1.71	0.77 – 1.11	HSC / WS	SM and PZ
PCc4D	CCUS4	Mar-12	302615	6196925	339.5	1.60	0.45 – 0.94	SC / WS	SM and PZ

Site ID	Swamp Site	Installed	Easting GDA94 Z56	Northing GDA94 Z56	Ground Level mAHD ¹	TOC magl ²	Screen mbgl ³	Intake Lithology ⁴	Type ⁵
PCc5A	CCUS5	May-12	302110	6197150	315.2	1.41	0.70 – 1.20	HSC / WS	SM and PZ
PCc5B	CCUS5	May-12	302245	6197250	299.2	1.39	0.80 – 1.23	HSC / WS	SM and PZ
PCc5C	CCUS5	Oct-14	302234	6197073	319.5	1.46	0.50 – 0.84	HSC / WS	PZ
PCc5D	CCUS5	Oct-14	302295	6197172	307.7	1.72	0.73 – 1.22	HSC / WS	SM and PZ
PCc6	CCUS6	Mar-12	303165	6196790	351.0	1.33	0.70 – 1.12	WS	PZ
PCr1A	CRUS1	Mar-12	302330	6196625	349.3	1.70	0.30 – 0.49	HSC / WS	SM and PZ
PCr1B	CRUS1	Oct-14	302247	6196655	337.3	1.57	0.44 – 0.69	HSC / WS	SM and PZ
PCr1C	CRUS1	Oct-14	302229	6196762	341.7	1.32	0.65 – 1.15	HSC / WS	SM and PZ
PCr1D	CRUS1	Oct-14	302263	6196879	346.4	1.36	0.22 – 0.38	SC / WS	PZ
SP1	Near CCUS6	Mar-12	303245	6196955	331.6	1.36	0.10 - 0.57	SC / WS	PZ
SP2	Near CCUS3 & CCUS4	Mar-12	302830	6196905	346.0	1.66	0.55 - 1.02	SC / WS	PZ

- Notes: 1. Ground level based on DEM
2. TOC – Top of Casing in magl – meters above ground level
3. mbgl – meters below ground level
4. WS – weathered sandstone HC – humic clay CS – clayey sand
HSC – humic sandy clay SC – sandy clay
5. SM – soil moisture PZ – piezometer

Figure 4-1 Swamp Monitoring Network



4.2 Swamp Monitoring

4.2.1 Soil Moisture and Water Levels

Monitoring of the soil moisture and water level within swamp deposits is conducted in RVE UEP at swamps BCUS4, CCUS10, CCUS12, CCUS4, CCUS5 and CRUS1. It is noted that there are currently no monitoring sites at swamps CCUS1, CCUS14, CCUS20, CCUS21, CRUS2 and CRUS6. Additional monitoring sites for these locations have been proposed (refer **Section 4.1**).

Soil moisture is measured with Odyssey SM probe which measures the dielectric constant of moist soil to determine the moisture content. Probes are typically 1 m deep with five sensors typically at 10, 30, 50, 70 and 90 cm below surface. The observed soil moisture trends are presented in **Appendix B** compared to total monthly rainfall at site. The data shows a good correlation between increasing moisture content in response to rainfall events, with the highest rainfall generally occurring within the summer to autumn months from February to March (refer **Section 3.2**). Some data gaps are visible intermittently in the graphs in **Appendix B**. These are due to instrument error related to the age of equipment; the swamp soil moisture probes were replaced across the site in November 2020 to enable ongoing monitoring.

Water level trends for site monitoring piezometers show a good correlation to rainfall trends, with water levels in the swamps rising to at or near surface generally in response to rainfall (i.e. over 100 mm/month). Across the RVE swamp monitoring network the available manual dipped water levels indicate unsaturated conditions approximately 47% of the time. For periods when the swamps are saturated, the median (50th percentile) of readings indicates water present around 0.57 m below surface.

The swamps are recharged from rainfall and shallow surface flow; however, the site data also shows variability in the response to rainfall between the different swamp monitoring locations (refer to **Appendix B** and **Appendix H**). Dry bore conditions generally correspond to low rainfall periods (i.e. below 10th percentile of monthly rainfall, 20 mm rainfall per month), and appears to be more prevalent for monitoring points at the edge of swamp clusters. Other factors such as the slope aspect and localised disturbance (i.e. tracks and historical subsidence impacts) also influences water level and soil moisture conditions.

The swamps at site are generally perched, meaning they are hydraulically separated from the lower Hawkesbury Sandstone regional water table. There are existing paired bores within the underlying Hawkesbury Sandstone at swamps CRUS1 (PCr1D and RV18), BCUS4 (PB4C and RV21), CCUS2 (PCc2 and NRE A) and CCUS6 (PCc6, SP1, RV20). The baseline data for the open standpipes are presented in **Appendix D** and show that the water heads in the Hawkesbury Sandstone are generally 1.5 m to 28.9 m below surface.

Further discussion on the soil moisture and water trends for selected individual swamps is included below. The discussion is included to provide background on the pre-existing impacts to the groundwater regime and the current groundwater conditions, prior to commencement of the RVE UEP.

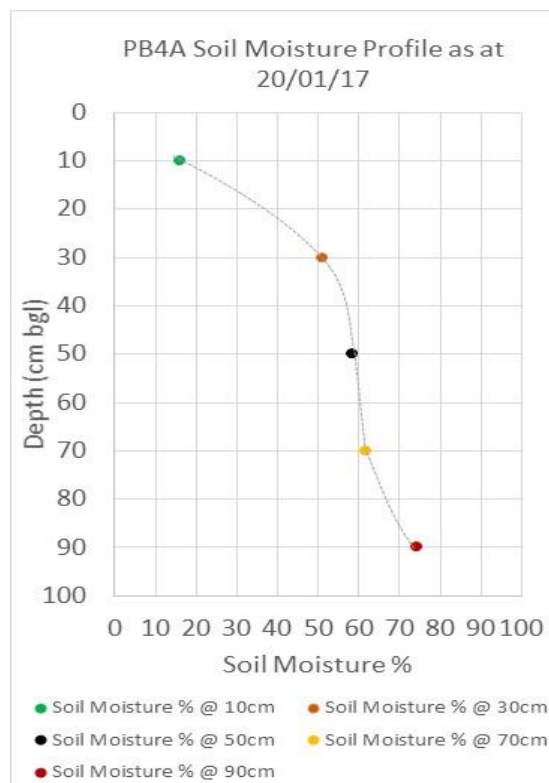
Swamp BCUS4

There are three sites monitoring soil moisture in swamp BCUS4 (PB4A, PB4B and PB4D). All three sites show fluctuations in response to rainfall. PB4B has a constant high soil moisture percentage at depths of 70 and 90 cm below surface. In comparison, PB4A and PB4D fluctuate between moist and dry, likely due to their location on the edge of the swamp whereas PB4B is closer to the centre. Swamp BCUS4 will overlie RVE UEP but not the EP area.

A soil moisture profile is shown in **Figure 4-2** for site PB4A near swamp BCUS4. The figure shows that the soil moisture content continues to increase with depth up to 75 percent at 90 cm below surface. The depth to the water table at swamp BCUS4 recorded at PB4A ranges from 2 to 152 cm below surface. The results show an increase in soil moisture with depth that likely relates to influence of evaporation at surface and evapotranspiration by swamp vegetation. These trends are consistent with trends observed at other swamp locations.

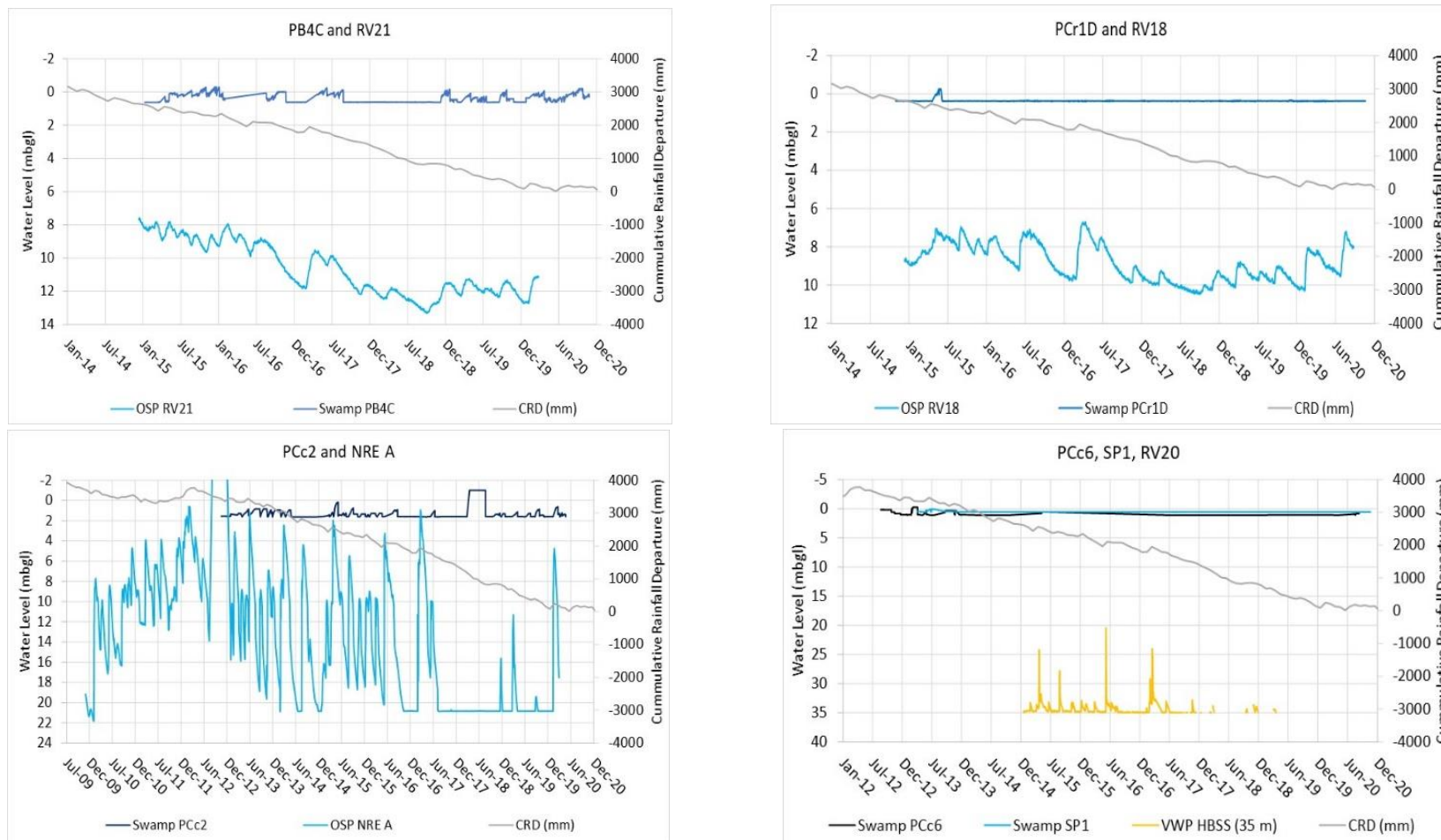
Groundwater level trends for PB4C and nearby Hawkesbury Sandstone bore RV21 are shown in **Figure 4-3**. RV21 is screened within the upper Hawkesbury Sandstone from 9 m to 22 m below surface, with PB4C 0.77 m deep and screened within swamp deposits. **Figure 4-3** shows groundwater levels within the upper Hawkesbury Sandstone have been recorded 8 m to 13 m below surface since monitoring began in 2014. This indicates swamp BCUS4 is hydraulically separated from the Hawkesbury Sandstone water table based on available data. Monitoring at BCUS4 provides a useful reference site of current soil moisture and swamp water level conditions for site swamps unaffected by initial workings under the RVE UEP.

Figure 4-2 Soil moisture profile: PB4A at BCUS4



Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
Type	Plan	Date Published	17/11/2021
Doc Title	GROUNDWATER MANAGEMENT PLAN		

Figure 4-3 Paired bores in swamps and underlying Hawkesbury Sandstone



Swamp CCUS2

There is one water level monitoring site in swamp CCUS2 (PCc2). Groundwater level monitoring is also recorded at nearby monitoring points NRE A and NRE1A (VWP). Water levels within PCc2 are generally at or near the base of the piezometer, with water level rise recorded in response to periods of significant rainfall (i.e. over 100 mm/month).

Groundwater level trends for PCc2 and nearby Hawkesbury Sandstone bore NRE A are shown in **Figure 4-3**. NRE A is screened within the upper Hawkesbury Sandstone from 24 m to 47 m below surface, while PCc2 is 1.63 m deep and is screened within swamp deposits. **Figure 4-3** shows groundwater levels within the upper Hawkesbury Sandstone have fluctuated rapidly compared to all other bores, with levels recorded at surface to 22 m below surface since monitoring began in 2009. These trends have previously been reported as being due to pre-existing tension cracks from historical longwall mining that have increased the vertical connectivity in this area and resulted in localised enhanced recharge to the Hawkesbury Sandstone (GeoTerra/GES 2020). This relationship is represented in the ecohydrological section (**Figure 3-4**). No new subsidence impacts are predicted for future operations at RVE UEP as it only involves bord and pillar.

Additional monitoring with a soil moisture probe is proposed, along with a paired bore within the upper Hawkesbury Sandstone near CCUS2 at RV45.

Swamp CCUS3

There is one monitoring site in swamp CCUS3 (PCc3). The site has been recorded as dry since installation in 2012. The monitoring piezometer extends to 1.2 m depth within sandy clay and weathered sandstone and the site overlies historical workings, including LW5. There is no pre-mining site data available to verify the cause for these dry conditions. Mining commenced in the area in the 1880s, with Bulli Seam workings active until the 1950's, Balgownie Seam longwall workings until 1982 and Wongawilli Seam workings (LW4 to LW6) active between 2012 and 2015.

Groundwater modelling of historical groundwater conditions by GeoTerra (2020) and HydroAlgorithmics (2020a) predicted the presence of shallow water table (within 5 m of surface) in the Hawkesbury Sandstone near PCc3. Swamp water conditions were not modelled due to the perched nature of these systems. The Hawkesbury Sandstone groundwater levels were predicted to have been drawn down over 10 m below surface following longwall mining in the area. Localised drawdown in the Hawkesbury Sandstone was also predicted in the area due to depressurisation with the RVE UEP mine, but no additional impacts on swamp CCUS3 were predicted beyond those already experienced.

Swamp CCUS4

There are three sites monitoring soil moisture in swamp CCUS4 (PCc4B, PCc4C and PCc4D). All three sites show fluctuations in response to rainfall. PCc4C and PCc4D are relatively moist ranging between 10 and 90 cm below surface. In comparison, PCc4B is relatively dry, likely due to its location on the edge of the swamp whereas PCc4C and PCc4D are closer to the centre. Swamp CCUS4 will not overlie active RVE UEP workings but does overlie the Wongawilli Seam LW6 that was actively mined until 2015, as well as previous historical mining within the Bulli and Balgownie seams. The soil moisture data has been collected since 2014 and is representative of groundwater conditions pre-commencement of RVE UEP; however, there is no unimpacted pre-mining data is available for comparison.

Swamp CCUS5

There are three sites monitoring soil moisture in swamp CCUS5 (PCc5A, PCc5B and PCc5D). All three sites show fluctuations in response to rainfall. PCc5B has a high soil moisture percentage at 30 and 90 cm below surface, but drier at 50 and 70 cm below surface suggesting alternating soil horizons. PCc5D is relatively moist between 30 and 90 cm below surface, with the highest moisture percentage at 30 cm below surface. In comparison, PCc5A is relatively dry, likely due to its location on the edge of the swamp whereas PCc5B and PCc5D are closer to the centre. Swamp CCUS5 will overlie RVE UEP.

Swamp CCUS6

There is one monitoring site near swamp CCUS6 (PCc6); however, this monitoring location is not directly within the mapped swamp. An additional two piezometers (SP1 and SP2) are also located near CCUS6 and intersect the surficial Hawkesbury Sandstone.

Site PCc6 has been recorded as dry since installation in 2012. The monitoring piezometer extends to 1.2 m depth within sandy clay and weathered sandstone and the site overlies historical longwall workings including Wongawilli Seam LW4. It is noted that monitoring points SP1 and SP2 near CCUS6 have also been recorded as dry since monitoring commenced in 2012, both overlying LW5. This likely relates to the shallow construction of these piezometers (less than 1 m depth).

There are currently no open standpipes near swamp CCUS6 within the Hawkesbury Sandstone water table. Therefore, trends have been compared to groundwater head readings within the deeper Hawkesbury Sandstone from nearby VWP RV20 (at 35 m depth). The results show a separation of around 30 m between swamp levels and the potentiometric surface in the deeper Hawkesbury Sandstone. Groundwater level trends between the paired sites are shown in **Figure 4-3**.

Groundwater modelling of historical groundwater conditions conducted by GeoTerra (2020) and HydroAlgorithmics (2020a) predicted the presence of shallow water table (within 5 m of surface) in the Hawkesbury Sandstone near PCc6. Swamp water conditions were not modelled due to the perched nature of these systems. Groundwater in the Hawkesbury Sandstone was predicted to have been drawn down over 10 m below surface following longwall mining in the area. Localised drawdown in the Hawkesbury Sandstone was also predicted in the area due to depressurisation with the RVE UEP mine, but no additional impacts on swamp CCUS6 were predicted beyond those already experienced.

Additional monitoring locations are proposed for CCUS6 to monitor swamp water levels and moisture levels within an area of mapped swamp (PCc6B) as well as a proposed standpipe to characterise the water table conditions in the Hawkesbury Sandstone (RV43) and monitor potential changes with future mining.

Swamp CCUS10

There are two sites monitoring soil moisture in swamp CCUS10 (PCc10A and PCc10B). Both sites show fluctuations in response to rainfall, with the highest moisture content between 50 and 90 cm below surface. Swamp CCUS10 will overlie RVE UEP, but not in the initial year of operations. Monitoring at CCUS10 provides a useful reference site of current soil moisture conditions for site swamps unaffected by initial workings under the RVE UEP.

Swamp CCUS12

There are two sites monitoring soil moisture in swamp CCUS12 (PCc12A and PCc12B). Both sites show minor fluctuations in response to rainfall and are relatively dry in comparison to other swamps. PCc12A is only moist at 50 to 90 cm below surface, while PCc12B is only moist at 70 to 90 cm below surface. Monitoring at CCUS12 provides a useful reference site of current soil moisture conditions for site swamps unaffected by initial workings under the RVE UEP.

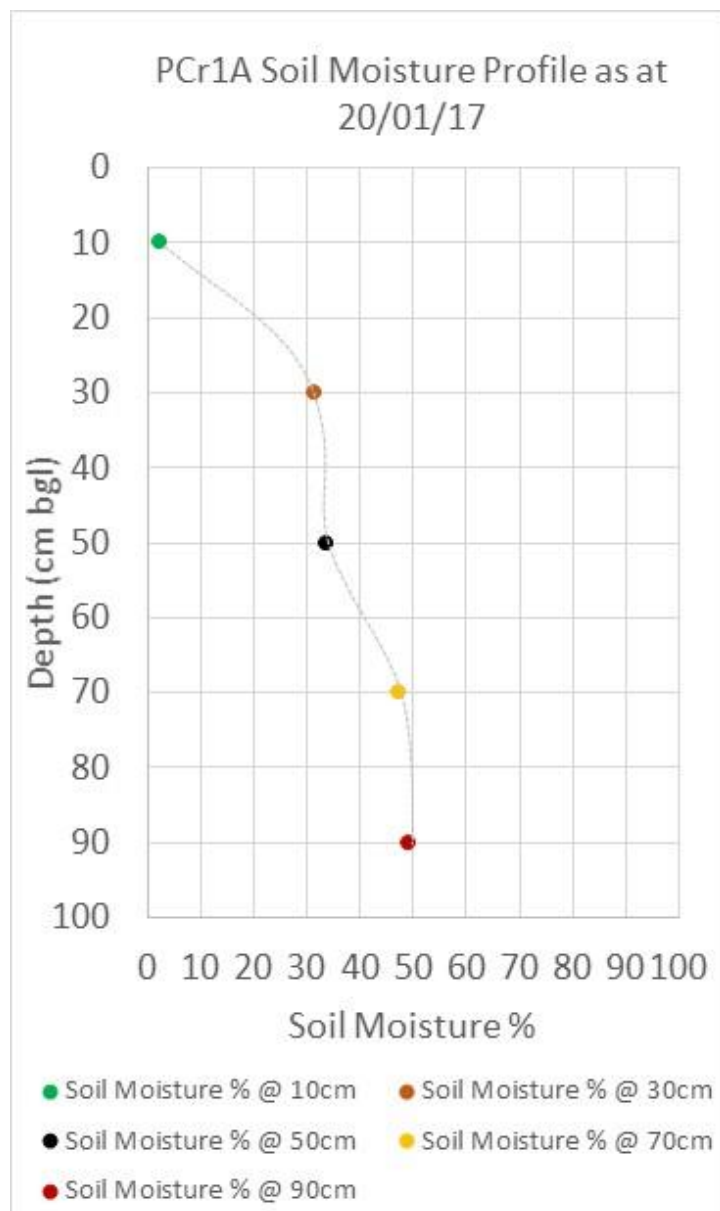
Swamp CRUS1

There are three sites monitoring soil moisture in swamp CRUS1 (PCr1A, PCr1B and PCr1C) and water levels are recorded at PCr1D. All three soil moisture sites show fluctuations in response to rainfall. PCr1B has a high soil moisture percentage at 10 and 90 cm below surface. PCr1C is relatively moist between 10 and 90 cm below surface. In comparison, PCr1A has large fluctuations between 100 percent moist and dry conditions, possibly due to its location on the edge of the swamp whereas PCr1B is closer to the centre. Swamp CRUS1 will overlie RVE UEP.

Groundwater level trends for PCr1D and nearby Hawkesbury Sandstone bore RV18 are shown in **Figure 4-3**. RV18 is screened within the upper Hawkesbury Sandstone from 8 m to 20 m below surface, and PCr1D is 0.38 m deep and screened within swamp deposits. **Figure 4-3** shows groundwater levels within the upper Hawkesbury Sandstone have been recorded 6 m to 11 m below surface since monitoring began in 2015. This indicates swamp CRUS1 is hydraulically separated from the Hawkesbury Sandstone water table based on available data.

A soil moisture profile is shown in **Figure 4-4** for site PCr1A near swamp CRUS1, which is present above historical mining (i.e. LW6). The figure shows the soil moisture content increases with depth to 50 cm below surface where it stabilises at 50 percent. The depth to the water table at swamp CRUS1 is recorded at the PCr1A piezometer, about 250 m to the north, as being generally unsaturated. When water is present it can range from 23 to 47 cm below surface. The results show an increase in soil moisture with depth that likely relates to influence of evaporation at surface and evapotranspiration by swamp vegetation.

Figure 4-4 Soil moisture profile - PCr1A at CRUS1



4.2.2 Water Quality

Water quality monitoring of the shallow swamp piezometers has occurred since March 2012. A summary of the swamp water quality data is presented in **Table 7** and timeseries pH and EC trends shown in **Figure 4-5** and **Figure 4-6**, respectively. The swamp water quality is generally acidic to neutral (pH 3.3 – 8.5) and fresh (EC 23 – 420 $\mu\text{S}/\text{cm}$). Full water quality results are contained in **Appendix C**.

Table 7 Swamp Water Quality Data Summary

Analyte	ANZG 2018 95% species protection default guideline (mg/L)	Swamp Data				
		Range	Median	5 th Percentile	95 th Percentile	Population
Field Data						
pH	6.5 - 8.5	3.3 - 8.5	5.0	3.8	6.3	402
EC (uS/cm)	125 - 2200	23 - 420	93	56	193	402
Temp (°C)	-	10.0 - 21.7	15.0	11.3	19.2	402
Total Dissolved Solids (mg/L)	50	18 - 273	60	36	126	377
Dissolved Oxygen (% Sat)	85 - 110	28.2 - 101.3	65.0	34.4	94.8	207
Dissolved Oxygen (mg/L)	-	1.9 - 9.8	6.0	3.0	9.0	402
Oxidation Reduction Potential (E _h) (mV)	-	-6.5 - 553.7	264.0	41.5	405.6	402
Resistivity (Ohms.cm)	-	2840 - 40000	13513	6106	22727	376

Figure 4-5 Swamp Field pH

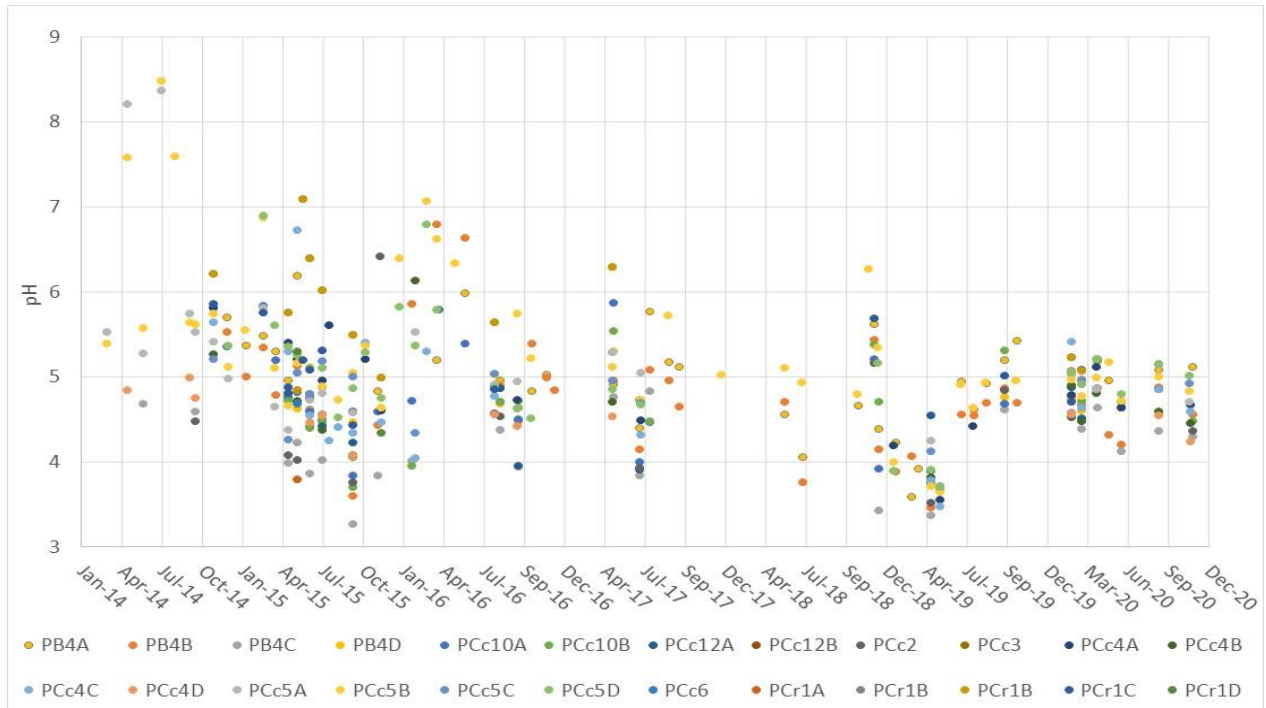
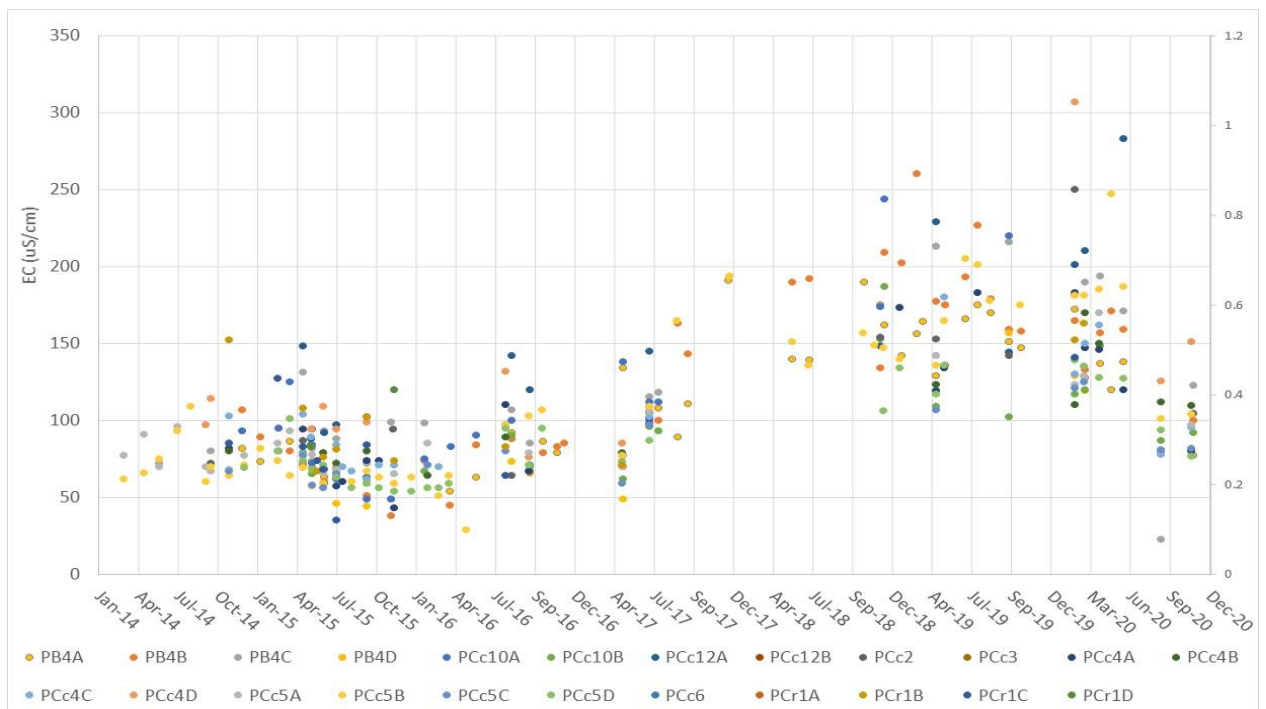


Figure 4-6 Swamp Field EC



5. GROUNDWATER BASELINE DATA

5.1 Pit Top Area Groundwater Monitoring

In accordance with **Condition B17** and **Condition F5 (a)/ Schedule 2** of the project approval, WCL is required to detail any baseline data of groundwater levels, yield and quality for groundwater resources potentially impacted by the development. The project also involves upgrades to the surface facilities within the Pit Top Area; however, as outlined in **Section 3.6** and **Section 6.1**, additional impacts to groundwater are considered unlikely.

No impacts to groundwater have been previously identified for the approved Pit Top Area activities, likely due to the site geology (detailed in **Section 3.4**) and absence of a productive aquifer. As discussed in **Section 3.4** and **Section 3.6**, the geology within the Pit Top Area comprises the Permian Woonona Coal Member. Drill holes across the site reported by Terra Insight (2020) show the lithology comprises weathered Permian coal measures (siltstone and shale) and fill material at surface. The geotechnical investigation by Terra Insight (2020) also identified potential alluvium or colluvium localised along Bellambi Gully. Drill logs indicate the alluvium and colluvium comprises low permeability clays, unconformably overlying weathered Permian coal measures. No groundwater monitoring bores occur within the Pit Top Area.

Baseline data and monitoring within the Pit Top Area includes surface water monitoring and geotechnical assessments. Details on the surface water monitoring program for the surface facilities are captured in the Colliery Pit Top Water Management Plan. Further work will also be undertaken to assess potential impacts on groundwater conditions within the Pit Top Area and based on the outcome of the assessment suitable shallow ground water open standpipe piezo will be installed to monitor for any potential impacts. This work including installation of the shallow ground water piezo will be completed within the first 12 months of approval of this plan and the management plan will be updated accordingly.

5.2 Extraction Area Groundwater Monitoring Network

Wollongong Coal has an extensive groundwater monitoring network across RVE UEP that targets multiple groundwater units, including:

- 12 open standpipes (OSP) within the shallow Triassic strata, to depths of between 20 m to 53 m below surface
- vibrating wire piezometer (VWP) locations with sensors across the Hawkesbury Sandstone and Narrabeen Group within the RVE UEP area
- VWPs with sensors in the Hawkesbury Sandstone, Narrabeen Group and Permian coal measures to the west of the RVE UEP area

Details on the current bore and VWP network are included in **Table 8** and locations shown in **Figure 5-1**. Due to the limited access in the catchment, and to limit disturbance to the catchment, the majority of drilling has been positioned along cleared access tracks.

The piezometers were installed between 2009 and 2020, after obtaining regulatory approval. They were established with accurate surface datum levels and groundwater levels or pressures are recorded at least 12 hourly, whilst field groundwater parameters (pH, EC) are monitored at least bi-monthly, (every two months), with water samples sent for a full laboratory analysis at least annually.

It is considered that the site has an adequate network to capture current and initial potential groundwater impacts.

Table 8 Groundwater Monitoring Network

Site ID	Type ¹	Easting GDA94 Z56	Northing GDA94 Z56	Ground Level mAHD	Screen/ Sensor Depth mbgl	Geology ²	Year Installed
GW1 A	OSP	303742	6196983	311.7	21-27	HBSS/BGSS	2012
NRE A	OSP	303692	6196033	376.18	24-47	Upper HBSS	2009
NRE C	OSP	303233	6198797	362.72	18-24	Upper HBSS	2009
NRE D	OSP	301870	6198509	348.83	40-52	Upper HBSS	2009
NRE E	OSP	296727	6202286	329.24	26-29	Upper HBSS	2009
NRE F (NE 3)	OSP	294803	6201954	359.27	~ 20	Upper HBSS	2009
NRE G	OSP	296949	6201954	363.03	50-53	Upper HBSS	2009
RV18	OSP	302041	6196884	339.6	8-20	Upper HBSS	2014
RV19	OSP	301867	6196787	312.1	10-18.4	Upper HBSS	2014
RV21	OSP	302633	6197894	349.81	9-22.65	Upper HBSS	2014
RV22A	OSP	303026	6197634	342.66	7-37.35	Upper HBSS	2014
RV23A	OSP	301370	6198233	296.84	7-26.4	NPFM	2014
GW1 (NRE1 GW01)	VWP	303693	6196913	318.20	18	BGSS	2012
					30	BGSS	2012
					45	BGSS	2012
					63	BGSS	2012
					93	BGSS	2012
					125	BGSS	2012
					140	SPCS	2012
NRE 3 (905)	VWP	294803	6201954	360.23	165	SBSS	2012
					100	HBSS	2009
					130	HBSS	2009
					155	HBSS	2009
NRE1A*	VWP	303680	6196034	376.23	255	BGSS	2009
					45	HBSS	2009
					60	BHCS	2009
					75	BGSS	2009
					140	BGSS	2009

Site ID	Type ¹	Easting GDA94 Z56	Northing GDA94 Z56	Ground Level mAHD	Screen/ Sensor Depth mbgl	Geology ²	Year Installed
NRE1B	VWP	303939	6197567	372.69	27.5	HBSS	2009
					43	BHCS	2009
					63	BGSS	2009
					168	BGSS	2009
NRE1D (939)	VWP	301870	6198509	348	70	HBSS	2009
					90	BHCS	2009
					110	BGSS	2009
					160	BGSS	2009
RV16	VWP	303567	6196288	362.3	21.8	HBSS	2014
					51.8	BHCS	2014
					91.8	BGSS	2014
					131.8	BGSS	2014
					161.8	BGSS	2014
					196.8	SPCS	2014
					241.8	SBSS	2014
RV17	VWP	301979	6196818	333.4	20	HBSS	2014
					40	NPFM	2014
					60	BGSS	2014
					79.5	BGSS	2014
RV20	VWP	302944	6196635	374.27	35	HBSS	2014
					65	HBSS	2014
					85	BHCS	2014
					105	BGSS	2014
					134	BGSS	2014
RV22	VWP	303026	6197634	342.66	25	HBSS	2014
					50	BHCS	2014
					75	BGSS	2014
					100	BGSS	2014
					140	BGSS	2014
					175	BGSS	2014
					230	SBSS	2014
RV23	VWP	301370	6198233	296.84	20	NPFM	2014
					40	BHCS	2014
					70	BGSS	2014
					90	BGSS	2014
					130	BGSS	2014
					170	BGSS	2014
					200	SPCS	2014
					220	SBSS	2014

Site ID	Type ¹	Easting GDA94 Z56	Northing GDA94 Z56	Ground Level mAHD	Screen/ Sensor Depth mbgl	Geology ²	Year Installed
RV24	VWP	301004.6	6201932	397.7	85	HBSS	2018
					110	HBSS	2018
					125	BHCS	2018
					220	BGSS	2018
					300	SPCS	2018
					325	WMCS	2018
					430	WWCO	2018
RV25	VWP	301367	6201056	386.6	65	HBSS	2018
					100	HBSS	2018
					127	BHCS	2018
					150	BGSS	2018
					257	BGSS	2018
					320	WMCS	2018
					381	BUCO	2018
RV27	VWP	298743	6201421	350.9	423	WWCO	2018
					135	HBSS	2020
					149	NPF	2020
					178	BHCS	2020
					315	BGSS	2020
					330	SPCS	2020
					380	SBSS	2020
RV29	VWP	300533	6200938	386.7	475	WWCO	2020
					90	HBSS	2018
					120	HBSS	2018
					140	BHCS	2018
					240	BGSS	2018
					295	SPCS	2018
					350	WMCS	2018
RV35	VWP	291578	6205739	306.0	443	WWCO	2018
					90	HBSS	2020
					155	HBSS	2020
					195	BHCS	2020
					300	BGSS	2020
					395	SPCS	2020
					422	SBSS	2020
					446	BUCO	2020
					485	WWCO	2020

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
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Site ID	Type ¹	Easting GDA94 Z56	Northing GDA94 Z56	Ground Level mAHD	Screen/ Sensor Depth mbgl	Geology ²	Year Installed
RV36	VWP	291880	6203229	332.0	75	HBSS	2020
					100	HBSS	2020
					116	HBSS	2020
					255	BGSS	2020
					300	BGSS	2020
					324	BGSS	2020
					371	SBSS	2020
					405	WMCS	2020

- Notes: 1. **OSP** – Open Standpipe
2. **HBSS** – Hawkesbury Sandstone
BGSS – Bulgo Sandstone
SBSS – Scarborough Sandstone
BUCO – Bulli Coal
WWCO – Wongawilli Coal
* NRE1A VWP failed in 2017, to be repaired in 2021
- VWP** – Vibrating Wire Piezometer
BHCS – Bald Hill Claystone
SPCS – Stanwell Park Claystone
NPFM – Newport Formation
WMCS – Wombarra Claystone

Figure 5-1 Groundwater Monitoring Network

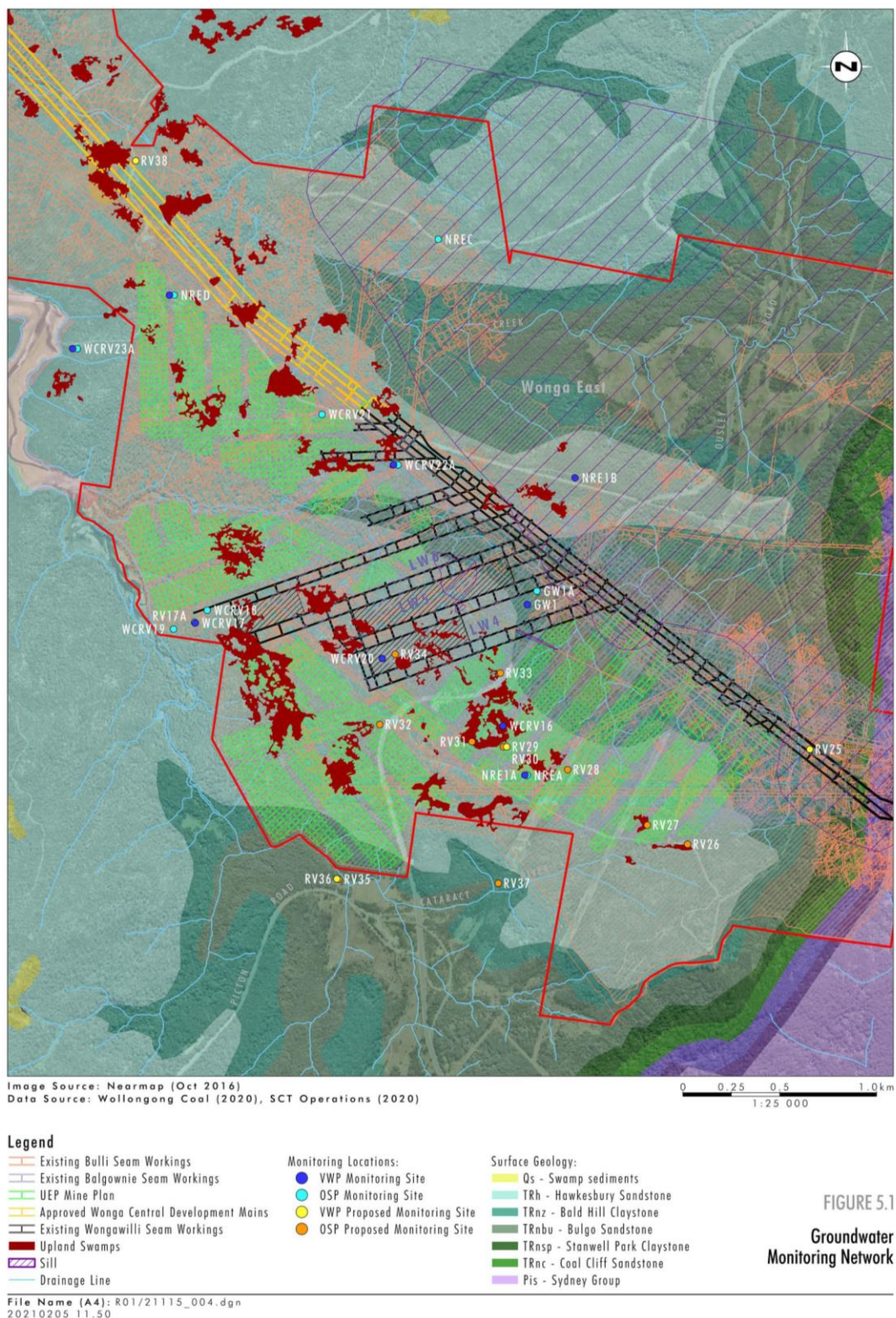


FIGURE 5.1
Groundwater
Monitoring Network

5.3 Groundwater Monitoring

5.2.1 Hawkesbury Sandstone

Groundwater Levels

Groundwater levels within the Hawkesbury Sandstone are monitored across RVE UEP within open standpipes and VWP's (refer **Section 5.1**). Hydrographs of baseline water levels are presented in **Appendix D** and interpolated groundwater levels and depth to groundwater based on observation data from September 2019 are presented in **Figure 5-2**.

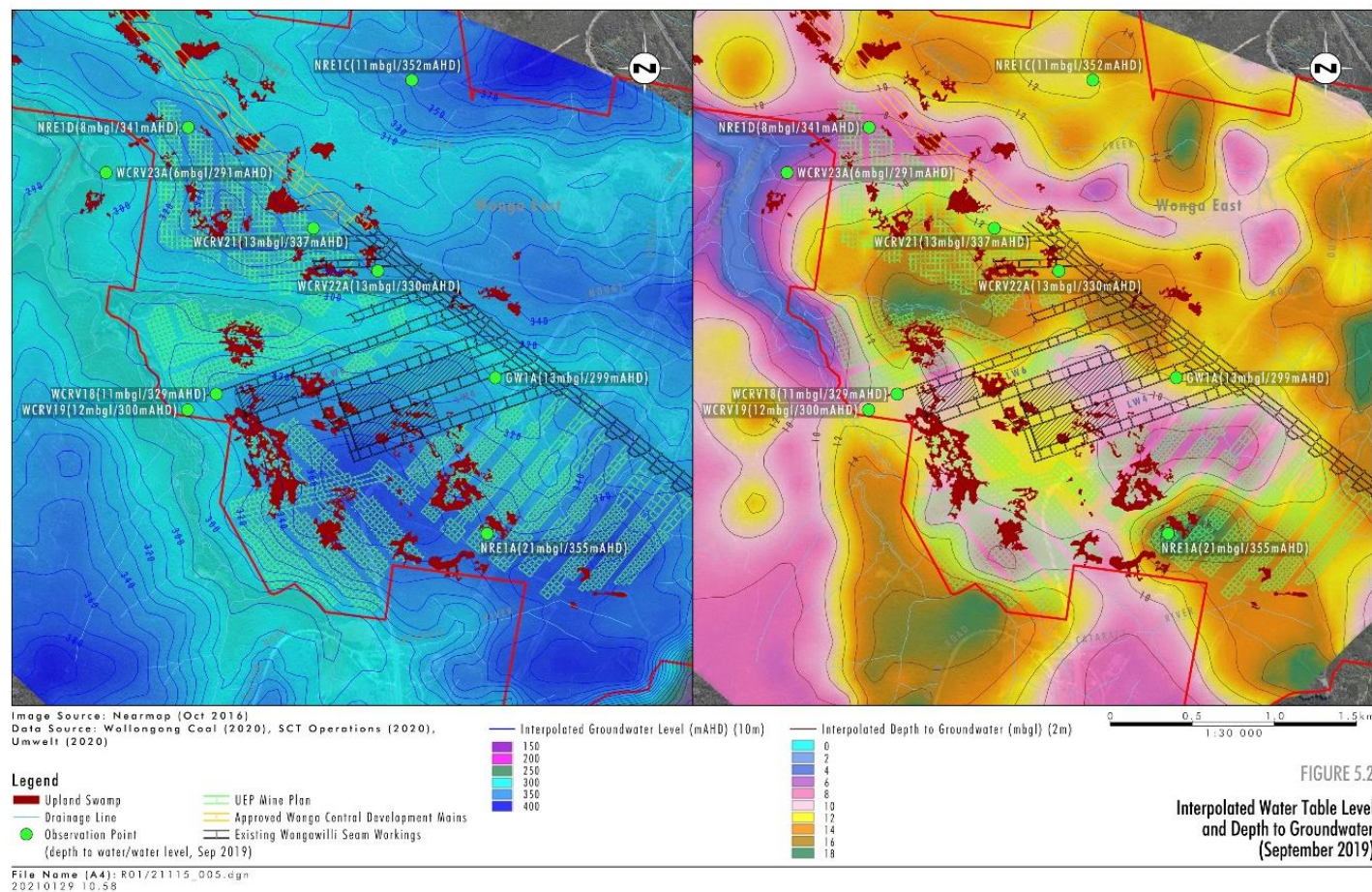
Based on the site data and drill logs, groundwater within the Hawkesbury Sandstone was first intersected around 17 to 48 m below surface across RVE UEP. Groundwater heads show confined to semi-confined conditions, with a general downward gradient within the unit. The groundwater level trends show good correlation to rainfall trends. Mining related drawdown (and recovery) within the Hawkesbury Sandstone has also been observed in localised areas around historical longwall extraction but water levels have generally recovered.

As shown in **Figure 5-2**, shallow groundwater levels within the RVE UEP area are generally around 13 m below surface. Relatively shallow groundwater levels (2 m to 6 m below surface) are interpolated along incised rivers and near the Cataract Reservoir to the north west. Deeper groundwater levels are seen towards the south-east, at around 21 m below surface.

The Hawkesbury Sandstone is recharged from rainfall where it occurs at outcrop. Ephemeral perched water tables within the upper 20 m of the Hawkesbury Sandstone can occur following extended rainfall recharge periods. Groundwater within the shallow strata discharges as baseflow to streams where it is incised and gradients enable this, as well as downward seepage (refer **Figure 5-2**). Evapo-transpiration losses from deep and shallow rooted vegetation would also reduce the phreatic surface of the shallow water table to varying degrees. Discharge also likely occurs across the escarpment face under natural conditions.

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
Type	Plan	Date Published	17/11/2021
Doc Title	GROUNDWATER MANAGEMENT PLAN		

Figure 5-2 Interpolated Water Table Level and Depth of Groundwater (Sep 2019)



Groundwater Quality

Groundwater quality monitoring of the open standpipes within the Hawkesbury Sandstone across RVE UEP has occurred since December 2009. A summary of the Hawkesbury Sandstone water quality data is presented in **Table 9** and timeseries pH and EC trends shown in **Figure 5-3** and **Figure 5-4**, respectively.

Water quality in the Hawkesbury Sandstone within the RVE UEP area generally has low salinity (45 – 685 $\mu\text{S}/\text{cm}$) with relatively acidic to neutral pH (2.7 – 8.2) and sulphate concentration of around 2 to 404 mg/L.

As shown in **Table 9** the water quality within the Hawkesbury Sandstone exceeds the ANZG 2018 95% Species Protection Level for Freshwater Aquatic Ecosystem for a range of analytes. Full water quality results are shown in **Appendix E**.

Table 9 Hawkesbury Sandstone Water Quality Data Summary

Analyte	ANZG 2018 95% species protection default value (mg/L)	Hawkesbury Sandstone Data				
		Range	Median	5 th Percentile	95 th Percentile	Population
Field Data						
pH	6.5-8.5	2.7 - 8.2	5.0	3.7	6.5	388
EC (uS/cm)	125-2200	45 - 685	135	72	376	386
Temp (°C)	-	13.0 - 24.2	17.0	15.0	19.8	307
Total Dissolved Solids (mg/L)	50	29 - 356	85	45	241	297
Turbidity (NTU)	6-50	0.3 - 2074	15.0	2.6	411.8	187
Dissolved Oxygen (% Sat)	85-110	11 - 101.8	54.0	27.2	88.8	201
Dissolved Oxygen (mg/L)	-	1.0 - 9.1	5.0	2.9	8.1	307
Oxidation Reduction Potential (E _h) (mV)	-	1.9 - 563.9	301.0	39.8	441.1	307
Resistivity (Ohms.cm)	-	2109 - 24390	8969	3432	16850	296
Laboratory Data						
Total Dissolved Solids (mg/L)	-	36 - 4320	102	50	257	194
Sodium (mg/L)	-	6 - 558	12.0	9.0	34.3	195
Calcium (mg/L)	-	1 - 134	4.9	1.0	32.5	171
Potassium (mg/L)	-	0.3 - 38.0	1.0	1.0	32.5	126
Magnesium (mg/L)	-	1 - 10	2.2	1.0	9.0	194
Chloride (mg/L)	-	10 - 88	22.5	14.7	72.3	195
Fluoride (mg/L)	-	0.1 - 2.2	0.1	0.1	0.2	83
Sulphate (mg/L)	-	2 - 404	22.0	3.0	56.6	195
Bicarbonate (mg/L)	-	1 - 1540	2.0	1.0	98.8	150
Filtered Iron (mg/L)	-	0.010 - 31.90	0.300	0.050	16.80	142
Filtered Manganese (mg/L)	1.9	0.006 - 4.240	0.200	0.018	1.705	195
Filtered Copper (mg/L)	0.0014	0.001 - 0.095	0.005	0.001	0.010	160
Filtered Lead (mg/L)	0.0034	0.001 - 0.209	0.002	0.001	0.066	145

Analyte	ANZG 2018 95% species protection default value (mg/L)	Hawkesbury Sandstone Data				
		Range	Median	5 th Percentile	95 th Percentile	Population
Filtered Zinc (mg/L)	0.008	0.005 - 0.665	0.043	0.010	0.178	192
Filtered Nickel (mg/L)	0.011	0.001 - 0.099	0.004	0.001	0.018	178
Filtered Aluminium (mg/L)	0.055	0.010 - 2.000	0.290	0.010	0.860	175
Filtered Arsenic (mg/L)	0.024	0.001 - 0.097	0.001	0.001	0.011	76
Filtered Lithium (mg/L)	-	0.001 - 0.293	0.001	0.001	0.028	125
Filtered Barium (mg/L)	-	0.003 - 0.420	0.012	0.005	0.224	194
Filtered Strontium (mg/L)	-	0.004 - 0.646	0.026	0.005	0.107	192
Total Iron (mg/L)	-	0.02 - 10400	13.60	0.177	49.010	194
Total Manganese (mg/L)	-	0.013 - 218.0	0.230	0.028	2.186	195
Total Nitrogen (mg/L)	0.5	0.100 - 103.0	0.600	0.200	4.335	174
Total Phosphorus (mg/L)	0.025	0.010 - 620.0	0.030	0.010	0.375	139
Silicon (mg/L)	-	0.320 - 14.40	7.120	4.416	10.820	177
Dissolved Organic Carbon (mg/L)	-	1.00 – 22.00	2.00	1.000	8.100	133

Figure 5-3 Hawkesbury Sandstone Field pH

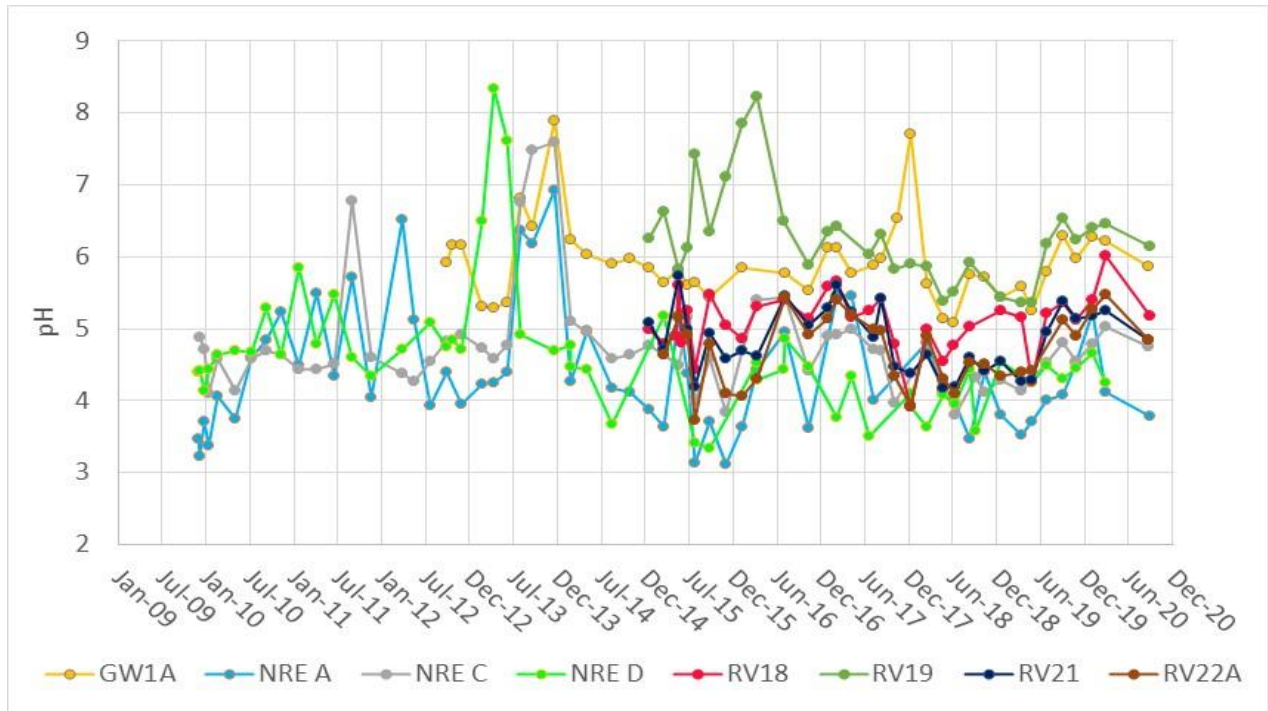
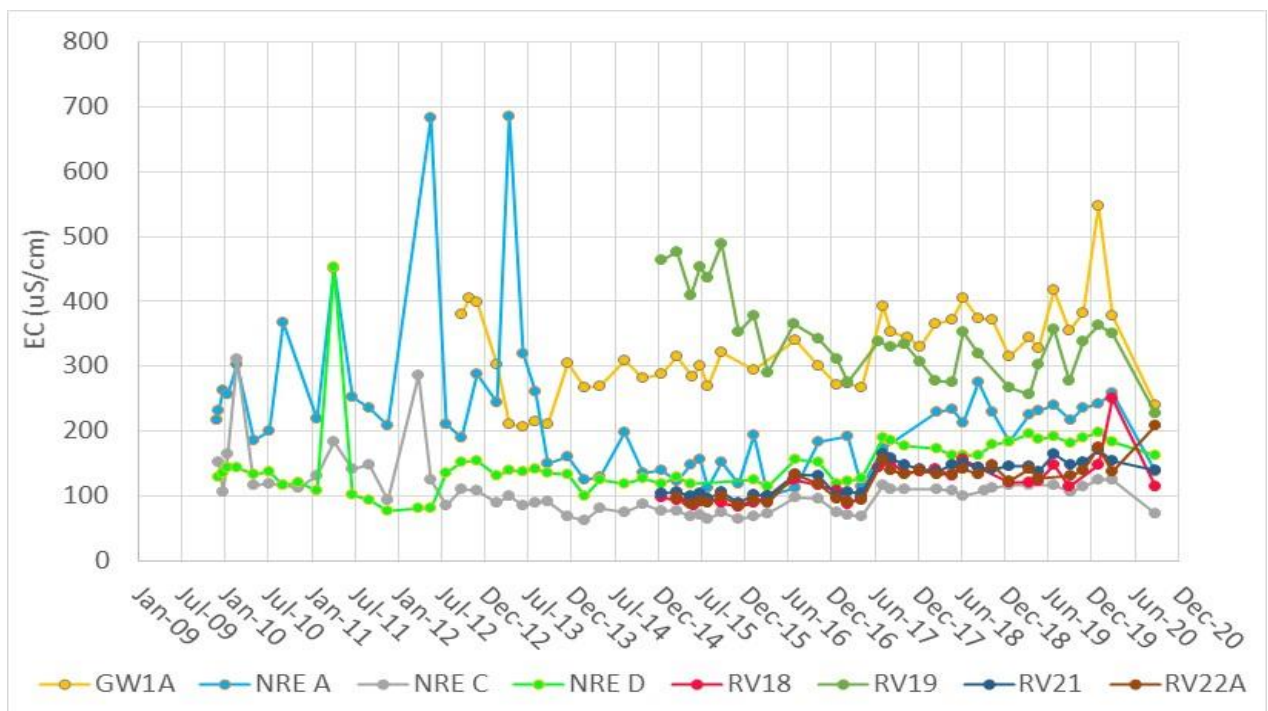


Figure 5-4 Hawkesbury Sandstone Field EC



5.2.2 Narrabeen Group

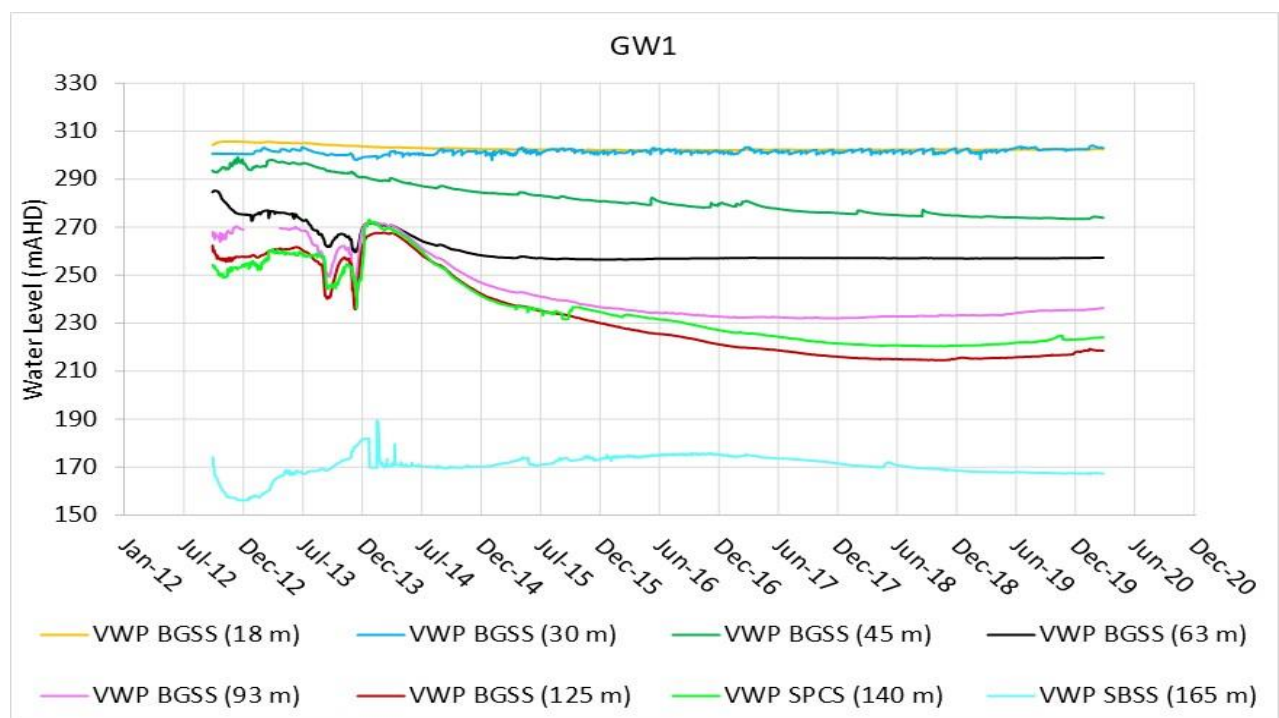
Groundwater Levels

Groundwater levels within the Narrabeen Group are monitored across RVE UEP within ten VWP (refer **Section 5.15.1**). Hydrographs of baseline water levels are presented in **Appendix D**. Total head profiles showing groundwater heads at different depths and strata are also presented in **Appendix D**.

Based on the site data and drill logs, groundwater within the Narrabeen Group is intersected around 17 to 48 m below surface across RVE UEP. Groundwater heads show confined to semi-confined conditions, with a general downward gradient within the unit. Groundwater monitoring within RVE UEP also shows a general downward gradient and depressurisation in response to the historic mining. To illustrate this, a hydrograph for VWP GW1 is shown in **Figure 5-5** and a total head profile shown in **Figure 5-6**.

Figure 5-5 shows that water levels in the Bulgo Sandstone rapidly changed during the period of active mining from 2012 to 2015. With recovery of groundwater conditions in the underground workings during the period of care and maintenance, levels continued to gradually decline until 2018. Minor recovery in the Bulgo Sandstone is observed from 2018 to 2020.

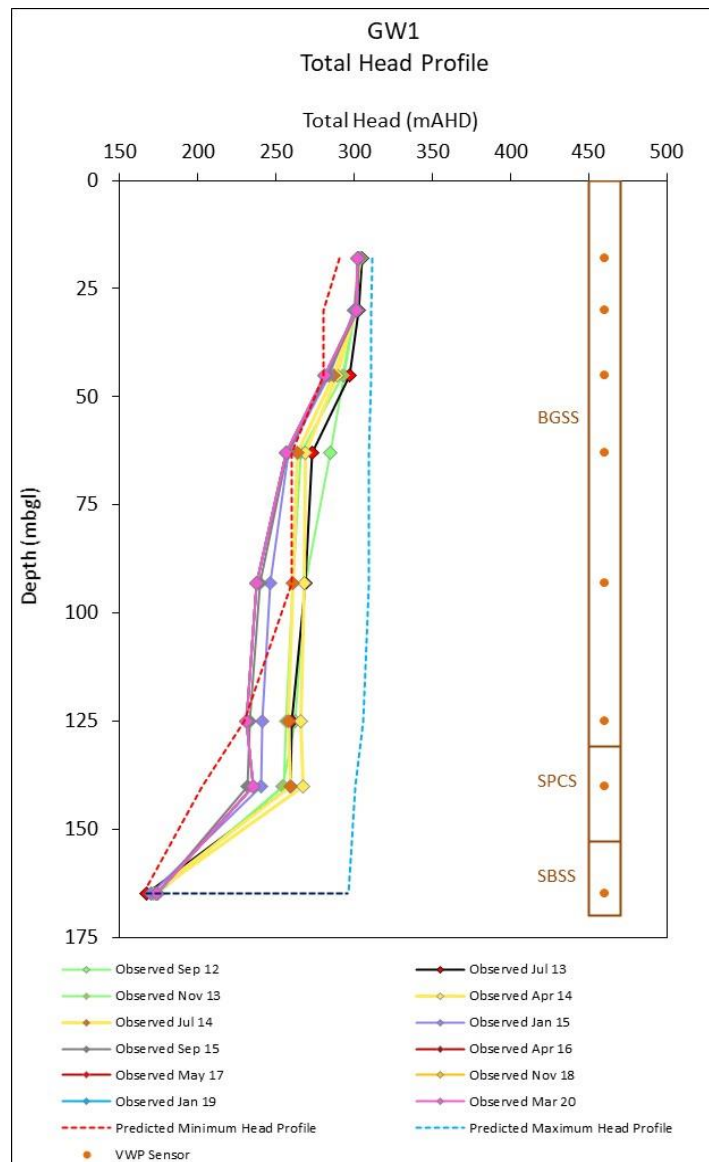
Figure 5-5 GW1 VWP Hydrograph



The total head profile in December 2015 to monitor **Figure 5-6** shows the groundwater head at different depths and strata within the Narrabeen Group, to help illustrate the vertical gradients. The profile shows a reduction in groundwater head with depth, illustrating a downward gradient.

Where it occurs at surface, the Narrabeen Group is recharged by rainfall and surface water storage areas. Where the Hawkesbury Sandstone is underlain by the Bald Hill Claystone it generally inhibits vertical flow to the underlying Bulgo Sandstone. However, within the RVE UEP area there are localised areas where the Bald Hill Claystone has been impacted by historical mining (goaf effects) and facilitates vertical flow and recharge via downward seepage. Groundwater within the uppermost Bulgo Sandstone discharges as baseflow to streams where the topography is incised and gradients enable this. Discharge also likely occurs across the escarpment face under natural conditions.

Figure 5-6 GW1 Total Head Profile



Groundwater Quality

Groundwater within the Bulgo Sandstone has been recorded at Appin Mine monitoring point S2080 as moderately saline (median of 5,660 $\mu\text{S}/\text{cm}$) with a relatively neutral pH (median of 6.95) and sodium-bicarbonate type water (HGEO 2018), which is considered representative of the Bulgo Sandstone water quality. There is currently no site water quality data for the Bulgo Sandstone; however, the proposed monitoring program includes additional bores in order to obtain baseline data for the Bulgo Sandstone.

5.2.3 Permian Coal Measures

Groundwater Levels

There are currently no monitoring points within the Permian coal measures within RVE UEP, therefore additional monitoring locations have been proposed as outlined in **Section 5.1**.

The Balgownie, Bulli and Wongawilli Seams have previously been mined and therefore significant depressurisation has likely occurred in the strata over time. However, recovery and ponding of water within the historical workings has been observed, including within the Bulli Seam workings west of Cataract Reservoir, the Cordeaux workings and Bulli Colliery bord and pillar workings.

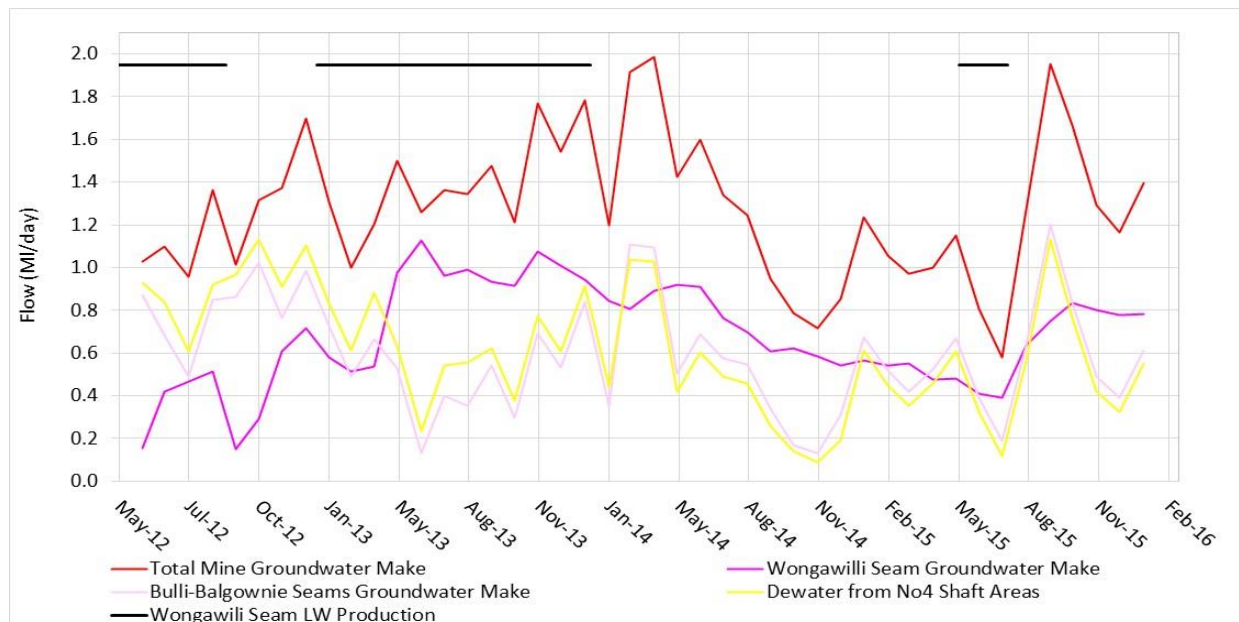
Groundwater within the Permian coal measures is recharged by rainfall where the seams outcrop along the escarpment, as well as downward seepage from the overlying Narrabeen Group. Downward seepage is restricted by the low permeability claystones within the Narrabeen Group, but is possible where the claystones are absent or exhibit goaf effects from historical and approved longwall mining. Discharge is via downward seepage, natural seepage along the escarpment (where gradients enable this), as well as abstraction with mining.

5.2.4 Underground Dewatering (Mine Inflows)

Reported groundwater inflows into the existing workings at Russell Vale have been relatively low, generally at around 1.1 ML/day for the whole mine and 0.4 ML/day for the Wongawilli Seam (SCT 2019a). This is down from 1.4 ML/day for the whole mine at the end of 2016 (SCT 2019a). Approximately up to 0.6 ML/day is currently pumped out at the RVC Pit Top. Estimated groundwater inflows within the mine water balance are presented in **Figure 5-7**.

It is assessed there is no free drainage into the existing workings at RVE UEP (including historical workings) as they are currently depressurised and essentially dry, apart from a few small ponded areas at the down dip end of the old workings where the dewatering pump is not able to extract the water, until it 'spills' into a down gradient section of the workings (SCT Operations 2014). Monitoring of water pump-out from the RVE workings indicates there is no observed associated short term increase in mine water make from the current RVE workings following significant rain in the Cataract Creek, Cataract River or Bellambi Creek catchments.

Figure 5-7 Mine Inflows – Monthly Average (2012 – 2016)



Groundwater Quality

AGL (2013) characterised the groundwater quality within the coal measures based on observed data in the region and indicated groundwater is generally alkaline with saline water quality, sulfate concentrations of up to 202 mg/L and some metals at low concentrations. WCL have collected a full suite of water quality data from the underground workings since 2020, which is summarised in **Table 10**.

As shown in **Table 10**, the mine water quality is generally alkaline (pH 7.7 – 9.4) (8.2/9.3 for 5th/95th percentiles) and relatively brackish (2,360 – 5,790 $\mu\text{S}/\text{cm}$) (5,226 $\mu\text{S}/\text{cm}$ 95th percentile).

Water quality analysis indicates the mine inflow contains bicarbonate of up to 2,700 mg/L and sulfate of up to 204 mg/L. As well as dissolved metals with up to 0.107 mg/L of copper, 0.039 mg/L of nickel and 0.159 mg/L zinc. The available data indicates water within the mine inflows is generally consistent with water quality characterised for the Illawarra Coal Measures in the region by AGL (2013). However, some instances of higher concentrations of metals are noted.

Table 10 Permian Coal Measures Water Quality Summary

Analyte	Mine Inflow Range (Median) ¹	Illawarra Coal Measures (AGL,2013)	Geochemical assessment of rejects (WCL, 2020)
EC ($\mu\text{S}/\text{cm}$)	2,360 – 5,790 (3,400)	6,130 – 36,100	85 – 214 (soil)
pH	7.7 – 9.4 (8.8)	8 – 9	8.2 – 9.6 (soil)
Bicarbonate (mg/L)	1,210 – 2,700 (1,554)	3,360 – 16,400	700 – 13,700 mg/kg (soil)

Analyte	Mine Inflow Range (Median) ¹	Illawarra Coal Measures (AGL,2013)	Geochemical assessment of rejects (WCL, 2020)
Sulfate (mg/L)	1 – 204 (31)	<1 – 202	60 – 170 mg/kg (soil)
Aluminium (mg/L)	0.01 – 0.12 (0.03)	<LOR – 0.07	<LOR – 0.8 mg/L (water extract)
Antimony (mg/L)	0.00 – 0.13 (0.01)	-	<LOR – 0.08 mg/L (water extract)
Arsenic (mg/L)	0.002 – 0.269 (0.018)	<LOR – 0.03	<LOR – 1.8 mg/L (water extract)
Molybdenum (mg/L)	0.01 – 0.09 (0.05)	<LOR – 0.10	<LOR – 0.06 mg/L (water extract)
Copper (mg/L)	0.001 – 0.107 (0.010)	<LOR – 0.03	<LOR (water extract)
Nickel (mg/L)	0.001 – 0.039 (0.003)	<LOR – 0.02	<LOR (water extract)
Zinc (mg/L)	0.005 – 0.159 (0.016)	<LOR – 0.07	<LOR (water extract)

Note: 1. Site mine inflow data collected from February to December 2020

5.4 Reject Material

Reject material comprises Permian coal measures separated during coal processing to improve the overall quality of the product coal through a dry separation process. The process of removing the reject material from the product coal does not involve the use of any chemical treatment processes.

Wollongong Coal conducted geochemical testing of existing reject material at site that was derived from the Wongawilli Seam and interburden material (i.e. Kembla Sandstone, shale and coaly shale). Twelve samples were collected for testing. The geochemical assessment found the rejects tested are likely to be non-acid forming (NAF) and have a high factor of safety with respect to potential acid generation. Analysis of the reject samples found they had an alkaline pH of 8.2 to 9.6, low electrical conductivity of 85 to 214 $\mu\text{S}/\text{cm}$, with less than 10 mg/kg of chloride (WCL 2019). Samples also contained between 60 to 170 mg/kg of soluble sulfate with a low total sulfur content of 0.005 to 0.2 %. Water extract testing found concentrations of soluble metals were generally below or close to the laboratory limit of reporting (LOR), but higher readings were recorded for one sandstone sample (REA08) with up to 0.08 mg/L antimony and 1.8 mg/L arsenic recorded. The quality of water from the rejects is largely consistent with the water quality within the Illawarra Coal Measures, however some samples can record slightly higher concentrations of specific metals (i.e. aluminium and arsenic). Spatial variability of rock geochemistry is expected and the slight differences between monitored groundwater quality and the results from the reject testings are considered unlikely to significantly impact on water quality within the Wongawilli Seam workings once groundwater levels recover. A summary of the results is shown in **Table 10**.

WCL have committed to undertaking the operations at RV UEP in a staged approach under development consent MP09_0013, as outlined in the Project Descriptions of the Environmental Management Plans under development. Specifically, WCL intend to assess the financial viability of the Coal Processing Plant (CPP) during stage 1 of the operations to determine whether or not the company will construct the CPP in stage 2b.

As the generation of rejects material will only occur once the CPP is constructed during stage 2b, if deemed financially viable, WCL is applying to the Department to approve the staging of the waste and water management plans in accordance with Schedule 2, Condition A21 (a) of the consent which states that:

With the approval of the Planning Secretary, the Applicant may:

Prepare and submit any strategy, plan or program required by this consent on a staged basis (if a clear description is provided as to the specific stage and scope of the development to which the strategy, plan or program applies, the relationship of the stage to any future stages and the trigger for updating the strategy, plan or program).

5.5 Private Bores

RVE UEP is located within the Metropolitan Special Area and forms part of the Sydney drinking water supply catchment. There are no private water supply works located within the Cataract Reservoir catchment. There are also no registered private water supply works located along Bellambi Gully.

6. POTENTIAL GROUNDWATER IMPACTS

6.1 Pit Top Area Groundwater Impacts

The RVE UEP area includes the existing approved Russell Vale Pit Top Area. The Pit Top Area has been in use since the later 1800's and under the Mine Operations Plan the site currently comprises:

- **Top bench** – mine dam, fire dam, pumps, water pipes, water tanks, fire trail, access roads, electrical cables and power supply, stormwater diversion drainage channels, stormwater drainage pipes, retaining walls and benching, portable buildings, old redundant shed, original 1887 portal, 1918 ventilation tunnel, Gibson's portal, numerous closed adits, rubber tyred vehicle portal, ventilation portal, conveyor portal, steel-cored belt portal, ventilation fan, 'Castle' offices, muster room, administration building, car parking areas, workshop/store, external storage areas, vehicle wash down bay, bathhouses, transformers, conveyor transfer and RV1 conveyor.
- **Stockpile Area** – access road, truck washes, weightometer, unmade roads, contractor's lunchroom, contractor's bathhouse, stockpile control office and workshop. Old bathhouse workshop, clarifier tanks and associated infrastructure, truck loading bins and conveyors, stockpile area 1, coal processing area, stormwater pipes, Bellambi Gully Diversion pipe, weirs, dirty water system pipes, sumps and swales, water pipes, electrical cables and power supply, Dam 1, Dam 2, Stormwater Control Dam, Highway Dam, pump sheds, fencing, and automated monitoring systems.

Within the Pit Top Area, there have been no known activities undertaken that result in the take or interception groundwater (i.e. abstraction bores). Therefore, no impacts related to drawdown in groundwater within the Pit Top Area are anticipated.

The Pit Top Area includes the storage and management of potential contaminant sources, including mine water, process material and chemical storage associated with site offices and workshop. Measures are in place to manage potential contaminants on site, including:

- Dirty water storage dams at the Pit Top Area are lined with impermeable material (i.e. clay);
- The main Storm Water Control Dam (SWCD) has been engineered with a seepage collection drain within the dam wall, which collects seepage at LDP 3 and then pumps it back into the SWCD; and
- Chemicals and hydrocarbons are stored in bunds and/or bunded area's designed to Australian Standards, and any spills are cleaned up promptly to prohibit migration into the groundwater table.

Further work will also be undertaken to assess potential impacts on groundwater conditions within the Pit Top Area and based on the outcome of the assessment suitable shallow ground water open standpipe piezo will be installed to monitor for any potential impacts. This work including installation of the shallow ground water piezo will be completed within the first 12 months of approval of this plan and the management plan will be updated accordingly.

The Project will involve changes to the existing site surface infrastructure within the Pit Top Area, including:

- Redesign of the Pit Top layout to relocate infrastructure to more shielded locations to reduce amenity impacts.
- Extension to the height of existing bunds, construction of new bunds and noise walls within the existing surface infrastructure area for improved noise mitigation.
- Construction of a new truck loading facility and associated conveyors.
- Construction of a suitable dry coal processing plant (CPP) to improve the quality of product coal removing reject rock material via use of dry separation methods will also be evaluated at this stage and if required to be installed, will be commissioned to align with the ramp up of production to 1.2Mtpa ROM.
- Waste rock from the CPP to be used in rehabilitation and for beneficial re-use as engineered material (where applicable). Prior to re-use or disposal of rejects material, further geochemical testing will be undertaken to verify appropriate management options.

Further work will also be undertaken to assess potential impacts on groundwater conditions within the Pit Top Area and based on the outcome of the assessment suitable shallow ground water open standpipe piezo will be installed to monitor for any potential impacts. This work including installation of the shallow ground water piezo will be completed within the first 12 months of approval of this plan and the management plan will be updated accordingly.

As detailed in the WMP, measures will be put in place to manage and control surface water flow and sediments. All water and sediment captured on site will be stored and appropriately managed in accordance with the Surface Facilities Water Management Plan and the Environmental Protection Licence (EPL 12040) requirements.

6.2 Groundwater Modelling

A Groundwater Impact Assessment was conducted by GeoTerra/GES (2020) and peer reviewed by Dr Noel Merrick (HydroAlgorithmics 2020b). The impact assessment and review included development of a MODFLOW numerical groundwater model and uncertainty analysis by HydroAlgorithmics (2020a) (peer reviewed by Dr Frans Kalf) in order to predict the cumulative.

6.2.1 Cumulative Impact

Modelling predicted there will not be any superposition of drawdown cones between the Russell Vale and Appin/Dendrobium mining areas. Therefore, there is no cumulative depressurisation resulting from the proposed bord and pillar workings and other adjoining active mines. However, there are cumulative impacts associated with the existing approved operations at Russell Vale Colliery, Cordeaux workings and Bulli Colliery and their residual impacts and recovery post closure. These cumulative historical impacts are captured within the groundwater assessment and modelling by GeoTerra/GES (2020) and HydroAlgorithmics (2020a).

Full details on the modelling and impact assessment predictions are included in GeoTerra (2020) and HydroAlgorithmics (2020a).

6.3 Existing Groundwater Impacts

Historical mining at site resulted in depressurisation within the Permian coal measures, Narrabeen Group and drawdown in the Lower Hawkesbury Sandstone in localised areas. These impacts were caused by subsidence and goaf effects associated with the longwall mining method, and groundwater extraction with mine progression. Recovery in groundwater levels has been observed over time, but residual impacts are present, including:

- Fracturing and subsequent increase in hydraulic conductivity within the Illawarra Coal Measures above the Wongawilli Seam, as well as the Narrabeen Group up to the Bulgo Sandstone in areas of longwall mining in the Wongawilli and Balgownie Seams and secondary extraction in the Bulli Seam. In some localised areas where extraction occurred across the three coal seams, multi-seam goaf effects have been identified as extending to the Lower Hawkesbury Sandstone.
- Groundwater inflows to the existing workings. Approximately 0.6 ML/day on average is currently pumped out of the Russell Vale workings (i.e. LDP2); however historically, higher levels of inflows were reported and modelled during the mining of LWs 4-6.
- Depressurisation around the active mine area and areas that have experienced goaf effects. This includes depressurisation within the Illawarra coal seams, localised around active mine areas. Areas showing some recovery with water ponding in historical workings include Bulli Seam workings west of Cataract Reservoir, the Cordeaux workings and Bulli Colliery bord and pillar workings. Depressurisation is also observed within the sandstone units of the Narrabeen Group, localised around active mine areas. Short-term localised depressurisation also occurred within the Lower Hawkesbury Sandstone.
- Reduction in natural seepage and flow to the escarpment with depressurisation during active mining, as well as development of preferential seepage pathways with adits and portals.
- Localised changes in groundwater quality within the Hawkesbury Sandstone, visible as iron staining along incised creeks that receive baseflow contributions from groundwater.
- There is no evidence of subsidence near Cataract Reservoir to suggest there are any existing links between RVE UEP and the Cataract Reservoir. No further linkages are expected in the future.

6.3.1 Impacts Post Closure

Post-closure, groundwater levels within the coal measures will recover back towards pre-mining conditions over time. Due to the long history of mining within the region (since the 1800s) the pre-mining conditions are not well understood within the region. It is anticipated that if groundwater conditions recover back to natural conditions there is potential for natural seepage from the escarpment. Therefore, the existing adit opening may form a potential pathway for additional localised seepage post closure.

The Wongawilli Seam and mined areas dip to the west from the existing mine entry adit located on the Illawarra Escarpment at the RVC Pit Top. The existing underground workings would eventually fill with groundwater, possibly up to the level of the adit and spill from the adit to the Bellambi Gully catchment. The recovery of groundwater levels within the Wongawilli Seam localised around the Pit Top is therefore defined by the lowest adit outflow point at 117 mAHD.

6.3.2 Mine Sealing

The installation of seals to isolate areas can be conducted as specific mining areas are completed, with the seals containing monitoring, drainage and sampling facilities to allow water accumulation behind the seals to be monitored, sampled and managed while current areas are mined.

The final sealing of the mine requires bulkheads to be installed that ensure that any water reporting to the mine will be controlled. However, a return to natural seepage from the Permian and Triassic strata where it occurs at outcrop along the Illawarra escarpment would be expected once groundwater levels recover.

Trigger mechanisms that will initiate the decision to abandon other remedial techniques and commence the installation of bulkheads either to isolate areas or to seal the mine are defined as part of the mine closure plan.

6.4 UEP Additional Impacts

This section presents a summary of the predicted groundwater impacts based on the groundwater assessment conducted by GeoTerra/GES (2020) that present a base case of predicted impacts due to the UEP, as well as the MODFLOW-USG base case and uncertainty analysis conducted by HydroAlgorithmics (2020a) that presents a range of predicted impacts based on specified uncertainty bounds.

6.4.1 Groundwater Inflows

The GeoTerra/GES (2020) modelling predicts mine inflows of around 288 ML/year for the basecase model, with the current uncertainty analysis indicating inflows are likely as not to be about 294 ML/year for the RVE UEP. This is similar to observed inflows for existing operations, measured at around 219 ML/year between 2013 and 2014 but less than the peak modelled Wongawilli Seam groundwater make during the mining of LW5. The predicted mine inflows vary over time, and will be continually refined as new data becomes available and modelling updated.

The total licensable volume is predicted to be around 288 ML/year under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 (Groundwater WSP). Wollongong Coal holds a Water Access Licence (WAL) for the groundwater source of 615 ML, which more than covers the predicted take.

6.4.2 Depressurisation

Depressurisation due to the RVE UEP mine plan is expected or modelled to be greatest within the Wongawilli Seam and immediate overburden where it occurs within the immediate footprint of the proposed workings. The areal extent of the 2 m drawdown contour within the Wongawilli Seam at the end of the proposed mining extends a maximum of 0.5 km to the north of the main headings. The uncertainty analysis predicted drawdown within the Wongawilli

Seam due to the RVE UEP mine plan could extend up to 2 km from the proposed workings. This includes drawdown associated with delayed recovery within the existing mine workings and represents a temporal impact, as opposed to a change in the drawdown extent due to the RVE UEP. The modelled results are also based on additional impact from the end of LW6, so account for residual cumulative impacts from existing operations.

There is minimal transgression of depressurisation within the overlying strata associated with RVEUEP mining, due to the lack of any additional goaf development or subsidence due to the proposed bord and pillar mining method. Maximum drawdown of up to 50 m above the Wongawilli Seam is predicted to occur just to the north of the Mains out to a distance of approximately 0.5 km from the proposed workings. As the overlying Balgownie and Bulli seams have also previously been mined, significant depressurisation has occurred historically. Results show maximum predicted drawdown of up to 5 m within the Balgownie Seam with the RVE UEP mine plan, localised over the proposed bord and pillar workings (GeoTerra/GES 2020).

The Bulli Seam has been mined over a very long period of time over a large regional area. Within the Russell Vale area where there is over 100 years of historical mining activity, unsaturated voids still exist and continue to be drained. Recovery within the mined workings is predicted to be delayed with the RVE UEP mining but would have no significant effect on the long-term recovery.

6.4.3 Water Table Drawdown

The shallower water table is predicted to be largely unaffected by the RVE UEP bord and pillar workings. This is because the workings do not result in a change in existing connective cracking/goaf effects, so groundwater impacts are largely localised to within 50 m above the Wongawilli Seam. However, around LWs 4 to 6, where multi-seam mining has previously occurred, the existing goaf effects extend into the Hawkesbury Sandstone.

The base case modelling by GeoTerra/GES (2020) and uncertainty analysis by HydroAlgorithmics (2020a) predicted a localised area of water table drawdown above LWs 4 to 6. This predicted drawdown relates to approved longwall mining, with the RVE UEP potentially causing a delay in timing in recovery of water levels and a slight increase in drawdown where drawdown has already occurred due to the delay in commencement of recovery. In the absence of any subsidence impacts which affect the water holding capacity within the swamps, no additional impacts to swamps already impacted by historical mining are predicted as a result of the proposed bord and pillar mining.

6.4.4 Water Storage Interaction

The water storage areas relate to the reservoirs and lakes. There is no subsidence near Cataract Reservoir to provide a causal pathway for groundwater. No further linkages between RVE UEP and Cataract Reservoir are expected.

6.4.5 Baseflow Losses

RVE UEP will have no perceptible subsidence impacts. No direct impacts to surface features are expected to result from the Proposed Action, with the exception of the Pit Top works which are further addressed in the Russell Vale Colliery Pit Top Biodiversity Management Plan. The groundwater assessment predicted minor indirect impact associated with predicted drawdown in a localised area. Uncertainty analysis by HydroAlgorithmics (2020a) predicted

negligible baseflow reduction along Cataract Creek of around 2.1 ML/year (0.0058 ML/day), with uncertainty bounds (10th and 90th percentile) of 1.3 ML/year (0.0036 ML/day) to 3.4 ML/year (0.0093 ML/day). Negligible baseflow reduction was also predicted in the uncertainty analysis (50th percentile) for Cataract River of around 1.0 ML/year (0.0027 ML/day) and 0.7 ML/year (0.0019 ML/day) along Bellambi Creek. These modelled annual changes for the Cataract River and Bellambi Creek will be practically unobservable and likely reflect model computational changes between the runs. Details on the surface water monitoring program are contained in the EP WMP.

6.4.5 Groundwater Quality

Due to the very low level of predicted subsidence, and by association, the minimal overburden fracturing that could develop as a result of the proposed bord and pillar workings, no observable pH or iron hydroxide changes are anticipated in the shallow strata during active mining.

7. MONITORING PROGRAM

7.1 Swamp Monitoring

The proposed swamp water level and soil moisture monitoring network is outlined in **Table 6** and shown in **Figure 4-1**. Additional long-term swamp monitoring locations across RVE UEP are also proposed, as presented in **Table 11** and shown in **Figure 4-1**. This includes additional monitoring near swamps CCUS1, CCUS6, CCUS14, CCUS20, CCUS21, CRUS2 and CRUS6. **Table 11** includes indicative locations, to be confirmed based on land accessibility and agreement with the regulatory authority. It is recommended that the piezometers at the proposed monitoring sites be installed as close to the centre of the swamp, rather than close to the edge, to collect more accurate data. Soil moisture probes (without companion piezometers) are proposed for CCUS11, CCUS21, CRUS2, CRUS3, CRUS6 and BCUS11 due to likely impact from ground disturbance with installation of a piezometer at these locations. The indicative swamp monitoring locations are identified in **Table 11** and shown on **Figure 4.1**. This monitoring will be installed progressively with mine advancement. Confirmed monitoring locations and the timing of the monitoring program in each swamp will be detailed in the Extraction Plans developed for second workings under condition C10. Additional short-term monitoring may also be undertaken at swamps when mining is active beneath the swamp. The triggers for this monitoring will be identified in the Extraction Plan.

Deeper groundwater monitoring bores within the Hawkesbury Sandstone or Bulgo Sandstone near swamp locations and mapped potential GDEs are also proposed. These locations are proposed to verify the water table conditions and hydraulic separation from swamps and enable early identification of changes in conditions with mining. The proposed deeper paired bores are noted in **Table 11** below, and full details are included in **Table 12**.

Table 11 Proposed Additional Network for Swamps

Site ID	Swamp Site	Easting GDA94 Z56	Northing GDA94 Z56	Depth mbgl	Intake Lithology	Type ¹	Install Timing ²	Paired Bore ³
PCc1A	CCUS1	303382	6196263	~ 0.5 - 2	Swamp deposits	SM and PZ	Prior to commencement	RV42
PCc1B	CCUS1	303512	6196355	-	Swamp deposits	SM		
PCc1C	CCUS1	303609	6196292	~ 0.5 - 2	Swamp deposits	SM and PZ		
PCc11	CCUS11	302531	6197700	-	Swamp deposits	SM	Year 2	-
PCc14A	CCUS14	304311	6195771	~ 0.5 - 2	Swamp deposits	SM and PZ	Year 1	RV46
PCc14B	CCUS14	304276	6195820	-	Swamp deposits	SM	Year 1	
PCc20	CCUS20	303513	6196568	~ 0.5 - 2	Swamp deposits	SM and PZ	Prior to commencement	RV41
PCc21	CCUS21	303481	6196772	-	Swamp deposits	SM	Prior to commencement	-

Site ID	Swamp Site	Easting GDA94 Z56	Northing GDA94 Z56	Depth mbgl	Intake Lithology	Type ¹	Install Timing ²	Paired Bore ³
PCc6B	CCUS6	303020	6196609	~ 0.5 - 2	Swamp deposits	SM and PZ	Prior to commencement	RV39
PCr2	CRUS2	302784	6196158	–	Swamp deposits	SM	Year 2	RV40
PCr3	CRUS3	303177	6195925	-	Swamp deposits	SM	Year 2	
PCr6	CRUS6	301928	6198123	–	Swamp deposits	SM	Year 1	-
PB11	BCUS11	302220	6197915	-	Swamp deposits	SM	Year 2	-

Notes: 1. SM – soil moisture PZ – piezometer
 2. All swamp monitoring sites will be installed prior to commencement of mining below the swamp, indicative staging is included only – timing to be confirmed in Extraction Plan.
 3. Proposed paired open standpipe bore within the Hawkesbury Sandstone, details of proposed bores in **Table 12**

General details on the swamp water level and soil moisture monitoring program are included in **Appendix F** which refers to monitoring requirements prior to mining, during mining and post closure. The specific installation and monitoring requirements for each swamp in potential areas of impact are set out in the Extraction Plan relevant to the bord and pillar mining to be undertaken in that area. The Extraction Plan for LW6 also includes specific monitoring requirements for swamps potentially impacted by the mining of the final 25 metres of LW6.

Details on the swamp ecological monitoring program are captured separately within the Upland Swamp Ecological Monitoring Plan and Biodiversity Management Plan.

The Extraction Plans developed under Condition C10 of the Development Consent will detail specific swamp monitoring requirements and TARPs related to potential impacts on swamps from the 'second workings' covered by those plans.

7.2 Groundwater Monitoring

The proposed groundwater monitoring network is outlined in **Table 8** and shown in **Figure 5-1**. Additional monitoring locations are proposed to assist in future model updates and mine closure planning, as presented in **Table 12** and shown in **Figure 5-1**. This includes an additional two VWP's and seven open standpipes within the Hawkesbury Sandstone and three within the Bulgo Sandstone. **Table 12** includes indicative locations, to be confirmed based on land accessibility and agreement with the regulatory authority. The proposed additional sites would be gradually installed over a two year period to enable collection of data to inform the future model update.

Details are included on the likely construction, geology and purpose of the additional monitoring locations. The proposed monitoring locations include additional sites within the Permian coal measures, Narrabeen Group and Hawkesbury Sandstone to characterise current local groundwater conditions and monitor response to depressurisation and the vertical head gradient.

During the installation of the monitoring points additional data on hydraulic properties will be collected to inform future updates to the groundwater model. With the installation of the VWP, downhole geophysics will be conducted, and drill core collected for analysis of vertical and horizontal hydraulic conductivity. Packer testing will also be conducted to collect hydraulic properties across the various geological units. Head tests will also be conducted on newly installed open standpipes where water is present and sufficient to conduct a test.

Table 12 Proposed Additional Groundwater Monitoring Sites

Site ID	Type ¹	Easting GDA94 Z56	Northing GDA94 Z56	Screen/ Sensor Depth mbgl	Geology ²	Install Timing ²	Purpose
RV39	OSP	302937	6196635	9-15 m	HBSS	Year 1	Located near an existing track and swamp CCUS6. To be paired with swamp site PCc6B and VWP RV20 and to characterise depth to groundwater and water characteristics for future model updates.
RV40	OSP	302931	6196295	9-15 m	HBSS	Year 1	Located near Mount Ousley Road and swamp CRUS2. To be paired with swamp site PCr2 and to characterise depth to groundwater and water characteristics for future model updates.
RV41	OSP	303554	6196560	9-15 m	HBSS	Year 1	Located near Mount Ousley Road and near CCUS20. To be paired with swamp site PCc20 and to characterise depth to groundwater and water characteristics for future model updates.
RV42	OSP	303374	6196261	30-36 m	HBSS	Year 1	Located along existing track near swamp CCUS1. To characterise groundwater and level and quality changes and detection of subsidence impacts with mining and verify levels in nearby VWP site RV16.

Site ID	Type ¹	Easting GDA94 Z56	Northing GDA94 Z56	Screen/ Sensor Depth mbgl	Geology ²	Install Timing ²	Purpose
RV43 A	OSP	302700	6195481	9-15 m	BGSS	Year 2	Located in cleared area near Picton Road, along Cataract Creek and mapped high potential GDE. To characterise depth to groundwater and water characteristics for future model updates. As well as verify trends with paired VWP RV43.
RV43	VWP	302691	6195477	Various to ~ 270 m	BGSS, SPCS, CCSS, BUCO, WWCO	Year 2	Located in cleared area near Picton Road, outside of immediate mine area in order to intersect coal measures. Enable ongoing monitoring of groundwater level and vertical head profile response to mining and recovery post closure.
RV44	OSP	303660	6195798	9-15 m	HBSS	Year 2	Located near existing track and near CRUS3. To characterise depth to groundwater and water characteristics for future model updates.
RV45	OSP	303920	6195974	9-15 m	HBSS	Year 1	Located near existing track near swamp CCUS2. To characterise depth to groundwater and water characteristics for future model updates.
RV46	OSP	304279	6195739	9-15 m	HBSS	Year 2	Located near existing track near swamp CCUS14. To be paired with swamp site PCc14 and to characterise depth to groundwater and water characteristics for future model updates.
RV47	OSP	304523	6195674	9-15 m	HBSS	Year 2	Located along existing track near swamp CRUS4. To characterise depth to groundwater and level and for future model updates.

Site ID	Type ¹	Easting GDA94 Z56	Northing GDA94 Z56	Screen/ Sensor Depth mbgl	Geology ²	Install Timing ²	Purpose
RV48	VWP	30437 5	61966 76	Various to ~ 250 m	BHCS, BGSS, SPCS, CCSS, BUCO, WWCO	Year 2	Located north of site, aiming to avoid historical mining in order to intersect coal measures. Enable ongoing monitoring of groundwater level and vertical head profile response to mining and recovery post closure.

Notes: 1. **OSP** – Open Standpipe **VWP** – Vibrating Wire Piezometer
2. **HBSS** – Hawkesbury Sandstone **BHCS** – Bald Hill Claystone **BGSS** – Bulgo Sandstone **SPCS** – Stanwell Park Claystone
SBSS – Scarborough Sandstone **BUCO** – Bulli Coal Seam **WWCO** – Wongawilli Coal Seam
3. Indicative install timing, Year 1 is within the first year of operations, Year 2 is within the second year of operations.

Details on the groundwater monitoring program are included in **Appendix F** and outline that basement groundwater level/head pressure data will be monitored in the existing and proposed OSPs as well as the existing and proposed VWP arrays. The OSP and VWP bores will have pressure transducers installed to read at least 12 hourly, and will be downloaded bi-monthly as outlined in **Appendix F**. During logger downloads, the field pH and EC will be measured from the OSPs with calibrated handheld meters, whilst sampling for laboratory analysis of the waters will be conducted quarterly.

Appendix F refers to monitoring requirements prior to mining, during mining and post closure. The monitoring frequency and triggers designated during mining apply to bores located within 500 m of the bord and pillar footprint. Bores located further than 500 m from the bord and pillar footprint will remain monitored at a pre-mining frequency. With the progression of mining resulting in a bore that was within 500 m of the bord and pillar footprint becoming further than 500 m away, it will be monitored at the post-mining frequency. The specific groundwater monitoring bores within 500 m of the bord and pillar will be designated within the extraction management plan. The timing of installation of proposed monitoring locations (refer **Table 12**) will be prioritised based on active mine areas as specified within the extraction management plan.

Groundwater level and quality triggers are included in **Appendix G** and **Appendix H** for the existing and additional proposed OSPs, and groundwater head profile trigger criteria included for the VWPs. The established water quality triggers can be applied to any newly installed monitoring locations within the Hawkesbury Sandstone. As the water level triggers are site specific and there is limited data on the Bulgo Sandstone, a minimum of twelve months of data will be collected in order to establish water level trigger levels and water quality triggers for any newly installed monitoring locations.

The groundwater monitoring program will be linked to the subsidence monitoring program and analysis will enable direct correlation of any groundwater impact with subsidence. The use of GNSS units located at targeted locations along the panel and at locations proximate to sensitive nearby features and can also be used to detect subsidence changes in near real-time which can also inform the analysis of groundwater monitoring results.

Water quality monitoring will be conducted before, during and after the period of extraction associated with the RVE UEP, as outlined in **Appendix F**.

Water quality monitoring will be conducted monthly for analysis of field parameters of pH, EC, DO, ORP and temperature for early detection of water quality changes. Full water quality analysis will be conducted consistent with current monitoring, which includes the field parameters plus suspended solids, major ions, metals and nutrients will be conducted on a two to three monthly basis, as outlined in **Appendix F**. The water quality analysis will be increased with a full metals suite on an annual basis, to include boron, cadmium, copper, mercury, selenium and silver.

A summary of the water quality analytes and terminology is outlined below:

- **Field analysis:** includes field analysis of pH, EC, DO, ORP and temp.
- **Discrete:** includes field analysis of pH, EC, DO, ORP and temp, as well as laboratory analysis of TDS, TSS, major ions (Na, K, Ca, Mg, Cl, SO₄), F, HCO₃, CaCO₃, NO₃, Total N, Total P, Total alkalinity, filtered DOC and dissolved metals Al, P, Cu, Pb, Zn, Ni, Sb, Fe, Mn, Mo As, Li and Ba.
- **Full metals suite:** includes field analysis of pH, EC, DO, ORP and temp, as well as discrete laboratory analysis suite **plus** laboratory analysis of additional dissolved metals B, Cd, Co, Hg, Se and Ag.

The LW 6 Extraction Plan and Extraction Plans developed for the bord and pillar workings meeting the definition of 'second workings' in the Development Consent will include further details on monitoring timeframes and frequencies relative to the potential impacts managed under the particular plans.

7.3 Mine Water

RVC has developed procedures as part of an In-Rush Hazard Management Plan to manage the potential risk of in-rush from:

- water stored in decommissioned adjacent workings;
- water stored in completed WCL workings;
- mining under surface water bodies; and
- intersection with bores or gas drainage holes.

Flow meters have been strategically located throughout the mine to enable reliable measurement of water pumped in and out of the workings to assist in the identification of groundwater make and water accumulation as mining progresses and inform the site water balance. Due to the inherent complexity associated with underground water movement and inflows from historical workings, the water balance will be informed by numerical groundwater modelling. This modelling will be updated over time based on collection of new data.

Ongoing monitoring of mine inflow water volumes and quality will also be conducted daily to inform the site water balance, verify characterisation of mine inflow water quality and for future updates to the groundwater model. The capture of incidental water is an important component of the site's water balance. If mine water is pumped to underground storages, then pumped volumes will also be recorded via flow meters or other suitable gauging apparatus. Flow meters will be in place for daily volumetric flow monitoring to inform the site water balance.

Water samples of pumped (dewatered) mine water will be collected monthly for field analysis with the objective of providing an early indication of any mixing with (lower salinity) natural groundwater. Samples will also be collected for discrete analysis on a quarterly basis during active mining. The water quality analytical suite will be the same as that adopted for groundwater monitoring bores. To summarise, the seepage monitoring program will include:

- metering the volume of water pumped from the mining areas using flow meters or other suitable gauging apparatus at local collection point and at the outflow discharge point;
- monthly to bi-monthly monitoring quality of mine inflow water (including field analysis, discrete and full suite) in accordance with current underground mine water monitoring regime; and
- correlation of rainfall records with mining area seepage records/model estimates so that the groundwater and any surface water/shallow alluvial incidental take can be separated.

7.4 Cataract Reservoir

The mine inflow volume monitoring and water quality analysis, outlined in **Section 7.4**, can also be used to determine if any potential linkages have formed between RVE UEP and the Cataract Reservoir.

7.5 Groundwater Model Verification

Every three years, an independent review of the groundwater model will be undertaken to determine the validity of the groundwater model predictions and will include a comparison of monitoring results with modelled predictions. This includes comparison between observed and modelled groundwater level trends and mine inflow volumes.

If the data indicates significant divergence from the model predictions, an updated groundwater model will be constructed to better replicate current trends and for simulating future mining and recovery.

8. MANAGEMENT, MITIGATION AND REMEDIATION MEASURES

8.1 Swamp Management System

The swamp management system at RVE UEP consists of:

- swamp water monitoring program described in **Section 7.1** with further detailed contained in the Extraction Plans;
- swamp subsidence monitoring program described in the Extraction Plans;
- ecological monitoring program described in the Upland Swamp Ecological Monitoring Plan prepared for each EP and Biodiversity Management Plan; and
- surface water monitoring program described in the EP WMP.

Details on the swamp ecological monitoring program are captured separately within the Upland Swamp Ecological Monitoring Plan and Biodiversity Management Plan. The Extraction Plans developed under Condition C10 of the Development Consent will detail specific swamp monitoring requirements and TARPs related to potential impacts on swamps from the 'second workings' covered by those plans.

8.2 Groundwater Management System

The groundwater management system at RVE UEP consists of:

groundwater monitoring program described in **Section 7.2** with further detailed contained in the Extraction Plans;

- subsidence monitoring program described in the Extraction Plan;
- management of the groundwater inflows into the underground workings as described **Section 7.3** and in the EP WMP; and
- management and monitoring of adit outflows as described in the EP WMP.

Groundwater mitigation and remediation measures include mine inflows and mine sealing, as described below.

8.2.1 Pit Top Area Groundwater Management

In accordance with **Condition B17(v)/Schedule 2** of the project approval, WCL is required to provide a detailed description of the groundwater management system for the RVC pit top area. The project involves upgrades to the surface facilities within the Pit Top Area; however, as outlined in **Section 3.6** and **Section 6.1**, impacts to groundwater are considered unlikely.

No impacts to groundwater have been previously identified for the approved Pit Top Area activities, likely due to the site geology (detailed in **Section 3.4**) and absence of a productive aquifer.

Measures in place to manage possible groundwater impacts from water loss or seepage include:

- Dirty water storage dams at the pit top lined with impermeable material (i.e. clay);

- The main Storm Water Control Dam (SWCD) has been engineered with a seepage collection drain within the dam wall, which collects seepage at LDP 3 and then pumps it back into the SWCD; and
- Chemicals and hydrocarbons are stored in bunds and/or bunded area's designed to Australian Standards, and any spills are cleaned up promptly to prohibit migration into the groundwater table.
- Further work will also be undertaken to assess potential impacts on groundwater conditions within the Pit Top Area and based on the outcome of the assessment suitable shallow ground water open standpipe piezo will be installed to monitor for any potential impacts. This work including installation of the shallow ground water piezo will be completed within the first 12 months of approval of this plan and the management plan will be updated accordingly.

8.2.2 Mine Inflows and Dewatering Water

Investigations will be instigated if the rate of groundwater inflow significantly increases for a period of greater than seven days. There is considered to be a significant increase if the inflow rate increases to more than 1 ML/day, above the inflow rates that were generally occurring at the time. An exception to this is where dewatering volumes are influenced by dewatering of water stored in historical workings to minimise inrush risk, or due to variability in pump rates due to equipment maintenance.

Application of an appropriate technique to manage an abnormal inflow to the mine will be determined by agreement with all stakeholders based on the advice of hydrogeologists and ground consolidation technical experts.

The mine has used materials in ground control applications and inflow control applications in the past and will apply these as appropriate to regain control of inflows should the need arise.

Selection of the optimum application and combination of materials and techniques will depend on the nature and magnitude of the inflow, expert advice and stakeholder input.

The company would work closely with specialist ground support and polyurethane resin (PUR) injection companies with appropriate experience in chemical injection techniques for consolidation of unstable and porous ground and in the use of such measures to control ground water flows.

The In-rush Hazard Management Plan details methodologies relating to grout and PUR based solutions to localised inflow situations and defines the capability of each product used for ground consolidation and water control, MSDS documents, technical specifications as well as case studies of applications where each product and sealing technique would be most effective.

Pro-active responses based on projected inflows mean that actions may be considered and planned at the time, with reference to pre-planned scenarios.

In addition to underground sealing of inflows it may be practical to undertake sealing works from the surface, depending on specific environmental factors related to the proposed work.

With predicted inflows for the RVE UEP mine plan, at any point in the progress of mining the Review Team will take appropriate early remedial action that is anticipated to negate the need to activate the defined response to an actual trigger.

PUR and grout is available at short notice. However, with the exception of localised occurrences, it is not considered to be necessary to maintain stocks of materials as these may be very circumstance-specific, and, with the time afforded by forward projection of inflows, their application and acquisition should not be a matter of urgency.

Ground consolidation would be made available to be rapidly deployed to water control activities if necessary.

Operators will be trained to conduct supporting activities for contract drillers and PUR injection personnel.

WCL will require water access licences (WALs) under the *Water Management Act 2000* to authorise the taking of groundwater in the course of mining operations. RVC is located within the Sydney Basin Nepean Water Source under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. Groundwater inflows to the mine will be taken from this water source.

WC holds sufficient allocation to account for the predicted maximum groundwater inflows to RVC workings of 288 ML/year. Mine inflows removed/dewatered from the workings will be managed under the site water balance system outlined in the WMP.

As discussed in **Section 6**, the peak reduction in baseflow for Cataract River, Cataract Creek and Bellambi Creek combined is predicted to be very small, with the volume apportioned to the RVE UEP being between 2.3 ML/year and 6 ML/year based on groundwater modelling. WC currently holds sufficient licences to account for the volume of predicted water take at RVC. These licences are however held in the water sharing plan relevant to groundwater sources only.

8.2.3 Mine Sealing

The installation of seals to isolate areas can be conducted as specific mining areas are completed, with the seals containing monitoring, drainage and sampling facilities to allow water accumulation behind the seals to be monitored, sampled and managed while current areas are mined.

The final sealing of the mine requires bulkheads to be installed to manage seepage. Trigger mechanisms that will initiate the decision to abandon other remedial techniques and commence the installation of bulkheads either to isolate areas or to seal the mine will be defined as part of the mine closure plan.

8.3 Trigger Action Response Plan

The groundwater TARP, as presented in **Appendix G**, has been designed to illustrate how the various predicted impacts, monitoring components, performance measures and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

8.4 Trigger Criteria

The trigger criteria are based on the existing trigger criteria for RVC, with baseline data used to set trigger values and consideration of current predicted impacts due to the RVE UEP. The triggers are set on the basis that readings outside these ranges represent a potential change in conditions that 'may' indicate an impact. Level 2 triggers are a sign of a potential change, but the reading may be within natural variability. Level 3 triggers are set at a level which is statistically unlikely to occur due to natural variability based on historic monitoring. An exceedance of a level 3 trigger may still be due to natural variability and may not have any adverse environmental impacts but warrants further investigation based on it being unlikely based on past monitoring.

Specific to the RVE UEP, the main predicted future impacts relate to drawdown and depressurisation within the Permian coal measures and Narrabeen Group with mine progression; localised potential drawdown in the Hawkesbury Sandstone related to historical goaf effects; and potential impacts associated with mine inflow water quality and underground rejects storage (refer **Section 6**). The first workings for future operations are considered unlikely to cause subsidence impacts and no additional impacts to swamps are predicted. In accordance with the conditions of consent (Table 6), subsidence impacts performance measures will be monitored and assessed and captured within the Extraction Plan. The swamp and groundwater monitoring captured within this management plan will be utilized to help inform the subsidence monitoring and assessment.

The groundwater trigger levels and criteria are summarised in **Table 13** and detailed further in **Appendix G** and **Appendix H**. The table includes proposed triggers for mine inflow water quality, which are based on current baseline mine inflow water quality as presented in **Table 10**. Triggers for pH, EC and SO₄ are proposed for early detection of potential changes in water quality and source with progression of mining. Triggers are also proposed for metals (Al, As, Mo and Sb) that were identified through laboratory leachate analysis as potentially becoming mobilized under acidic conditions. These triggers have been applied to provide an early indicator of unexpected changes in water quality or water source. However, it should be noted that no impacts to water quality and metals concentrations are expected due to mine progression, with the interburden material exhibiting a high buffering capacity with alkaline conditions.

Moisture monitoring is not proposed to be used as a trigger due to variability between and within monitoring points. However, soil moisture data will be collected at each representative swamp location within the mine area to inform investigation processes should swamp vegetation or swamp groundwater level Trigger Criteria be exceeded. Full details on the monitoring program for swamps are included in the Upland Swamp Management Plan. .

Additional groundwater monitoring points have been proposed to inform future model updates and mine closure planning, to be progressively installed over a two year period. Once installed, default triggers have been proposed for the initial 12 months of monitoring, as outlined in **Table 13** and **Appendix H**. The proposed groundwater triggers are based on baseline monitoring and predicted impacts, with monitoring changes and/or specific triggers continuing to be developed as monitoring matures and becomes refined in consultation with key stakeholders and subject to approval by relevant departments.

Refined triggers will be proposed, where required, and documented in the Annual Environmental Management Reports (AEMR).

Table 13 Groundwater Trigger Criteria

Area	Trigger Criteria
Swamps	pH - 5 th and 95 th percentile of baseline swamp data (all RVE swamps)
	EC - 95 th percentile of combined baseline swamp data (all RVE swamps)
	SWL - 95 th percentile of site-specific baseline depth to groundwater, calculated with dry readings excluded
Hawkesbury Sandstone	pH - 5 th and 95 th percentile of baseline data (all RVE OSPs)
	EC - 95 th percentile of combined baseline data (all RVE OSPs)
	WL - 95 th percentile of site-specific baseline water levels New sites: initial trigger based on maximum 2 m groundwater level decline over 12 month period
Bulgo Sandstone	pH - 5 th and 95 th percentile of baseline data after 12 months of data collection. New sites: initial trigger based on Hawkesbury Sandstone trigger
	EC - 95 th percentile of baseline data after 12 months of data collection. New sites: initial trigger based on Hawkesbury Sandstone trigger
	WL - 95 th percentile of site-specific baseline water levels after 12 months of data collection. New sites: initial trigger based on maximum 2 m groundwater level decline over 12 month period
Hawkesbury Sandstone and Narrabeen Group	Groundwater head - vertical groundwater head profile per VWP location (site-specific), based on baseline and predicted vertical groundwater head for the RVE UEP
Permian coal measures - Mine Inflow Volumes	Mine pump volumes within predicted mine inflow range
Permian coal measures - Mine Inflows Quality	pH - minimum and maximum of site baseline mine inflow data
	EC - 95 th of site baseline mine inflow data
	Sulfate - 95 th of site baseline mine inflow data
	Dissolved Al - 95 th of site baseline mine inflow data
	Dissolved As - 95 th of site baseline mine inflow data
	Dissolved Mo - 95 th of site baseline mine inflow data
	Dissolved Sb - 95 th of site baseline mine inflow data

8.5 Response to TARP Criteria Exceedances

The TARP presented in **Appendix H** has been designed to illustrate how the various predicted impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

Table 14 below outlines the trigger level definitions to be applied to the TARPs provided within **Appendix H**.

Table 14 Trigger Levels

TRIGGER LEVEL	DESCRIPTION
Level 1 - Normal	No exceedance of level 2 or level 3 triggers. Operations continue as normal.
Level 2 - Warning	Minor or persistent low-level exceedances indicate potential degradation or failure of a system. Internal investigation of potential causes and rectify if practical.
Level 3 - Exceedance	Exceedance of trigger limits, requiring reporting to agencies, clean up action, and post-incident investigation.

Whilst significant impacts are not predicted, the TARPs provide a process of tiered and escalating trigger levels/performance triggers for performance measures should subsidence and associated impacts be greater than predicted/approved. If monitoring indicates a trigger has been exceeded, investigations will be undertaken to identify the cause of the particular criteria exceedance and may require management measures to be implemented as outlined in this section and **Appendix H**.

Where Level 3 trigger criteria are exceeded, WCL will inform DPIE and WaterNSW of the trigger criteria exceedance and proposed response as per the TARP. Investigation into the cause of the trigger exceedance will be instigated within one week of trigger exceedance being noted and will be informed by any advice received from DPIE and WaterNSW.

An investigation will be undertaken into the potential cause by a suitably qualified person. The investigation will be commenced within one week of the trigger exceedance. The investigation may include additional groundwater level and quality monitoring, as well as review of groundwater level and quality trends for other relevant sites and climatic conditions.

For swamps, the investigation will also include comparison to soil moisture/swamp water level reference sites, such as CCUS10, CCSU12 and BCUS4 that will be unaffected by the first year of operations. The use of environmental tracers and swamp specific water balances may also be used where these investigation tools are identified as likely to inform the investigation process.

For more complex investigations where additional monitoring is required (as will be likely for the monitoring of impacts on swamps), longer investigation periods are likely to be required and a final investigation report will be provided within a reasonable timeframe as agreed with regulators.

DAWE, DPIE – Water, Water NSW and BCD will be informed of the investigation outcomes within one month of assessment completion.

The requirement, need and potential cost/benefit of a mitigation plan will be discussed with DPIE and WaterNSW and any other relevant stakeholders identified by these agencies. If required, site specific mitigation, or Corrective Management Action (CMA) plans may include:

- description of the impact to be managed;
- results of the investigations;
- aims and objections for the plan;

- specific actions required to mitigate/manage the issue;
- timeframes for implementation;
- roles and responsibilities;
- identification of and gaining appropriate approvals from government agencies; and
- providing a consultation and communication plan.

The mitigation or remediation plans will outline methods to ensure that ongoing impacts are reduced to levels below the impact assessment criteria as quickly as possible.

8.6 Potential Incident Notifications

Level 3 triggers in the TARPs under this management plan are set at a level that may indicate more than 'trivial' environmental harm. Where monitoring indicates a Level 3 Performance Measure TARP trigger related to biodiversity or groundwater values has been exceeded but the cause of the trigger being exceeded is unclear, DPIE and Water NSW will be notified of a *potential* incident. All *potential* incident notifications related to biodiversity features will be sent to DPIE and BCD. *Potential* incident notifications related to surface or groundwater impacts or which may have consequent impacts of groundwater or surface water will also be provided to Water NSW.

The notification will include the same matters required to be included in an Incident Notification as required by Condition F9 including the development (including the development application number and name) and set out the location and nature of the potential incident.

The investigation process will also consider any remedial action that may be required.

8.7 Contingency Issues

All works in the Metropolitan Special Area require WaterNSW approval, and there is a requirement for compliance with the Sydney Catchment Authority Water Supply Catchment Special Areas Standard Conditions for Entry (SCA, 2001).

These requirements ensure strict limits are placed on any impacts associated with undertaking rehabilitation works on WaterNSW land.

Access to the catchment is subject to WaterNSW authorisation and is only permitted in dry weather. Therefore, proposed monitoring frequencies may be delayed due to wet weather, whilst notification and investigation timeframes commence when triggers have been confirmed by the Environment Manager.

The management program and TARP provide a basis for the design and implementation of any mitigation and remediation, whilst monitoring of the area's environmental aspects will provide key data when determining any requirement for mitigation or rehabilitation.

In the event that a Level 3 trigger occurs, as detailed in the TARP (contained in **Appendix G**), WCL will implement the following Contingency Plan:

- the observation will be reported to WCL's Environment Manager immediately;
- the observation will be recorded;

- WCL will report any exceedance of the performance measure to the Secretary of DPIE and other relevant stakeholders immediately after WCL becomes aware of the exceedance;
- WCL will assess the exceedances of the relevant TARP and where appropriate, implement safety measures in accordance with the appropriate Management Plan/s;
- the Environment Manager will investigate any potential contributing factors and, where relevant, identify an appropriate action plan to manage any identified impact(s) associated with the Project, in consultation with specialists and/or relevant agencies if necessary;
- WCL will develop an appropriate action plan to manage any identified impact(s) associated with the Project, in consultation with other specialists and/or key stakeholders;
- WCL will submit the proposed course of action to the DPIE for approval;
- WCL will implement the approved course of action to the satisfaction of the DPIE;
- WCL will continue to monitor performance with the new action plan in place and, if successful will formalise these actions as part of a revised Management Plan; and
- contingency measures will be developed in consideration of the specific circumstances of the issue and the assessment of consequences as outlined below.

8.8 Adaptive Management

Due to the nature of the proposed bord and pillar mining, adaptive management measures can be proactive or reactive.

The Extraction Plans will include Adaptive Management TARPs which are designed to identify circumstances where observed impacts differ from those predicted. These broadly relate to subsidence and groundwater impact predictions which form the basis of the predictions of negligible impact and proposed monitoring framework. Departures from these predictions may indicate the potential for exceedances of performance criteria.

An exceedance of Level 2 or 3 Adaptive Management Performance Trigger will result in a review of underground mining operations and monitoring to identify any potential causative factors for the observed trigger exceedances. Depending on the nature, magnitude and location of the trigger exceedance, precautionary adjustments to the mine plan or mining practices may be required to avoid or mitigate the risk of performance measures being exceeded.

Additionally, in accordance with Condition F4 of the Development Consent and the RVC EMS, where exceedances of criteria or performance measures has occurred, WCL will:

- a) take all reasonable and feasible steps to ensure that the exceedance ceases and does not re-occur (i.e. TARPs, contingency planning).
- b) consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action;

- c) within 14 days of the exceedance occurring, submit a report to the Secretary describing these remediation options and any preferred remediation measures or other course of action; and
- d) implement remediation measures as directed by the Planning Secretary.

Additional adaptive management measures may also be required to prevent a reoccurrence of the circumstances that gave rise to the exceedance of criteria or performance measure. This may include changes to the mine plan or underground mining practices.

8.9 Site Access

Vehicle access to some monitoring sites is via existing fire trails. Other monitoring sites will be accessed by foot from the nearest fire trail.

9. INCIDENTS, COMPLAINTS AND NON-CONFORMANCES

9.1 Incidents

The Development Consent (MP09_0013) defines:

- An 'incident' to be *"an occurrence or a set of circumstances that causes or threatens to cause material harm and which may or not be or cause a non-compliance"*. Examples may include a breach of specific development consent criteria or performance measure.
- Exceedance or non-compliance as *"an occurrence, set of circumstances or development that is a breach of this consent"*.

In both circumstances, an Incident or Non-Compliance must be attributable to the development approved under the development consent.

Material harm is defined in the development consent as:

"Is harm to the environment that:

- involves actual or potential harm to the health or safety of human beings or to the environment that is not trivial, or
- results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding \$10,000 (such loss includes the reasonable costs and expenses that would be incurred in taking all reasonable costs and expenses that would be incurred in taking all reasonable and practical measures to prevent, mitigate or make good harm to the environmental).

This definition excludes "harm" that is authorised under either this consent or any other consent.

Incidents and associated reporting requirements will be managed through established procedures set out in the EMS or, in the case of groundwater management related to subsidence impacts, the EPs. All incident notification related to groundwater features will be sent to DPIE and WaterNSW.

9.2 Complaints Handling

Complaints will be managed through established WCL procedures and as required by Part F – Environmental Management, Reporting and Auditing Condition 17 of the PA, by where a copy of a complaints register (updated on a Monthly basis) will be kept on the WCL website. A summary of complaints will be available to regulatory authorities on request and provided in the Annual Environmental Management Reports (AEMRs).

9.3 Reporting

Progress against the requirements of this plan will be reported regularly to the DPIE and other relevant agencies as required by the Project Approval. Details on requirements on reporting, incidents, complaints and non-conformances are specified within **Appendix F**.



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The notification requirements relate to the relevant regulatory authorities. No notification to water users is include, as outlined in **Section 5.4**, there are no private water supply works located within or surrounding the project area.

In accordance with the requirements of the Project Approval, the environmental performance of the colliery will be reported on the WCL website.

10. PLAN ADMINISTRATION

10.1 Roles and Responsibilities

Environment and community management is regarded as part of the responsibilities of all Colliery personnel. The roles and function of the main personnel responsible for the implementation of environmental and community management including the plans, procedures and action plans contained in this EMP are outlined in WCL's Management Operating System.

10.2 Resources Required

In accordance with the WCL SYS POL 003 Environmental Policy, Management shall ensure that the appropriate resources are made available to achieve the implementation of this Plan.

It is the role of the Group Environment Manager to ensure that these requirements are communicated to WCL Management.

10.3 Training

All training and inductions that relate to this Management Plan are to be undertaken as per the WCL training procedures.

10.3.1 Staff Training

Staff training will be undertaken as detailed in the EMS. This consists of three levels of training applicable to different types of staff:

- Level 1 – High level training on environmental requirements (management staff);
- Level 2 – Operational level training (project managers, supervisors, surface personnel, control room operators); and
- Level 3 – Basic environmental awareness (underground staff, all personnel).

Targeted training will be provided to individuals or groups of workers with a specific authority or responsibility for operational environmental management, or those undertaking an activity with a high risk of groundwater related impacts.

Training will be provided as deemed necessary to contractors to provide them with the knowledge, skills and awareness to minimise impacts on groundwater. At a minimum this will include:

- contractors whose activities are not directly supervised by Colliery personnel; and
- contractors whose activities are ongoing and have the potential to result in a groundwater quality incident (e.g., drillers, underground contractors).

10.3.2 Inductions

All personnel, including contractors, sub-contractors and staff, are required to attend a compulsory site induction that includes an environmental component prior to commencement on site. The Environment Manager/Site Environment Representative, or delegate, will conduct the environmental component of the site induction.

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The environmental component will include an overview of:

- Relevant details of this Management Plan, including purpose and objectives;
- Key environmental issues;
- Conditions of environmental licences, permits and approvals;
- Specific groundwater management requirements and responsibilities;
- Mitigation measures for the control of groundwater impacts; and
- Incident response and reporting requirements.

A record of all environment inductions will be maintained and kept on site. The Site Environment Representative may authorise amendments to the induction where required to address project modifications, legislative changes or amendments to this Management Plan or related documentation.

The Environment Manager/Site Environment Representative will review and endorse the induction program and monitor its implementation.

11. REPORTING, AUDIT AND REVIEW

11.1 Annual Review

In accordance with Part F – Environmental management, reporting and auditing of the PA, an Annual Review of the environmental performance of the Proposed Action is prepared.

The Annual Review will:

- Describe the works carried out in the past year, and the works proposed to be carried out over the next year.
- Include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
 - relevant statutory requirements, limits or performance measures/criteria;
 - monitoring results of previous year/s; and
 - relevant predictions in the EA(s).
- Identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance.
- Identify any trends in the monitoring data over the life of the Project.
- Identify any discrepancies between the predicted and actual impacts of the development and analyses the potential cause of any significant discrepancies.
- Describe what measures will be implemented over the next year to improve the environmental performance of the Project.

11.2 Auditing

In accordance with Part F of the PA an Independent Environmental Audit will be undertaken by a suitably qualified auditor and include experts in any field specified by the Secretary within 12 months of the approval and every three years after that.

This audit must:

- Be conducted by a suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Planning Secretary.
- Include consultation with the relevant agencies.
- Assess the environmental performance of the project and assess whether it is complying with the requirements in the PA and any relevant EPL or Mining Lease (including any assessment, plan or program required under these approvals).
- Review the adequacy of strategies, plans or programs required under the abovementioned approvals.
- Recommend measures or actions to improve the environmental performance of the project, and/or any strategy, plan or program required under these approvals.

In accordance with Part F 14 of the PA, WCL would submit a copy of the audit report, along with responses to any recommendations contained within the report to the Planning Secretary. The audit and response to recommendations would be submitted within 3 months of the completion of the audit unless otherwise agreed by the Planning Secretary.

11.3 Plan Revision

In accordance with Part F 7 of the PA, this BMP will be reviewed within three months of:

- The submission of an incident report.
- The submission of an annual review.
- The submission of an Independent Environmental Audit
- Any modification to the conditions of approval (unless the conditions require otherwise or as otherwise agreed with DPIE).

The revision status of this plan is indicated in the Footer of each copy. Revisions to any documents listed within this Plan will not necessarily constitute a revision of this document.

12. RECORDS AND DOCUMENT CONTROL

12.1 Environmental records

The EM/SER is responsible for maintaining all environmental management documents so that they are always current at the point of use.

Types of records include:

- monitoring, inspection and compliance reports/records;
- correspondence with public authorities;
- induction and training records;
- reports on environmental incidents, other environmental non-conformances, complaints and follow-up action;
- community engagement information; and
- minutes of environmental management system review meetings and evidence of any action taken.

All waste management documents are subject to ongoing review and continual improvement. This includes times of change to scheduled activities or to legislative or licensing requirements.

Only the EM/SER, or delegate, has the authority to change any of the waste management documentation.

12.2 Document control

The EM/SER will coordinate the preparation, review and distribution, as appropriate, of the environmental documents. During construction and operation, the environmental documents will be stored at the main site compound.

The WMP will be developed, approved, implemented and maintained in accordance with the Document Control Procedure (WCL SYS PRO 001).

13. REFERENCES

- AGL, 2013, *Hydrogeological Summary of the Camden Gas Project area*, January 2013.
- ANZECC, 2000, *Australian and New Zealand Guidelines For Fresh and Marine Water Quality*.
- Biosis, 2014, *Russell Vale Colliery Underground Expansion Project: Preferred project Report Biodiversity*.
- Biosis, 2020, *Russell Vale Colliery – Underground Expansion Project: EPBC Act Matter of National Environmental Significance Report – Ecology*. Prepared for Umwelt (Australia) Pty Ltd. Published 5 June 2020.
- Bureau of Meteorology (BoM), 2018, *Groundwater Dependent Ecosystems Atlas*, <http://www.bom.gov.au/water/groundwater/gde/>
- Geoterra, 2012. *NRE No.1 Colliery Major Expansion Groundwater Assessment, Bellambi NSW*. Report prepared for Gujarat NRE Coking Coal Ltd.
- GeoTerra/GES, 2020, *Russell Vale Colliery Underground Expansion Project Russell Vale East First Workings Groundwater Assessment*. Revised Assessment Report, 5 February 2020.
- HGEO Pty Ltd, 2018, *Appin Mine Area 9 Longwall 901 End of Panel surface water and groundwater monitoring review*, prepared for South32, January 2018.
- HydroAlgorithmics Pty Ltd, 2020a, *Russell Vale Colliery Underground Expansion Project – Groundwater Uncertainty Analysis*, dated 30 January 2020.
- HydroAlgorithmics Pty Ltd, 2020b, *Russell Vale Colliery Underground Expansion Project – Groundwater Peer Review*, dated 3 February 2020.
- NRE Technical Services Department, 2014, *Gujarat NRE No.1 Colliery Geological Report on the Wonga East Area*. Appendix C in *Russell Vale Colliery Commencement of Long Wall 6, Submissions Report*.
- NSW Department of Environment and Conservation, 2004, *Approved Methods for the Sampling and Analysis of Water Pollutants in Groundwater*.
- Queensland Government, 2020, *The Long Paddock (SILO)*, www.longpaddock.qld.gov.au, accessed January 2021.
- SCT Operations, 2019, *Russell Vale Colliery: Subsidence Assessment for Proposed Wongawilli Seam at Russell Vale East*. Report No. UMW4609 to Umwelt (Australia) Pty Ltd dated 3 October 2019.
- SCT Operations, 2019a, *Russell Vale Colliery 2018 Update of Water Balance Estimation*. Report No. WCRV4929.

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
Type	Plan	Date Published	17/11/2021
Doc Title	GROUNDWATER MANAGEMENT PLAN		

Serov, P. Kunginis, L., Williams, J.P., 2012, *Risk assessment guidelines for groundwater dependent ecosystems*, NSW Department of Primary Industries, Office of Water, Sydney.

Terra Insight, 2020, Bellambi Gully Diversion Investigation, Russell Vale Colliery NSW: Report on Geotechnical Investigation, Report No. TERRA20-323, October 2020.

Umwelt, 2019, *Russell Vale Colliery Revised Underground Expansion Project: Submissions Report – Part A*. Prepared for Wollongong Coal Ltd. Published 29 November 2019.

Wollongong Coal 2019. *Russell Vale Colliery Russell Vale East Water Management Plan*.

Wollongong Coal, 2020, *Russell Vale Colliery Reject Geochemical Analysis ROM Working Section Sample March 2020*.

14. GLOSSARY OF TERMS AND ABBREVIATIONS

TERMS	
Aquifer	rock or sediment capable of holding and transmitting groundwater.
Baseflow	the portion of stream flow that comes from the sum of deep subsurface flow and delayed shallow subsurface flow.
Bi-monthly	once every two months.
Bord and Pillar	Mining method comprising of a series of self-supporting roadways (or bords) within the coal seam leaving a grid of pillars of unmined coal which are designed to be stable in the long term.
Bore	a well, usually of less than 20 cm diameter, sunk into the ground and from which water is pumped. Catchment - the entire land area from which water (e.g. rainfall) drains to a specific water course or water body.
Concentration	the amount of a substance, expressed as mass or volume, in a unit volume of air. Clay - very fine-grained sediment or soil (often defined as having a particle size less than 0.002 mm (2 microns) in diameter).
Claystone	general term for a clastic sedimentary rock composed primarily of clay-sized particles (less than 1/256 millimetre in diameter).
Confined aquifer	A confined aquifer lies between two aquitards. The hydraulic head in a confined aquifer lies above the base of the upper confining layer.
Depressurisation	reduction in groundwater pore pressure (pressure head) in a confined groundwater system due to extraction of groundwater.
Drawdown	change in groundwater level in a bore or the change in water table elevation in an unconfined groundwater system, due to the extraction of groundwater.
Ecosystem	a functional unit of energy transfer and nutrient cycling in a given place, it includes all the relationships within the biotic community and between the biotic components of the system. Electrical conductivity (EC) - the ability of a substance (either solid, liquid or gas) to transmit electricity – an indicator of salinity.
Ephemeral (water body)	is a wetland, spring, stream, river, pond or lake that only exists for a short period following precipitation.
Evaporation	the loss of water as vapour from the surface of a liquid that has a temperature lower than its boiling point.
Evapotranspiration	the sum of evaporation and plant transpiration from the Earth's land surface to atmosphere.
First Workings	Development of main headings, gate roads, related cut throughs, and other workings for mine access and ventilation
First workings (development)	long term stable (non-caving) bord and pillar mining method that comprises a series of self-supporting roadways or 'tunnels' driven into the coal seam by a continuous miner. Method leaves a grid of pillars between the roadways, designed to provide stability to the seam void and support roof strata.

TERMS	
Groundwater	all waters occurring below the land surface. The upper surface of the soils saturated by groundwater in any particular area is called the water table.
Groundwater Dependent Ecosystem (GDE)	ecosystems dependant on current groundwater conditions.
Groundwater discharge	an area on the surface that intersects a groundwater aquifer, allowing it to discharge to the surface.
Hydraulic conductivity (K)	the capacity of a rock to transmit water; numerically equivalent to the rate of flow of water in an aquifer through a gradient, at the prevailing temperature. Usually expressed in units of metres per second or metres per day.
Hydrology	the study of water, particularly its movement in streams, rivers, or underground.
Intermittent	flows periodically, irregularly.
Longwall mining	underground mining of coal seams. Longwall shearer has a face of 100m or more and rotating drum that moves mechanically back-and-forth across a coal seam.
Mudstone	general term for a fine-grained sedimentary rock whose original constituents were clays or muds. Grain size is up to 0.0625 mm (0.0025 in) with individual grains too small to be distinguished without a microscope.
Open standpipe	drilled open hole to a specific depth with casing only in the top of the hole (i.e. to 6 m depth commonly). Used to monitor groundwater levels in a specific stratigraphic unit.
Overburden	subsoil and decomposed rock overlying the main rock body that is not suitable for use in the final product.
Perched groundwater	groundwater accumulated at an elevation above the regional aquifer water level usually above a low-permeability unit or stratum.
Permeability	a material property relating to the ability of the material to transmit water.
pH	a measure of the degree of acidity or alkalinity of a solution. expressed numerically (logarithmically) on a scale of 1 to 14, on which 1 is most acid, 7 is neutral acid, and 14 is most basic (alkaline).
Piezometer	a hole drilled and fitted with casing with a screened zone specifically designed for the monitoring of groundwater levels and water quality.
Recharge	the addition of water to an aquifer.
Recovery	the difference between the water level during the recovery period following pumping and the maximum drawdown when pumping stops.
Rehabilitation	the progressive formation of a landform after quarrying and its stabilisation with grasses, trees and/or shrubs.
Salinity	degree of salt content of water.
Sand	sediment comprising particles in 0.063mm to 2mm size range.

TERMS	
Sandstone	general term for sedimentary rock with grain size from 0.063 mm to 2 mm - grains may be minerals or rock fragments.
Second Workings	Extraction of coal from bord and pillar workings
Sediment	naturally occurring material that is broken down by processes of weathering and erosion and is subsequently transported.
Siltstone	general term for clastic sedimentary rock primarily composed of silt sized particles, defined as grains 1/16 - 1/256 mm.
Topography	the physical relief and contour of a region.
Total head profile	shows groundwater head at different depths and strata to illustrate vertical gradients.
Vibrating Wire Piezometer	transducer that converts a water pressure reading to a measurable frequency signal via a diaphragm, a tensioned steel wire, and an electromagnetic coil
Water level	the upper limit of the saturated zone within an unconfined rock mass, generally at atmospheric pressure. For confined aquifers the water level is represented by the pressure head of the confined zone.
Water quality	degree of the lack of contamination of water.

ABBREVIATIONS	
IPC	Independent Planning Commission
LGAs	Local Government Areas
LW	Longwall
Mtpa	Million tonnes per annum
OSP	Open Standpipe
PAC	Planning Assessment Commission
RPPR	Revised Preferred Project Report
ROM	Run of Mine
RVC	Russell Vale Colliery, which includes Russell Vale West and Russell Vale East
RVE	Russell Vale East
TARP	Trigger Action Response Plan
UEP	Underground Expansion Project
WCL	Wollongong Coal Limited.

15. CONTROL AND REVISION HISTORY

PROPERTY	VALUE
Approved by	Group Environment and Approvals Manager
Document Owner	Richard Sheehan
Effective Date	30/07/2021

Revisions

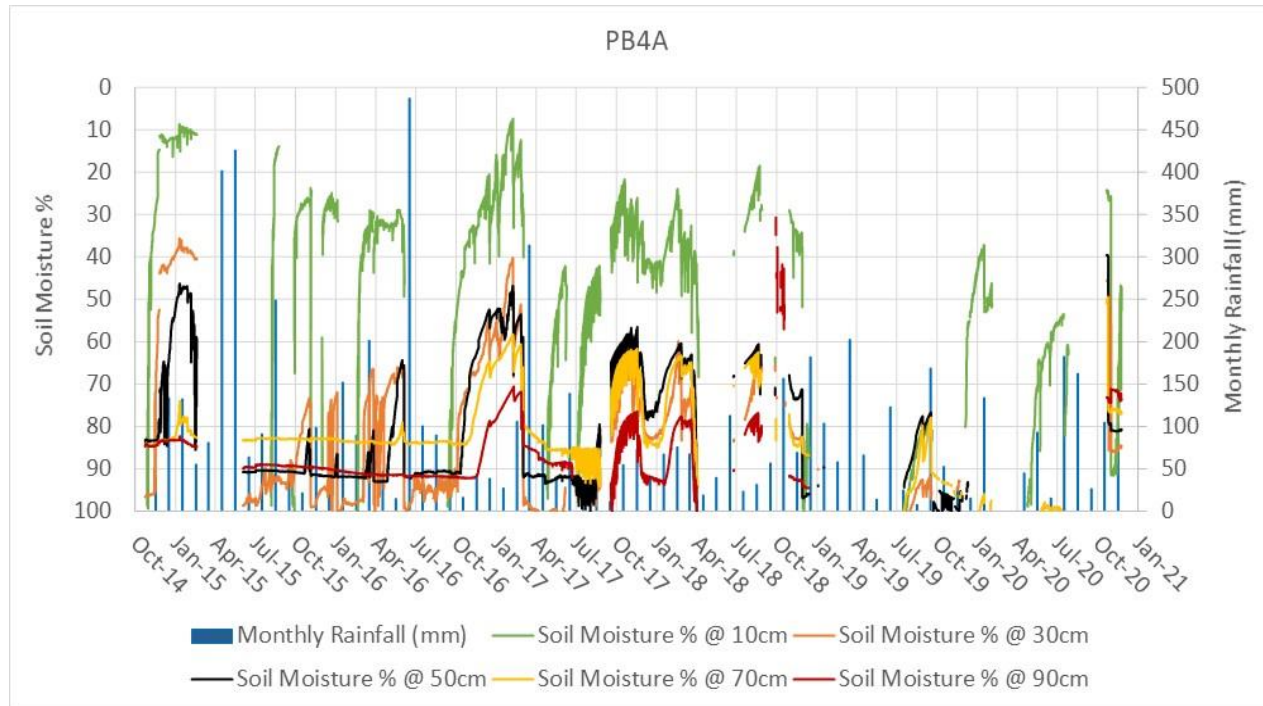
VERSION	DATE REVIEWED	REVIEW TEAM (CONSULTATION)	NATURE OF THE AMENDMENT
1	05/02/2021	Claire Stephenson	First draft document for review
2	05/03/2021	Claire Stephenson WCL	Version updated based on WCL comments on TARPS and alignment with other plans in preparation.
3	14/04/2021	Claire Stephenson WCL, DAWE	Version updated based on WCL comments and alignment with updates to the Public Environment Report from comments.
4	30/04/2021	Claire Stephenson WCL, WNSW, EPA	Version updated based on WCL comments and comments to the WMP and Waste Management Plan from WNSW and EPA.
5	14/05/2021	Claire Stephenson, WCL, DAWE	Version updated based on WCL comments and comments to the USMP from DAWE
6	30/07/2021	Claire Stephenson David Holmes WCL	Updates in response to updates to the USMP based on BDC consultation, and updates to address DPIE comments issued 22/07/21.
7	25/08/2021	WCL, Claire Stephenson	Updates by WCL in response to consultation with DPIE.
8	17/11/2021	Richard Sheehan (WCL)	Updates post initial submission review.



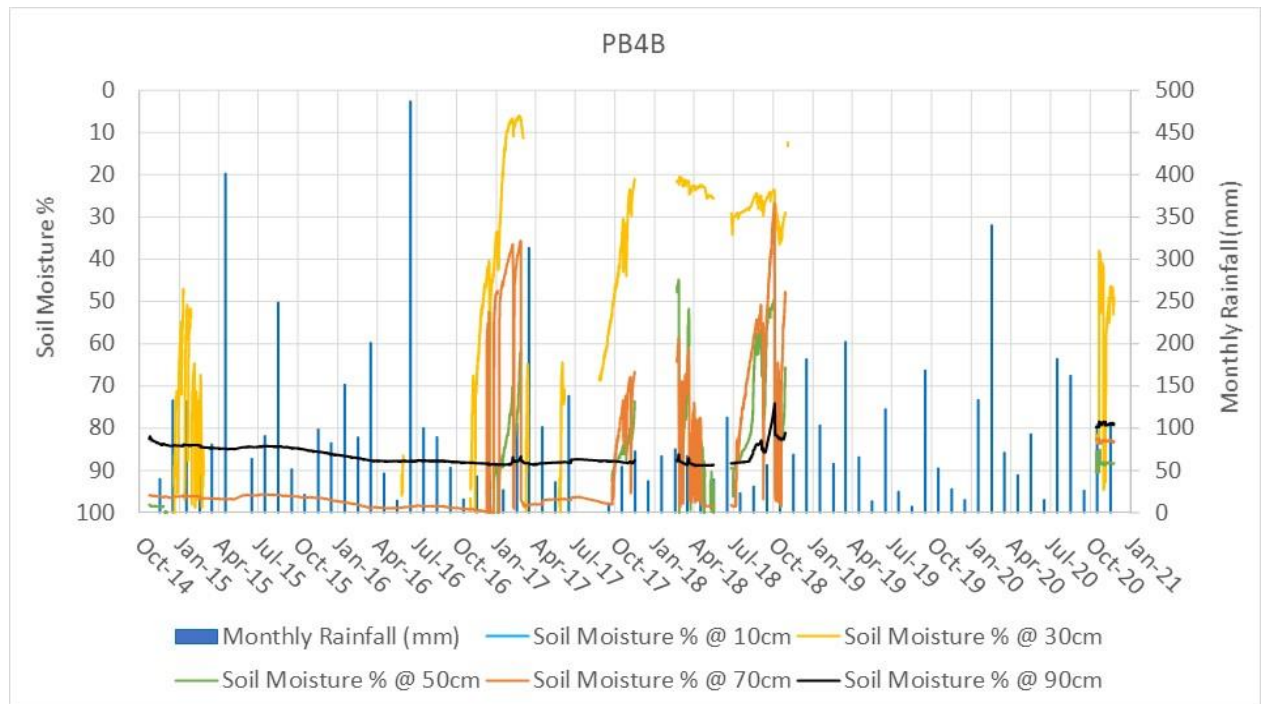
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APPENDIX A – SWAMP BASELINE DATA – SOIL MOISTURE

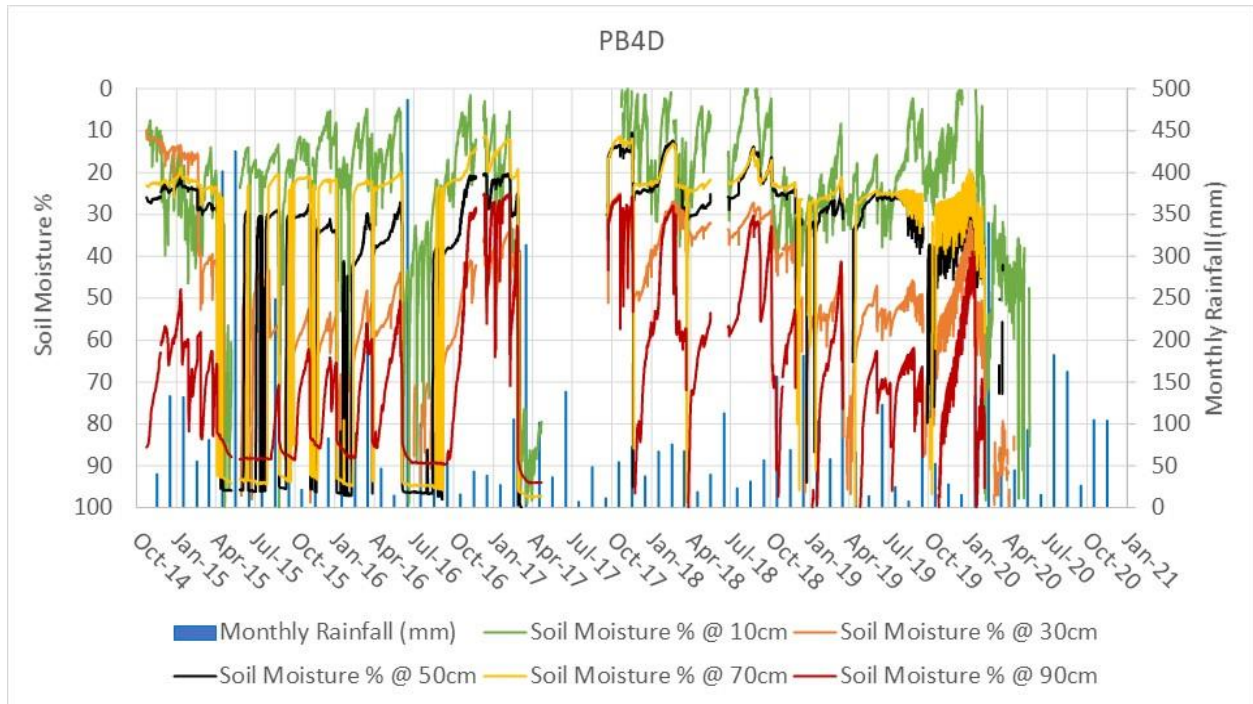
PB4 (A) near swamp BCUS4



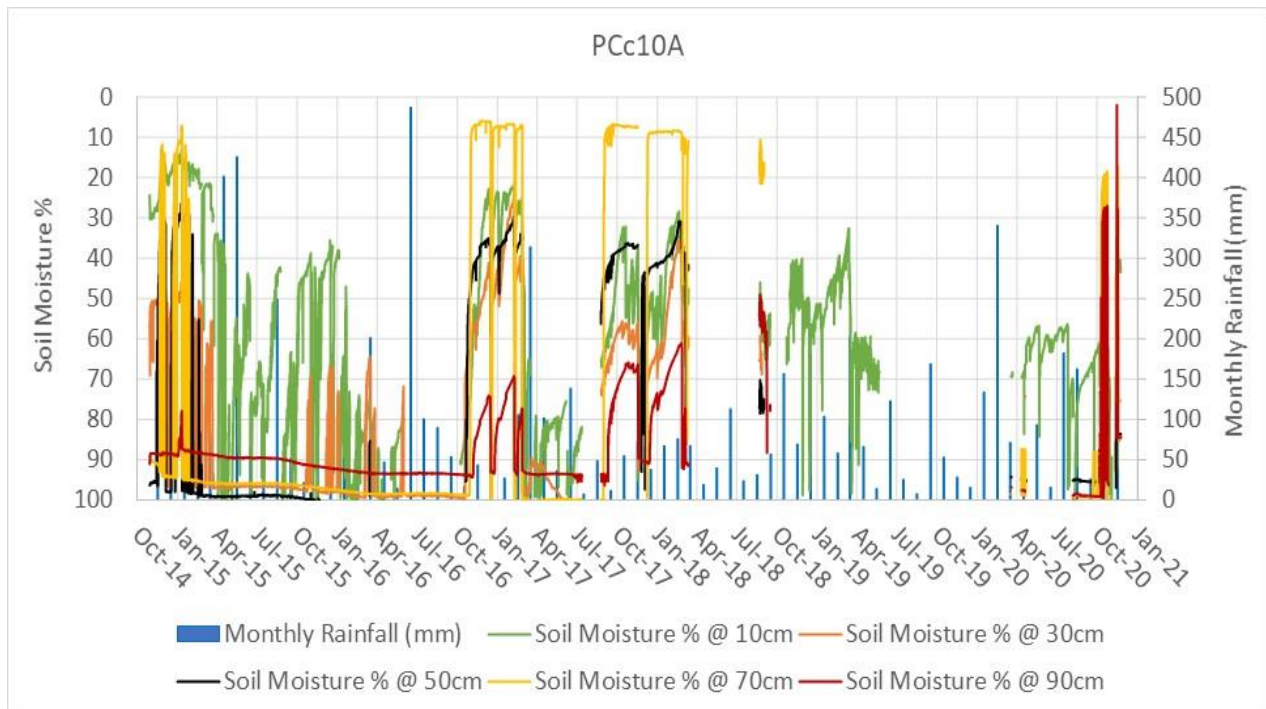
PB4 (B) near swamp BCUS4



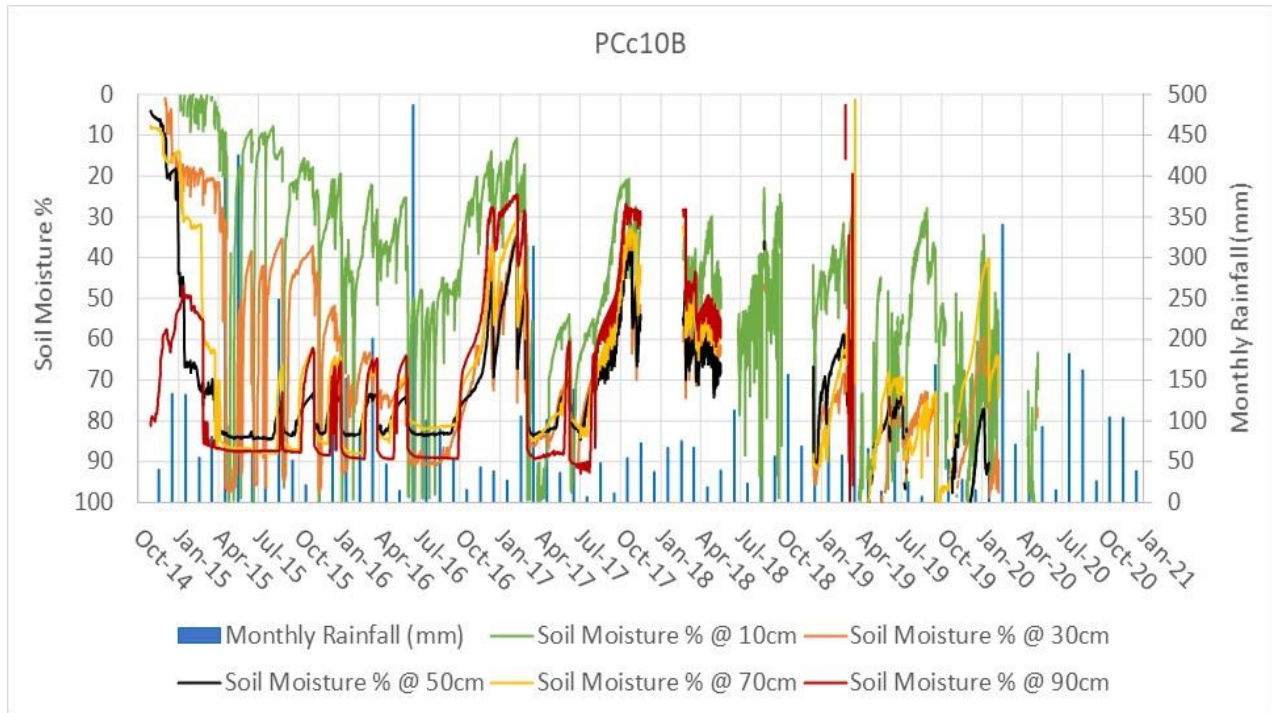
PB4 (D) near swamp BCUS4



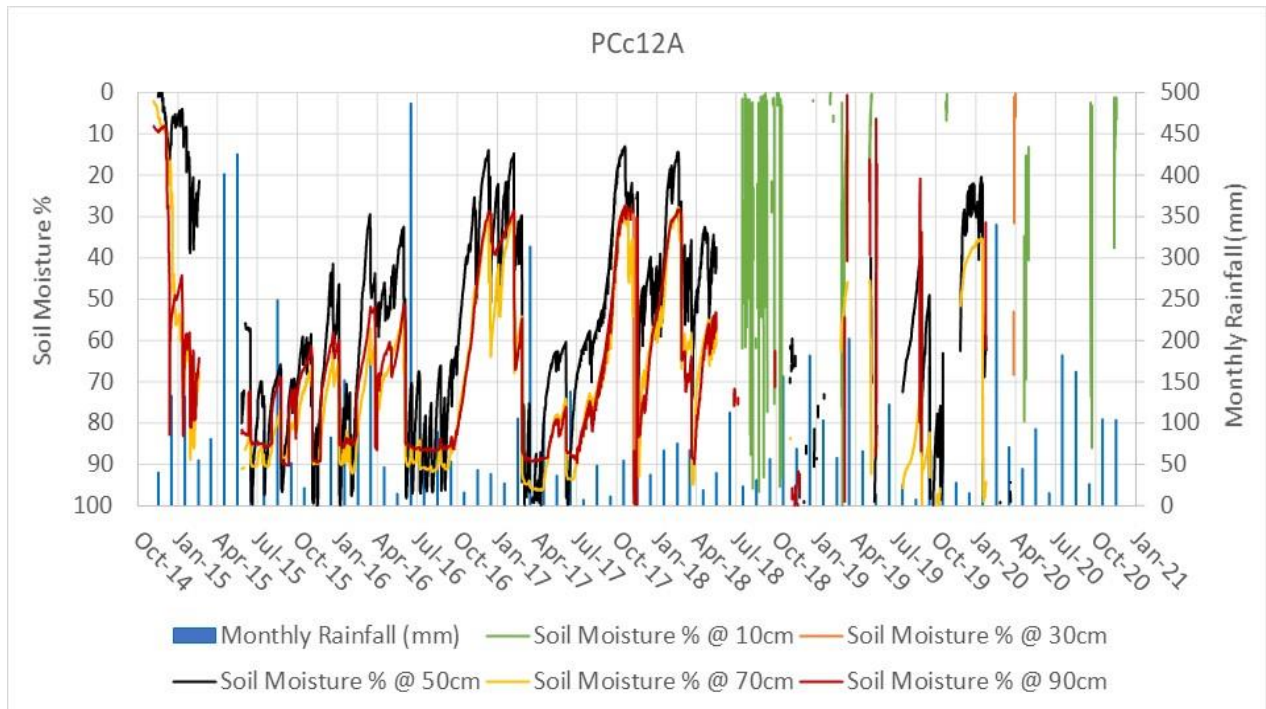
PCc10 (A) at CCUS10



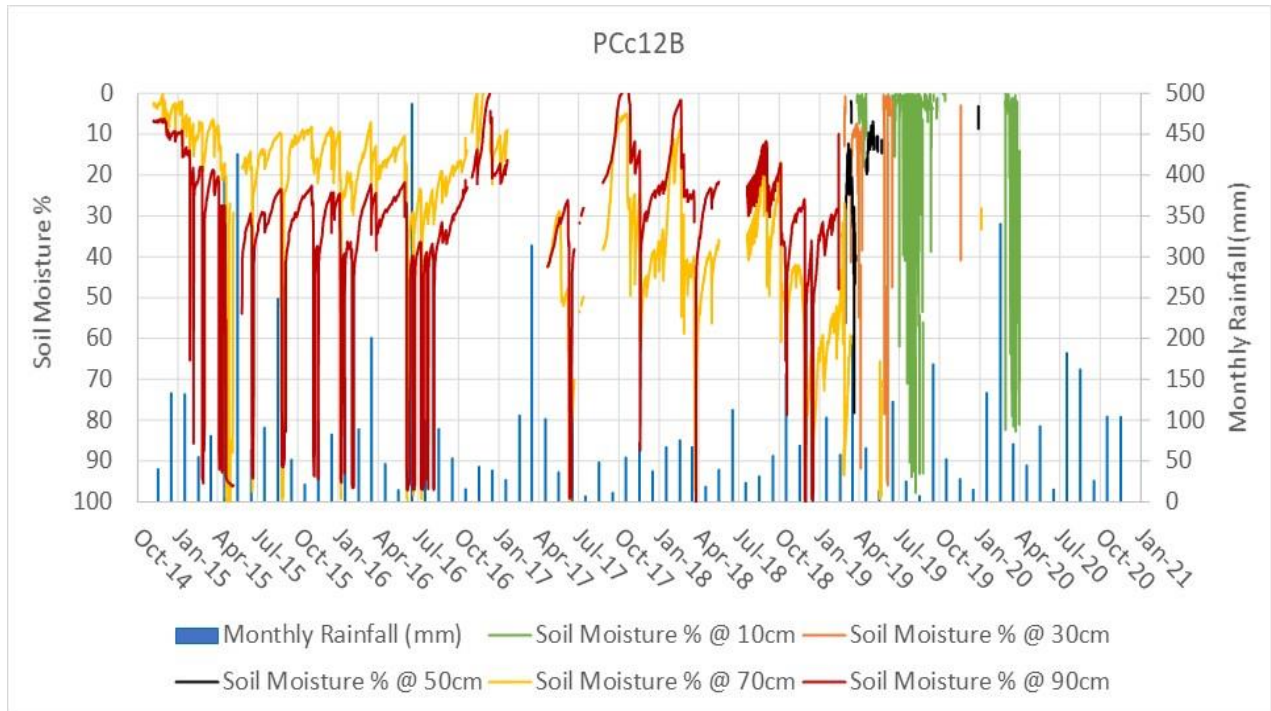
PCc10 (B) at CCUS10



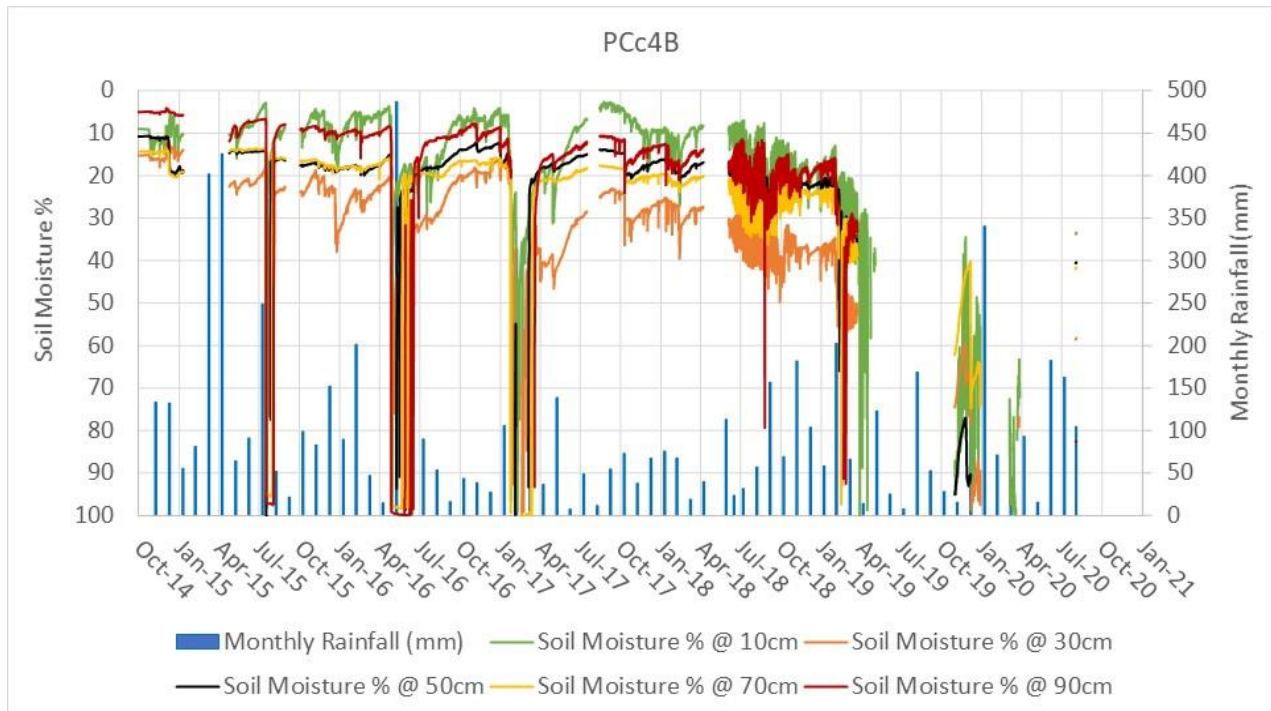
PCc12 (A) at CCUS12



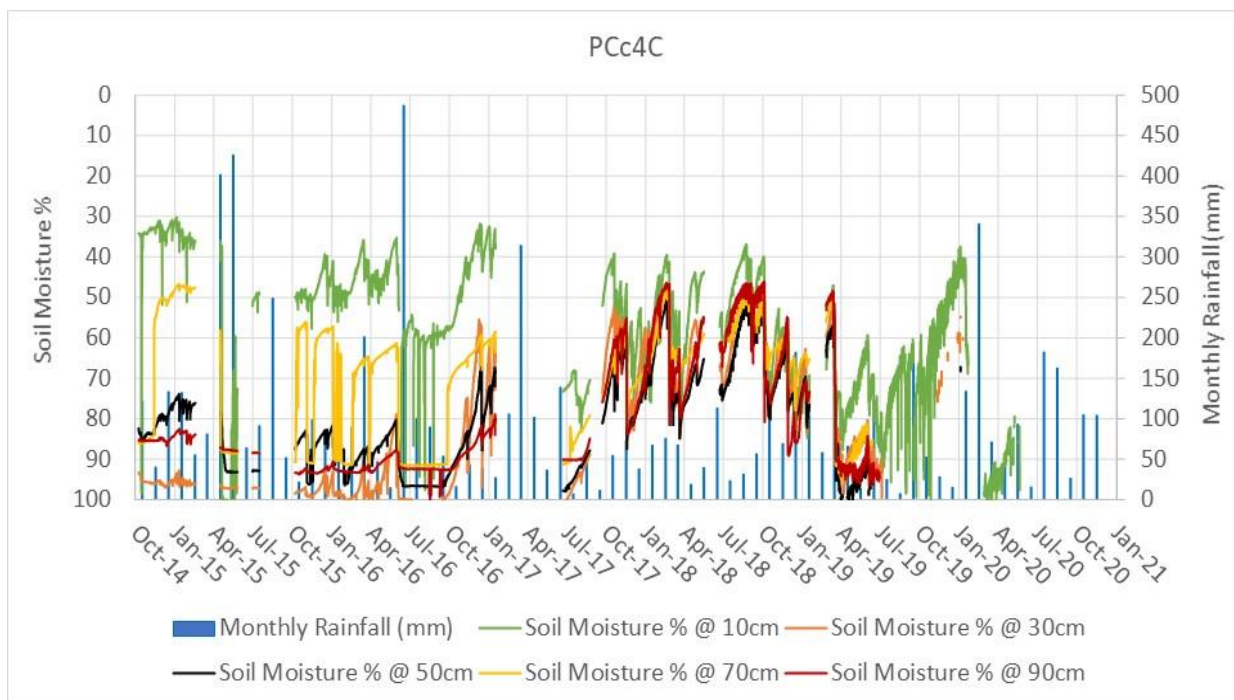
PCc12 (B) at CCUS12



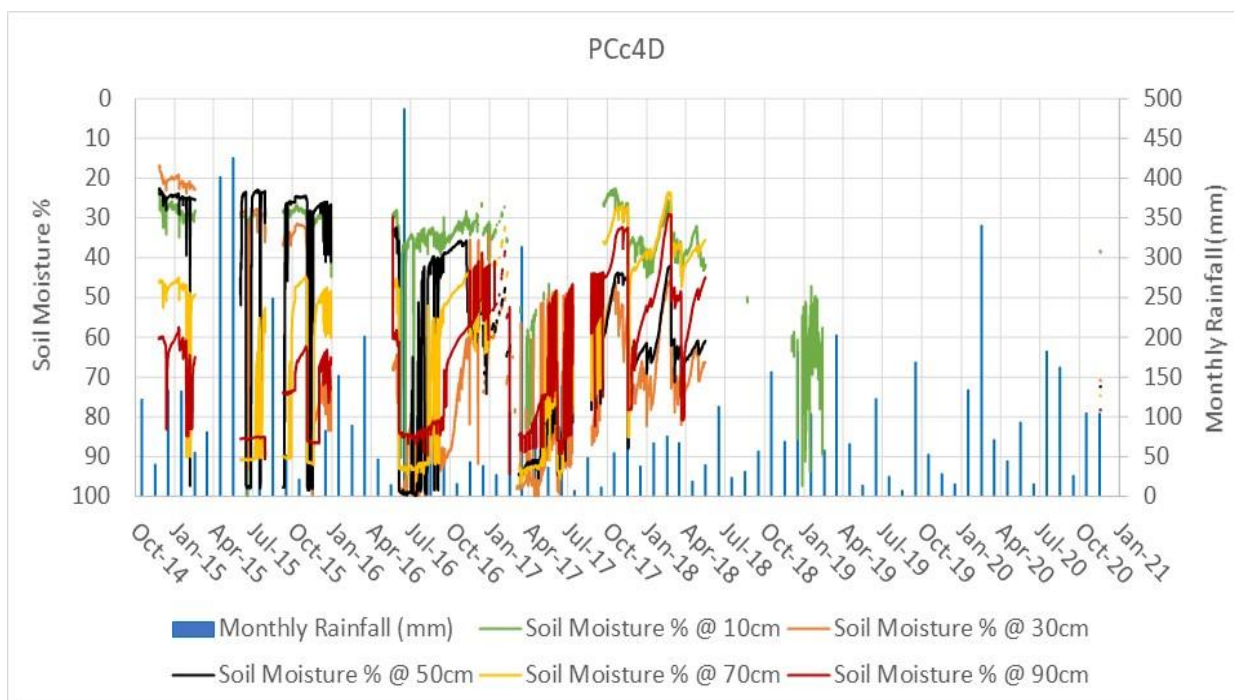
PCc4 (B) at CCUS4



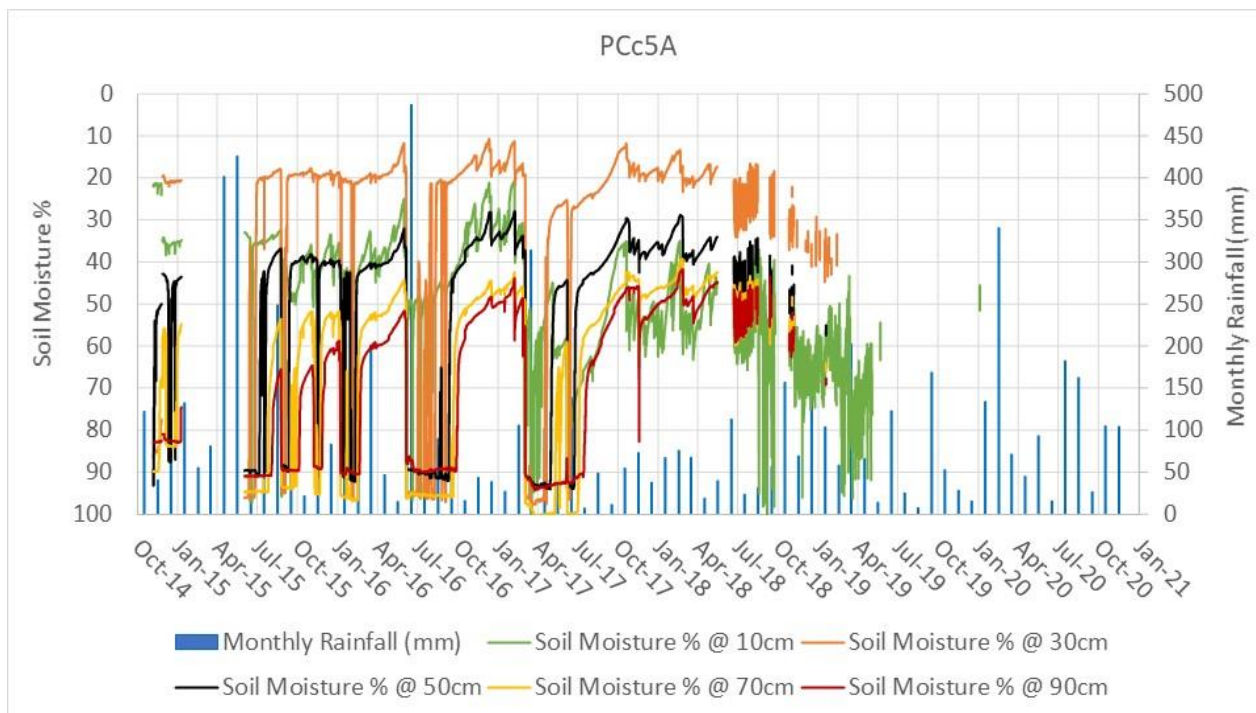
PCc4 (C) at CCUS4



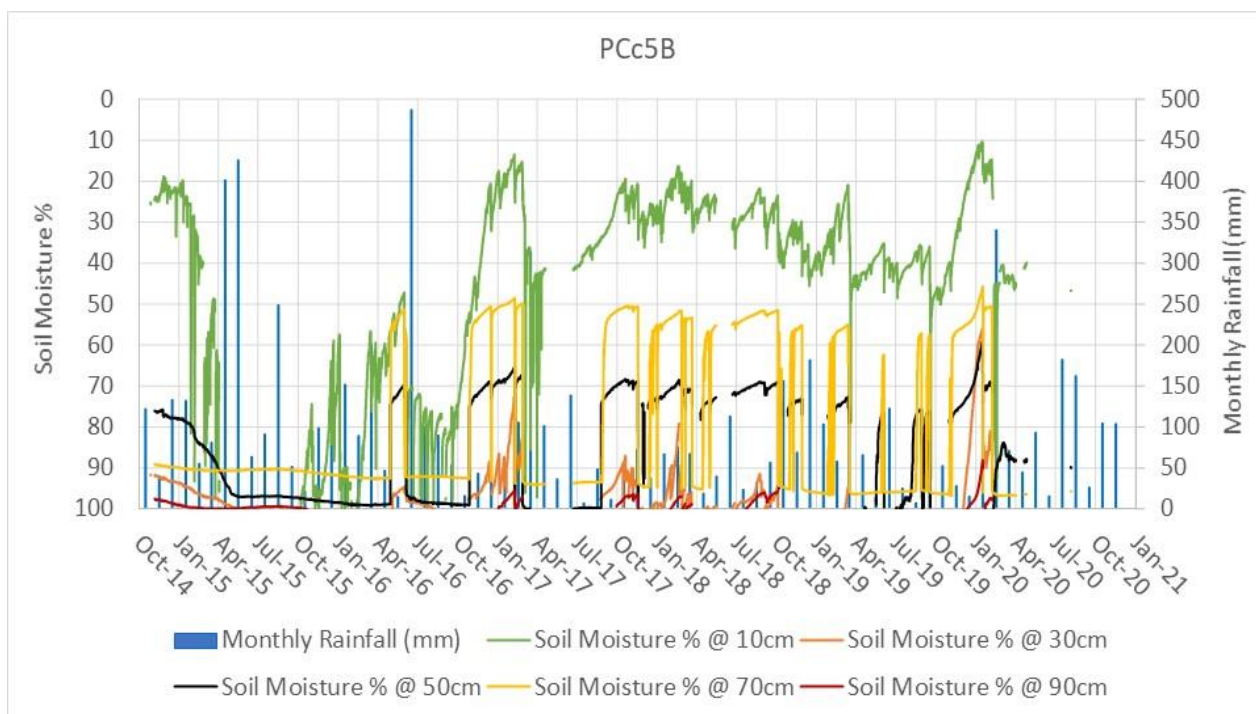
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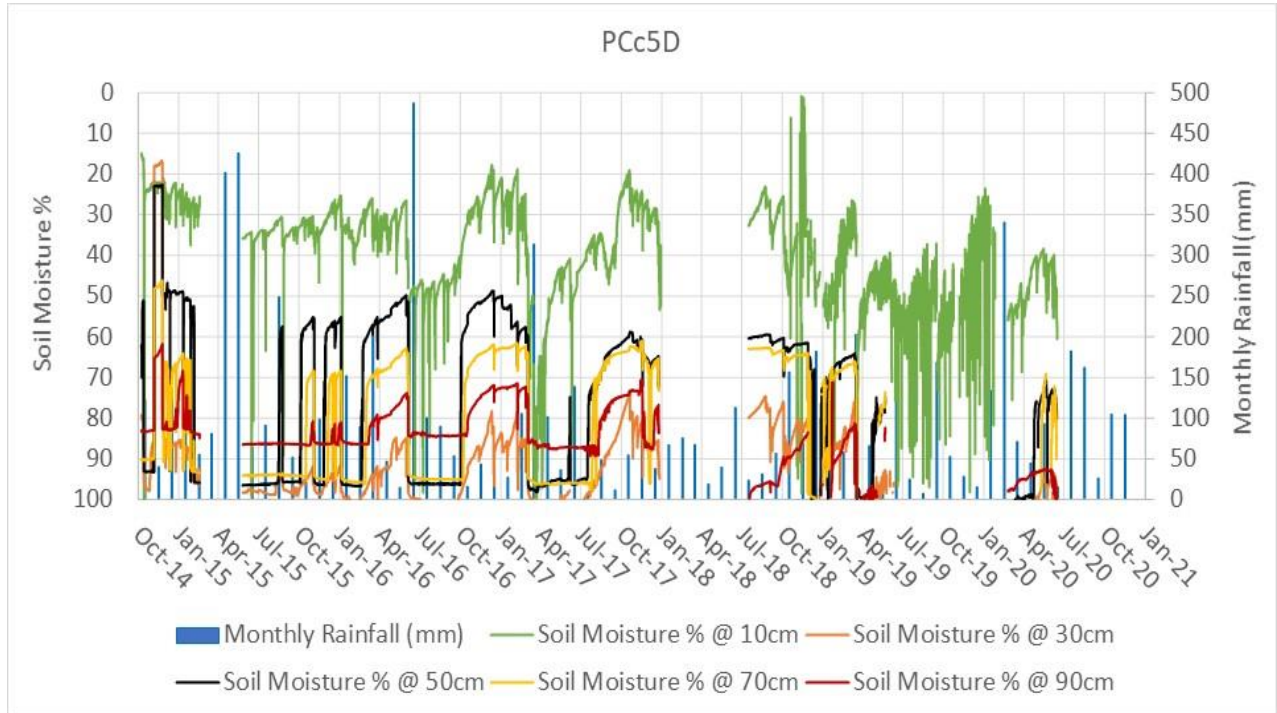
PCc5 (A) at CCUS5



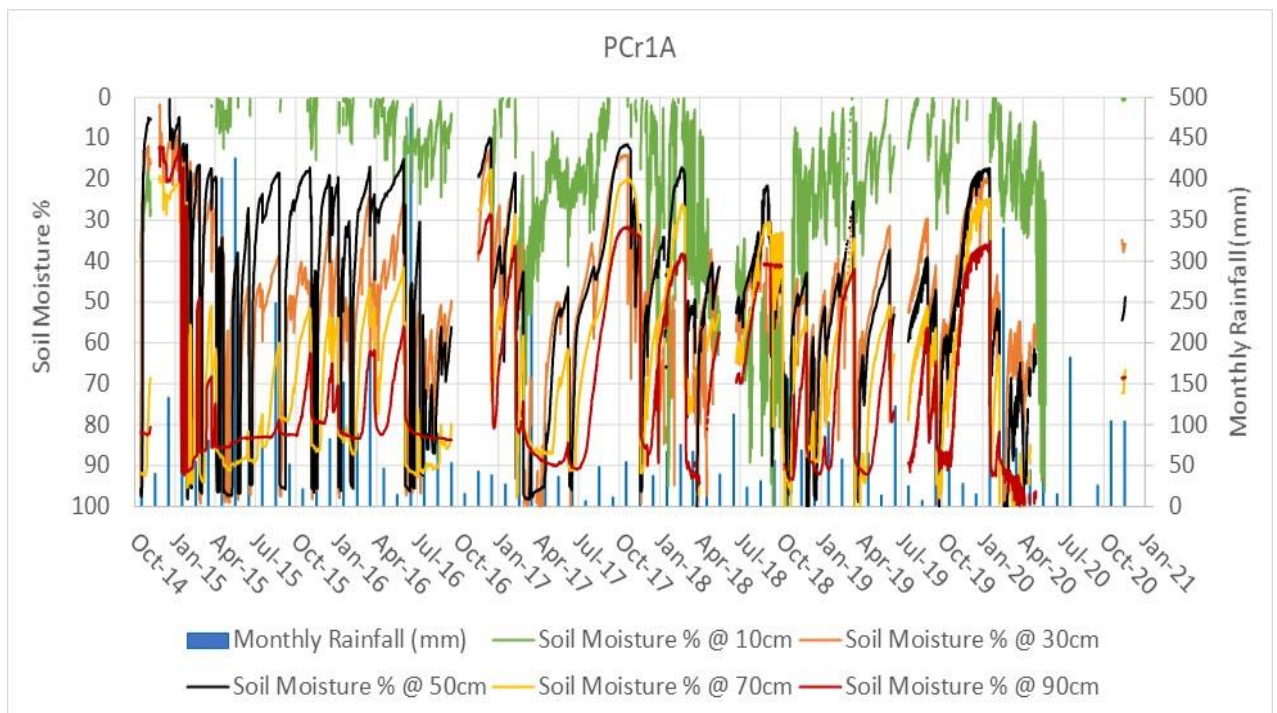
PCc5 (B) at CCUS5



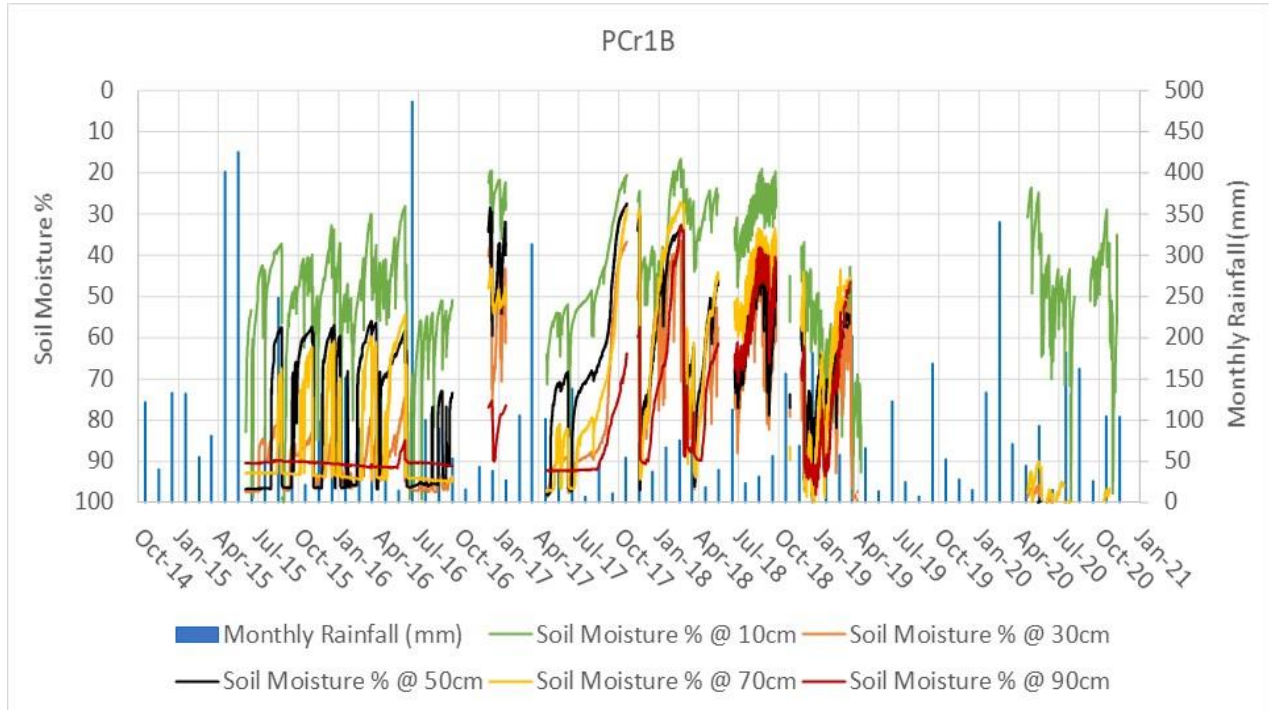
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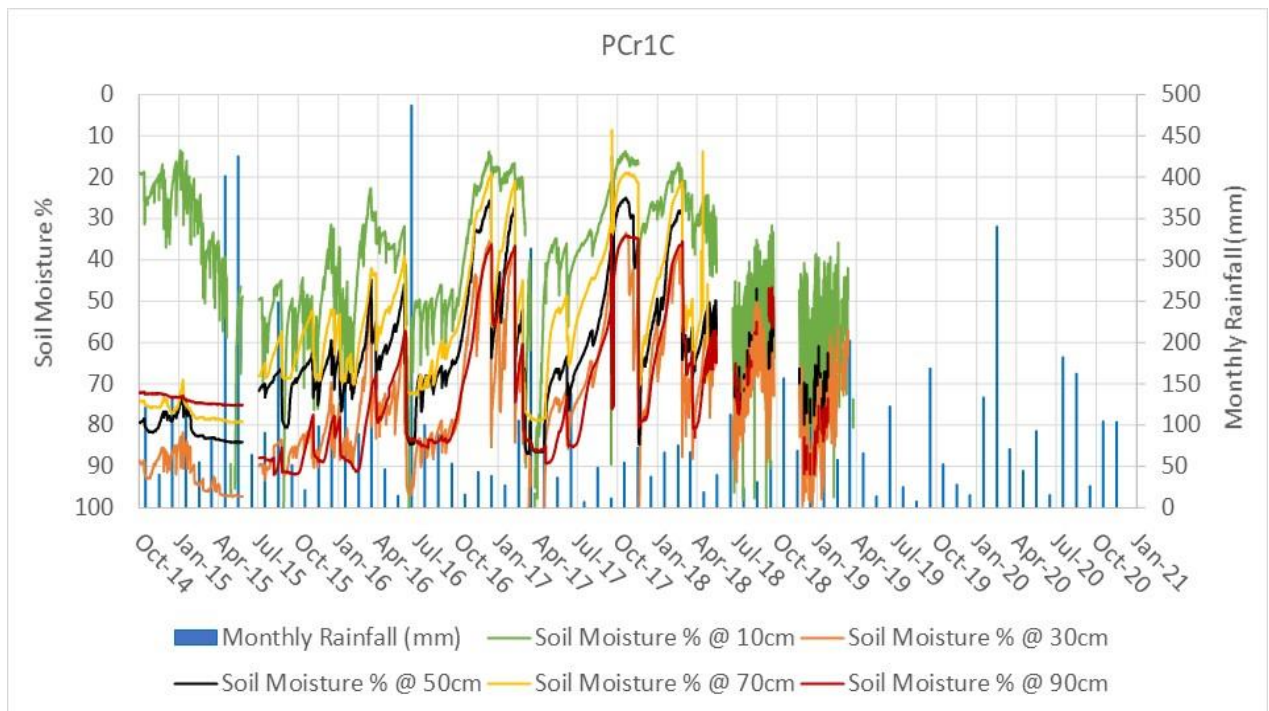
PCr1 (A) at CRUS1



PCr1 (B) at CRUS1

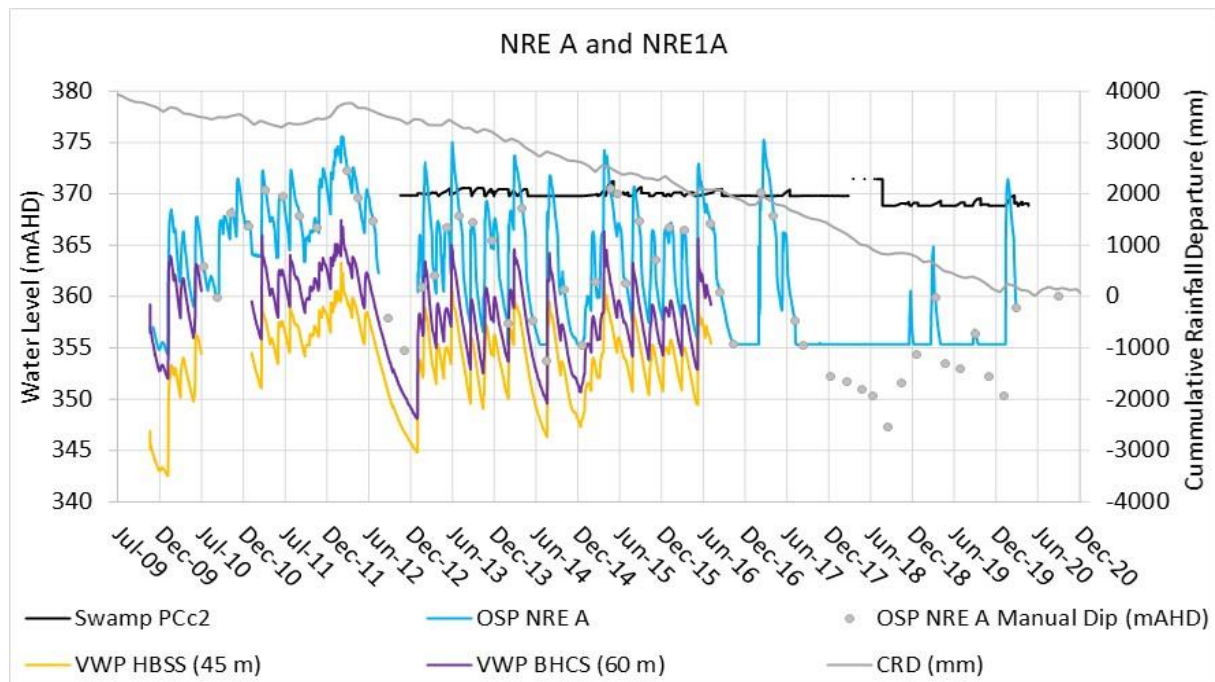


PCr1 (C) at CRUS1

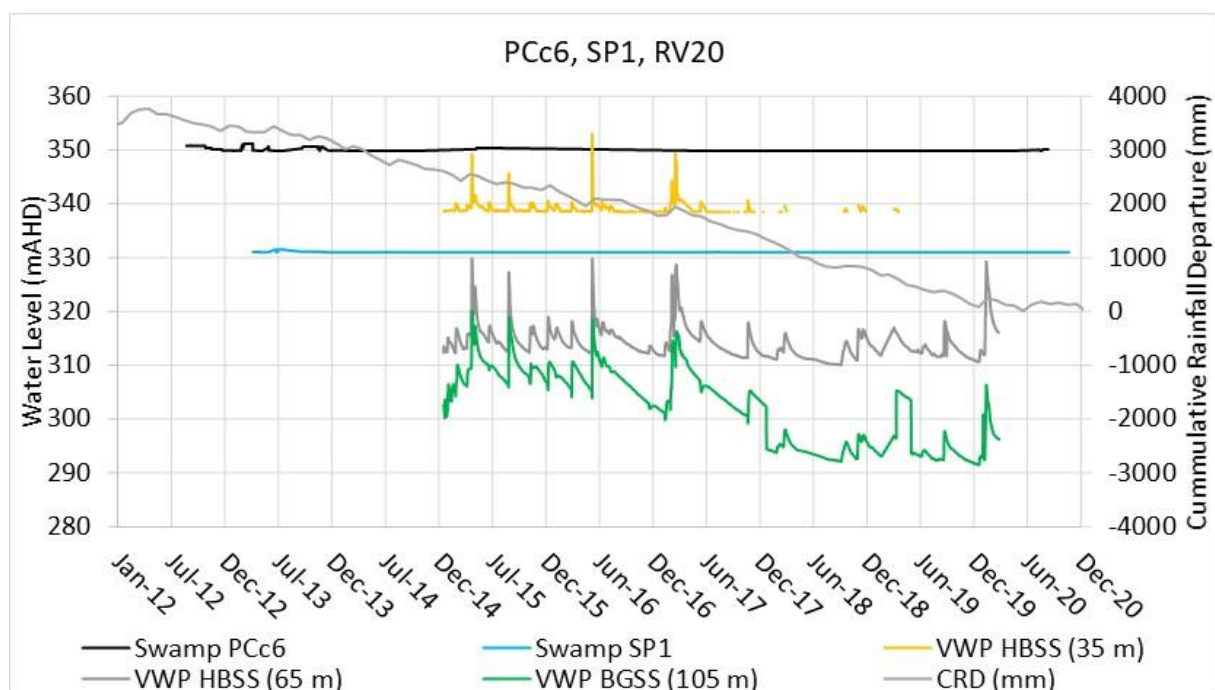


GROUNDWATER MONITORING SITES AT SWAMP LOCATIONS

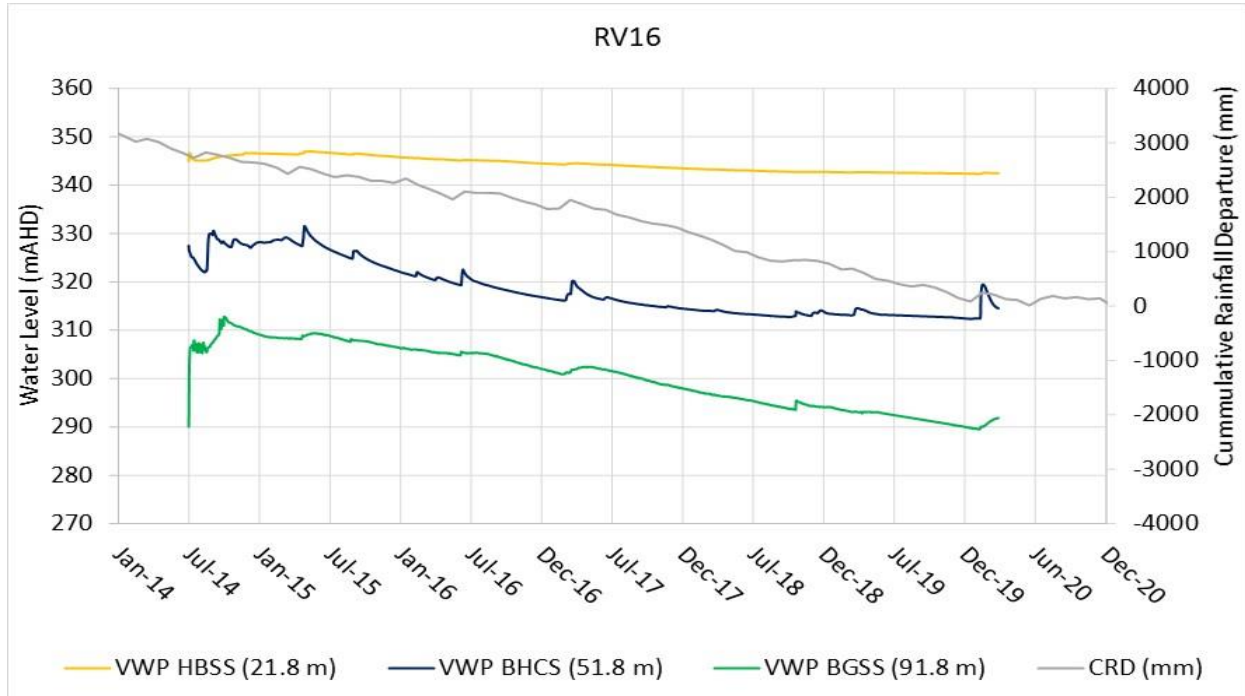
PCc2, NRE1A (OSP) and NREA (VWP) near CCUS2



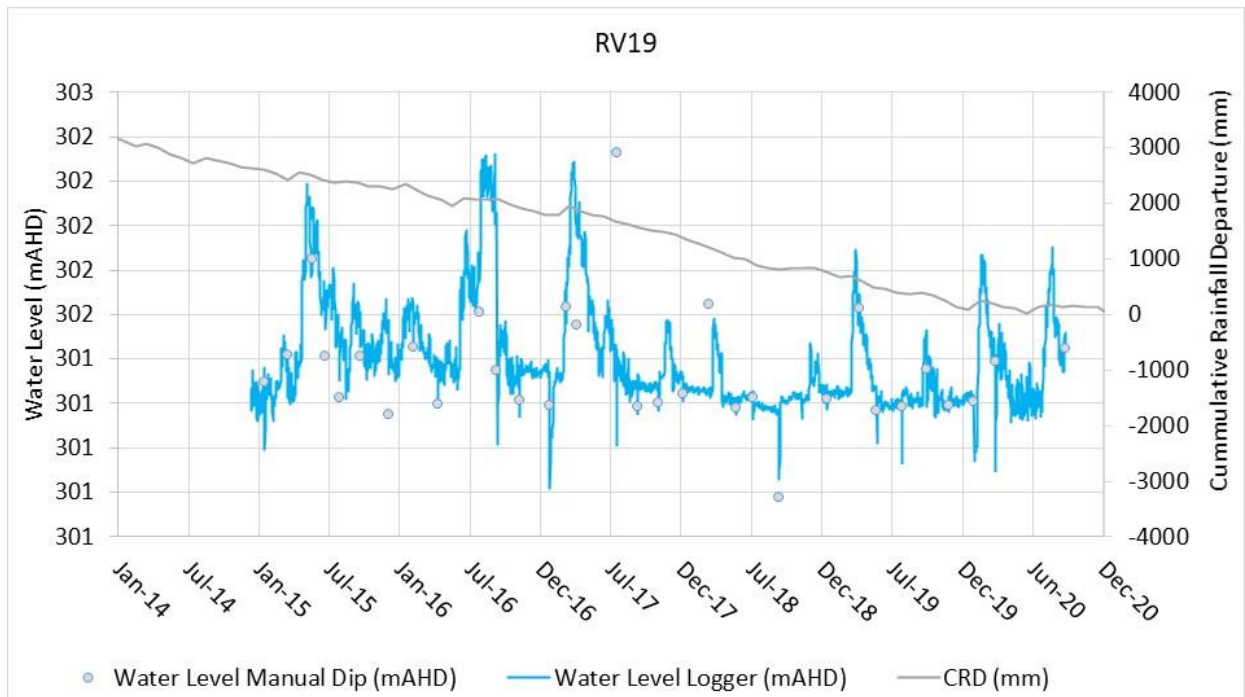
PCc6, SP1 and RV20 (VWP) near CCUS6



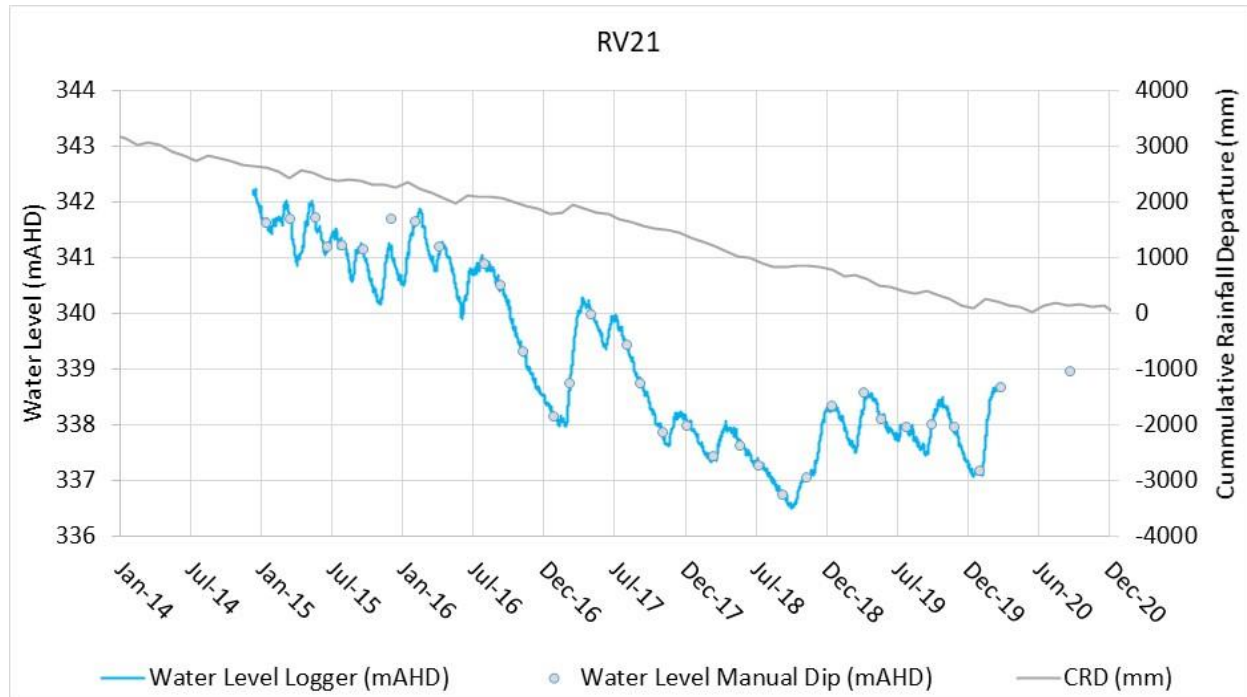
RV16 (VWP) within CCUS1



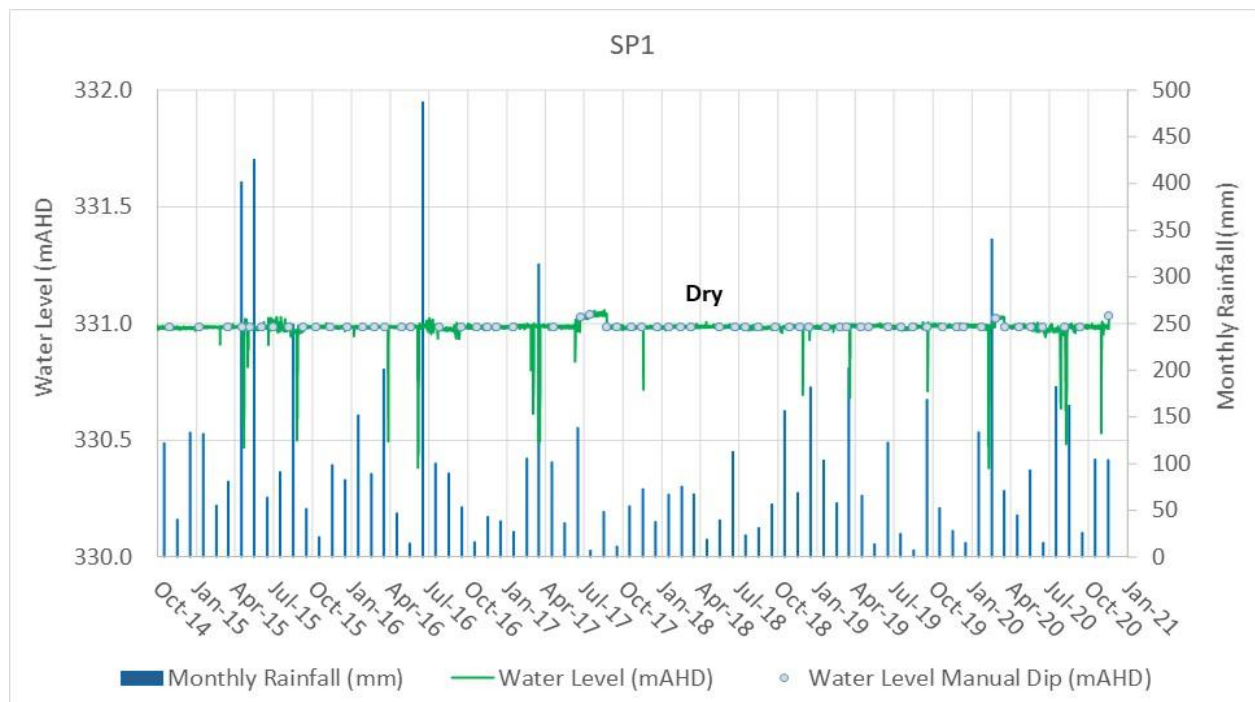
RV19 near CRUS1



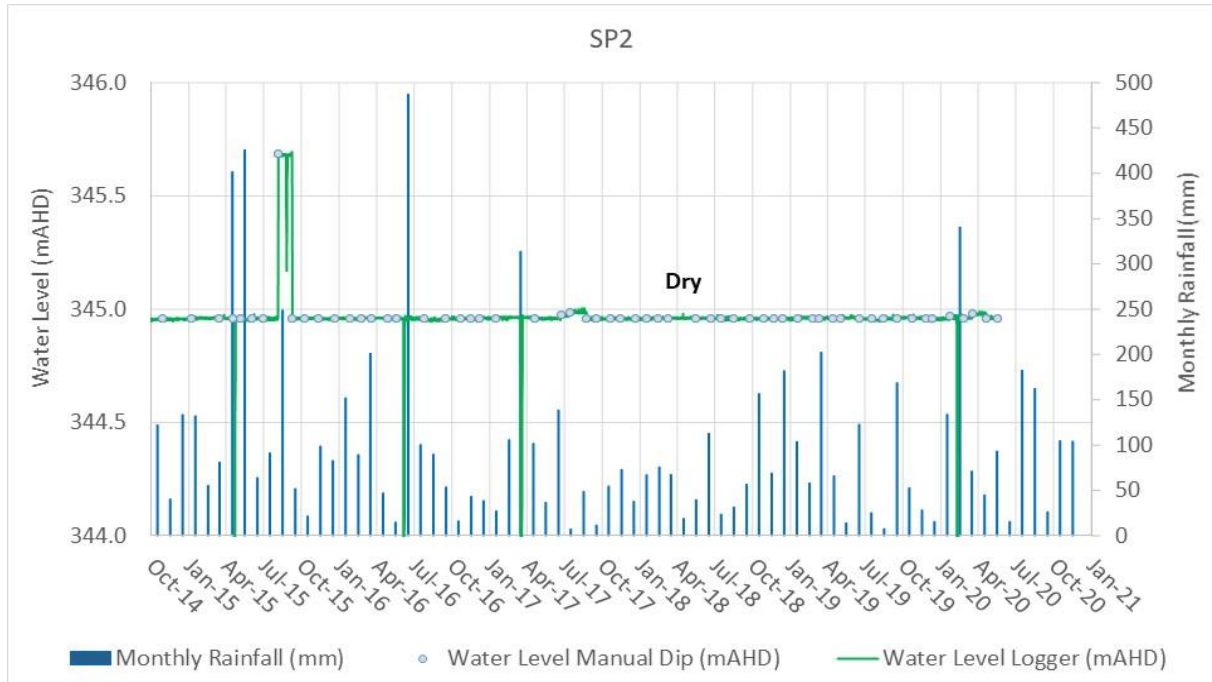
RV21 near BCUS4



SP1 near CCUS6



SP2 near CCUS4





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APPENDIX B – SWAMP BASELINE DATA - WATER QUALITY

[illegible]

1/05/2013	SP1	Dry												
1/05/2013	SP2	Dry												
8/05/2013	PCc6	Dry												
8/05/2013	SP1	Dry												
17/05/2013	PCc6	Dry												
17/05/2013	PCc6	Dry												
24/05/2013	PCc6	Dry												
24/05/2013	PCc6	Dry												
29/05/2013	PCc6	Dry												
29/05/2013	SP1	Dry												
31/05/2013	PCc3	2.41												
31/05/2013	PCc4D	Muddy												
31/05/2013	PCr1A	Dry												
31/05/2013	SP2	Dry												
4/06/2013	PCc6	Dry												
4/06/2013	SP1	Dry												
13/06/2013	PCc6	Dry												
13/06/2013	SP1	Dry												
20/06/2013	PCc3	Dry												
20/06/2013	PCc4D	Dry												
20/06/2013	PCc6	Dry												
20/06/2013	PCr1A	Dry												
20/06/2013	SP1	Dry												
20/06/2013	SP2	Dry												
16/07/2013	PCc2	Muddy												
16/07/2013	PCc3	Dry												
16/07/2013	PCc6	Dry												
16/07/2013	PCr1A	Dry												
16/07/2013	SP1	Dry												
16/07/2013	SP2	Dry												
19/07/2013	PCc4D	Muddy												
19/09/2013	PCc3	Dry												
19/09/2013	PCc5A	Cloudy												
19/09/2013	PCc6	Cloudy												
19/09/2013	PCr1A	Dry; Not enough water for field or lab sample. Cloudy.												
19/09/2013	SP1	Dry												
19/09/2013	SP2	Dry												
3/10/2013	PCc3	Dry												
3/10/2013	PCc5A	Cloudy												
3/10/2013	PCr1A	Dry												
27/11/2013	PCc3	Dry. Sample tested for pH at lab.												
27/11/2013	PCc5A	Sample tested for pH at lab.												
27/11/2013	PCc5B	Sample tested for pH at lab.												
27/11/2013	PCc6	Dry. Sample tested for pH at lab.												
27/11/2013	PCr1A	Dry. Sample tested for pH at lab.												
27/11/2013	SP1	Dry. Sample tested for pH at lab.												
27/11/2013	SP2	Dry. Sample tested for pH at lab.												
18/12/2013	PCc2	Dry. Piezo changed to 6 hour intervals.												
18/12/2013	PCc3	Dry. Piezo changed to 6 hour intervals.												
18/12/2013	PCc4D	Cloudy. Piezo changed to 6 hour intervals.												
18/12/2013	PCc5A	Piezo changed to 6 hour intervals.												
18/12/2013	PCc5B	Piezo changed to 6 hour intervals.												
18/12/2013	PCc6	Dry. Piezo changed to 6 hour intervals.												
18/12/2013	PCr1A	Dry. Piezo changed to 6 hour intervals.												
18/12/2013	SP1	Dry. Piezo changed to 6 hour intervals.												
18/12/2013	SP2	Dry. Piezo changed to 6 hour intervals.												
28/01/2014	PCc3	Dry												
28/01/2014	PCc4D	Dry												
28/01/2014	PCc5A	Cloudy												
28/01/2014	PCc5B	Cloudy												
28/01/2014	PCc6	Dry												
28/01/2014	PCr1A	Dry												
28/01/2014	SP1	Dry												
28/01/2014	SP2	Dry												
27/02/2014	PCc3	Dry												
27/02/2014	PCc4D	Dry												
27/02/2014	PCc5A	Muddy												
27/02/2014	PCc5A	Muddy	17.3	5.5	77.0	50.0		3.1	114.9	68.7	15151.0	0.0		
27/02/2014	PCc5B	Cloudy												
27/02/2014	PCc5B	Cloudy	17.2	5.4	62.0	40.0		5.8	110.4	76.1	18867.0	0.0		
27/02/2014	PCc6	Dry												
27/02/2014	PCr1A	Dry												
27/02/2014	SP1	Dry												
27/02/2014	SP2	Dry												
15/04/2014	PCc3	Dry												
15/04/2014	PCc4D	1.94												
15/04/2014	PCc4D	1.94	16.5	4.8	0.0	0.0		7.4	342.7	102.7		0.0		
15/04/2014	PCc5A	Took depth after water												
15/04/2014	PCc5A	Took depth after water	16.9	8.2	91.0	59.0		6.7	306.8	-88.9	12987.0	0.0		
15/04/2014	PCc5B	Comment on field sheet reads: "Time on logger changed after PCc5b"												
15/04/2014	PCc5B	Comment on field sheet reads: "Time on logger changed after PCc5b"	16.8	7.6	66.0	42.0		7.7	222.0	-54.3	17857.0	0.0		
15/04/2014	PCr1A	not enough sample												
21/05/2014	PB4C		15.3	4.7	72.0	46.0		8.2	404.0	104.3	16949.0	0.0		
21/05/2014	PCc2	Dry												
21/05/2014	PCc3	Dry												
21/05/2014	PCc4D	Dry; not enough for F + L												
21/05/2014	PCc5A	Cloudy												
21/05/2014	PCc5A	Cloudy	14.9	5.3	70.0	45.0		6.3	323.8	69.7	17543.0	0.0		
21/05/2014	PCc5B		14.0	5.6	75.0	48.0		9.5	319.0	52.2	16666.0	0.0		
21/05/2014	PCc6	Dry												
21/05/2014	PCr1A	Dry												
21/05/2014	SP1	Dry												
21/05/2014	SP2	Dry												
2/07/2014	PCc3	Dry												
2/07/2014	PCc4D	Dry												
2/07/2014	PCc5A	Milky												
2/07/2014	PCc5A	Milky	13.2	8.4	96.0	62.0		6.7	218.9	-104.3	13333.0	0.0		
2/07/2014	PCc5B		12.5	8.5	93.0	60.0		8.6	249.8	-110.8	14084.0	0.0		
2/07/2014	PCr1A	Dry												
1/08/2014	PCc3	Dry												
1/08/2014	PCc4D	Dry												
1/08/2014	PCc5A	Water not enough for field or lab												
1/08/2014	PCc5B		11.9	7.6	109.0	70.0		9.4	228.9	-61.1	12195.0	0.0		
1/08/2014	PCr1A	Dry												
1/08/2014	SP1	Dry												

1/08/2014	SP2	Dry											
4/09/2014	PCc3	Dry											
4/09/2014	PCc4D		11.7	5.0	97.0	63.0			9.1	360.0	80.4	13698.0	0.0
4/09/2014	PCc5A		12.2	5.7	70.0	45.0			5.9	315.9	39.3	18867.0	0.0
4/09/2014	PCc5B		11.8	5.6	60.0	39.0			8.4	293.0	44.3	22222.0	0.0
4/09/2014	PCr1A	Not enough water for lab or field.											
4/09/2014	SP1	Dry											
4/09/2014	SP2	Dry											
17/09/2014	PB4C		13.8	4.6	80.0	52.0			6.0	360.5	103.3	15873.0	0.0
17/09/2014	PCc2		14.7	4.5	72.0	46.0			7.6	357.4	110.1	17241.0	0.0
17/09/2014	PCc3	Dry											
17/09/2014	PCc4D		13.4	4.8	114.0	74.0			7.1	338.9	94.4	11235.0	0.0
17/09/2014	PCc5A		13.5	5.5	67.0	43.0			3.3	251.5	51.2	18867.0	0.0
17/09/2014	PCc5B		13.5	5.6	70.0	45.0			8.3	267.9	46.3	18181.0	0.0
17/09/2014	PCr1A	Not enough sample for field or lab											
28/10/2014	PCc3	Dry											
28/10/2014	PCc4A		13.5	5.8	82.0	53.0			5.6	183.6	31.9	15625.0	0.0
28/10/2014	PCc4B	Dry											
28/10/2014	PCc4B	Dry	14.3	5.3	80.0	52.0			4.8	252.0	62.5	15625.0	0.0
28/10/2014	PCc4C		13.5	5.6	103.0	66.0			4.9	225.5	41.6	12345.0	0.0
28/10/2014	PCc5A		15.5	5.4	68.0	44.0			5.7	262.6	55.0	17857.0	0.0
28/10/2014	PCc5B		15.5	5.7	64.0	41.0			7.8	250.1	36.2	18867.0	0.0
28/10/2014	PCc5C		16.2	5.2	67.0	43.0			4.9	291.9	66.0	17857.0	0.0
28/10/2014	PCc6	Dry. No time given on data sheet.											
28/10/2014	PCr1A	Dry											
28/10/2014	PCr1B		15.0	6.2	152.0	98.0			3.6	113.2	10.1	8130.0	0.1
28/10/2014	PCr1C		14.9	5.9	85.0	55.0			4.4	158.7	29.2	14492.0	0.0
28/10/2014	PCr1D	Dry											
28/10/2014	SP1	Dry											
28/10/2014	SP2	Dry											
28/11/2014	PB4A		15.8	5.7	82.0	53.0			2.8	159.5	35.7	14705.0	0.0
28/11/2014	PB4B		15.4	5.5	107.0	69.0			2.9	162.5	45.9	11363.0	0.0
28/11/2014	PCc10A		16.9	5.4	93.0	60.0			4.5	224.9	55.7	12658.0	0.0
1/12/2014	PCc5A		17.2	5.0	77.0	50.0			4.3	207.9	76.6	15151.0	0.0
1/12/2014	PCc5B		17.5	5.1	71.0	46.0			3.9	198.4	69.3	16393.0	0.0
1/12/2014	PCc5D		17.1	5.4	69.0	44.0			2.3	162.5	54.8	16949.0	0.0
8/01/2015	PCc3	Dry											
8/01/2015	PCc4A	dry											
8/01/2015	PCc4B	Dry											
8/01/2015	PCc4C	Dry											
8/01/2015	PCc4D	Dry											
8/01/2015	PCc5A	Not enough for F or L											
8/01/2015	PCc5B		19.7	5.6	82.0	53.0			4.3	-6.5	44.2	13513.0	0.0
8/01/2015	PCc5C	Dry											
8/01/2015	PCc5D	Not enough											
8/01/2015	PCr1A	Dry											
8/01/2015	PCr1B	Dry											
8/01/2015	PCr1C	Dry											
8/01/2015	PCr1D	Dry											
8/01/2015	SP1	Dry											
8/01/2015	SP2	Dry											
9/01/2015	PB4A	Grey.	19.2	5.4	73.0	47.0			2.2	15.9	55.4	15384.0	0.0
9/01/2015	PB4B	Brown	20.2	5.0	89.0	57.0			3.0	266.9	76.7	12345.0	0.0
9/01/2015	PB4C	Dry											
9/01/2015	PB4D	dry											
9/01/2015	PCc10B	Dry											
9/01/2015	PCc12A	Dry											
9/01/2015	PCc12B	Dry											
9/01/2015	PCc2	dry											
17/02/2015	PCc3	Dry											
17/02/2015	PCc4A	not enough sample											
17/02/2015	PCc4B	Dry											
17/02/2015	PCc4C	Dry											
17/02/2015	PCc4D	Dry											
17/02/2015	PCc5A		18.6	5.8	85.0	55.0			3.6	213.3	51.5	13333.0	0.0
17/02/2015	PCc5B		18.7	6.9	75.0	48.0			6.8	96.0	-6.7	15151.0	0.0
17/02/2015	PCc5B		18.7	6.9	73.0	47.0			6.8	96.8	-5.9	15384.0	0.0
17/02/2015	PCc5C	Dry											
17/02/2015	PCc5D		17.4	6.9	80.0	52.0			4.2	150.3	-7.0	14492.0	0.0
17/02/2015	PCr1A	Dry											
17/02/2015	PCr1B	Not enough for field or lab											
17/02/2015	PCr1C	Not enough for field or lab											
17/02/2015	PCr1C	Not enough for field or lab	19.2	5.8	127.0	82.0			3.2	69.8	55.0	8849.0	0.0
17/02/2015	PCr1D	Dry											
18/02/2015	PB4A	Not enough water for sample. Cloudy	18.3	5.5	80.0	52.0			3.3	31.5	69.5	14285.0	0.0
18/02/2015	PB4B	Slightly Cloudy	18.0	5.3	95.0	61.0			5.0	62.0	77.2	12048.0	0.0
18/02/2015	PB4D	Dry											
18/02/2015	PCc10A	Not enough for lab samples. Cloudy Brown	18.7	5.8	95.0	61.0			5.6	219.0	50.8	11904.0	0.0
18/02/2015	PCc10A	Not enough for lab samples. Cloudy Brown											
18/02/2015	PCc12A	Dry											
18/02/2015	PCc12B	Dry											
16/03/2015	PCc3	Dry											
16/03/2015	PCc4A	not enough											
16/03/2015	PCc4B	Dry											
16/03/2015	PCc4C	Dry											
16/03/2015	PCc4D	Dry											
16/03/2015	PCc5A	Cloudy	17.5	4.7	93.0	60.0			3.7	125.5	95.6	12500.0	0.0
16/03/2015	PCc5A	Cloudy											
16/03/2015	PCc5B		17.4	5.1	64.0	41.0			6.2	51.2	73.7	18181.0	0.0
16/03/2015	PCc5C	Not enough for field or lab											
16/03/2015	PCc5D		16.5	5.6	101.0	65.0			5.3	118.3	48.5	11764.0	0.0
16/03/2015	PCr1A	Dry											
16/03/2015	PCr1B	Not enough water											
16/03/2015	PCr1D	Dry											
16/03/2015	SP1	Dry											
16/03/2015	SP2	Dry											
17/03/2015	PB4A		16.9	5.3	86.0	55.0			6.8	68.5	63.4	13698.0	0.0
17/03/2015	PB4B		16.2	4.8	80.0	52.0			5.9	133.0	88.7	14925.0	0.0
17/03/2015	PB4C	not enough											
17/03/2015	PB4D	Dry											
17/03/2015	PCc10A	Field only	16.1	5.2	125.0	81.0			5.4	119.9	68.4	9615.0	0.0
17/03/2015	PCc10A	Field only											
17/03/2015	PCc10B	Not enough											
17/03/2015	PCc12A	Dry											
17/03/2015	PCc2	not enough											
15/04/2015	PB4A		16.3	5.0	71.0	46.0			6.2	48.8	74.7	16666.0	0.0
15/04/2015	PB4B		15.7	4.8	72.0	46.0			7.5	50.4	85.0	16666.0	0.0

15/04/2015	PB4C		16.1	4.0	131.0	85.0			6.3	52.1	129.6	9174.0	0.0
15/04/2015	PB4D	Dry											
15/04/2015	PCc10A	Brown											
15/04/2015	PCc10A	Brown	15.2	4.8	79.0	51.0			6.9	49.2	85.7	15384.0	0.0
15/04/2015	PCc10B		15.6	4.7	79.0	51.0			5.3	46.8	87.9	15384.0	0.0
15/04/2015	PCc12A		15.7	4.8	148.0	96.0			6.4	47.0	82.8	8196.0	0.1
15/04/2015	PCc12B	Dry											
15/04/2015	PCc2		17.6	4.1	87.0	56.0			7.1	49.7	125.2	13333.0	0.0
15/04/2015	PCc2		17.6	4.1	87.0	56.0			7.1	49.7	125.5	13333.0	0.0
16/04/2015	PCc3	Dry											
16/04/2015	PCc4A	Field only, not enough for lab											
16/04/2015	PCc4A	Field only, not enough for lab	16.9	5.4	94.0	61.0			4.0	200.3	65.1	12500.0	0.0
16/04/2015	PCc4B	Dry; not enough for field or lab											
16/04/2015	PCc4C	Muddy											
16/04/2015	PCc4C	Muddy	15.9	5.3	104.0	67.0			4.1	274.5	70.2	11627.0	0.0
16/04/2015	PCc4D	Dry; not enough for field or lab											
16/04/2015	PCc5A		16.7	4.4	78.0	50.0			4.9	376.8	122.4	15151.0	0.0
16/04/2015	PCc5B		17.3	4.7	69.0	44.0			7.0	344.8	106.7	16949.0	0.0
16/04/2015	PCc5C	Cloudy											
16/04/2015	PCc5C	Cloudy	18.3	4.3	77.0	50.0			4.6	391.2	129.4	14705.0	0.0
16/04/2015	PCc5D		16.0	5.4	74.0	48.0			6.2	219.3	67.4	16129.0	0.0
16/04/2015	PCc6	Dry											
16/04/2015	PCr1A	Not enough for F or L											
16/04/2015	PCr1B	Not enough for Lab. Brown.											
16/04/2015	PCr1B	Not enough for Lab. Brown.	17.4	5.8	108.0	70.0			6.4	45.4	29.6	10752.0	0.0
16/04/2015	PCr1C	Brown.											
16/04/2015	PCr1C	Brown.	17.3	4.9	83.0	53.0			5.0	49.5	79.2	14084.0	0.0
16/04/2015	PCr1D	Dry											
16/04/2015	SP1	Dry											
16/04/2015	SP2	Dry											
3/05/2015	PCc12A	Murky. Forgot to press m+ button on probe.											
5/05/2015	PCc4A		15.1	5.2	88.0	57.0			4.1	45.2	57.6	13888.0	0.0
5/05/2015	PCc4B		15.3	4.7	84.0	54.0			8.4	47.6	85.6	14492.0	0.0
5/05/2015	PCc4C		15.2	6.7	89.0	57.0			6.4	43.7	-28.6	13698.0	0.0
5/05/2015	PCc4D		14.8	5.3	94.0	61.0			6.9	46.7	52.9	13157.0	0.0
5/05/2015	PCr1A	Murky											
5/05/2015	PCr1A	Murky	16.7	3.8	83.0	53.0			5.3	52.5	138.8	14285.0	0.0
5/05/2015	PCr1B	Murky											
5/05/2015	PCr1B	Murky	15.7	4.8	83.0	53.0			6.0	50.2	77.9	14492.0	0.0
5/05/2015	PCr1D	Murky											
5/05/2015	PCr1D	Murky	15.8</										

[illegible]

11/11/2015	PCr1A	Not enough for field or lab											
11/11/2015	PCr1B	Brown	16.2	5.0	74.0	48.0		3.7	39.6	74.1	16129.0	0.0	
11/11/2015	PCr1B	Brown											
11/11/2015	PCr1D	Dry	16.4	4.3	120.0	78.0		7.3	44.1	112.0	9900.0	0.0	
11/11/2015	PCr1D	Dry											
11/11/2015	SP1	Dry											
11/11/2015	SP2	Dry											
22/12/2015	PCc3	Dry											
22/12/2015	PCc4A	Dry											
22/12/2015	PCc4B	Dry											
22/12/2015	PCc4C	Not enough for F											
22/12/2015	PCc4D	Dry											
22/12/2015	PCc5A	Dry											
22/12/2015	PCc5B		16.6	6.4	63.0	40.0		4.2	193.1	15.4	18867.0	0.0	
22/12/2015	PCc5C	Dry											
22/12/2015	PCc5D		15.0	5.8	54.0	35.0		3.1	180.0	44.6	22727.0	0.0	
22/12/2015	PCc6	Dry											
22/12/2015	PCr1A	Dry											
22/12/2015	PCr1C	Dry											
22/12/2015	PCr1D	Dry											
22/12/2015	SP1	Dry											
22/12/2015	SP2	Dry											
21/01/2016	PB4B	Time may be wrong; hard to read field sheet." Grey", but hard to read sheet.	18.8	5.9	74.0	48.0		7.2	87.3	43.9	15151.0	0.0	
21/01/2016	PB4C		18.0	4.0	98.0	63.0		4.8	272.0	139.6	11764.0	0.0	
21/01/2016	PB4D	Dry											
21/01/2016	PCc10A		18.8	4.7	75.0	48.0		5.4	240.6	103.3	14925.0	0.0	
21/01/2016	PCc10B		19.0	4.0	67.0	43.0		5.5	324.9	143.2	16666.0	0.0	
21/01/2016	PCc12A	Dry											
21/01/2016	PCc12B	Dry											
21/01/2016	PCc2	Not enough water											
27/01/2016	PCc3	Dry											
27/01/2016	PCc4A	Insufficient											
27/01/2016	PCc4B	Insufficient	18.1	6.1	64.0	41.0		6.6	114.4	29.0	17857.0	0.0	
27/01/2016	PCc4B	Insufficient											
27/01/2016	PCc4C		17.1	4.0	71.0	46.0		4.0	312.4	137.7	16393.0	0.0	
27/01/2016	PCc4D	Insufficient											
27/01/2016	PCc5A		18.2	5.5	85.0	55.0		6.8	151.5	60.4	13513.0	0.0	
27/01/2016	PCc5C		19.2	4.3	71.0	46.0		6.0	271.6	123.0	15625.0	0.0	
27/01/2016	PCc5D		16.9	5.4	56.0	36.0		6.6	170.1	68.5	20833.0	0.0	
27/01/2016	PCc6	Dry											
27/01/2016	PCr1A	Not enough for field sampling											
27/01/2016	PCr1B	Insufficient											
27/01/2016	PCr1D	Insufficient											
27/01/2016	SP1	Dry											
27/01/2016	SP2	Dry											
23/02/2016	PCc3	Dry											
23/02/2016	PCc4A	Insufficient sample											
23/02/2016	PCc4B	Insufficient sample											
23/02/2016	PCc4C		19.9	5.3	70.0	45.0		3.2	300.8	73.0	15625.0	0.0	
23/02/2016	PCc4D	Dry											
23/02/2016	PCc5A	Insufficient sample											
23/02/2016	PCc5B	"Check Depth"	21.2	7.1	51.0	33.0		6.8	213.3	-20.1	20833.0	0.0	
23/02/2016	PCc5B	"Check Depth"											
23/02/2016	PCc5C	Dry											
23/02/2016	PCc5D		19.9	6.8	56.0	36.0		5.9	201.5	-5.0	19607.0	0.0	
23/02/2016	PCc6	Dry											
23/02/2016	PCr1A	Dry											
23/02/2016	PCr1B	Insufficient sample											
23/02/2016	PCr1C	Insufficient sample											
23/02/2016	PCr1D	Dry											
23/02/2016	SP1	Dry											
23/02/2016	SP2	Dry											
17/03/2016	PCc3	Dry											
17/03/2016	PCc4A	Dry											
17/03/2016	PCc4B	Dry											
17/03/2016	PCc4C	Not enough for L											
17/03/2016	PCc4D	Dry											
17/03/2016	PCc5A	Dry											
17/03/2016	PCc5B	Smells like sulphur	18.3	6.6	64.0	41.0		2.7	95.6	10.1	17857.0	0.0	
17/03/2016	PCc5B	Smells like sulphur											
17/03/2016	PCc5C	Dry											
17/03/2016	PCc5D	"Not enough for Lab." Difficult to tell from sheet if this comment is related to this data point. Muddy grey.	17.4	5.8	59.0	38.0		2.7	156.1	53.1	19607.0	0.0	
17/03/2016	PCc5D	"Not enough for Lab." Difficult to tell from sheet if this comment is related to this data point. Muddy grey.											
17/03/2016	PCc6	Dry											
17/03/2016	PCr1B	Not neough for F or L											
17/03/2016	PCr1C	Not enough for F or L											
17/03/2016	PCr1D	Dry											
17/03/2016	SP1	Dry											
17/03/2016	SP2	Dry											
18/03/2016	PB4A		18.9	5.2	54.0	35.0		7.5	256.6	84.8	20833.0	0.0	
18/03/2016	PB4B	Black sediment	18.9	6.8	45.0	29.0		4.6	135.8	1.3	25000.0	0.0	
18/03/2016	PB4C	Insufficient for field and lab											
21/03/2016	PCc10A	Insufficient for lab samples	17.4	5.8	83.0	53.0		5.9	199.1	53.2	14084.0	0.0	
21/03/2016	PCc10A	Insufficient for lab samples											
26/03/2016	PCr1A	Dry											
26/04/2016	PCc3	Dry											
26/04/2016	PCc4A	Dry											
26/04/2016	PCc4B	Dry											
26/04/2016	PCc4C	Dry											
26/04/2016	PCc4D	Dry											
26/04/2016	PCc5A	Dry											
26/04/2016	PCc5B	Brown	16.5	6.3	29.0	18.0		2.1	111.0	25.1	40000.0	0.0	
26/04/2016	PCc5B	Brown											
26/04/2016	PCc5C	Dry											
26/04/2016	PCc5D	Dry											
26/04/2016	PCc6	Dry											
26/04/2016	PCr1A	Dry											
26/04/2016	PCr1B	Dry											
26/04/2016	PCr1C	Dry											
26/04/2016	PCr1D	Dry											
26/04/2016	SP1	Dry											
26/04/2016	SP2	Dry											
19/05/2016	PB4A		16.1	6.0	63.0	40.0		6.9	248.0	43.1	18867.0	0.0	
19/05/2016	PB4B		14.8	6.6	84.0	54.0		7.8	239.2	8.7	14705.0	0.0	

19/05/2016	PB4C	Dry											
19/05/2016	PB4D	Dry											
19/05/2016	PCc10A		15.3	5.4	90.0	58.0		7.7	257.8	74.1	13513.0	0.0	
19/05/2016	PCc10B	Dry											
19/05/2016	PCc12A	Dry											
19/05/2016	PCc12B	Beeped at total depth.											
19/05/2016	PCc2	Dry											
20/05/2016	PCc3	Dry											
20/05/2016	PCc4B	Dry											
20/05/2016	PCc4C	Dry											
20/05/2016	PCc4D	Dry											
20/05/2016	PCc5A	Dry											
20/05/2016	PCc5B	Not enough for field											
20/05/2016	PCc5C	Dry											
20/05/2016	PCc5D	Beeped at TD.											
20/05/2016	PCc6	Dry											
20/05/2016	PCr1A	Dry											
20/05/2016	PCr1B	Dry											
20/05/2016	PCr1C	Dry											
20/05/2016	PCr1D	Dry											
20/05/2016	SP1	Dry											
20/05/2016	SP2	Dry											
23/07/2016	PCr1D	Dry											
25/07/2016	PCc3	Dry											
25/07/2016	PCc4A		13.1	4.6	110.0	71.0	38.2	95.5	9.6	376.4	117.5	11764.0	0.0
25/07/2016	PCc4B		12.4	4.9	89.0	57.0	48.4	84.7	8.6	376.4	98.6	14705.0	0.0
25/07/2016	PCc4C		12.2	4.8	97.0	63.0	35.3	70.6	7.2	352.9	105.5	13513.0	0.0
25/07/2016	PCc4D	Brown.											
25/07/2016	PCc4D	Brown.	11.7	4.6	132.0	85.0	80.6	69.4	7.2	363.7	117.8	10101.0	0.0
25/07/2016	PCc5A		11.7	4.9	96.0	62.0	46.6	55.1	5.7	409.7	97.5	13888.0	0.0
25/07/2016	PCc5B		11.7	5.0	97.0	63.0	52.0	92.5	9.6	405.2	91.2	13698.0	0.0
25/07/2016	PCc5C		12.3	5.0	80.0	52.0	42.2	70.5	7.2	352.6	90.8	16393.0	0.0
25/07/2016	PCc5D		12.0	4.9	95.0	61.0	39.7	71.7	7.4	368.7	99.3	13888.0	0.0
25/07/2016	PCr1B	Clear/Brown											
25/07/2016	PCr1B	Clear/Brown	10.8	5.6	83.0	53.0	107.0	77.1	8.2	325.0	55.5	16393.0	0.0
25/07/2016	PCr1C	Not enough for lab. Brown.											
25/07/2016	PCr1C	Not enough for lab. Brown.	10.6	4.9	64.0	41.0	1827.0	78.1	8.3	374.2	100.1	21276.0	0.0
25/07/2016	SP1	Dry											
25/07/2016	SP2	Dry											
28/07/2016	PCr1A	Not enough for F or L.											
9/08/2016	PB4A	Time on the feildsheet is hard to distinguish	12.9	5.0	92.0	59.0	23.1	84.7	8.6	385.3	95.7	14084.0	0.0
9/08/2016	PB4B	20.5cm of string added to logger	11.7	4.9	88.0	57.0	38.2	90.0	9.4	375.6	98.2	15151.0	0.0
9/08/2016	PB4C	Logger not registering on loader; took logger out of piezo	11.7	4.4	107.0	69.0	17.9	71.8	7.5	392.2	128.5	12500.0	0.0
9/08/2016	PB4D		11.7	4.7	73.0	47.0	75.4	80.0	8.4	374.6	110.5	18181.0	0.0
9/08/2016	PCc10A		11.6	4.7	100.0	65.0	59.9	93.7	9.8	379.6	109.5	13333.0	0.0
9/08/2016	PCc10B		12.7	4.7	90.0	58.0	57.0	43.6	4.5	390.5	110.0	14492.0	0.0
9/08/2016	PCc12A	Slightly Milky											
9/08/2016	PCc12A	Slightly Milky	12.0	4.9	142.0	92.0	64.7	54.5	5.6	369.7	100.2	9345.0	0.1
9/08/2016	PCc2	Cloudy											
9/08/2016	PCc2	Cloudy	13.3	4.5	64.0	41.0	360.0	95.9	9.6	385.8	119.9	20000.0	0.0
15/09/2016	PCc5D	Cloudy											
16/09/2016	PCc3	Dry											
16/09/2016	PCc4A	Cloudy											
16/09/2016	PCc4A	Cloudy	14.3	4.7	67.0	43.0			7.8	237.7	76.2	18518.0	0.0
16/09/2016	PCc4B	Dry											
16/09/2016	PCc4C	2.24											
16/09/2016	PCc4D	Dry											
16/09/2016	PCc4D	Dry	12.8	4.4	76.0	49.0			3.4	253.6	92.0	16949.0	0.0
16/09/2016	PCc5A	Cloudy											
16/09/2016	PCc5A	Cloudy	14.3	4.9	79.0	51.0			6.1	199.6	65.3	15873.0	0.0
16/09/2016	PCc5B		13.3	5.7	103.0	66.0			7.8	175.6	23.2	12500.0	0.0
16/09/2016	PCc5C	Dry											
16/09/2016	PCc5D		13.0	4.6	71.0	46.0			2.9	236.9	81.7	18181.0	0.0
16/09/2016	PCc6	Dry											
16/09/2016	PCr1A	Dry											
16/09/2016	PCr1B	Dry											
16/09/2016	PCr1C	Dry											
16/09/2016	PCr1D	Dry											
16/09/2016	SP1	Dry											
16/09/2016	SP2	Dry											
19/09/2016	PB4A		14.0	4.6	67.0	43.0			6.9	244.4	87.7	18867.0	0.0
19/09/2016	PB4B		13.8	4.5	66.0	42.0			7.5	241.2	95.8	19230.0	0.0
19/09/2016	PB4C		13.6	3.9	85.0	55.0			6.0	276.9	123.9	14925.0	0.0
19/09/2016	PB4D	Dry											
19/09/2016	PCc10A	Cloudy											
19/09/2016	PCc10A	Cloudy	13.6	4.5	71.0	46.0			6.7	202.5	94.3	17857.0	0.0
19/09/2016	PCc10B	Cloudy											
19/09/2016	PCc10B	Cloudy	13.5	4.7	70.0	45.0			5.8	206.7	83.5	18181.0	0.0
19/09/2016	PCc12A	Cloudy											
19/09/2016	PCc12A	Cloudy	13.9	4.0	120.0	78.0			5.0	290.6	123.3	10526.0	0.0
19/09/2016	PCc12B	Dry											
19/09/2016	PCc2	Dry											
7/10/2016	PCc5C	Dry											
17/10/2016	PCc4A	Dry											
17/10/2016	PCc4C	Dry											
17/10/2016	PCc4D	Dry											
17/10/2016	PCc5A	Dry; Download incomplete - lost connection											
17/10/2016	PCc5B	SM logger would not download	12.7	5.2	107.0	69.0	333.0	47.8	4.8	293.8	78.2	12195.0	0.0
17/10/2016	PCc5B	SM logger would not download											
17/10/2016	PCc5C	Dry											
17/10/2016	PCc5D	Not downloaded.											
17/10/2016	PCc5D	Not downloaded.	12.2	4.5	95.0	61.0	1531.0	52.0	5.3	336.6	118.8	13888.0	0.0
17/10/2016	PCr1A	Dry											
17/10/2016	PCr1B	Dry; Couldnt download, maybe not restarted? Runtime Error 8012 - Logger not responding.											
17/10/2016	PCr1C	Dry. Soil Moisture not downloading. Not connecting to logger. Battery ok.											
17/10/2016	PCr1D	Dry											
20/10/2016	PB4A	Murky. Data downloaded from soil moisture probe 20/10/16. Unable to restart probe. Probe downloaded and restarted 31/10/16.	14.9	4.8	86.0	55.0	49.5	55.6	5.4	313.2	101.7	14285.0	0.0
20/10/2016	PB4A	Murky. Data downloaded from soil moisture probe 20/10/16. Unable to restart probe. Probe downloaded and restarted 31/10/16.											
20/10/2016	PB4B		15.3	5.4	79.0	51.0	19.5	84.8	8.2	284.3	69.2	15384.0	0.0
20/10/2016	PCc3	Dry											

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19/04/2017	SP1	Dry											
19/04/2017	SP2	Dry											
21/04/2017	PB4A		17.7	4.9	134.0	87.0	3.4	78.5	7.3	325.1	77.9	8620.0	0.0
21/04/2017	PB4B		17.3	5.0	70.0	45.0	0.2	76.3	7.1	333.4	75.9	16666.0	0.0
21/04/2017	PB4C	Orange/Brown	16.5	4.8	77.0	50.0	6.4	50.1	4.8	348.1	85.0	15384.0	0.0
21/04/2017	PB4D		16.7	5.3	49.0	31.0	6.4	60.3	5.7	328.0	58.7	23809.0	0.0
21/04/2017	PCc10A		17.0	5.9	138.0	89.0	4.1	59.6	5.6	320.3	31.2	8547.0	0.0
21/04/2017	PCc10B		16.9	5.5	62.0	40.0	1.9	67.2	6.3	326.2	47.0	18867.0	0.0
21/04/2017	PCc12A	Not enough water for probe											
21/04/2017	PCc12B	Dry											
21/06/2017	PB4A		13.8	4.4	105.0	68.0	4.5	74.3	7.5	394.9	90.3	12048.0	0.0
21/06/2017	PB4B	Brownish	12.8	4.1	109.0	70.0	43.5	75.6	7.8	414.3	103.6	11904.0	0.0
21/06/2017	PB4C	New, 1.8552 top of cap	12.9	3.8	115.0	74.0	6.1	64.7	6.6	441.1	121.0	11235.0	0.0
21/06/2017	PB4D	Not enough water to properly test											
21/06/2017	PCc10A	Not enough water to properly test, 1cm below the line. Brownish											
21/06/2017	PCc10A	Not enough water to properly test, 1cm below the line. Brownish	12.3	4.0	112.0	72.0	115.0	67.3	7.0	420.7	111.5	11764.0	0.0
21/06/2017	PCc10B		12.3	4.7	96.0	62.0	7.7	68.4	7.1	370.8	71.0	13698.0	0.0
21/06/2017	PCc12A		13.3	3.9	145.0	94.0	114.0	69.1	7.0	434.6	117.0	8849.0	0.1
21/06/2017	PCc12B	Dry											
21/06/2017	PCc2	Cloudy White											
21/06/2017	PCc2	Cloudy White	15.2	3.9	98.0	63.0	163.0	94.2	9.1	428.8	117.1	12500.0	0.0
22/06/2017	PCc3	Dry											
22/06/2017	PCc4A		14.1	4.5	101.0	65.0	12.0	72.7	7.2	363.7	85.0	12500.0	0.0
22/06/2017	PCc4B	Not enough water to read											
22/06/2017	PCc4C		13.4	4.3	102.0	66.0	2.3	34.7	3.5	419.9	94.9	12500.0	0.0
22/06/2017	PCc4D	Not enough water to sample. Brown.											
22/06/2017	PCc5A		13.6	5.0	106.0	68.0	12.8	46.6	4.7	345.9	53.9	12048.0	0.0
22/06/2017	PCc5B		13.2	4.7	109.0	70.0	10.5	75.9	7.7	370.3	70.9	11764.0	0.0
22/06/2017	PCc5C		13.3	4.7	97.0	63.0	25.9	75.2	7.7	389.0	73.6	13157.0	0.0
22/06/2017	PCc5D		13.2	4.7	87.0	56.0	13.3	67.9	6.9	375.4	74.8	14705.0	0.0
22/06/2017	PCc6	Dry											
22/06/2017	PCr1A	Dry											
22/06/2017	PCr1B	Not enough for probe											
22/06/2017	PCr1C	Not enough water for probe											
22/06/2017	PCr1D	Dry											
22/06/2017	SP1	Dry											
22/06/2017	SP2	Dry											
12/07/2017	PB4A	Mostly Clear	12.7	5.8	108.0	70.0		76.9	8.0	378.6	22.1	12048.0	0.0
12/07/2017	PB4B	DL Failed on the 12/7/17. Looks liek the probe stopped logging between the 12/7/ - 25/8/17 due to the attempted DL on the 12th. Data block dates on the Odyssey program are 21/4/17 - 25/8/17 from the download on the 24th.	11.7	5.1	100.0	65.0		85.8	9.1	411.1	58.3	13333.0	0.0
12/07/2017	PB4C	Dirty	11.5	4.8	118.0	76.0		61.0	6.5	428.6	71.5	11363.0	0.0
12/07/2017	PCc10A	DL . Orangey-Brown.											
12/07/2017	PCc10A	DL . Orangey-Brown.	11.3	4.5	112.0	72.0		90.6	9.7	467.5	90.9	12048.0	0.0
12/07/2017	PCc10B	Brown											
12/07/2017	PCc10B	Brown	11.7	4.5	93.0	60.0		60.1	6.4	430.1	90.1	14285.0	0.0
12/07/2017	PCc12A	Not enough water to bail											
12/07/2017	PCc2	Dry											
13/07/2017	PCc3	Dry											
13/07/2017	PCc4A	Dry											
13/07/2017	PCc4B	Dry; solinist logger knot undid and lost down piezo											
13/07/2017	PCc4C	Brownish											
13/07/2017	PCc4D	Battery fine, not responding											
13/07/2017	PCc5A	Water is there but not enough for probe/lab											
13/07/2017	PCc5C	Damp; Not enough water for probe											
13/07/2017	PCc6	Dry											
13/07/2017	PCr1A	Dry; Not enough water for probe											
13/07/2017	PCr1B	Not enough water for probe											
13/07/2017	PCr1C	Not enough water for probe											
13/07/2017	PCr1D	Not enough water for probe											
13/07/2017	SP1	Dry											
13/07/2017	SP2	Dry											
24/08/2017	PCc3	Could not DL. Replaced logger											
24/08/2017	PCc4A	Not enough to bail for probe											
24/08/2017	PCc4B	Dry											
24/08/2017	PCc4C	Dry											
24/08/2017	PCc4D	Dry											
24/08/2017	PCc5A	Dry											
24/08/2017	PCc5B		12.7	5.7	165.0	107.0	27.0	78.7	8.0	276.6	56.3	7874.0	0.1
24/08/2017	PCc5C	Dry											
24/08/2017	PCc5D	Not enough water to bail											
24/08/2017	PCc6	Dry											
24/08/2017	PCr1A	Dry											
24/08/2017	PCr1B	Dry											
24/08/2017	PCr1C	Dry											
24/08/2017	PCr1D	Dry											
24/08/2017	SP1	Dry											
24/08/2017	SP2	Dry											
25/08/2017	PB4A	Not sure why dates are missing for 25.8.17 - 18.9.17. New laptop used for the first time in September 2017.	13.5	5.2	89.0	57.0	920.0	70.9	7.1	297.9	88.2	14285.0	0.0
25/08/2017	PB4B		12.6	5.0	163.0	105.0	17.4	69.0	7.1	282.7	99.9	8000.0	0.1
25/08/2017	PB4C	Dry											
25/08/2017	PB4D	Dry											
25/08/2017	PCc10B	Dry											
25/08/2017	PCc12A	Dry											
25/08/2017	PCc12B	Dry											
25/08/2017	PCc2	Dry											
15/09/2017	PCc3	Dry.											
15/09/2017	PCc4A	Dry											
15/09/2017	PCc4B	logger at bottom of well, broken string											
15/09/2017	PCc4C	Dry											
15/09/2017	PCc4D	Dry											
15/09/2017	PCc5A	Dry											
15/09/2017	PCc5B	Not enough water to bail for probe											
15/09/2017	PCc5C	Dry											
15/09/2017	PCc5D	Dry											
15/09/2017	PCc6	Dry											
15/09/2017	PCr1A	Dry											
15/09/2017	PCr1B	Dry											
15/09/2017	PCr1C	Dry											
15/09/2017	PCr1D	Dry											
15/09/2017	SP1	Dry											
15/09/2017	SP2	Dry											

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13/02/2018	PCc3	Dry											
13/02/2018	PCc4A	Dry											
13/02/2018	PCc4B	Dry											
13/02/2018	PCc4C	Dry											
13/02/2018	PCc4D	Dry											
13/02/2018	PCc5A	Dry											
13/02/2018	PCc5B	Dry											
13/02/2018	PCc5C	Dry											
13/02/2018	PCc5D	Dry											
13/02/2018	PCc6	Dry											
13/02/2018	PCr1A	Dry											
13/02/2018	PCr1B	Dry											
13/02/2018	PCr1C	Dry											
13/02/2018	PCr1D	Dry											
13/02/2018	SP1	Dry											
13/02/2018	SP2	Dry											
20/02/2018	PB4A	Dry											
20/02/2018	PB4B	Not enough water for porbe											
20/02/2018	PB4D	Dry											
20/02/2018	PCc10A	Dry; Logger dropped in pipe											
20/02/2018	PCc10B	Dry											
20/02/2018	PCc12A	Dry											
20/02/2018	PCc12B	Dry											
20/02/2018	PCc2	Dry											
9/03/2018	PCc4A	Dry											
9/03/2018	PCc4B	Dry											
9/03/2018	PCc4C	Dry											
9/03/2018	PCc5B	Dry											
9/03/2018	PCc5C	Dry											
9/03/2018	PCc5D	Dry											
9/03/2018	PCc6	Dry											
9/03/2018	PCr1A	Dry											
9/03/2018	PCr1C	Dry											
9/03/2018	PCr1D	Dry											
9/03/2018	SP1	Dry											
9/03/2018	SP2	Dry											
12/03/2018	PB4A	Dry											
12/03/2018	PB4B	Not enough water for probe											
12/03/2018	PB4C	Dry											
12/03/2018	PB4D	battery ok, logger downloaded											
12/03/2018	PCc10B	Dry											
12/03/2018	PCc12A	Dry											
12/03/2018	PCc12B	Dry											
17/03/2018	PCc2	Dry											
9/05/2018	PCc3	Dry											
15/05/2018	PCc4B	Dry											
15/05/2018	PCc5A	Dry											
15/05/2018	PCc5B	Forgot bucket so put probe down piezo to get reading then bailed dry to remove any potential contamination from probe. Clear water with white suspension.											
15/05/2018	PCc5B	Forgot bucket so put probe down piezo to get reading then bailed dry to remove any potential contamination from probe. Clear water with white suspension.	15.5	5.1	151.0	98.0	17.6	100.2	9.7	325.2	92.7	8064.0	0.1
15/05/2018	PCc5C	Dry											
15/05/2018	PCc5D	Dry											
15/05/2018	PCr1A	Dry											
15/05/2018	PCr1B	Dry											
15/05/2018	PCr1C	Dry											
15/05/2018	PCr1D	Dry											
16/05/2018	PB4A	Replaced battery, new battery is 6.9 V	16.1	4.6	140.0	91.0	11.8	69.1	6.6	339.5	122.1	8547.0	0.0
16/05/2018	PB4B		15.5	4.7	190.0	123.0	1.3	72.4	7.0	309.6	114.1	6410.0	0.1
16/05/2018	PB4C	Dry											
16/05/2018	PB4D	logger started successfully, data values did not filuctuate much - concerned about the reliability of the data											
16/05/2018	PCc12A	Dry											
16/05/2018	PCc12B	Dry											
16/05/2018	PCc4A	Dry											
16/05/2018	PCc4C	Dry											
16/05/2018	PCc4D	Dry											
16/05/2018	PCc6	Dry											
16/05/2018	SP1	Dry											
16/05/2018	SP2	Dry											
17/05/2018	PCc10A	Dry											
17/05/2018	PCc10B	Dry											
22/05/2018	PCc3	Dry											
22/06/2018	PCc2	Dry											
22/06/2018	PCc3	Dry											
22/06/2018	PCc4A	Dry											
22/06/2018	PCc4B	Dry											
22/06/2018	PCc4D	Dry											
22/06/2018	PCc5B		14.0	4.9	136.0	88.0	216.0	90.7	9.1	259.7	85.9	9259.0	0.0
22/06/2018	PCc5C	Dry											
22/06/2018	PCc5D	Battery replaced											
22/06/2018	PCc6	Dry											
22/06/2018	PCr1A	Dry											
22/06/2018	PCr1B	Dry											
22/06/2018	PCr1D	Dry											
22/06/2018	SP1	Dry											
22/06/2018	SP2	Dry											
25/06/2018	PB4A	water looks milky white	14.3	4.1	139.0	90.0	231.0	62.7	6.2	370.5	132.6	9009.0	0.0
25/06/2018	PB4B	Little brown, mostly clear	13.2	3.8	192.0	124.0	96.2	68.7	7.0	364.0	148.4	6711.0	0.1
25/06/2018	PB4C	Dry											
25/06/2018	PB4D	Dry											
25/06/2018	PCc10A	Not enough to bail											
25/06/2018	PCc10A	Not enough to bail											
25/06/2018	PCc10B	Dry											
25/06/2018	PCc12A	Dry											
25/06/2018	PCc12B	Dry											
27/06/2018	PCc5A	Dry											
27/06/2018	PCr1C	Dry											
16/07/2018	PCc3	Dry											
16/07/2018	PCc4A	Dry											
16/07/2018	PCc4B	dry											
16/07/2018	PCc4C	Dry											

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21/11/2018	PCr1B	DL successfully but "data is empty" window shows up											
21/11/2018	PCr1C	Dry											
21/11/2018	PCr1D	Dry											
21/11/2018	SP1	Dry											
21/11/2018	SP2	Dry											
4/12/2018	PB4A		16.0	5.6	175.0	113.0	-5.9	95.2	9.0	376.7	43.1	6896.0	0.1
4/12/2018	PB4B	Couldnt restart logger so replaced battery then re-sarted successfully. Logger stopped recording on 6/11/18, and all the data looks abnormal. Water% is -2000 at all 5 sensors. Clear - brown.	15.9	5.4	134.0	87.0	52.6	77.2	7.3	376.5	53.7	9009.0	0.0
4/12/2018	PB4C	Dry											
4/12/2018	PB4D	logger stopped on 6/11/2018, All the water% values are negative (e.g - 2000)											
4/12/2018	PCc10A	Not enough water to sample. Clear brown.											
4/12/2018	PCc10A	Not enough water to sample. Clear brown.	15.6	5.2	174.0	113.0	12.6	95.8	9.2	403.9	65.7	6993.0	0.1
4/12/2018	PCc10B	Old battery 1.8V, new battery 6.7V; couldnt connect to logger, then replaced battery. Logger stopped recording on 11/11/18											
4/12/2018	PCc10B	Old battery 1.8V, new battery 6.7V; couldnt connect to logger, then replaced battery. Logger stopped recording on 11/11/18	16.9	5.4	153.0	99.0	0.6	100.7	9.4	359.6	56.7	7692.0	0.1
4/12/2018	PCc12A	Not enough water to sample. Cloudy Grey.											
4/12/2018	PCc12A	Not enough water to sample. Cloudy Grey.	17.8	5.7	148.0	96.0	185.0	89.9	8.2	324.3	40.0	7812.0	0.1
4/12/2018	PCc12B	Dry											
4/12/2018	PCc2	Not enough water to sample											
4/12/2018	PCc2	Not enough water to sample	16.0	5.2	154.0	100.0	45.1	97.7	9.2	381.7	68.5	7812.0	0.1
12/12/2018	PCc4A	Not enough to bail											
12/12/2018	PCc4B	Dry											
12/12/2018	PCc4C	Dry											
12/12/2018	PCc4D	Dry											
12/12/2018	PCc5A	Dry											
12/12/2018	PCc5B		17.4	5.3	147.0	95.0	0.3	60.1	5.6	330.4	59.1	7936.0	0.1
12/12/2018	PCc5C	Dry											
12/12/2018	PCc5D		16.9	5.2	106.0	68.0	-1.2	101.3	9.4	359.8	68.7	11111.0	0.0
12/12/2018	PCc6	Dry											
12/12/2018	PCr1A	Dry											
12/12/2018	PCr1B	Dry											
12/12/2018	PCr1C	Dry											
12/12/2018	PCr1D	Dry											
12/12/2018	SP1	Dry											
12/12/2018	SP2	Dry											
13/12/2018	PB4A	Download corrupted on first attempt	16.7	4.4	162.0	105.0	0.4	86.2	7.9	375.0	112.0	7299.0	0.1
13/12/2018	PB4B		18.3	4.2	209.0	135.0	9.4	42.7	3.8	370.6	126.1	5494.0	0.1
13/12/2018	PB4C		16.5	3.4	420.0	273.0	5.8	80.1	7.4	478.0	164.6	2840.0	0.1
13/12/2018	PB4D	Dry											
13/12/2018	PCc10A	Light Brown											
13/12/2018	PCc10A	Light Brown	17.0	3.9	244.0	158.0	178.0	88.6	8.1	421.7	137.8	4830.0	0.1
13/12/2018	PCc10B		17.2	4.7	187.0	121.0	24.3	81.3	7.4	333.9	94.6	6289.0	0.1
13/12/2018	PCc12A	Dry											
13/12/2018	PCc12B	Dry											
17/01/2019	PCc3	Dry											
17/01/2019	PCc4A	Turbidity clear and read - 0.0, but sheet says turbidity probe is faulty.											
17/01/2019	PCc4A	Turbidity clear and read - 0.0, but sheet says turbidity probe is faulty.	21.0	4.2	173.0	112.0	0.0	79.0	6.7	349.8	135.4	6250.0	0.1
17/01/2019	PCc4B	Dry											
17/01/2019	PCc4C	Dry											
17/01/2019	PCc4D	Dry											
17/01/2019	PCc5A	Dry											
17/01/2019	PCc5B	Turbidity clear and read - 0.0, but sheet says turbidity probe is faulty.											
17/01/2019	PCc5B	Turbidity clear and read - 0.0, but sheet says turbidity probe is faulty.	20.2	4.0	140.0	91.0	0.0	41.5	3.6	235.2	146.1	7812.0	0.0
17/01/2019	PCc5C	Dry											
17/01/2019	PCc5D	Turbidity clear and read - 0.0, but sheet says turbidity probe is faulty.											
17/01/2019	PCc5D	Turbidity clear and read - 0.0, but sheet says turbidity probe is faulty.	21.7	3.9	134.0	87.0	0.0	35.2	3.0	324.9	153.1	7936.0	0.0
17/01/2019	PCr1A	Dry											
17/01/2019	PCr1B	Dry											
17/01/2019	PCr1C	Dry											
17/01/2019	PCr1D	Dry											
17/01/2019	SP2	Dry											
22/01/2019	PB4A	All the value of water% was negative	20.5	4.2	142.0	92.0	0.0	73.2	6.3	342.3	133.2	7692.0	0.1
22/01/2019	PB4B	Turbidity clear and read - 0.0, but sheet says turbidity probe is faulty.	21.6	3.9	202.0	131.0	0.0	31.7	2.7	333.8	153.5	5291.0	0.1
22/01/2019	PB4C	Not enough water											
22/01/2019	PB4D	Dry											
22/01/2019	PCc10A	Dry											
22/01/2019	PCc10B	Not enough water											
22/01/2019	PCc12A	Dry											
22/01/2019	PCc12B	Dry											
22/01/2019	PCc2	Dry											
22/01/2019	PCc6	Dry											
22/01/2019	SP1	Dry											
22/02/2019	PCc5A	Dry											
22/02/2019	PCc5B	Not enough water to test											
22/02/2019	PCr1A	Dry											
22/02/2019	PCr1B	Dry											
22/02/2019	PCr1B	Dry											
22/02/2019	PCr1C	Dry											
22/02/2019	PCr1D	Dry											
25/02/2019	PCc3	Dry											
25/02/2019	PCc4A	Dry											
25/02/2019	PCc4B	Dry											
25/02/2019	PCc4C	Dry											
25/02/2019	PCc4D	Dry											
25/02/2019	PCc5C	Dry											
25/02/2019	PCc5D	Dry											
25/02/2019	PCc6	Dry											
25/02/2019	SP1	Dry											
25/02/2019	SP2	Dry											
26/02/2019	PB4A		19.7	3.6	156.0	101.0	9.9	35.0	3.1	312.0	160.3	7092.0	0.1
26/02/2019	PB4B		18.5	4.1	260.0	169.0	0.0	51.9	4.7	223.6	131.0	4385.0	0.1
26/02/2019	PB4C	Dry											
26/02/2019	PCc10A	Dry											
26/02/2019	PCc10B	Dry											

26/02/2019	PCc12A	Replaced battery											
26/02/2019	PCc12B	Dry											
26/02/2019	PCc2	Dry											
12/03/2019	PCc3	Dry											
12/03/2019	PCc4A	Dry; found knot in string but the logger can reach bottom of pipe.											
12/03/2019	PCc4C	Dry											
12/03/2019	PCc4D	Dry											
12/03/2019	PCc5A	Dry											
12/03/2019	PCc5B	Dry											
12/03/2019	PCc5C	Dry											
12/03/2019	PCc5C	Dry											
12/03/2019	PCc5D	Dry											
12/03/2019	PCc6	Dry											
12/03/2019	PCr1A	Dry											
12/03/2019	PCr1B	Dry											
12/03/2019	PCr1C	Dry											
12/03/2019	PCr1D	Dry											
12/03/2019	SP1	Dry											
12/03/2019	SP2	Dry											
13/03/2019	PB4A	Not enough water to sample. Milky Brown.	18.4	3.9	164.0	106.0	0.0	33.4	3.0	249.6	141.3	6944.0	0.1
13/03/2019	PB4B	0.6V, couldnt download											
13/03/2019	PB4C	Dry											
13/03/2019	PB4D	Dry; CC: "Corrupted data". DC: Not sure where the data corrupted comment is sourced from.											
13/03/2019	PCc10A	Dry											
13/03/2019	PCc10B	Dry											
13/03/2019	PCc12A	Dry											
13/03/2019	PCc12B	Dry											
13/03/2019	PCc2	Dry											
11/04/2019	PB4A	0.0? Couldnt DL; logger not responding	17.4	3.7	129.0	83.0		50.7	4.7	357.2	156.1	9009.0	0.0
11/04/2019	PB4B	0.2V; couldnt download, logger not responding. Condensation in logger	17.0	3.5	177.0	115.0		72.9	6.8	331.8	171.5	6666.0	0.1
11/04/2019	PB4C		16.9	3.4	213.0	138.0		30.1	2.8	420.2	176.2	5555.0	0.1
11/04/2019	PB4D	Not enough water to test; Readings are 0 on level loader, real time data seems fine											
11/04/2019	PCc10A	Not enough water to test											
11/04/2019	PCc10B	Strange data. All the water% values are more than 100 @ all sensors											
11/04/2019	PCc10B	Strange data. All the water% values are more than 100 @ all sensors	16.5	3.8	109.0	70.0		28.2	2.7	304.8	154.1	10869.0	0.0
11/04/2019	PCc12A	1.5V, no battery to replace. Couldnt DL, logger didnt respond. Yellow brown.											
11/04/2019	PCc12A	1.5V, no battery to replace. Couldnt DL, logger didnt respond. Yellow brown.	17.1	4.5	229.0	148.0		42.5	4.0	193.0	111.2	5128.0	0.1
11/04/2019	PCc12B	Dry											
11/04/2019	PCc2		18.4	3.5	153.0	99.0		60.8	5.5	225.2	169.1	7462.0	0.1
12/04/2019	PCc3	Dry											
12/04/2019	PCc4A	Dipper not responding	18.0	3.9	119.0	77.0		54.3	5.0	326.6	148.3	9708.0	0.0
12/04/2019	PCc4B	Dipper not responding	18.1	3.8	123.0	79.0	0.0	83.3	7.6	333.0	152.5	9345.0	0.0
12/04/2019	PCc4C	Dipper not responding	17.6	3.8	142.0	92.0	0.0	35.0	3.2	320.1	154.2	8196.0	0.1
12/04/2019	PCc4D	Not enough water to bail											
12/04/2019	PCc5A	pH outside range specified on field sheet											
12/04/2019	PCc5A	pH outside range specified on field sheet	18.3	4.3	142.0	92.0		62.0	5.7	341.2	128.1	8064.0	0.1
12/04/2019	PCc5B		18.7	3.7	136.0	88.0		60.4	5.5	330.1	158.6	8333.0	0.0
12/04/2019	PCc5C	Dipper not responding	18.5	4.1	107.0	69.0		43.7	4.0	330.8	135.5	10638.0	0.0
12/04/2019	PCc5D	pH outside range specified on field sheet											
12/04/2019	PCc5D	pH outside range specified on field sheet	18.1	3.9	117.0	76.0	0.0	69.7	6.4	337.1	146.8	9803.0	0.0
12/04/2019	PCc6	Dry											
12/04/2019	PCr1A	Dry											
12/04/2019	PCr1B	Dry											
12/04/2019	PCr1C	Dry											
12/04/2019	PCr1D	Dry											
12/04/2019	SP1	Dry											
12/04/2019	SP2	Dry											
1/05/2019	PCc3	Dry											
1/05/2019	PCc4A		17.5	3.6	134.0	87.0		44.8	4.1	300.0	156.1	8695.0	0.0
1/05/2019	PCc4B	Not enough water											
1/05/2019	PCc4C		17.0	3.5	180.0	117.0	0.0	30.5	2.8	301.9	160.4	6535.0	0.1
1/05/2019	PCc4D	Dry											
1/05/2019	PCc5A	Not enough water											
1/05/2019	PCc5B		16.3	3.6	165.0	107.0		49.4	4.7	307.9	150.2	7246.0	0.1
1/05/2019	PCc5C	Dry											
1/05/2019	PCc5D		16.4	3.7	136.0	88.0		46.5	4.4	300.1	147.0	8771.0	0.0
1/05/2019	PCc6	Dry											
1/05/2019	PCr1A	Dry											
1/05/2019	PCr1B	Dry											
1/05/2019	PCr1C	Dry											
1/05/2019	PCr1D	Dry											
1/05/2019	SP1	Dry											
1/05/2019	SP2	Dry											
2/05/2019	PB4A	battery was dead- could not download, replaced battery - new voltage 7.33	16.6	3.7	136.0	88.0	0.0	28.4	2.7	339.8	146.7	8695.0	0.0
2/05/2019	PB4B		16.9	3.7	175.0	113.0	0.0	67.5	6.3	297.5	148.4	6756.0	0.1
2/05/2019	PB4C	Not enough water											
2/05/2019	PCc10A	Not enough water											
2/05/2019	PCc10B	Not enough water											
2/05/2019	PCc12A	Dry											
2/05/2019	PCc12B	Dry											
2/05/2019	PCc2	Dry											
14/06/2019	PCr1A	Dry											
14/06/2019	PCr1B	Could not start: No communication port available											
14/06/2019	PCr1C	Dry											
14/06/2019	PCr1D	Dry; Logger string too long											
18/06/2019	PCc3	Dry											
18/06/2019	PCc4A	Not enough to bail											
18/06/2019	PCc4B	Dry											
18/06/2019	PCc4C	not enough to bail											
18/06/2019	PCc4D	Dry											
18/06/2019	PCc5B		14.1	4.9	205.0	133.0	13.5	50.1	5.0	166.2	95.9	6134.0	0.1
18/06/2019	PCc5C	Dry											
18/06/2019	PCc5D	Dry											
18/06/2019	PCc6	Dry											
18/06/2019	SP1	Dry											
18/06/2019	SP2	Dry											
19/06/2019	PB4A	everything ok	13.8	4.9	166.0	107.0	27.3	52.9	5.3	133.9	94.3	7633.0	0.1
19/06/2019	PB4B	Black.	13.3	4.6	193.0	125.0	127.0	74.3	7.5	178.3	116.4	6666.0	0.1

19/06/2019	PB4C	Insufficient to sample											
19/06/2019	PB4D	Dry; Data corrupted											
19/06/2019	PCc10A	Dry - Insufficient water											
19/06/2019	PCc10B	Dry											
19/06/2019	PCc12A	Dry (muddy)											
19/06/2019	PCc12B	Dry											
19/06/2019	PCc2	Dry											
16/07/2019	PCc3	Dry											
16/07/2019	PCc4A		16.3	4.4	183.0	118.0	227.0	87.3	8.2	193.0	100.2	6535.0	0.1
16/07/2019	PCc4B	Dry											
16/07/2019	PCc4C	not enough to bail											
16/07/2019	PCc4D	Dry											
16/07/2019	PCc5A	Not enough to bail											
16/07/2019	PCc5B		13.2	4.6	201.0	130.0	5.6	43.2	4.4	214.9	87.3	6410.0	0.1
16/07/2019	PCc5C	Dry											
16/07/2019	PCc5D	Not enough to bail											
16/07/2019	PCc6	Dry											
16/07/2019	PCr1A	Dry											
16/07/2019	PCr1B	Dry											
16/07/2019	PCr1C	Dry											
16/07/2019	PCr1D	Dry											
16/07/2019	SP1	Dry											
16/07/2019	SP2	Dry											
17/07/2019	PB4A	d/I was successfu, but only had 3 data on the data sheet on 13/03/2019	13.7	4.6	175.0	113.0	10.0	59.2	5.9	220.8	88.5	7246.0	0.1
17/07/2019	PB4B	Couldnt download due to flat battery. Replaced battery (7.33V).	12.8	4.5	227.0	147.0	37.7	78.5	8.0	210.7	91.7	5747.0	0.1
17/07/2019	PB4C	Dry											
17/07/2019	PCc10A	Not enough water											
17/07/2019	PCc10B	Dry											
17/07/2019	PCc12A	Replaced battery, old batt was 0.68V, new batt was 7.33V											
17/07/2019	PCc12B	Dry											
17/07/2019	PCc2	Not enough water											
13/08/2019	PCc3	Dry											
13/08/2019	PCc4A	Dry											
13/08/2019	PCc4B	Dry											
13/08/2019	PCc4C	Dry											
13/08/2019	PCc4D	Dry											
13/08/2019	PCc5A	Dry											
13/08/2019	PCc5B		14.6	4.9	178.0	115.0	0.0	44.6	4.4	165.6	82.5	6993.0	0.1
13/08/2019	PCc5C	Dry											
13/08/2019	PCc5D	Dry											
13/08/2019	PCc6	Dry											
13/08/2019	PCr1A	Dry											
13/08/2019	PCr1B	Dry											
13/08/2019	PCr1C	Dry											
13/08/2019	PCr1D	Dry											
13/08/2019	SP1	Dry											
13/08/2019	SP2	Dry											
14/08/2019	PB4A	sensors 3 to 5, some raw value readings were 0. water % fluctuates from 600 to 8000	14.5	4.9	170.0	110.0	12.4	35.8	3.5	175.9	82.5	7352.0	0.1
14/08/2019	PB4B	all data "0"	13.0	4.7	179.0	116.0	104.0	67.3	6.9	144.7	94.6	7246.0	0.1
14/08/2019	PB4C	Dry											
14/08/2019	PB4D	Dry & Data corruption error											
14/08/2019	PCc10A	Dry											
14/08/2019	PCc10B	Dry											
14/08/2019	PCc12A	Dry											
14/08/2019	PCc12B	Dry											
14/08/2019	PCc2	Dry											
10/09/2019	PCr1A	Dry											
16/09/2019	PCc3	Dry											
16/09/2019	PCc4A	Dry											
16/09/2019	PCc4B	Dry											
16/09/2019	PCc4C	Dry											
16/09/2019	PCc4D	Dry											
16/09/2019	PCc5A	Dry											
16/09/2019	PCc5C	Dry											
16/09/2019	PCc5D	Dry											
16/09/2019	PCc6	Dry											
16/09/2019	PCr1B	Dry											
16/09/2019	PCr1C	Dry											
16/09/2019	PCr1D	Dry											
16/09/2019	SP1	Dry											
16/09/2019	SP2	Dry											
25/09/2019	PB4A	all readings are ok	14.1	5.2	151.0	98.0	6.3	50.9	5.1	373.9	73.7	8333.0	0.1
25/09/2019	PB4B	all readings "0"	13.8	4.9	159.0	103.0	5.8	66.8	6.7	356.6	89.8	8000.0	0.1
25/09/2019	PB4C		13.1	4.6	216.0	140.0	5.9	44.6	4.6	394.8	101.3	5988.0	0.1
25/09/2019	PB4D	Quick DL only took 1 sec	14.0	4.8	157.0	102.0	8.6	77.5	7.8	400.5	94.4	8064.0	0.1
25/09/2019	PCc10A		13.4	4.7	220.0	143.0	7.0	78.5	8.0	375.5	98.3	5813.0	0.1
25/09/2019	PCc10B		13.5	5.3	102.0	66.0	9.4	75.6	7.7	300.4	67.6	12500.0	0.0
25/09/2019	PCc12A	A little bit murky brown.											
25/09/2019	PCc12A	A little bit murky brown.	14.0	5.0	144.0	93.0	18.5	82.7	8.2	287.1	82.2	8771.0	0.1
25/09/2019	PCc12B	Dry											
25/09/2019	PCc2		14.5	4.8	142.0	92.0	11.6	82.0	8.1	405.7	91.0	8771.0	0.1
22/10/2019	PCc3	Dry											
22/10/2019	PCc4A	Insufficient to sample											
22/10/2019	PCc4B	Dry											
22/10/2019	PCc4C	Dry											
22/10/2019	PCc4D	Dry											
22/10/2019	PCc5A	Dry											
22/10/2019	PCc5B	Grey											
22/10/2019	PCc5B	Grey	15.0	5.0	175.0	113.0	34.6	42.5	4.2	130.9	88.1	7042.0	0.1
22/10/2019	PCc5C	Dry											
22/10/2019	PCc5D	Insufficient to sample; Ants in OSP											
22/10/2019	PCc6	Dry											
22/10/2019	PCr1A	Dry											
22/10/2019	PCr1B	Dry											
22/10/2019	PCr1C	Dry											
22/10/2019	PCr1D	Dry											
22/10/2019	SP1	Dry											
22/10/2019	SP2	Dry											
23/10/2019	PB4A	Higher than Max EC	15.6	5.4	147.0	95.0	6.8	54.6	5.3	126.7	61.4	8264.0	0.1
23/10/2019	PB4B	Water is black. Changed battery. Old battery was 0.95V and new battery was 7.33V	17.2	4.7	158.0	102.0	184.0	68.1	6.3	224.5	104.3	7407.0	0.1
23/10/2019	PB4C	Insufficient											
23/10/2019	PB4D	all sensor readings are fine											

23/10/2019	PCc10A	Insufficient to sample											
23/10/2019	PCc10B	Insufficient to sample											
23/10/2019	PCc12A	Dry											
23/10/2019	PCc12B	Dry											
23/10/2019	PCc2	Insufficient											
25/11/2019	PB4A	Dry											
25/11/2019	PCc4A	Dry											
25/11/2019	PCc4B	Dry											
25/11/2019	PCc4C	Dry											
25/11/2019	PCc4D	Dry											
25/11/2019	PCc5A	Dry											
25/11/2019	PCc5B	Dry											
25/11/2019	PCc5C	Dry											
25/11/2019	PCc5D	Dry											
25/11/2019	PCr1A	Dry											
25/11/2019	PCr1B	Dry											
25/11/2019	PCr1C	Dry											
25/11/2019	PCr1D	Dry											
25/11/2019	SP2	Dry											
26/11/2019	PB4B	all readings "0"											
26/11/2019	PB4C	Dry											
26/11/2019	PB4D	Dry											
26/11/2019	PCc10A	Dry											
26/11/2019	PCc10B	Dry											
26/11/2019	PCc12A	Replaced battery. Old battery was 2.25V and new battery was 7.34V											
26/11/2019	PCc12B	Dry											
26/11/2019	PCc2	Dry											
26/11/2019	PCc6	Dry											
26/11/2019	SP1	Dry											
11/12/2019	PB4A	Not enough water to sample with probe											
11/12/2019	PB4B	Not enough water for probe. New TD of 2.324 recorded.											
11/12/2019	PB4C	Dry											
11/12/2019	PB4D	Dry											
11/12/2019	PCc10A	Dry											
11/12/2019	PCc10B	Dry											
11/12/2019	PCc12A	Dry											
11/12/2019	PCc12B	Dry											
11/12/2019	PCc2	Dry											
12/12/2019	PCc4A	Dry											
12/12/2019	PCc4B	Dry											
12/12/2019	PCc4D	Dry											
12/12/2019	PCc5A	Dry											
12/12/2019	PCc5B	Dry											
12/12/2019	PCc5C	Dry											
12/12/2019	PCc5D	Dry											
12/12/2019	PCc6	Dry											
12/12/2019	PCr1A	Dry											
12/12/2019	PCr1B	Dry											
12/12/2019	PCr1C	Dry											
12/12/2019	PCr1D	Dry											
12/12/2019	SP1	Dry											
12/12/2019	SP2	Dry											
22/01/2020	PCc3	Dry. New total depth of 2.387 measured..											
22/01/2020	PCc4A	New total depth of 2.989 measured.											
22/01/2020	PCc4B	All sensors from 2 to 5 reading zero											
22/01/2020	PCc4C	All sensors from 2 to 5 reading zero											
22/01/2020	PCc4D	Dry. New total depth of 2.524 measured.											
22/01/2020	PCc5A	All Sensor from 2 to 5 reading zero											
22/01/2020	PCc5B	Dry. New totaly depth of 2.615 measured.											
22/01/2020	PCc5C	Dry. New total depth of 2.304 measured.											
22/01/2020	PCc5D	Dry. New total depth of 2.931 measured.											
22/01/2020	PCc6	Dry											
22/01/2020	PCr1A	Dry. New total depth measured: 2.195											
22/01/2020	PCr1B	Dry. New total depth measured.											
22/01/2020	PCr1C	All sensor reading zero											
22/01/2020	PCr1D	Dry. New total depth measured.											
22/01/2020	SP2	New total depth of 2.690 measured.											
24/01/2020	PB4A	could not bring laptop into site due to heavy rain											
24/01/2020	PB4B	laptop not available to use due to heavy rain											
24/01/2020	PB4C	New total depth of 1.581											
24/01/2020	PB4D	laptop not available to use due to heavy rain											
24/01/2020	PCc10A	Laptop not available to use due to heavy rain											
24/01/2020	PCc10B	laptop not available to use due to heavy rain											
24/01/2020	PCc12A	Dry											
24/01/2020	PCc12B	All sensors form 3 to 5 reading zero											
24/01/2020	SP1	Dry											
24/02/2020	PCc4C	clear											
24/02/2020	PCc4C	clear											
24/02/2020	PCc4C	clear	18.3	5.4	130.0	84.0	0.0	61.7	5.6	253.2	37.6	8771.0	0.0
24/02/2020	PCc5A	All sensors from 2 to 5 reading zero											
24/02/2020	PCc5A	All sensors from 2 to 5 reading zero	19.1	5.0	123.0	79.0	0.0	45.4	4.1	261.7	59.0	9090.0	0.0
24/02/2020	PCc5B		19.4	5.0	181.0	117.0	0.0	46.7	4.2	89.9	61.9	6172.0	0.1
24/02/2020	PCc5C	Turbidity read 14 but water looks clear.											
24/02/2020	PCc5C	Turbidity read 14 but water looks clear.	21.7	5.2	121.0	78.0	14.3	51.1	4.3	253.5	48.4	8771.0	0.0
24/02/2020	PCc5D	Battery Changed new vltage 7.23 V, All sensors reading zero											
24/02/2020	PCc5D	Battery Changed new vltage 7.23 V, All sensors reading zero	19.9	5.0	139.0	90.0	7.4	81.7	7.2	250.1	58.2	7936.0	0.0
24/02/2020	PCr1A	Dry. New total depth of 2.146 recorded.											
24/02/2020	PCr1B	All sensors reading zero											
24/02/2020	PCr1B	All sensors reading zero	18.9	5.2	152.0	98.0	0.0	45.5	4.1	120.3	47.6	7407.0	0.1
24/02/2020	PCr1C	There is no data in the logger, download will be abandoned											
24/02/2020	PCr1C	There is no data in the logger, download will be abandoned	18.5	4.7	141.0	91.0	0.0	34.3	3.1	252.6	75.8	8064.0	0.0
24/02/2020	PCr1D	Dry											
24/02/2020	SP1	dry new depth 1.935											
25/02/2020	PB4A	Most reading in leveloder are zero	18.6	5.1	172.0	111.0	0.0	91.2	8.2	233.4	56.0	6622.0	0.1
25/02/2020	PB4A	Most reading in leveloder are zero											
25/02/2020	PB4B	Battery replaced	19.8	4.8	165.0	107.0	103.0	67.1	5.9	248.0	74.0	6711.0	0.1
25/02/2020	PB4C		18.8	4.6	181.0	117.0	0.0	55.9	5.0	329.6	82.7	6250.0	0.1
25/02/2020	PB4D		19.0	4.7	129.0	83.0	0.0	42.5	3.8	314.4	75.3	8695.0	0.0
25/02/2020	PCc10A	Insufficient Water To Sample											
25/02/2020	PCc10B	Readings on sensor 5 is zero											
25/02/2020	PCc10B	Readings on sensor 5 is zero	18.9	5.0	117.0	76.0	1.7	40.2	3.6	242.4	58.6	9615.0	0.0

25/02/2020	PCc12A	Block already downloaded, sensor 2 to 5 reading mostly zeros	20.6	4.9	201.0	130.0	439.0	61.8	5.3	244.8	67.7	5405.0	0.1
25/02/2020	PCc12A	Block already downloaded, sensor 2 to 5 reading mostly zeros											
25/02/2020	PCc12B	Dark Brown											
25/02/2020	PCc2	milky											
25/02/2020	PCc2	milky	19.3	4.5	250.0	162.0	96.1	62.0	5.5	286.7	86.0	4484.0	0.1
25/02/2020	PCc3	Dry											
25/02/2020	PCc4A	clear											
25/02/2020	PCc4A	clear											
25/02/2020	PCc4A	clear	18.7	4.8	183.0	118.0	0.0	94.1	8.4	195.4	71.9	6211.0	0.1
25/02/2020	PCc4B	All sensors form 2 to 5 reading zero	18.9	4.9	110.0	71.0	0.0	81.8	7.3	244.3	65.5	10204.0	0.0
25/02/2020	PCc4D	Black											
25/02/2020	PCc4D	Black	18.0	4.6	307.0	199.0	68.3	54.4	4.9	291.3	83.6	3759.0	0.1
25/02/2020	PCc6	Too dry to sample. Insufficient water											
25/02/2020	SP2	Dry											
17/03/2020	PCc5A	murky brown.											
17/03/2020	PCc5A	murky brown.	17.5	5.0	129.0	83.0	18.5	37.0	3.5	102.5	90.1	9009.0	0.0
17/03/2020	PCc5B	Grey											
17/03/2020	PCc5B	Grey	17.0	4.8	181.0	117.0	73.6	57.0	5.4	27.4	101.0	6493.0	0.1
17/03/2020	PCc5C	Light Brown											
17/03/2020	PCc5C	Light Brown	17.7	5.0	125.0	81.0	4.5	31.0	2.9	154.0	90.2	9259.0	0.0
17/03/2020	PCc5D	Grey											
17/03/2020	PCc5D	Grey	16.8	4.9	135.0	87.0	52.6	41.8	4.0	124.9	92.7	8771.0	0.0
17/03/2020	PCc6	Dry.											
17/03/2020	PCr1A	Dry. New total depth of 2.166 recorded.											
17/03/2020	PCr1B	No data in logger, data download abandoned. Battery changed and old voltage not recorded											
17/03/2020	PCr1B	No data in logger, data download abandoned. Battery changed and old voltage not recorded	16.9	5.1	163.0	105.0	14.1	65.3	6.1	27.1	83.8	7246.0	0.1
17/03/2020	PCr1C	All sensor reading zero											
17/03/2020	PCr1D	Dry											
17/03/2020	SP1	dry											
17/03/2020	SP1	dry											
18/03/2020	PB4A	no data, battery dead	17.8	5.0	128.0	83.0	67.3	70.8	6.5	176.3	89.7	9009.0	0.0
18/03/2020	PB4B	error to restart the logger	18.5	4.7	133.0	86.0	79.5	80.5	7.3	228.6	107.1	8547.0	0.0
18/03/2020	PB4C		17.3	4.4	190.0	123.0	29.0	68.5	6.4	307.6	122.8	6172.0	0.1
18/03/2020	PB4D	Brown	17.7	4.6	119.0	77.0	43.6	43.2	4.0	267.3	110.4	9708.0	0.0
18/03/2020	PCc10A	fluctuations in data for sensor 1, rest all sensors reading zero											
18/03/2020	PCc10B	fluctuations in sensor 4 and 5 data											
18/03/2020	PCc10B	fluctuations in sensor 4 and 5 data	17.1	4.7	120.0	78.0	36.3	36.2	3.4	175.0	104.3	9803.0	0.0
18/03/2020	PCc12A	Beige											
18/03/2020	PCc12A	Beige	17.4	4.5	210.0	136.0	168.0	46.1	4.3	212.6	115.9	5555.0	0.1
18/03/2020	PCc12B	data fluctuatons in sensor 4 data, rest all sensor reading zero											
18/03/2020	PCc2	Dry - Insufficient to sample.											
18/03/2020	PCc3	Dry											
18/03/2020	PCc4A	clear											
18/03/2020	PCc4A	clear											
18/03/2020	PCc4A	clear	16.9	5.1	147.0	95.0	0.0	52.3	4.9	113.3	83.1	8000.0	0.1
18/03/2020	PCc4B	fluctuations in senor 1 data , rest all sensors reading zero											
18/03/2020	PCc4B	fluctuations in senor 1 data , rest all sensors reading zero	17.7	4.5	170.0	110.0	65.4	68.0	6.3	187.3	117.4	6802.0	0.1
18/03/2020	PCc4C	clear											
18/03/2020	PCc4C	clear	16.7	4.6	150.0	97.0	0.0	41.2	3.9	91.4	108.2	7874.0	0.1
18/03/2020	PCc4C	clear											
18/03/2020	PCc4D	Insufficient water to sample											
18/03/2020	SP2	Dry. New dry depth: 2.68											
20/04/2020	PCc5A	Fluctuations in sensor 1 data, rest all sensors reading zero											
20/04/2020	PCc5A	Fluctuations in sensor 1 data, rest all sensors reading zero	16.4	4.9	170.0	110.0	208.0	58.5	5.5	264.6	102.0	7042.0	0.1
20/04/2020	PCc5B	not enough water to test, clear											
20/04/2020	PCc5B	not enough water to test, clear	15.5	5.0	185.0	120.0	1.9	66.3	6.4	298.8	93.7	6578.0	0.1
20/04/2020	PCc5C	dry											
20/04/2020	PCc5D	black											
20/04/2020	PCc5D	black	15.5	5.2	128.0	83.0	182.0	53.7	5.2	296.9	81.1	9523.0	0.0
20/04/2020	PCc6	dry, new depth 2.460											
20/04/2020	PCr1A	dry, new depth 2.191											
20/04/2020	PCr1B	No data in logger memory, download will be abandoned											
20/04/2020	PCr1C	All sensors reading zero											
20/04/2020	PCr1D	dry, new depth 1.742											
20/04/2020	SP1	dry											
21/04/2020	PCc12A	not enough to sample											
21/04/2020	PCc12B	Fluctuations in sensors data											
21/04/2020	PCc2	not enough to sample											
21/04/2020	PCc3	new depth 2.387											
21/04/2020	PCc4A	grey											
21/04/2020	PCc4A	grey	16.6	5.1	146.0	94.0	57.9	52.3	4.9	236.2	86.9	8130.0	0.1
21/04/2020	PCc4B	grey											
21/04/2020	PCc4B	grey	17.2	4.8	150.0	97.0	418.0	78.7	7.3	280.5	104.7	7812.0	0.1
21/04/2020	PCc4C	fluctuations in sensor 1 data, rest all sensors reading zero	15.9	4.9	162.0	105.0	57.1	36.0	3.4	80.7	101.3	7462.0	0.1
21/04/2020	PCc4C	fluctuations in sensor 1 data, rest all sensors reading zero											
21/04/2020	PCc4D	All sensors reading zero											
21/04/2020	SP2	new depth 2.676											
22/04/2020	PB4A	replaced the battery, the connection of the logger to its body was disconnected	16.7	5.2	137.0	89.0	582.0	39.3	3.7	203.3	81.3	8620.0	0.0
22/04/2020	PB4B	dark grey	15.9	4.9	157.0	102.0	34.6	74.2	7.1	269.7	101.2	7692.0	0.1
22/04/2020	PB4C	amber	17.6	4.6	194.0	126.0	160.0	73.2	6.7	378.2	115.2	5988.0	0.1
22/04/2020	PB4D	dry											
22/04/2020	PCc10A	fluctuations in sensors readings											
22/04/2020	PCc10B	Fluctuations in sensors data											
22/04/2020	PCc10B	Fluctuations in sensors data	15.9	5.2	148.0	96.0	110.0	64.9	6.2	226.3	82.7	8130.0	0.1
18/05/2020	PB4A	fluctuations in the data	15.2	5.0	120.0	78.0	96.4	43.8	4.3	266.3	66.6	10204.0	0.0
18/05/2020	PB4B	Murky brown, logger downloaded abnormally quick	14.4	4.3	171.0	111.0	30.2	70.6	7.0	316.4	102.1	7299.0	0.1
18/05/2020	PB4D	flcutuations in the data											
18/05/2020	PCc10A	sensors 2 to 5 reading zero											
18/05/2020	PCc10B	Fluctuations in data. Found moisture in the logger body wiped it and it worked											
18/05/2020	PCc12A	except for data in sensor 1, all reading zero for sensors 2 to 5											
18/05/2020	PCc12B	Found moisture between logger and the body. The number of measuring depths set up at the site is different than the depth recorded by the recorder											
18/05/2020	PCc2	dry											
19/05/2020	PCc3	dry											

19/05/2020	PCc4A	not enough to sample											
19/05/2020	PCc4B	all data readings in sensors is zero											
19/05/2020	PCc4C	except sensor 1, the readings of 2 to 5 sensor is zero											
19/05/2020	PCc4D	dry											
19/05/2020	PCc5A	all sensors reading zero											
19/05/2020	PCc5B	diper broken, water depth measured approximately, murky brown											
19/05/2020	PCc5B	diper broken, water depth measured approximately, murky brown	15.1	5.2	247.0	160.0	62.2	78.6	7.7	142.8	54.7	4975.0	0.1
19/05/2020	PCc5C	dry											
19/05/2020	PCc5D	dark brown											
19/05/2020	PCc6	Dry											
19/05/2020	PCr1A	dry											
19/05/2020	PCr1B	dry											
19/05/2020	PCr1C	Empty data block: there is no data in the logger memory, download will be abandoned											
19/05/2020	PCr1D	dry											
19/05/2020	SP1	dry											
19/05/2020	SP2	dry											
21/05/2020	CT1A		12.4	6.6	233.0	151.0	229.0	53.3	5.5	22.7	-28.1	5649.0	0.1
21/05/2020	CT2		14.2	6.7	233.0	151.0	22.2	80.4	7.9	36.2	-30.7	5405.0	0.1
21/05/2020	CT3		13.9	6.5	205.0	133.0	31.1	53.1	5.3	45.2	-22.1	6172.0	0.1
21/05/2020	CT3A		13.4	4.8	196.0	127.0	6.8	81.8	8.2	272.7	75.1	6535.0	0.1
15/06/2020	PCc3	dry											
15/06/2020	PCc4A	dipper broken, approx depth measured	15.1	4.6	120.0	78.0	106.0	81.4	7.9	247.2	76.5	10204.0	0.0
15/06/2020	PCc4A	dipper broken, approx depth measured											
15/06/2020	PCc4B	dry											
15/06/2020	PCc4C	Sensor one has data, the rest zero											
15/06/2020	PCc4D	dry											
15/06/2020	PCc5A	dry											
15/06/2020	PCc5B	dipper broken, water depth measured approximately, clear											
15/06/2020	PCc5B	dipper broken, water depth measured approximately, clear	14.3	4.7	187.0	121.0	26.3	63.7	6.3	208.6	71.5	6711.0	0.1
15/06/2020	PCc5C	dry											
15/06/2020	PCc5D	murky grey, dipper not detecting water depth, approx depth obtained from lowering the dipper until it picks up moisture											
15/06/2020	PCc5D	murky grey, dipper not detecting water depth, approx depth obtained from lowering the dipper until it picks up moisture	14.4	4.8	127.0	82.0	80.1	70.9	7.0	233.6	68.0	9803.0	0.0
15/06/2020	PCc6	dry											
15/06/2020	PCr1A	dry											
15/06/2020	PCr1B	dry											
15/06/2020	PCr1C	dry											
15/06/2020	PCr1D	dry											
15/06/2020	SP1	dry											
15/06/2020	SP2	dry											
16/06/2020	PB4A	clear	14.7	4.7	138.0	89.0	28.2	54.5	5.3	224.8	73.0	9009.0	0.0
16/06/2020	PB4B	changed batteries, The number of measuring depths set up in this site file is different to the number of depths recorded by the recorder (download of the data will be aborted)											
16/06/2020	PB4B	changed batteries, The number of measuring depths set up in this site file is different to the number of depths recorded by the recorder (download of the data will be aborted)	13.7	4.2	159.0	103.0	21.6	57.2	5.7	223.3	99.6	8000.0	0.1
16/06/2020	PB4C	light brown	14.2	4.1	171.0	111.0	54.5	42.3	4.2	322.6	104.0	7352.0	0.1
16/06/2020	PB4C	light brown											
16/06/2020	PB4D	dry											
16/06/2020	PCc10A	not enough to sample											
16/06/2020	PCc10B	dry											
16/06/2020	PCc12A	murky grey											
16/06/2020	PCc12A	murky grey	13.6	4.6	283.0	183.0	253.0	81.5	8.2	115.1	75.6	4504.0	0.1
16/06/2020	PCc12B	dry											
16/06/2020	PCc2	dry											
5/08/2020	PCc3	DRY											
5/08/2020	PCc4A	Clear, no lab samples taken											
5/08/2020	PCc4B	clear											
5/08/2020	PCc4C	clear											
5/08/2020	PCc4D	semi-clear											
5/08/2020	PCc5A	all zero											
5/08/2020	PCc5B	No data in logger memory, restarted successfully											
5/08/2020	PCc5C	clear											
5/08/2020	PCc5D	clear											
5/08/2020	PCc6	Insufficient to sample											
5/08/2020	PCr1A	a few comm cable errors											
5/08/2020	PCr1B	insufficient to sample											
5/08/2020	PCr1C	light grey											
5/08/2020	PCr1D	DRY											
5/08/2020	SP1	DRY											
5/08/2020	SP2	DRY											
6/08/2020	PB4A	Clear											
6/08/2020	PB4C	clear											
6/08/2020	PB4D	Couldnt dowload logger, suspect it was not restarted properly last time. restarted											
6/08/2020	PCc10A	light grey, lab sample not taken											
6/08/2020	PCc10B	clear											
6/08/2020	PCc12A	murky brown											
6/08/2020	PCc12B	DRY											
6/08/2020	PCc2	clear											
9/09/2020	PB4A	cloudy	12.7	5.1	78.0		146.5	31.8	3.3	257.5			
9/09/2020	PB4B		12.1	4.9	80.2		108.5	74.5	7.8	383.5			
9/09/2020	PB4C		12.1	4.4	22.7		3.9	32.1	3.4	553.7			
9/09/2020	PB4D	DRY											
9/09/2020	PCc10A	Insufficient to sample											
9/09/2020	PCc10B		12.0	4.9	86.8		255.3	69.7	7.3	402.8			
9/09/2020	PCc12A	Total depth 2.364; not enough to sample											
9/09/2020	PCc12B	DRY											
9/09/2020	PCc2	DRY											
9/09/2020	PCc6	DRY											
10/09/2020	PCc3	DRY											
10/09/2020	PCc4A	Murkey Grey											
10/09/2020	PCc4A	Murkey Grey	12.8	4.8	80.7		213.2	73.3	7.6	395.1			
10/09/2020	PCc4B	only 2 data blocks											
10/09/2020	PCc4B	only 2 data blocks	13.3	4.6	111.7		546.0	90.3	9.2	404.3			
10/09/2020	PCc4C	slightly cloudy											

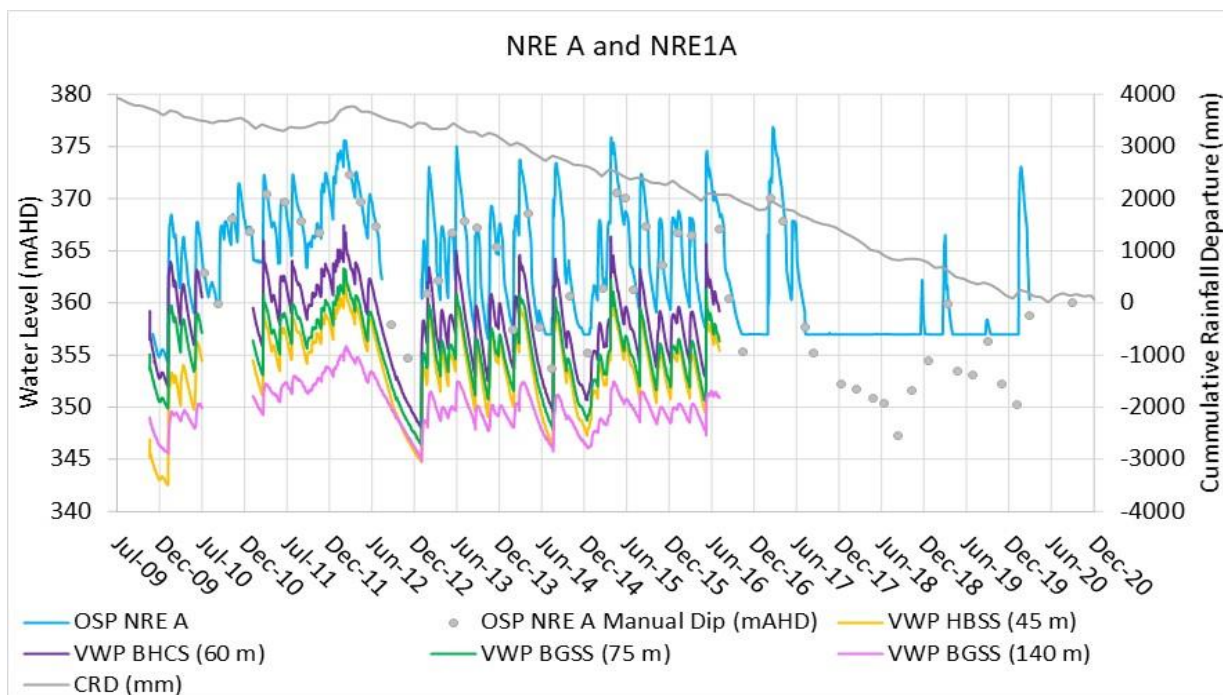
10/09/2020	PCc4C	slightly cloudy	13.4	4.9	77.7		21.1	29.1	3.0	335.4			
10/09/2020	PCc4D	Black											
10/09/2020	PCc4D	Black	12.6	4.5	125.8		533.5	62.2	6.5	383.0			
10/09/2020	PCc5A	Milky											
10/09/2020	PCc5A	Milky	14.3	5.1	80.1		221.1	49.9	5.0	344.4			
10/09/2020	PCc5B	only 3 data rows, rusty screws											
10/09/2020	PCc5B	only 3 data rows, rusty screws	13.9	5.0	101.3		103.7	55.6	5.6	332.8			
10/09/2020	PCc5C	Milky Greay											
10/09/2020	PCc5C	Milky Greay	13.6	5.1	80.5		106.4	61.3	6.2	357.4			
10/09/2020	PCc5D	Milky											
10/09/2020	PCc5D	Milky	14.1	5.2	93.8		632.4	67.9	6.8	334.9			
10/09/2020	PCr1A	DRY											
10/09/2020	PCr1B	No response, cleaned casing and then it worked											
10/09/2020	PCr1C	No response, cleaned casing and then worked. Battery changed											
10/09/2020	PCr1C	No response, cleaned casing and then worked. Battery changed											
10/09/2020	PCr1D	DRY											
10/09/2020	SP1	DRY											
10/09/2020	SP2	DRY											
18/11/2020	PCc5A	clear. New total depth measured at 2.606											
18/11/2020	PCc5A	clear. New total depth measured at 2.606	16.7	4.7	97.1		6.3	34.9	3.3	385.8			
18/11/2020	PCc5B	clear. Total depth measured at 2.619											
18/11/2020	PCc5B	clear. Total depth measured at 2.619	16.6	4.8	103.8		9.8	66.2	6.3	310.0			
18/11/2020	PCc5C	Clear. Total depth measured as 2.303											
18/11/2020	PCc5C	Clear. Total depth measured as 2.303	17.5	4.9	81.6		32.8	57.9	5.4	364.3			
18/11/2020	PCc5D	Light Brown. Total depth measured as 2.935											
18/11/2020	PCc5D	Light Brown. Total depth measured as 2.935	16.9	5.0	76.4		76.7	58.0	5.5	298.1			
18/11/2020	PCc6	DRY. New total depth recorded											
18/11/2020	PCr1A	DRY											
18/11/2020	PCr1B	Insufficient water to sample, new total depth measured at 2.264											
18/11/2020	PCr1C	Insufficient to sample. New total depth measure at 2.469											
18/11/2020	PCr1D	DRY, new total depth measured											
18/11/2020	SP1	Dry, new total depth recorded											
19/11/2020	PCc3	DRY, new total depth											
19/11/2020	PCc4A	Clear. New total depth measured as 2.968											
19/11/2020	PCc4A	Clear. New total depth measured as 2.968	16.6	4.7	80.1		6.0	95.0	9.0	394.2			
19/11/2020	PCc4B	clear	16.8	4.5	109.4		8.0	98.5	9.3	394.0			
19/11/2020	PCc4B	clear											
19/11/2020	PCc4C	New total depth measured as 2.821											
19/11/2020	PCc4C	New total depth measured as 2.821	16.2	4.6	95.4		2.9	38.0	3.6	375.6			
19/11/2020	PCc4D	Grey, New total depth measured as 2.535											
19/11/2020	PCc4D	Grey, New total depth measured as 2.535	16.4	4.2	151.0		257.7	54.4	5.2	395.9			
19/11/2020	SP2	DRY, new total depth											
24/11/2020	PB4A	Clear. New total depth measured at 2.936. Top of pvc pipe snapped 4.5 cm from top so this length should be added onto all measurements for continuity. See field sheets and photos for more information	17.3	5.1	77.4		8.0	65.1	6.0	349.8			
24/11/2020	PB4B	Light Grey. New total depth recorded as 2.328	16.4	4.6	100.2		90.0	72.4	6.8	356.0			
24/11/2020	PB4C	Light grey. New total depth measured at 1.851	16.6	4.3	122.6		119.5	54.8	5.1	368.9			
24/11/2020	PB4D	Dry. New total depth measured											
24/11/2020	PCc10A	Insufficient for sample. New total depth recorded as 2.206											
24/11/2020	PCc10B	Clear. New total depth recorded as 2.554											
24/11/2020	PCc10B	Clear. New total depth recorded as 2.554	17.2	4.5	92.1		16.3	55.7	5.2	371.4			
24/11/2020	PCc12A	New Tube placed in hole with sensor, ground level sitting 46.5cm above ground level. could not be pushed any deeper with available equipment.											
24/11/2020	PCc12B	DRY											
24/11/2020	PCc2	Milky, Insufficient to Lab Sample. New total depth measured at 2.594											
24/11/2020	PCc2	Milky, Insufficient to Lab Sample. New total depth measured at 2.594	17.8	4.4	104.6		869.2	82.4	7.5	326.6			



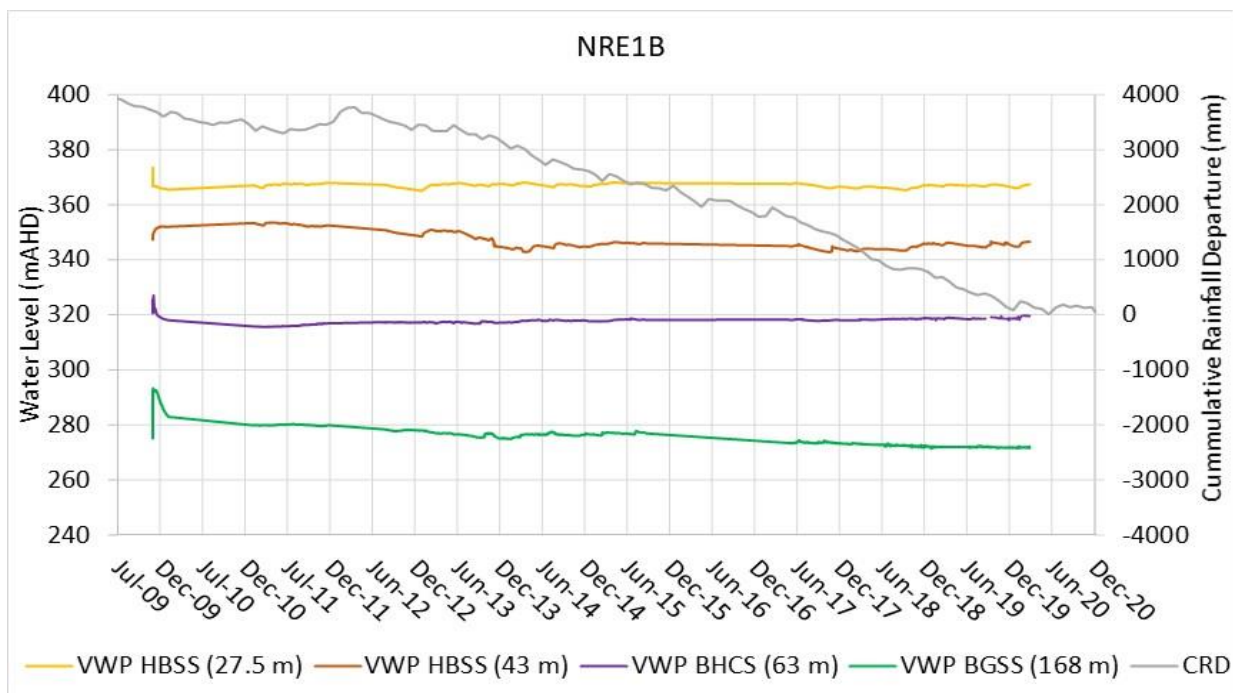
Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
Type	Plan	Date Published	17/11/2021
Doc Title	GROUNDWATER MANAGEMENT PLAN		

APPENDIX C – GROUNDWATER BASELINE DATA – WATER LEVEL

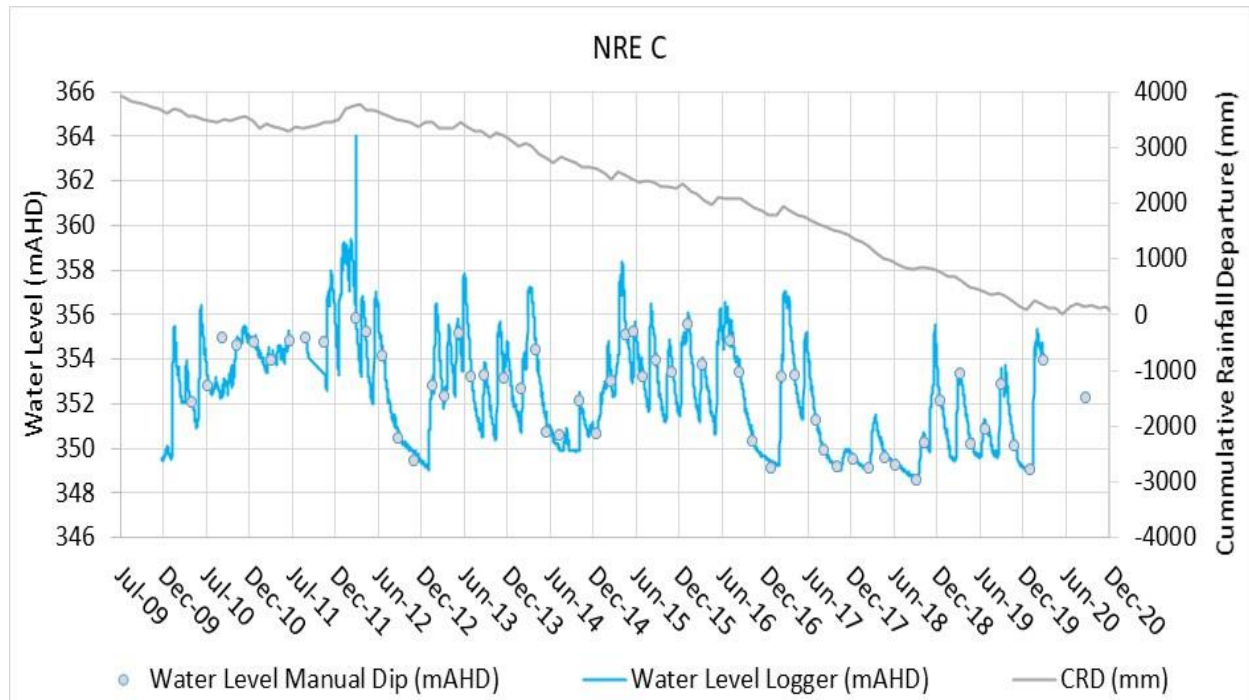
NRE A and NRE1A (VWP)



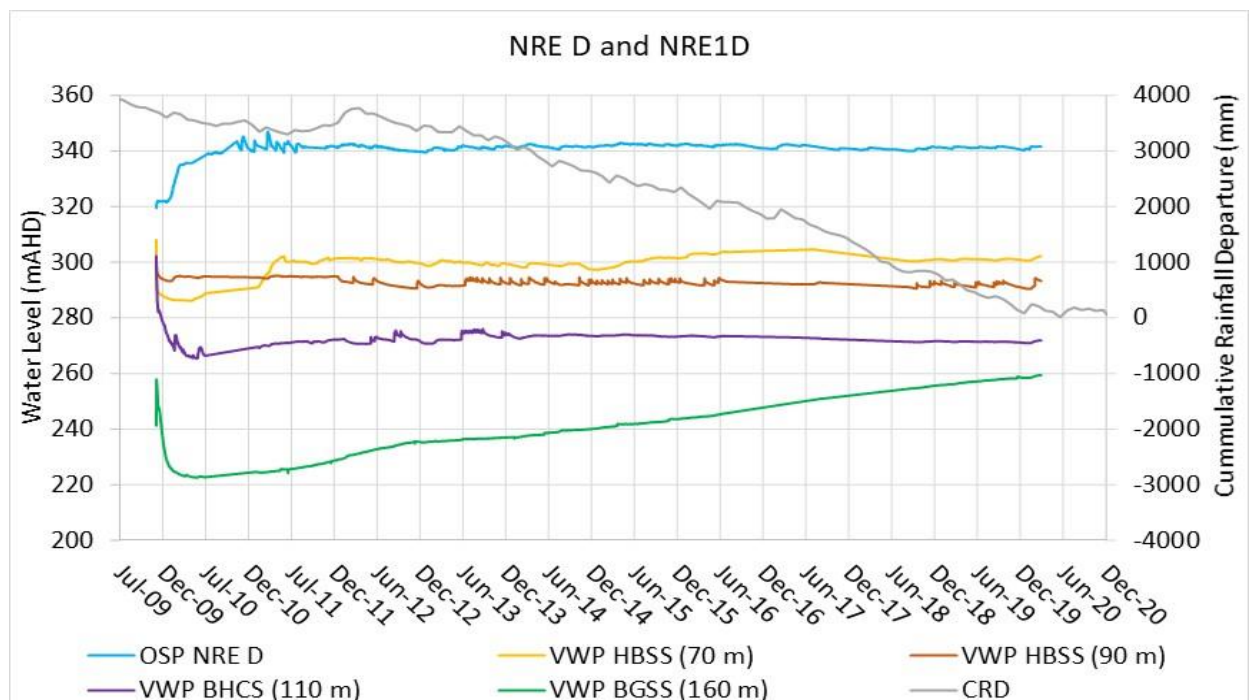
NRE1B (VWP)



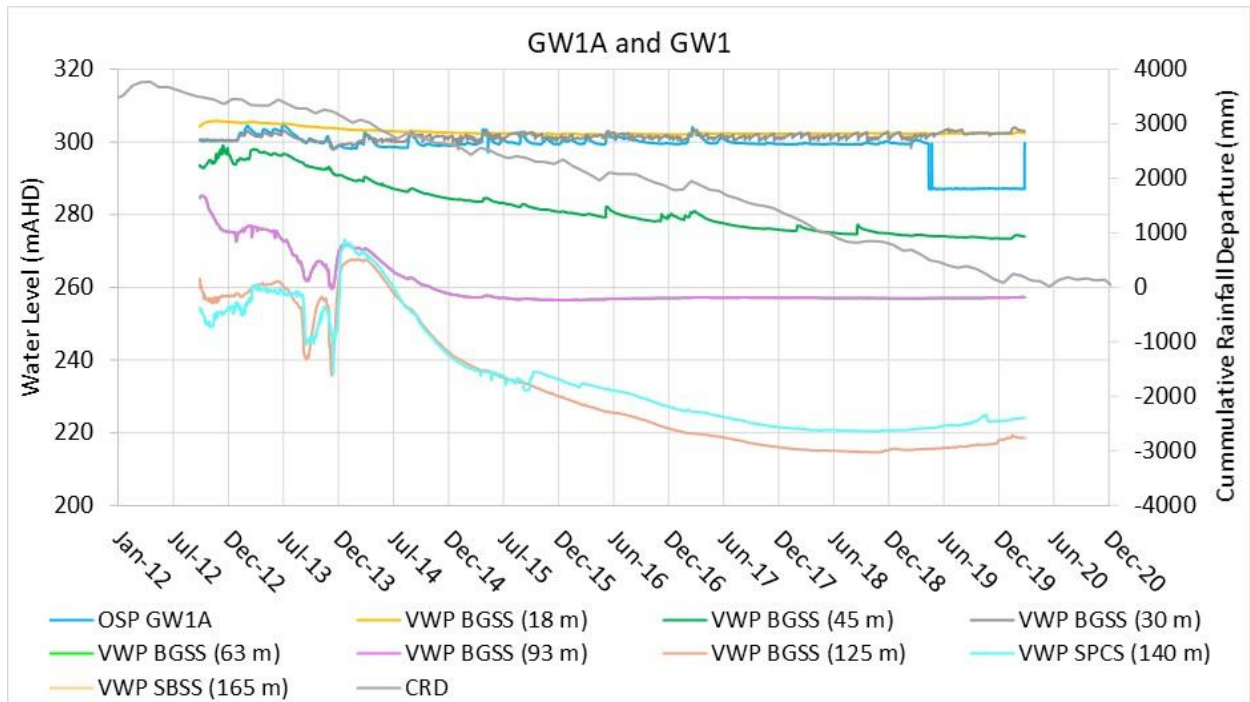
NRE C



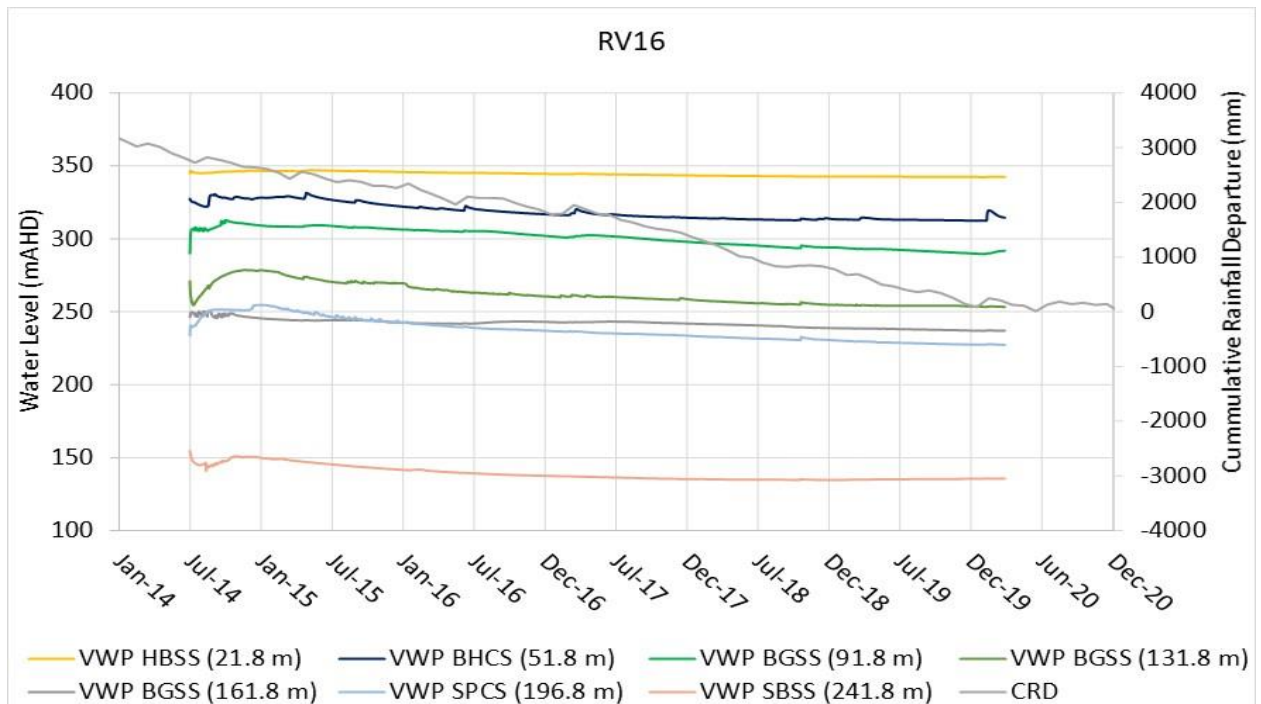
NRE D and NRE1D (VWP)



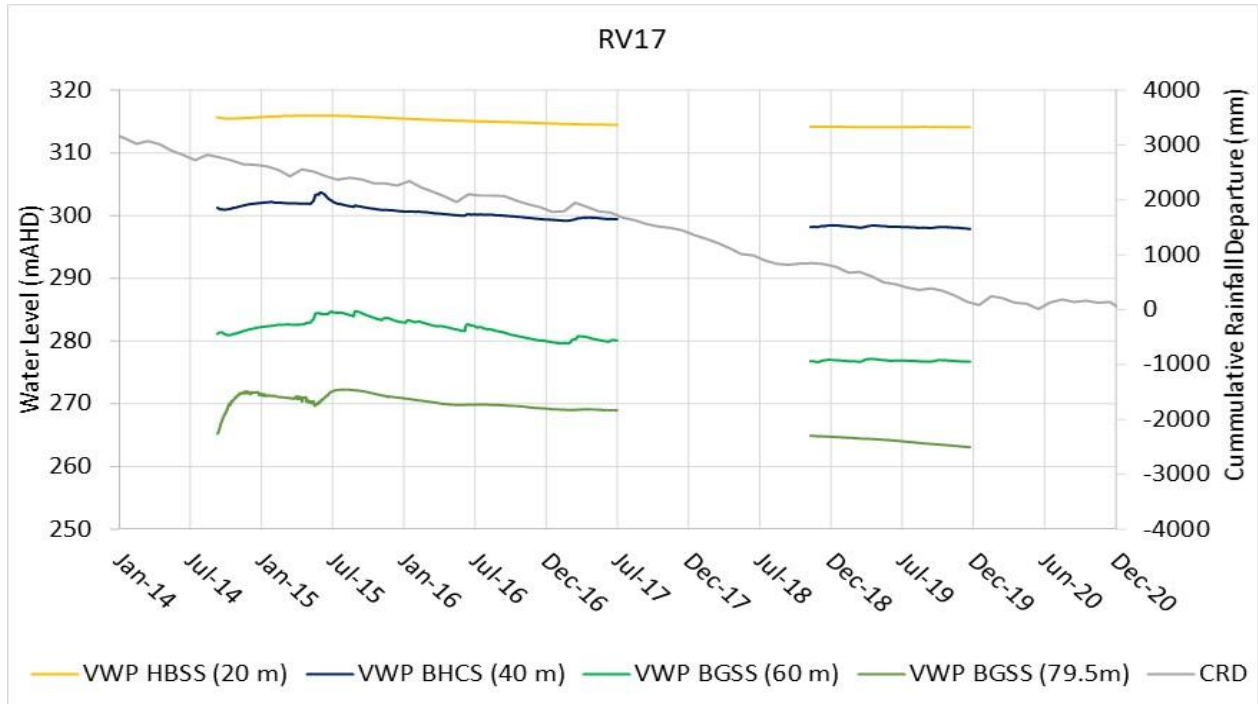
GW1A and GW1 (VWP)



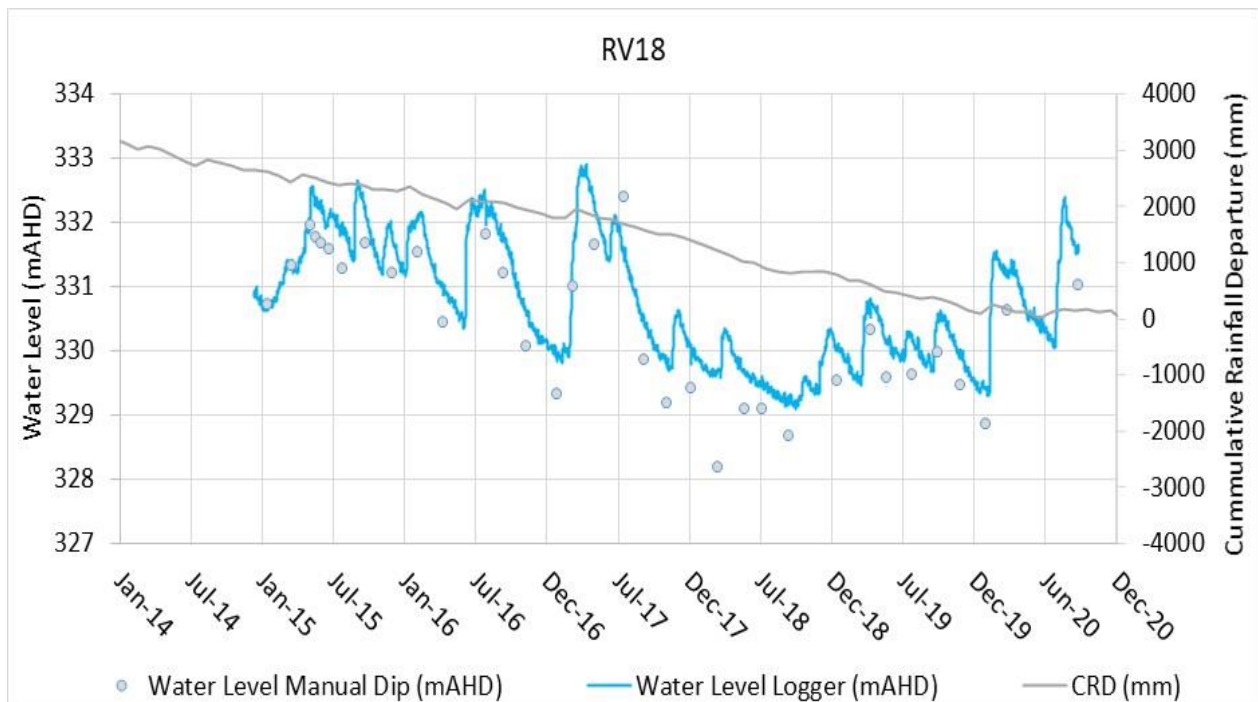
RV16 (VWP)



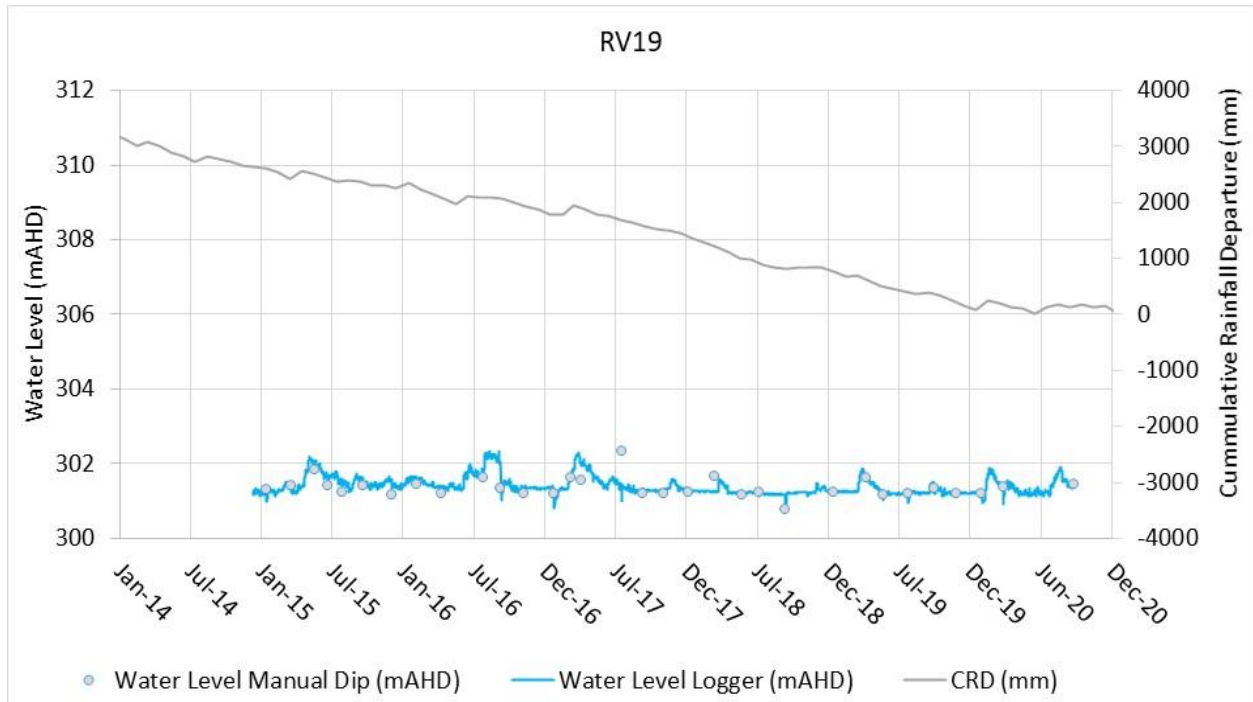
RV17 (VWP)



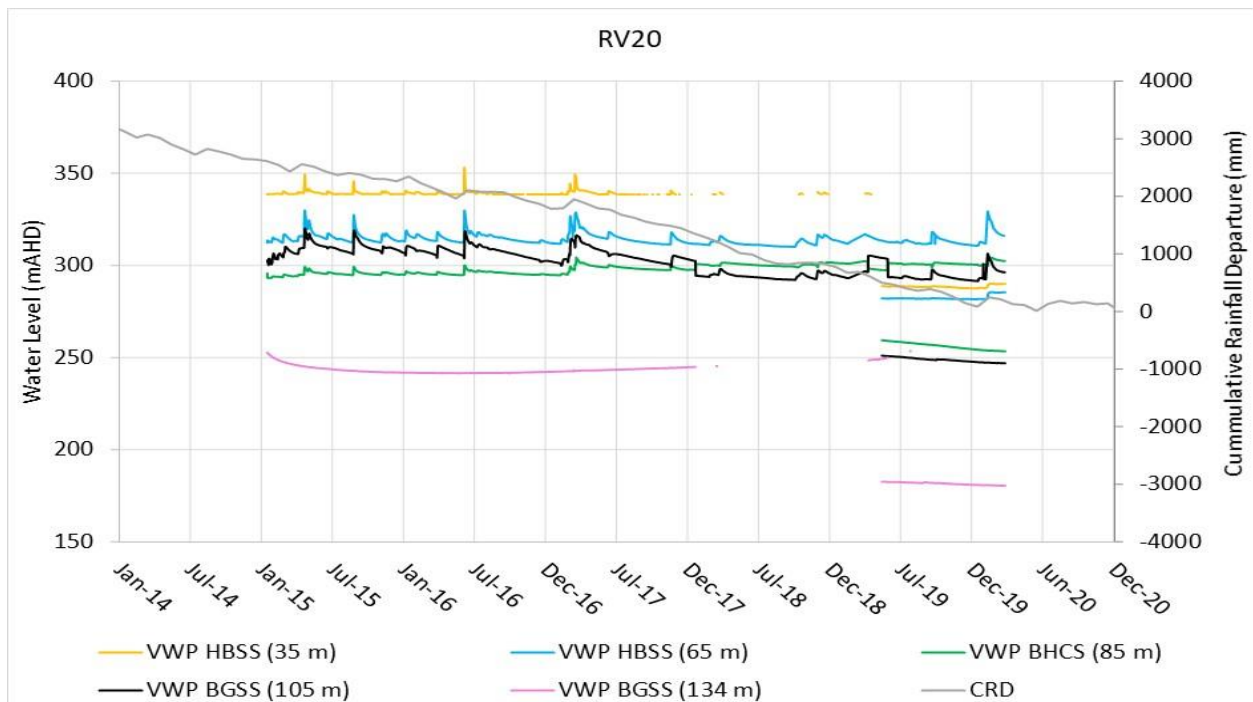
RV18



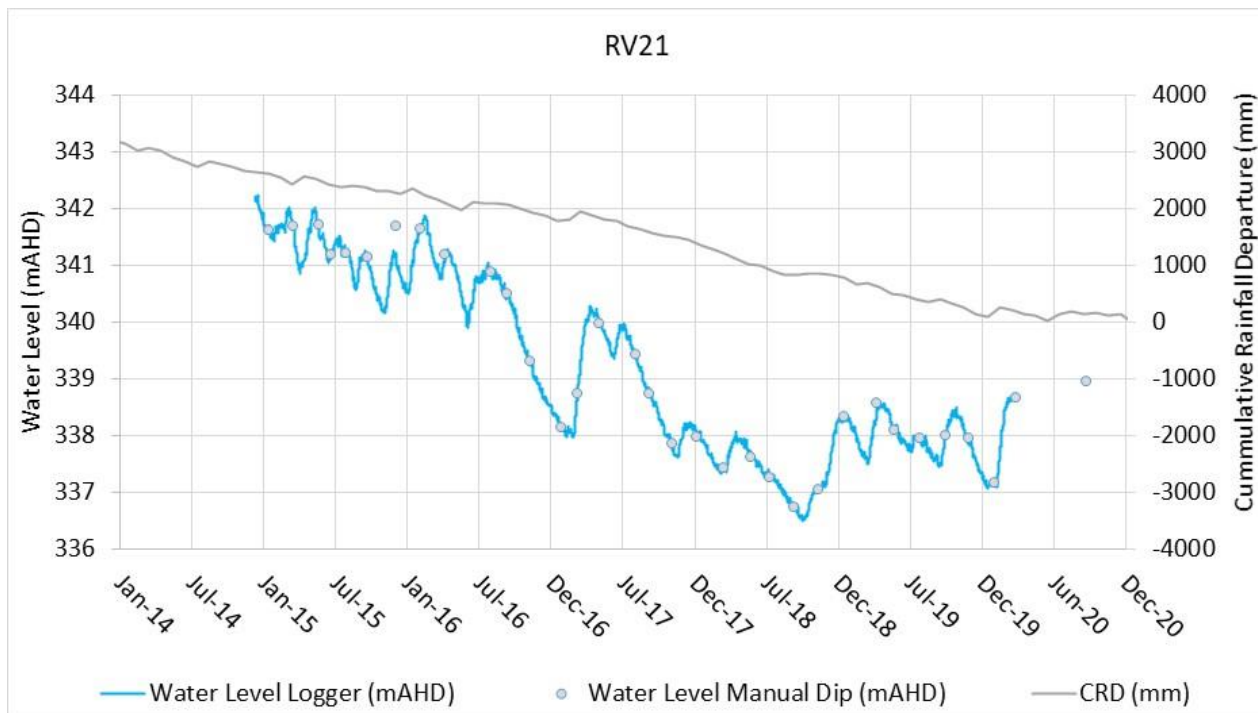
RV19



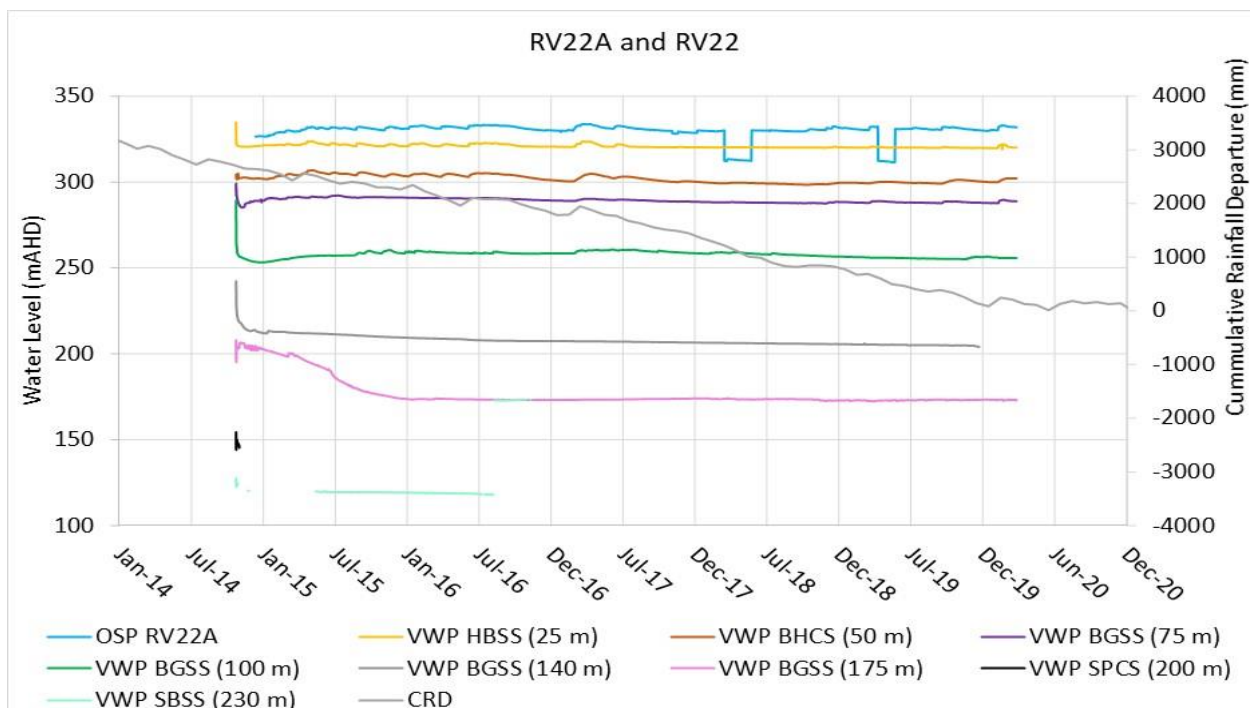
RV20 (VWP)



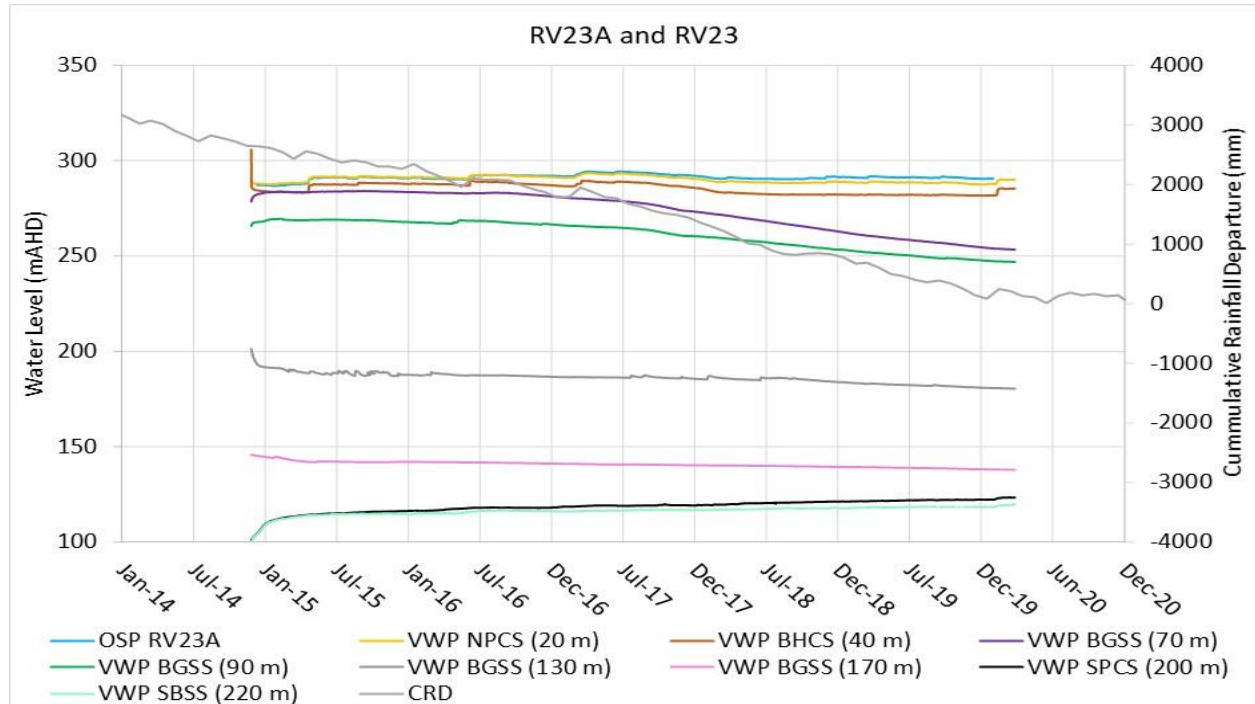
RV21



RV22A and RV22 (VWP)



RV23A and RV23 (VWP)





Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
Type	Plan	Date Published	17/11/2021
Doc Title	GROUNDWATER MANAGEMENT PLAN		

APPENDIX D – GROUNDWATER BASELINE DATA – WATER QUALITY

Date	Bore	Time	Temp (°C)	Field pH	Field EC (uS/cm)	Turbidity (NTU)	Field TDS (mg/L)	Lab TDS (mg/L)	Field DO (% Sat)	Field DO (mg/L)	Eh (mV) ORP	pH (mV)	RES (Ohms.cm)	SAL	Na (mg/L)	Ca (mg/L)	K (mg/L)	Mg (mg/L)	Cl (mg/L)	F (mg/L)	SO4 (mg/L)	HCO3 (mg/L)	Fe T (mg/L)	Fe Filtr (mg/L)	Mn T (mg/L)	Filtr Mn (mg/L)	Filtr Cu (mg/L)	Filtr Pb (mg/L)	Filtr Zn (mg/L)	Filtr Ni (mg/L)	Filtr Al (mg/L)	Filtr As (mg/L)	Filtr Li (mg/L)	Filtr Ba (mg/L)	Filtr Sr (mg/L)	DOC (mg/L)	Tot N (mg/L)	Tot P (mg/L)	Si (mg/L)	Total Cations (meq/L)	Total Anions (meq/L)		
28/10/2009	NRE G							125.0							28	3.9	16	3.1	62	0.23	2	15	0.08	0.01	0.84	0.57	<0.001	<0.001	0.005	<0.01	0.02	<0.01	0.012	0.42	0.049		1	0.03					
18/11/2009	NRE A		16.4	5.9	240.4	50.6		115.0	46.8	4.4	267.1				21	3.6	0.6	8.1	21	<0.1	60	1	0.22	0.08	0.57	0.43	0.031	0.002	0.098	0.002	0.28	<0.01	<0.001	0.03	0.03		<0.1	0.11					
18/11/2009	NRE D		17.1	4.7	72.3	722.7		77.0	57.6	5.3	333.4				17	7.3	0.3	2.2	30	<0.1	10	17	0.02	0.01	0.26	0.23	<0.001	<0.001	0.043	<0.01	<0.01	<0.01	<0.001	<0.01	<0.01		0.4	<0.01					
18/11/2009	NRE E		16.5	4.3	162.6	0.9		165.0	72.8	6.8	399.9				35	8.4	1.3	1.3	88	<0.1	7	18	12	<0.01	0.87	0.71	<0.001	<0.001	0.021	<0.01	<0.01	<0.01	0.002	0.23	<0.01		<0.1	0.04					
18/11/2009	NRE F							92.0							25	2.4	0.7	4.7	47	<0.1	6	17	1.6	1.5	0.94	0.69	<0.001	<0.001	0.08	<0.01	<0.01	<0.01	0.001	0.02	<0.01		<0.1	<0.01					
18/11/2009	NRE G							95.0							24	4.7	0.8	6	58	<0.1	4	1	0.07	<0.01	0.23	0.23	0.051	<0.001	0.54	<0.01	0.25	<0.01	0.002	0.04	0.02		<0.1	0.04					
24/01/2011	NRE A	9:15:00 AM						170.0							14	36	<1	3	30	<0.1	89	1	24.8	0.19	0.101	0.08	0.008	0.018	0.078	0.01	1.4	<0.001	<0.001	0.006	0.17	1	0.4	0.06	6.02	2.7	2.66		
24/01/2011	NRE C							77.0							17	1	1	2	38	<0.1	6	<1	6.17	0.33	0.047	0.031	0.006	0.007	0.064	0.002	0.59	<0.001	<0.001	0.006	0.018	3	4.8	<0.01	6.02	1.19	0.99		
24/01/2011	NRE D							55.0							14	2	<1	1	28	<0.1	7	1	1.41	<0.05	0.027	0.019	0.003	0.002	0.038	0.001	0.32	<0.001	<0.001	0.003	0.009	1	0.5	0.05	3.86	0.97	0.8		
24/01/2011	NRE F							122.0							28	3	<1	5	59	<0.1	9	4	11.3	6.02	0.305	0.287	0.002	<0.001	0.065	0.008	0.05	<0.001	0.001	0.009	0.02	1	0.3	0.02	8.43	1.95	1.8		
25/01/2011	NRE E							214.0							34	25	<1	5	65	<0.1	56	7	21.3	0.65	0.273	0.236	0.003	<0.001	0.033	0.004	0.04	<0.001	0.002	0.041	0.113	<1	0.4	0.04	5.97	3.12	3.16		
25/01/2011	NRE G							110.0							26	<1	1	4	50	<0.1	6	2	7.83	<0.05	0.159	0.127	0.005	0.007	0.114	0.007	0.26	<0.001	<0.001	0.001	0.012	0.015	3	1	0.2	8.4	1.54	1.5	
29/08/2011	NRE C							55.0							15	3	2	2	28	<0.1	6	7	21.4	0.28	0.041	0.033	0.004	0.002	0.043	0.003	0.41	<0.001	0.001	0.008	0.028	1	0.6	0.08	7.24	1.05	1.02		
29/08/2011	NRE D							36.0							9	3	<1	1	16	<0.1	11	1	0.47	<0.05	0.031	0.025	0.003	0.001	0.022	0.001	0.31	<0.001	<0.001	0.004	0.017	<1	0.6	0.26	4.34	0.7	0.62		
29/08/2011	NRE E							160.0							33	14	<1	4	64	<0.1	37	<1	4.04	0.67	0.12	0.111	0.002	<0.001	0.028	0.002	0.16	<0.001	<0.001	0.025	0.068	<1	1.5	0.08	6.81	2.58	2.46		
29/08/2011	NRE F							93.0							20	3	4	2	35	<0.1	8	8	3.24	0.14	0.037	0.024	0.007	<0.001	0.07	0.003	0.09	<0.001	0.004	0.014	0.029	5	1.6	0.13	7.18	1.31	1.29		
29/08/2011	NRE G							84.0							22	2	<1	3	45	<0.1	7	<1	1.24	<0.05	0.084	0.077	0.005	0.005	0.086	0.005	0.33	<0.001	0.001	0.013	0.028	<1	0.6	0.12	9.59	1.42	1.3		
2/09/2011	NRE A	12:40:00 PM						165.0							12	29	<1	3	21	<0.1	79	<1	30.9	0.22	0.129	0.098	0.015	0.019	0.071	0.01	1.46	<0.001	<0.001	0.006	0.125	<1	0.5	0.03	7.56	2.24	2.22		
26/03/2012	NRE A	9:49:00 AM						592.0							10	134	1	2	14	0.1	404	6	36.7	31.9	0.532	0.512	0.001	0.001	0.027	0.002	0.02	0.001	0.006	0.013	0.533	2	2.3	0.02					
26/03/2012	NRE C							85.0							17	1	1	2	27	0.1	17	1	0.69	0.05	0.021	0.015	0.004	0.006	0.037	0.002	0.56	0.001	0.001	0.006	0.015	2	1.8	0.01					
26/03/2012	NRE D							38.0							8	1	1	1	16	0.1	6	1	0.37	0.05	0.018	0.014	0.002	0.001	0.024	0.001	0.3	0.001	0.001	0.003	0.005	1	0.2	0.01					
26/03/2012	NRE E							200.0							33	23	1	4	66	0.1	53	1	7.37	0.47	0.106	0.089	0.002	0.001	0.033	0.002	0.15	0.001	0.001	0.016	0.098	1	1.7	0.01					
27/03/2012	NRE F							64.0							16	1	1	2	29	0.1	5	1	3.26	0.05	0.013	0.01	0.004	0.001	0.024	0.002	0.13	0.001	0.001	0.006	0.006	1	0.7	0.06	7.75				
27/03/2012	NRE G							73.0							20	1	1	2	40	0.1	7	2	4.42	0.05	0.096	0.064	0.011	0.004	0.087	0.009	0.3	0.001	0.001	0.011	0.024	1	0.2	0.02	9.26				
19/07/2012	NRE C							43.0							8	1	1	1	17	0.1	6	1	0.47	0.05	0.021	0.017	0.002	0.001	0.024	0.001	0.26	0.001	0.001	0.003	0.004	2	0.6	0.03	3.87	0.43	0.6		
19/07/2012	NRE D							68.0							14	1	1	2	24	0.1	4	1	0.64	0.05	0.015	0.012	0.002	0.006	0.021	0.001	0.55	0.001	0.001	0.005	0.009	1	0.4	0.01	6.12	0.77	0.76		
19/07/2012	NRE E							206.0							32	22	1	4	57	0.1	51	1	13.1	0.5	0.116	0.132	0.004	0.001	0.031	0.003	0.19	0.001	0.001	0.02	0.112	1	0.3	0.03	5.82	2.82	2.67		
19/07/2012	NRE F							71.0							17	1	1	1	27	0.1	4	1	1.25	0.05	0.02	0.017	0.095	0.097	0.49	0.099	0.96	0.097	0.099	0.099	0.099	0.099	0.099	1	0.2	0.04	6.13	0.9	0.84
19/07/2012	NRE G							109.0							20	1	1	2	35	0.1	6	1	1.11	0.09	0.071	0.009	0.009	0.01	0.049	0.01	0.09	0.01	0.011	0.01	0.009	1	0.4	0.03	7.76	1.03	1.11		
28/09/2012	GW1A							226.0							29	17	7	10	70	2.2	25	32	6.77	3.03	1.22	1.14	0.006	0.001	0.083	0.021	0.02	0.001	0.024	0.288	0.101	1	2.2	0.07	8.4	3.11	3.13		
20/02/2013	GW1A							180.0							23	12	3	8	48	0.1	14	56	7.13	4.69	1.11	1.06	0.002	0.001	0.253	0.02	0.01	0.001	0.026	0.249	0.092	3	0.3	0.07	9.37	2.33	2.76		
20/02/2013	NRE A	1:40:00 PM						62.0							10	10	0.3	2.2	20	<0.1	11	1	0.18	0.16	0.39	0.33	0.011	0.002	0.23	0.002	0.12	<0.01	<0.001	0.01	0.04		<0.1	0.51					
20/02/2013	NRE C							90.0							10	1	1	1	14	0.1	7	1	9.25	0.05	0.052	0.05	0.001	0.001	0.022	0.001	0.21	0.001	0.001	0.004	0.011	3	0.3	0.01	4.6	0.48	0.54		
20/02/2013	NRE D							108.0							17	1	1	2	35	0.1	4	1	27.6	0.63	0.077	0.073	0.002	0.002	0.041	0.003	0.38	0.001	0.001	0.009	0.014	3	0.3	0.07	7.02	0.9	1.07		
20/02/2013	NRE E							212.0							31	12	1	9	79	0.1	14	46	42.6	16.8	0.954	0.955	0.001	0.001	0.025	0.015	0.01	0.001	0.009	0.195	0.07	1	0.3	0.03	8.51	3.55	3.44		
20/02/2013	NRE F							232.0							30	2	1	6	61	0.1	5	1	12.5	10.2	0.534	0.51	0.001	0.001	0.053	0.011	0.01	0.001	0.003	0.016	0.019	4	5.4	0.02	9.35	1.92	1.82		
20/02/2013	NRE G							154.0							25	1	1	3	50	0.1	4	1	0.86	0.05	0.148	0.144	0.005	0.004	0.1	0.011	0.23	0.001	0.001	0.016	0.009	1	0.4	0.03	8.74	1.36	1.49		
1/08/2013	GW1A							113.0							19	6	2	5	34	0.1	18	14	31.1	0.05	0.996	0.969	0.001	0.001	0.056	0.015	0.01	0.001	0										

Date	Bore	Time	Temp (°C)	Field pH	Field EC (uS/cm)	Turbidity (NTU)	Field TDS (mg/L)	Lab TDS (mg/L)	Field DO (% Sat)	Field DO (mg/L)	Eh (mV) ORP	pH (mV)	RES (Ohms.cm)	SAL	Na (mg/L)	Ca (mg/L)	K (mg/L)	Mg (mg/L)	Cl (mg/L)	F (mg/L)	SO4 (mg/L)	HCO3 (mg/L)	Fe T (mg/L)	Fe Filtr (mg/L)	Mn T (mg/L)	Filtr Mn (mg/L)	Filtr Cu (mg/L)	Filtr Pb (mg/L)	Filtr Zn (mg/L)	Filtr Ni (mg/L)	Filtr Al (mg/L)	Filtr As (mg/L)	Filtr Li (mg/L)	Filtr Ba (mg/L)	Filtr Sr (mg/L)	DOC (mg/L)	Tot N (mg/L)	Tot P (mg/L)	Si (mg/L)	Total Cations (meq/L)	Total Anions (meq/L)	
18/03/2015	NRE C	10:55:04 AM	18.3	4.6	77.0		50.0			5.9	377.9	96.7	14705.0	0.0																												
18/03/2015	NRE C		18.3	4.6	77.0		50.0	61.0		5.9	377.9	96.7	14705.0	0.0	9	1	1	1	26	0.1	5	1	0.41	0.05	0.029	0.025	0.001	0.002	0.019	0.001	0.23	0.001	0.001	0.009	0.006	2	0.4	0.01	4.59	0.47	0.84	
18/03/2015	NRE D	10:12:39 AM	20.1	4.4	118.0		76.0			7.0	323.2	109.4	9345.0	0.0																												
18/03/2015	NRE D		19.0	3.7	129.0		83.0	75.0		7.1	413.9	144.2	8695.0	0.0	15	1	1	2	33	0.1	6	1	0.34	0.05	0.044	0.044	0.002	0.013	0.024	0.001	0.51	0.001	0.001	0.01	0.016	1	0.1	0.01	7.15	0.87	1.06	
18/03/2015	NRE F							179.0							35	2	1	7	78	0.1	6	5	1.7	0.96	0.473	0.47	0.003	0.001	0.062	0.012	0.09	0.001	0.004	0.021	0.015	1	0.3	0.01	9.62	2.22	2.43	
18/03/2015	RV18		16.2	4.8	94.0		61.0	59.0		4.3	298.2	88.1	12658.0	0.0	12	1	1	2	28	0.1	4	7	0.24	0.05	0.413	0.371	0.004	0.038	0.032	0.003	0.02	0.001	0.001	0.01	0.006	2	0.6	0.02	7.16			
18/03/2015	RV19		15.8	6.6	477.0		310.0	283.0		4.5	-41.9	-1.2	2538.0	0.2	42	40	4	7	47	0.1	33	164	6.53	6.22	1.34	1.37	0.004	0.016	0.081	0.01	0.02	0.001	0.031	0.16	0.098	22	2.6	0.03	12.6	4.84	5.29	
18/03/2015	RV21		17.3	4.7	107.0		69.0	71.0		6.1	341.5	92.6	10869.0	0.0	12	3	2	2	30	0.1	8	8	0.53	0.05	2.2	2.17	0.009	0.168	0.065	0.009	0.06	0.012	0.001	0.043	0.01	9	1.4	0.03	5.6	0.89	1.17	
18/03/2015	RV22A		15.8	4.6	97.0		63.0	80.0		4.6	358.9	95.7	12500.0	0.0	13	1	1	2	30	0.1	4	3	0.21	0.05	0.113	0.111	0.003	0.078	0.025	0.002	0.08	0.001	0.001	0.01	0.005	1	0.2	0.01	7.23	0.78	0.99	
18/03/2015	RV23A		17.6	6.5	423.0		274.0	293.0		4.3	130.6	3.9	2747.0	0.1	33	48	3	8	29	0.1	7	226	0.19	0.05	0.11	0.108	0.002	0.118	0.042	0.016	0.02	0.008	0.006	0.714	0.3	14	1.8	0.02	7.93	4.57	5.48	
19/03/2015	NRE E							282.0							33	18	1	10	82	0.1	17	41	54.6	8.7	0.756	0.762	0.001	0.001	0.024	0.012	0.01	0.001	0.008	0.118	0.08	1	0.8	0.04	6.88	3.16	3.49	
19/03/2015	NRE G							162.0							28	2	1	4	60	0.1	9	1	0.54	0.05	0.177	0.176	0.002	0.001	0.053	0.006	0.43	0.001	0.001	0.016	0.023	1	0.2	0.01	8.74	1.65	1.9	
19/05/2015	RV18	11:24:59 AM	16.3	4.9	92.0					5.5	48.6	75.1	12987.0	0.0																												
19/05/2015	RV18		15.6	5.6	90.0		58.0	75.0		4.7	40.8	34.4	13513.0	0.0	11	1	1	2	20	0.1	3	5	0.59	0.05	0.37	0.357	0.003	0.015	0.046	0.003	0.04	0.001	0.001	0.009	0.006	2	0.8	0.01	7.01	0.69	0.73	
19/05/2015	RV19		15.1	5.8	409.0		265.0	253.0		3.6	1.9	22.8	3012.0	0.1	34	43	3	6	35	0.2	23	158	7.99	5.49	1.74	1.37	0.001	0.009	0.074	0.003	0.02	0.001	0.032	0.11	0.09	16	2.6	0.03	13.9	4.2	4.62	
20/05/2015	NRE A	11:25:00 AM	17.9	3.6	123.0		79.0	118.0		4.3	421.6	146.0	9345.0	0.0	7	15	1	2	10	0.1	42	13	46	8.99	0.159	0.143	0.002	0.001	0.048	0.003	0.08	0.001	0.001	0.005	0.068	2	0.4	0.02	6.76	1.22	1.42	
20/05/2015	NRE C	11:10:06 AM	17.5	4.5	68.0		44.0			6.8	47.4	98.9	16949.0	0.0																												
20/05/2015	NRE C		17.5	4.5	68.0		44.0	61.0		6.8	47.4	98.9	16949.0	0.0	8	1	1	1	15	0.1	4	1	1.06	0.05	0.019	0.017	0.003	0.001	0.013	0.001	0.28	0.001	0.001	0.005	0.006	1	0.2	0.01	4.21	0.43	0.51	
20/05/2015	NRE D		17.3	5.2	119.0		77.0	71.0		7.5	46.9	59.5	9803.0	0.0	15	1	1	2	26	0.1	5	1	0.38	0.05	0.033	0.023	0.002	0.007	0.02	0.001	0.56	0.001	0.001	0.009	0.015	1	0.3	0.01	6.85	0.87	0.73	
20/05/2015	RV21		17.5	5.7	101.0		65.0	76.0		4.7	40.9	27.6	11494.0	0.0	11	2	1	2	21	0.1	6	6	0.27	0.05	2.03	2.11	0.009	0.209	0.076	0.06	0.006	0.001	0.046	0.01	8	1.1	0.01	5.8	0.77	0.84		
20/05/2015	RV22A		16.6	5.2	88.0		57.0	61.0		6.1	42.1	60.0	13513.0	0.0	12	1	1	2	21	0.1	6	2	0.27	0.05	0.155	0.119	0.003	0.066	0.033	0.002	0.08	0.001	0.001	0.011	0.005	1	0.3	0.01	6.81	0.74	0.76	
20/05/2015	RV23A		17.5	5.8	410.0		266.0	251.0		4.5	10.5	25.3	2840.0	0.1	34	50	3	8	22	0.2	3	220	0.43	0.19	0.121	0.106	0.002	0.069	0.015	0.005	0.01	0.002	0.006	0.7	0.299	14	1.6	0.04	7.74	4.71	5.08	
21/05/2015	GW1A		16.3	5.8	284.0		184.0	168.0		5.3	34.9	22.0	4219.0	0.1	26	12	2	8	51	0.1	16	42	14.6	12.9	1.06	1.03	0.002	0.001	0.064	0.018	0.03	0.001	0.018	0.217	0.079	2	0.6	0.08	8.7	2.44	2.61	
21/05/2015	NRE E							160.0							22	20	1	3	40	0.1	46	5	8.69	1.22	0.088	0.083	0.001	0.001	0.011	0.001	0.05	0.001	0.001	0.011	0.081	1	0.4	0.01	6.3	2.2	2.18	
21/05/2015	NRE F							105.0							16	1	1	2	27	0.1	6	1	3.25	0.08	0.027	0.024	0.002	0.001	0.019	0.001	0.06	0.001	0.001	0.007	0.005	2	0.3	0.01	6.54	0.86	0.91	
21/05/2015	NRE G							296.0							23	62	1	4	45	0.1	147	9	2.02	0.05	0.131	0.116	0.007	0.004	0.084	0.007	0.28	0.001	0.001	0.017	0.625	2	0.4	0.01	8.48	4.45	4.51	
19/06/2015	RV18	10:29:55 AM	13.8	4.8	85.0		55.0			5.4	42.8	77.6	14925.0	0.0																												
23/06/2015	NRE A	11:35:00 AM	18.4	5.2	148.0		96.0	114.0		3.5	41.3	60.5	7692.0	0.1	10	15	<1	2	14	<0.1	45	<1	30.1	0.4	0.133	0.123	0.006	0.005	0.052	0.006	0.81	<0.001	<0.001	0.011	0.07	1	0.6	0.02	6.93	1.35	1.33	
23/06/2015	NRE C	12:00:19 PM	16.6	5.2	70.0		45.0			6.6	41.9	59.5	16949.0	0.0																												
23/06/2015	NRE C		16.6	5.2	70.0		45.0	42.0		6.6	41.9	59.5	16949.0	0.0	9	<1	<1	1	14	<0.1	6	<1	0.72	<0.05	0.029	0.026	<0.001	0.001	0.014	<0.001	0.24	<0.001	<0.001	0.008	0.008	<1	<0.1	<0.01	4.14	0.47	0.52	
23/06/2015	NRE D		15.8	4.5	123.0		79.0	69.0		7.8	40.8	94.8	9803.0	0.0	16	<1	<1	2	29	<0.1	6	<1	0.25	<0.05	0.067	0.058	0.001	0.009	0.043	<0.001	0.64	<0.001	<0.001	0.01	0.016	<1	0.2	<0.01	7.19	0.86	0.94	
23/06/2015	NRE F							76.0							18	<1	<1	2	29	<0.1	6	1	5.23	0.2	0.044	0.036	0.001	<0.001	0.024	0.001	0.06	<0.001	<0.001	0.006	0.006	1	0.3	<0.01	7.05	0.95	0.96	
23/06/2015	RV18	9:55:26 AM	14.4	5.6	96.0		62.0			4.2	43.5	36.4	12987.0	0.0																												
23/06/2015	RV18		14.1	5.3	95.0		61.0	55.0		4.4	37.4	52.8	13157.0	0.0	12	<1	<1	2	22	<0.1	3	4	0.47	<005	0.438	0.407	0.002	0.009	0.029	0.003	2	<0.001	<0.001	0.008	0.005	<1	0.4	<0.1	6.9	0.69	0.76	
23/06/2015	RV19		13.1	6.1	454.0		295.0	256.0		2.9	11.6	5.1	2849.0	0.1	42	37	4	8	39	0.2	20	157	10	7.25	1.91	1.63	<0.001	0.002	0.011	0.002	0.01	<0.001	0.03	0.092	0.108	11	2.5	0.03	14.4	4.43	4.65	
23/06/2015	RV21		16.3	5.0	104.0		67.0	74.0		4.2	39.2	68.6	11494.0	0.0	11	2	1	2	24	<0.1	6	8	0.34	0.08	2.45	2.2	0.002	0.097	0.109	0.009	0.05	0.005	<0.001	0.043	0.01	6	0.7	<0.1	5.7	0.77	0.96	
23/06/2015	RV22A		14.5	4.9	92.0		59.0	73.0		5.2	38.6	71.7	13513																													

Date	Bore	Time	Temp (°C)	Field pH	Field EC (uS/cm)	Turbidity (NTU)	Field TDS (mg/L)	Lab TDS (mg/L)	Field DO (% Sat)	Field DO (mg/L)	Eh (mV) ORP	pH (mV)	RES (Ohms.cm)	SAL	Na (mg/L)	Ca (mg/L)	K (mg/L)	Mg (mg/L)	Cl (mg/L)	F (mg/L)	SO4 (mg/L)	HCO3 (mg/L)	Fe T (mg/L)	Fe Filtr (mg/L)	Mn T (mg/L)	Filtr Mn (mg/L)	Filtr Cu (mg/L)	Filtr Pb (mg/L)	Filtr Zn (mg/L)	Filtr Ni (mg/L)	Filtr Al (mg/L)	Filtr As (mg/L)	Filtr Li (mg/L)	Filtr Ba (mg/L)	Filtr Sr (mg/L)	DOC (mg/L)	Tot N (mg/L)	Tot P (mg/L)	Si (mg/L)	Total Cations (meq/L)	Total Anions (meq/L)	
27/07/2016	RV19	10:20:08 AM	16.4	8.2	291.0		189.0			3.6	24.7	-67.7	4098.0	0.1																												
27/07/2016	RV19		14.5	6.5	365.0	44.7	237.0	187.0	67.5	6.6	27.5	7.2	3424.0	0.1	32	15	2	5	40	0.2	17	80	17.5	19	1.49	1.49	0.003	0.002	0.054	0.003	0.01	<0.001	0.012	0.091	0.039	3	1	0.03	11.7	3.54	3.15	
1/08/2016	GW1A	12:28:35 PM	16.2	6.5	286.0		185.0			4.7	159.9	14.1	4201.0	0.1																												
1/08/2016	GW1A		14.5	5.8	340.0	44.3	221.0	158.0	70.5	6.9	247.6	48.6	3676.0	0.1	22	12	2	8	42	0.2	14	40	9.32	6.41	1.04	1.06	0.003	<0.001	0.046	0.017	<0.01	<0.001	0.019	0.222	0.084	2	0.4	0.07	8.63	2.26	2.28	
1/08/2016	NRE A	10:33:00 AM	17.1	4.4	100.0		65.0	58.0		5.9	372.9	123.9	11764.0	0.0	6	5	<1	1	10	<0.1	17	1	11.6	0.49	0.144	0.136	0.004	0.004	0.041	0.003	0.44	<0.001	<0.001	0.007	0.024	2	0.4	0.01	5.63	0.59	0.66	
1/08/2016	NRE C	2:03:48 PM	17.8	5.4	73.0		47.0			5.8	315.9	73.0	15873.0	0.0																												
1/08/2016	NRE C	2:03:48 PM	15.8	5.4	97.0	44.0	63.0		87.2	8.2	383.5	68.2	12500.0	0.0																												
1/08/2016	NRE C		15.8	5.4	97.0	44.0	63.0	42.0	87.2	8.2	383.5	68.2	12500.0	0.0	8	<1	<1	1	13	<0.1	4	1	1.64	<0.05	0.031	0.024	0.001	0.001	0.015	<0.001	0.22	<0.001	<0.001	0.01	0.008	<1	0.2	<0.01	4.16	0.43	0.47	
1/08/2016	NRE D	1:31:17 PM	18.3	3.3	114.0		74.0			7.6	437.9	181.7	10000.0	0.0																												
1/08/2016	NRE D		15.6	4.5	157.0	7.8	102.0	79.0	89.0	8.5	392.7	120.9	7751.0	0.1	14	<1	<1	2	27	<0.1	5	<1	0.56	<0.05	0.075	0.054	0.002	0.008	0.028	0.001	0.6	<0.001	<0.001	0.01	0.013	<1	0.2	0.01	6.85	0.77	0.86	
1/08/2016	NRE E							144.0							20	18	<1	2	31	<0.1	37	8	37.8	2.7	0.114	0.094	0.001	<0.001	0.016	0.002	0.04	<0.001	<0.001	0.012	0.071	1	0.4	0.02	5.88	1.93	1.8	
1/08/2016	NRE F							79.0							16	1	<1	2	27	<0.1	5	6	1.1	0.24	0.048	0.04	<0.001	<0.001	0.014	0.002	0.06	<0.001	0.002	0.006	0.01	1	0.2	<0.01	6.23	0.91	0.98	
1/08/2016	NRE G							135.0							24	15	<1	4	43	<0.1	31	4	<0.05	0.25	0.137	0.142	0.002	0.005	0.074	0.007	0.42	<0.001	0.002	0.019	0.164	<1	<0.1	<0.01	8.48	2.12	1.94	
1/08/2016	RV21	1:12:13 PM	16.7	4.6	101.0		65.0			6.0	335.0	113.9	11764.0	0.0																												
1/08/2016	RV21		16.0	5.5	134.0	16.0	87.0	61.0	61.7	5.8	331.4	67.1	9009.0	0.0	11	2	1	2	21	<0.1	6	8	1.37	<0.05	2.41	2.36	0.003	0.009	0.171	0.01	0.02	<0.001	0.001	0.042	0.010	2	0.8	0.01	5.72	0.77	0.88	
1/08/2016	RV22A	12:57:17 PM	16.0	4.3	90.0		58.0			5.7	354.7	129.4	13333.0	0.0																												
1/08/2016	RV22A		15.3	5.4	133.0	25.9	86.0	58.0	80.9	7.8	317.0	68.5	9174.0	0.0	12	2	<1	2	22	<0.1	3	4	0.96	<0.05	0.096	0.09	0.008	0.066	0.072	0.003	0.05	<0.001	<0.001	0.012	0.007	1	0.6	0.02	7.18	0.79	0.76	
1/08/2016	RV23A	1:43:38 PM	17.5	7.8	479.0		311.0			4.7	77.7	-48.0	2433.0	0.2																												
1/08/2016	RV23A		15.3	6.7	525.0	21.5	341.0	280.0	73.2	7.0	332.7	-6.6	2336.0	0.2	42	48	3	8	24	<0.1	4	238	0.36	<0.05	0.08	0.073	0.001	0.016	0.019	0.006	0.01	0.002	0.007	0.938	0.372	<1	1.1	0.03	7.93	4.96	5.52	
9/09/2016	RV18							61.0							11	2	1	2	23	<0.1	4	6	0.33	<0.05	0.297	0.298	0.004	0.002	0.120	0.004	<0.01	<0.001	0.001	0.013	0.007	2	1	0.03	7.12	0.77	0.85	
9/09/2016	RV19							161.0							31	15	3	5	40	0.2	16	90	16.2	15.7	1.52	1.42	0.003	0.001	0.04	0.006	<0.01	<0.001	0.014	0.108	0.046	<1	1	1.03	12.5	3.42	3.26	
9/09/2016	RV21							61.0							12	2	1	2	25	<0.1	7	10	0.66	<0.05	2.34	1.74	0.008	0.014	0.142	0.009	0.02	0.001	<0.001	0.044	0.011	3	0.8	<0.01	5.94	0.81	1.05	
9/09/2016	RV22A							52.0							11	1	<1	2	25	<0.1	4	3	0.13	<0.05	0.118	0.105	0.008	0.042	0.062	0.002	0.10	<0.001	<0.001	0.015	0.007	<1	0.4	<0.01	7.32	0.69	0.85	
9/09/2016	RV23A							254.0							41	48	4	8	28	<0.1	4	226	0.36	<0.05	0.056	0.043	0.005	0.007	0.04	0.005	0.01	0.002	0.007	0.987	0.423	3	1.3	0.03	8.11	4.94	5.39	
12/09/2016	NRE A	4:45:00 PM	15.4	5.0	113.0	75.4	73.0	69.0	81.2	7.7	403.2	96.7	10752.0	0.0	7	2	<1	2	13	<0.1	19	<1	15.2	0.05	0.156	0.146	0.006	0.003	0.068	0.006	0.51	<0.001	<0.001	0.006	0.015	2	0.6	0.02	6.42	0.57	0.76	
12/09/2016	NRE C							48.0							7	<1	<1	1	15	<0.1	5	<1	2.15	<0.05	0.037	0.026	<0.001	<0.001	0.026	<0.001	0.24	<0.001	<0.001	0.004	0.005	2	0.3	<0.01	4.42	0.39	0.53	
12/09/2016	NRE D							64.0							12	<1	<1	2	29	<0.1	6	<1	0.41	<0.05	0.033	0.024	0.002	0.007	0.035	0.002	0.71	<0.001	<0.001	0.008	0.013	1	0.3	0.05	6.65	0.69	0.94	
12/09/2016	NRE E							147.0							19	13	<1	2	37	<0.1	31	7	19.3	3.4	0.099	0.084	<0.001	<0.001	0.01	<0.001	0.05	<0.001	<0.001	0.011	0.053	<1	0.2	0.01	5.92	1.64	1.83	
12/09/2016	NRE F							90.0							16	2	1	2	33	<0.1	6	<1	28	0.42	0.091	0.073	0.004	0.001	0.032	0.002	0.06	<0.001	0.001	0.015	0.011	2	55.2	0.18	7.23	0.98	1.06	
12/09/2016	NRE G							232.0							19	25	<1	3	46	<0.1	19	4	0.98	<0.05	0.164	0.142	0.002	0.002	0.07	0.006	0.27	<0.001	0.001	0.017	0.017	<1	0.2	0.03	8.53	2.32	2.58	
8/11/2016	NRE A	3:55:00 PM	17.5	3.6	184.0	0.3	119.0			62.5	5.7	475.9	173.3	6329.0	0.1																											
8/11/2016	NRE C	2:10:41 PM	18.5	4.4	95.0	20.5	61.0			63.1	5.6	380.1	127.6	11904.0	0.0																											
25/01/2017	GW1A	11:14:00 AM	16.4	5.5	300.0	5.8	195.0			47.1	4.4	254.0	60.7	3984.0	0.1																											
25/01/2017	GW1A		16.6	6.1	272.0		176.0	198.0	47.5	4.5	24.1	18.4	4366.0	0.1	30	12	3	10	46	0.1	16	46	3.30	2.53	0.905	0.763	0.005	<0.001	0.092	0.019	0.01	<0.001	0.018	0.179	0.091	2	0.9	0.03	8.25	2.80	2.55	
25/01/2017	NRE C	2:57:00 PM	18.5	4.4	95.0	20.5	61.0			63.1	5.6	380.1	127.6	11904.0	0.0																											
25/01/2017	NRE C	2:57:00 PM	17.9	4.9	75.0		48.0			58.4	5.3	335.9	79.4	15384.0	0.0																											
25/01/2017	NRE D	1:00:00 AM	16.8	4.3	152.0	24.1	98.0			87.7	8.1	380.0	133.5	7751.0	0.1																											
25/01/2017	RV18	9:20:00 AM	16.3	5.1	116.0	25.6	75.0			83.4	7.8	322.1	83.8	10309.0	0.0																											
25/01/2017	RV18		16.5	5.6	108.0		70.0	91.0	73.2	6.9	129.8	45.1	10989.0	0.0	17	2	2	2	24	<0.1	4	4	0.26	<0.05	0.035	0.010	0.003	<0.001	0.1													

Date	Bore	Time	Temp (°C)	Field pH	Field EC (uS/cm)	Turbidity (NTU)	Field TDS (mg/L)	Lab TDS (mg/L)	Field DO (% Sat)	Field DO (mg/L)	Eh (mV) ORP	pH (mV)	RES (Ohms.cm)	SAL	Na (mg/L)	Ca (mg/L)	K (mg/L)	Mg (mg/L)	Cl (mg/L)	F (mg/L)	SO4 (mg/L)	HCO3 (mg/L)	Fe T (mg/L)	Fe Filtr (mg/L)	Mn T (mg/L)	Filtr Mn (mg/L)	Filtr Cu (mg/L)	Filtr Pb (mg/L)	Filtr Zn (mg/L)	Filtr Ni (mg/L)	Filtr Al (mg/L)	Filtr As (mg/L)	Filtr Li (mg/L)	Filtr Ba (mg/L)	Filtr Sr (mg/L)	DOC (mg/L)	Tot N (mg/L)	Tot P (mg/L)	Si (mg/L)	Total Cations (meq/L)	Total Anions (meq/L)	
24/05/2019	NRE C	11:50:52 AM	17.2	3.8	102.0	51.6	66.0			78.6	7.3	331.4	161.8	11494.0	0.0																											
24/05/2019	NRE D	10:47:23 AM	19.3	3.6	196.0		127.0			69.4	6.1	347.4	166.6	5714.0	0.1																											
24/05/2019	RV23A	11:07:50 AM	18.4	6.8	597.0		388.0			49.3	4.5	280.9	-11.6	1915.0	0.3																											
25/07/2019	GW1A	2:59:32 PM	16.2	5.3	328.0	142.0	213.0			60.1	5.8	147.6	81.9	3663.0	0.1																											
25/07/2019	GW1A		15.4	5.8	417.0	24.9	271.0	155.0	37.9	3.7	58.6	22.8	2932.0	0.1	22	11		8	47	<0.1	19	39	18.3	17.4	1.03	0.988	<0.001	<0.001	<0.005	0.018	0.01	<0.001	0.016	0.228	0.076	1	0.2	0.12	7.73	2.22	2.5	
25/07/2019	NRE A	3:00:00 PM	18.0	3.7	232.0	59.4	150.0	99.0	46.4	4.2	425.4	170.4	4975.0	0.1	10	7	<1	3	18	<0.1	41	<1	11.5	3.71	0.234	0.215	0.002	0.009	0.033	0.005	0.19	<0.001	<0.001	0.011	0.033	1	0.2	<0.01	7.27	1.03	1.36	
25/07/2019	NRE E							203.0							31	10	<1	10	73	<0.1	9	35	20.3	14.5	0.753	0.719	<0.001	<0.001	0.014	0.012	<0.01	<0.001	0.008	0.189	0.049	<1	<0.1	<0.01	8.18	2.67	2.94	
25/07/2019	NRE F							161.0							29	3	1	8	63	<0.1	17	4	5.53	0.56	0.812	0.782	<0.001	<0.001	0.052	0.012	0.02	<0.001	0.002	0.026	0.024	<1	<0.1	<0.01	6.95	2.1	2.21	
25/07/2019	NRE G							100.0							27	<1	<1	4	57	<0.1	3	<1	1.24	<0.05	0.176	0.168	<0.001	<0.001	0.04	0.005	0.36	<0.001	<0.001	0.015	0.006	<1	<0.1	<0.01	7.11	1.5	1.67	
26/07/2019	NRE C	2:36:22 PM	17.2	3.8	102.0	51.6	66.0			78.6	7.3	331.4	161.8	11494.0	0.0																											
26/07/2019	NRE C	2:36:22 PM	17.1	4.5	116.0	51.2	75.0			81.8	7.6	276.2	94.7	10101.0	0.0																											
26/07/2019	NRE C		17.1	4.5	116.0	51.2	75.0	51.0		81.8	7.6	276.2	94.7	10101.0	0.0	9	<1	<1	1	19	<0.1	4	<1	3.25	<0.05	0.066	0.062	<0.001	<0.001	0.012	<0.001	0.19	<0.001	<0.001	0.017	0.007	<1	<0.1	<0.01	4.78	0.47	0.62
26/07/2019	NRE D	1:35:37 PM	18.1	4.5	187.0	34.5	121.0			88.3	8.1	254.6	122.9	6134.0	0.1																											
26/07/2019	NRE D		17.0	4.3	191.0	26.1	124.0	90.0		84.8	7.9	283.5	110.4	6172.0	0.1	15	<1	<1	2	33	<0.1	8	<1	1.21	0.52	0.049	0.054	<0.001	0.008	0.013	0.002	0.68	<0.001	<0.001	0.008	0.012	<1	0.4	<0.01	6.8	0.82	1.1
26/07/2019	RV18	10:19:29 AM	17.0	4.3	123.0	32.4	79.0			35.7	3.4	305.2	137.7	9523.0	0.0																											
26/07/2019	RV18		15.0	5.2	147.0	17.6	95.0	69.0		41.4	4.0	199.6	54.7	8403.0	0.1	12	2	2	2	24	<0.1	4	4	0.36	<0.05	0.194	0.164	0.002	<0.001	0.231	0.006	0.01	<0.001	<0.001	0.01	0.006	<1	1.3	<0.01	6.71	0.84	0.84
26/07/2019	RV19	10:58:45 AM	17.0	5.4	303.0	89.4	196.0			43.2	4.1	121.8	75.3	3891.0	0.1																											
26/07/2019	RV19		14.8	6.2	358.0	27.3	232.0	143.0	57.7	5.7	36.3	1.2	3460.0	0.1	24	12	1	5	39	0.1	8	51	14.8	13.9	0.965	0.931	<0.001	<0.001	0.02	0.003	<0.01	<0.001	0.006	0.095	0.028	<1	0.9	0.09	6.34	2.08	2.28	
26/07/2019	RV21	12:59:26 PM	17.5	4.3	137.0	52.1	89.0			59.9	5.6	312.6	136.5	8474.0	0.0																											
26/07/2019	RV21		17.0	5.0	164.0	25.2	106.0	74.0	52.5	4.9	228.8	71.0	7194.0	0.1	13	1	<1	2	29	<0.1	7	4	0.46	<0.05	1.5	1.42	0.001	0.014	0.094	0.007	0.02	<0.001	<0.001	0.035	0.008	<1	1.3	<0.01	6.11	0.78	1.04	
26/07/2019	RV22A	12:31:03 PM	17.0	4.4	127.0	95.5	82.0			77.8	7.3	278.6	129.5	9259.0	0.0																											
26/07/2019	RV22A		16.1	4.8	153.0	22.9	99.0	60.0	40.7	3.9	181.0	77.5	7874.0	0.1	12	2	<1	2	26	<0.1	4	<1	0.36	<0.05	0.059	0.058	0.005	0.047	0.141	0.005	0.06	<0.001	<0.001	0.015	0.006	<1	0.9	<0.01	6.19	0.79	0.82	
26/07/2019	RV23A	2:05:13 PM	17.6	7.0	569.0	21.1	369.0			75.0	7.0	222.5	-14.9	2044.0	0.2																											
26/07/2019	RV23A		16.8	7.4	633.0	19.5	411.0	279.0	66.0	6.2	211.1	-69.8	1872.0	0.3	56	42	3	9	30	<0.1	3	213	0.26	<0.05	0.005	0.003	<0.001	<0.001	0.01	0.003	<0.01	<0.001	0.007	1.05	0.387	<1	0.8	<0.01	6.17	5.35	5.16	
1/10/2019	NRE A	2:40:00 PM	16.3	4.0	239.0	57.7	155.0			45.6	4.3	280.8	123.5	5000.0	0.1																											
1/10/2019	NRE C	2:17:55 PM	18.8	4.8	106.0	8.9	68.0			55.3	5.0	415.8	94.4	10638.0	0.0																											
25/11/2019	RV18	2:37:00 PM	17.0	5.4	114.0	2.3	74.0			45.5	4.3	339.6	65.5	10309.0	0.0																											
25/11/2019	RV19	3:11:00 PM	16.6	6.5	278.0	13.7	180.0			45.5	4.3	105.6	7.6	4273.0	0.1																											
26/11/2019	GW1A	9:39:00 AM	15.3	6.3	355.0	24.9	230.0			34.5	3.4	115.1	19.3	3448.0	0.1																											
26/11/2019	NRE A	2:03:00 PM	16.7	4.1	217.0	99.2	141.0			43.8	4.1	433.1	129.2	5464.0	0.1																											
26/11/2019	NRE C	12:27:00 PM	18.8	4.8	106.0	8.9	68.0			55.3	5.0	415.8	94.4	10638.0	0.0																											
26/11/2019	NRE C	12:27:00 PM	18.9	4.5	115.0	42.0	74.0			66.1	5.8	327.7	92.2	9803.0	0.0																											
26/11/2019	NRE D	11:24:00 AM	17.3	4.5	182.0	5.0	118.0			75.3	7.0	437.7	109.1	6410.0	0.1																											
26/11/2019	RV21	10:18:00 AM	17.4	5.4	147.0	11.1	95.0			55.9	5.2	301.9	64.4	7936.0	0.1																											
26/11/2019	RV22A	10:45:00 AM	16.5	5.1	131.0	2.6	85.0			48.0	4.6	260.2	77.2	9090.0	0.0																											
26/11/2019	RV23A	11:48:00 AM	16.8	7.9	544.0	12.3	353.0			69.3	6.6	351.6	-69.7	2178.0	0.2																											
30/01/2020	RV18	12:45:15 PM	19.0	5.1	0.0	0.0	0.0			47.1	4.2	241.3	58.9		0.0																											
30/01/2020	RV19	1:10:00 PM	18.4	6.2	338.0	12.8	219.0			35.3	3.2	66.1	-3.6	3378.0	0.1																											
31/01/2020	GW1A	9:37:14 AM	17.2	6.0	383.0	9.8	248.0			41.7	3.8	34.8	10.6	3067.0	0.1																											
31/01/2020	GW1A		17.9	6.3	548.0	7.9	356.0	154.0	41.2	3.8	56.1	-8.9	2109.0	0.2	24	13	2	9	46	<0.1	21	48	21.4	14.5	1.08	1.02	<0.001	<0.001	0.029	0.018	<0.01	<0.001	0.014	0.214	0.081	<1	0.7	0.11	8.47	2.48	2.69	
31/01/2020	NRE A	3:05:00 PM	18.7	4.5	235.0	25.5	152.0	126.0	39.8	3.5	313.8	93.0	4830.0	0.1	13	5	<1	4	18																							



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APPENDIX E – GROUNDWATER MONITORING PROGRAM

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
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Doc Title	GROUNDWATER MANAGEMENT PLAN		

Monitoring Requirement	Monitoring Location	Timing/ Frequency			Parameters	Purpose
		Prior to Mining	During Mining	Post Mining		
Monitoring of swamp soil moisture and shallow water	<p>Swamp sites with soil moisture probes and piezometers, including:</p> <p>Moisture probes and piezometers:</p> <p>PB4 (A/B/D) near swamp BCUS4</p> <p>PCc10 (A/B) at CCUS10</p> <p>PCc12 (A/B) at CCUS12</p> <p>PCc4 (B/C/D) at CCUS4</p> <p>PCc5 (A/B/D) at CCUS5</p> <p>PCr1 (A/B/C) at CRUS1</p> <p>Piezometers only:</p> <p>PB4C near swamp BCUS4</p> <p>PCc2 at CCUS2</p> <p>PCc3 at CCUS3</p> <p>PCc4A at CCUS4</p> <p>PCc5C at CCUS5</p> <p>PCc6 at CCUS6</p> <p>PCr1D at CRUS1</p>	<p>Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped 2 monthly (once every two months)</p> <p>2 monthly – field analysis</p> <p>Quarterly – discrete analysis</p> <p>Annual – full metals suite analysis</p>	<p>Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped monthly in swamps being actively undermined</p> <p>2 monthly – field analysis</p> <p>Quarterly – discrete analysis</p> <p>Annual – full metals suite analysis</p>	<p>Daily – water level monitoring with logger set at minimum 12 hourly interval and downloaded and dipped for an agreed period (minimum 1 year) after the swamp is undermined</p> <p>2 monthly – field analysis</p> <p>Quarterly – discrete analysis</p>	<p>Field analysis*</p> <p>Discrete#</p> <p>Full metals suite^</p>	<p>Verify predicted swamp water level/moisture response and water quality changes to existing operations and inform future model iterations and updates.</p> <p>Verify predicted swamp water level/moisture response to mine closure.</p>

Monitoring Requirement	Monitoring Location	Timing/ Frequency			Parameters	Purpose
		Prior to Mining	During Mining	Post Mining		
	Shallow piezometers near swamp locations, including: SP1 near CCUS6 SP2 near CCUS3 and CCUS4	Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped 2 monthly (once every two months) 2 monthly – field analysis Quarterly – discrete analysis	Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped monthly in swamps being actively undermined 2 monthly – field analysis Quarterly – discrete analysis	Daily – water level monitoring with logger set at minimum 12 hourly interval and downloaded and dipped for an agreed period (minimum 1 year) after the swamp is undermined 2 monthly – field analysis Quarterly – discrete analysis	Field analysis* Discrete#	Identify if current dry conditions may change with the cessation of longwall mining and recovery, and changes in climatic conditions.
	Installation of additional swamp soil moisture probes and water piezometers at identified swamp locations: PCc1 A (SM & PZ)/B(SM)/C(SM & PZ) at CCUS1 PCc6 B (SM & PZ) at CCUS6 PCc14 (SM & PZ) at CCUS14 PCc20 (SM & PZ) at CCUS20 PCc21 (SM) at CCUS21 PCr2 (SM) at CRUS2 PCr6 (SM) at CRUS6	Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped bi-monthly 2 monthly – field analysis of piezometers Quarterly – discrete analysis of piezometers Annual – full metals suite analysis	Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped monthly in swamps being actively undermined. 2 monthly – field analysis of piezometers Quarterly – discrete analysis of piezometers Annual – full metals suite analysis	Daily – water level monitoring with logger set at minimum 12 hourly interval and downloaded and dipped for an agreed period (minimum 1 year) after the swamp is undermined. 2 monthly – field analysis of piezometers Annual – discrete analysis of piezometers	Field analysis* Discrete# Full metals suite ^	Verify predicted swamp water level/moisture response to existing operations and inform future model iterations and updates. Verify predicted swamp water level/moisture response to mine closure.

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Monitoring Requirement	Monitoring Location	Timing/ Frequency			Parameters	Purpose
		Prior to Mining	During Mining	Post Mining		
Monitoring of groundwater levels and head gradients near swamps	Swamp monitoring paired open standpipes and VWP's at existing locations NRE1A and NREA near CCUS2 RV16 within CCUS1 RV20 near CCUS6 RV19 near CRUS1 RV21 near BCUS4	Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped (for open standpipes) bi-monthly	Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped (for open standpipes) monthly in areas being actively undermined	Daily – water level monitoring with logger set at 12 hourly interval and downloaded and dipped (for open standpipes) bi-monthly for an agreed period (minimum 1 year) after the area is undermined	Field analysis* Discrete# Full metals suite ^	Verify predicted groundwater level and swamp water level/moisture response to existing operations and inform future model iterations and updates. Assess head gradients and recharge/discharge processes in relation to the swamps.
		2 monthly – field analysis for open standpipes Quarterly – discrete analysis for open standpipes Annual – full metals suite analysis	2 monthly – field analysis for open standpipes Quarterly – discrete analysis for open standpipes Annual – full metals suite analysis	Quarterly – field analysis for open standpipes for an agreed period (minimum 1 year) after mining is completed Annual – discrete analysis for open standpipes for an agreed period (minimum 1 year) after mining is completed		Verify predicted groundwater level and swamp water level/moisture response to mine closure. Assess head gradient changes and recharge/discharge processes in relation to the swamps post closure

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
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Monitoring Requirement	Monitoring Location	Timing/ Frequency			Parameters	Purpose
		Prior to Mining	During Mining	Post Mining		
Monitoring of groundwater levels and head gradients near swamps to inform future model updates and mine closure planning	Installation of additional paired monitoring points near swamps: RV39 near CCUS6 RV40 near CRUS2 RV41 near CCUS20 RV42 near CCUS1 RV44 near CRUS3 RV46 near CCUS14	Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped (for open standpipes) bi-monthly 2 monthly – field analysis for open standpipes 2 monthly – discrete analysis for open standpipes within first 12 months of installation, reducing to quarterly frequency Annual – full metals suite analysis	Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped (for open standpipes) monthly in areas being actively undermined 2 monthly – field analysis for open standpipes 2 monthly – discrete analysis for open standpipes within first 12 months of installation, reducing to quarterly frequency Annual – full metals suite analysis	Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped (for open standpipes) bi-monthly for an agreed period (minimum 1 year after the area is undermined) 2 monthly – field analysis for open standpipes for an agreed period (minimum 1 year) after mining is completed Annual – discrete analysis for open standpipes for an agreed period (minimum 1 year) after mining is completed	Field analysis* Discrete# Full metals suite ^	Verify predicted groundwater level and swamp water level/moisture response to existing operations and inform future model iterations and updates. Assess head gradients and recharge/discharge processes in relation to the swamps.
Monitoring of existing groundwater sites	Open standpipes: NRE A, NRE C, NRE D, GW1A, RV18, RV19, RV21, RV22A, RV23A	Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped 2 monthly 2 monthly – field analysis for open standpipes Quarterly – discrete analysis for open standpipes	Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped monthly in areas being actively undermined 2 monthly – field analysis for open standpipes	Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped (for open standpipes) bi-monthly for an agreed period (minimum 1 year after the area is undermined) 2 monthly – field analysis for open standpipes for an agreed period	Field analysis* Discrete# Full metals suite ^	Verify predicted groundwater level response to existing operations and inform future model iterations and updates. Verify predicted groundwater level recovery response.

Monitoring Requirement	Monitoring Location	Timing/ Frequency			Parameters	Purpose
		Prior to Mining	During Mining	Post Mining		
		Annual – full metals suite analysis	Quarterly – discrete analysis for open standpipes Annual – full metals suite analysis	(minimum 1 year) after mining is completed Annual – discrete analysis for open standpipes for an agreed period (minimum 1 year) after mining is completed		
Monitoring of existing groundwater sites	VWPs: NRE1B, NRE1D, GW1, RV16, RV17, RV20, RV22, RV23, RV24, RV25, RV27, RV29, RV35 and RV36	Daily – water level monitoring with logger set at 6 hourly interval and downloaded 2 monthly	Daily – water level monitoring with logger set at 6 hourly interval and downloaded monthly in areas being actively undermined	Daily – water level monitoring with logger set at 6 hourly interval and downloaded 2 monthly for an agreed period (minimum 1 year after the area is undermined)	Water level/pressure	Verify predicted groundwater level response to existing operations and inform future model iterations and updates. Verify predicted groundwater level recovery response.
Establishment and monitoring of additional targeted monitoring sites to inform future Model updates and mine closure planning	Installation of additional monitoring locations Open standpipes: RV40, RV41, RV42, RV43A, RV45, RV46 RV47 VWPs: RV43 and RV48	Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped (for open standpipes) 2 monthly 2 monthly – field analysis for open standpipes 2 monthly – discrete analysis for open standpipes within first 12 months of installation, reducing to quarterly frequency	Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped (for open standpipes) monthly in areas being actively undermined 2 monthly – field analysis for open standpipes 2 monthly – discrete analysis for open standpipes within first 12 months of installation,	Daily – water level monitoring with logger set at 6 hourly interval and downloaded and dipped (for open standpipes) 2 monthly for an agreed period (minimum 1 year after the area is undermined) 2 monthly – field analysis for open standpipes for an agreed period (minimum 1 year) after mining is completed	Field analysis* Discrete# Full metals suite ^	Verify predicted groundwater levels and response to existing operations and inform future model iterations and updates. Characterise groundwater conditions and changes relevant to nearby GDEs and subsidence monitoring (where applicable)

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Monitoring Requirement	Monitoring Location	Timing/ Frequency			Parameters	Purpose
		Prior to Mining	During Mining	Post Mining		
		Annual – full metals suite analysis	reducing to quarterly frequency Annual – full metals suite analysis	Annual – discrete analysis for open standpipes for an agreed period (minimum 1 year) after mining is completed		Verify predicted groundwater level recovery response.
Inflows to existing underground workings – volume and quality	Mine workings	Daily volumetric flow monitoring of mine inflow and discharge Monthly – field analysis Quarterly – full metals suite analysis	Daily volumetric flow monitoring of mine inflow and discharge Monthly – field analysis Quarterly – full metals suite analysis	-	Field analysis* Full metals suite ^	Verify predicted groundwater inflows to existing operations and inform future model iterations and updates. Monitor water quality trends for early identification of changes compared to current mine inflow water quality.
Adit seepage monitoring and inspection – seepage rate and water quality	Mine workings	-	-	In accordance with the Adit Discharge Water Management Plan: Daily volumetric flow monitoring of discharge Monthly – field analysis for an agreed period (minimum 1 year) after mining is completed Quarterly – full metals analysis for an agreed period (minimum 1 year)	Field analysis* Full metals suite ^	Visualise and verify post closure seepage conditions.



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Monitoring Requirement	Monitoring Location	Timing/ Frequency			Parameters	Purpose
		Prior to Mining	During Mining	Post Mining		
				after mining is completed		

* **Field analysis:** includes field analysis of pH, EC, DO, ORP and temp

Discrete: includes field analysis of pH, EC, DO, ORP and temp. As well as laboratory analysis of TDS, TSS, major ions (Na, K, Ca, Mg, Cl, SO₄), F, HCO₃, CaCO₃, NO₃, Total N, Total P, Total alkalinity, filtered DOC and dissolved metals Al, P, Cu, Pb, Zn, Ni, Sb, Fe, Mn, Mo As, Li and Ba.

^ **Full metals suite:** includes field analysis of pH, EC, DO, ORP and temp. As well as discrete laboratory analysis suite **plus** laboratory analysis of additional dissolved metals B, Cd, Co, Hg, Se and Ag

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APPENDIX F - TRIGGER ACTION RESPONSE PLAN

NOTE: These TARPs (including the duration for which these TARPs apply to monitoring at specific locations) are subject to more detailed triggers as set out in approved Extraction Plans for LW 6 and approved Second Workings. To the extent of any inconsistency between these TARPs and TARPs contained in an approved EP, the EP provisions apply.

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
Swamp water quality	Existing swamp piezometers: PB4 B near swamp BCUS4 PCc10 (A/B) at CCUS10 PCc12 A at CCUS12 PCc2 at CCUS2 PCc4 (C) at CCUS4 PCc5 (B) at CCUS5 PCr1 (B) at CRUS1 For newly installed swamp piezometers refer to USMP	EC	Field analysis when piezometers are manually dipped: <ul style="list-style-type: none"> Every 2 months prior to and after swamp is mined under; Monthly during period when swamp is mined under. 	Detection of potential impact to swamp water conditions due to mine activities	Level 1: No exceedance of Level 2 or Level 3	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)
					Level 2: One reading above the trigger level of 193 $\mu\text{S}/\text{cm}$	1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review weather station data, groundwater quality and level data and subsidence monitoring to identify whether further investigation is warranted. If an impact due to mining is identified progress to Level 3.	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified (see Level 3 reporting requirements). One to two months to complete depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
					Level 3: Two consecutive readings above the trigger of 193 µS/cm	<ol style="list-style-type: none"> 1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances (e.g. climatic, systemic, failure) 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting 	<ol style="list-style-type: none"> 1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval 	Russell Vale Colliery (Environmental Manager)
Swamp water quality		pH	Field analysis when piezometers are manually dipped: <ul style="list-style-type: none"> • Every 2 months prior to and after swamp is mined under; • Monthly during period when swamp is mined under. 	Detection of potential impact to swamp water conditions due to mine activities	Level 1: No exceedance of Level 2 or Level 3	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)
					Level 2: One reading outside of the trigger range of 3.8 to 6.3	<ol style="list-style-type: none"> 1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review weather station data, 	<ol style="list-style-type: none"> 1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified (see Level 3 reporting) 	Russell Vale Colliery (Environmental Manager)

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
	Existing swamp piezometers: PB4 B near swamp BCUS4 PCc10 (A/B) at CCUS10 PCc12 A at CCUS12 PCc2 at CCUS2 PCc4 (C) at CCUS4 PCc5 (B) at CCUS5 PCr1 (B) at CRUS1 For newly installed swamp piezometers refer to USMP					groundwater quality and level data and subsidence monitoring to identify whether further investigation is warranted. If an impact due to mining is identified progress to Level 3.	requirements). One to two months to complete depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)
					Level 3: Two consecutive readings outside of the trigger range of 3.8 to 6.3	<ol style="list-style-type: none"> 1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances (e.g. climatic, systemic, failure) 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting 	<ol style="list-style-type: none"> 1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval 	

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
Swamp water levels	Existing swamp piezometers: PB4 B near swamp BCUS4 PCc10 (A/B) at CCUS10 PCc12 A at CCUS12 PCc2 at CCUS2 PCc4 (C) at CCUS4 PCc5 (B) at CCUS5 PCr1 (B) at CRUS1 For newly installed swamp piezometers refer to USMP	Water level	Daily – water level monitoring with logger set 6 hourly interval. Data downloaded and manually dipped: <ul style="list-style-type: none"> Every 2 months prior to and after swamp is mined under; Monthly during period when swamp is mined under. 	Detection of potential impact to swamp water conditions due to mine activities	Level 1: Water level readings consistently above the water level trigger* or levels below trigger during periods of low rainfall (<20 mm/month)	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)
					Level 2: One monthly water level reading above the water level trigger of: PCc10A: 0.56 mbgl; or PCc2: 1.6 mbgl; or PCc4C: 1.05 mbgl; or PCc5B: 1.13 mbgl; or PCr1B: 0.68 mbgl; or and the trigger is recorded during a period with	1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review weather station data, groundwater quality and level data and subsidence monitoring to identify whether further investigation is warranted. If an impact due to mining is identified progress to Level 3.	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified (see Level 3 reporting requirements). One to two months to complete depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
					rainfall above 20 mm/month			
					<p>Level 3: Two consecutive monthly water level readings above the water level trigger of:</p> <p>PCc10A: 0.56 mbgl; or PCc2: 1.6 mbgl; or PCc4C: 1.05 mbgl; or PCc5B: 1.13 mbgl; or PCr1B: 0.68 mbgl; or and the trigger is recorded during a period with rainfall above 20 mm/month</p>	<p>1. Inform DPIE and Water NSW</p> <p>2. Investigate and report on the cause of the trigger exceedances e.g. climatic, systemic, failure)</p> <p>3. Inform DPIE and WaterNSW of investigation outcomes</p> <p>4. Identify mitigation options</p> <p>5. Review monitoring frequency and parameter</p> <p>6. Report potential impact, and response, within six monthly reporting</p>	<p>1. Immediately</p> <p>2. Commence within one week</p> <p>3. One month</p> <p>4. Commence works within 2 months</p> <p>5. One month</p> <p>6. Six monthly reporting in accordance with Extraction Plan approval</p>	<p>Russell Vale Colliery (Environmental Manager)</p>

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
Hawkesbury Sandstone water quality	Existing open standpipes: NRE A, NRE C, NRE D, GW1A, RV18, RV19, RV21, RV22A	EC	2 monthly – field analysis for open standpipes Quarterly – discrete analysis for open standpipes	Detection of potential impact to Hawkesbury Sandstone water due to mine activities	Level 1: No exceedance of Level 2 or Level 3 triggers	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)
					Level 2: One reading above the trigger level of 376 µS/cm	1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review weather station data, groundwater quality and level data and subsidence monitoring to identify whether further investigation is warranted. If an impact due to mining is identified progress to Level 3.	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified (see Level 3 reporting requirements). One to two months to complete depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
					Level 3: Two consecutive readings above the trigger level of 376 $\mu\text{S}/\text{cm}$	<ol style="list-style-type: none"> 1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances (e.g. climatic, systemic, failure) 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting 	<ol style="list-style-type: none"> 1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval 	Russell Vale Colliery (Environmental Manager)
Hawkesbury Sandstone water quality	Existing open standpipes: NRE A, NRE C, NRE D, GW1A, RV18, RV19, RV21, RV22A	pH	2 monthly – field analysis for open standpipes Quarterly – discrete analysis for open standpipes	Detection of potential impact to Hawkesbury Sandstone water due to mine activities	Level 1: No exceedance of Level 2 or Level 3 triggers	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)
					Level 2: One reading outside of the trigger range of 3.7 to 6.5	<ol style="list-style-type: none"> 1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review 	<ol style="list-style-type: none"> 1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified 	Russell Vale Colliery (Environmental Manager)

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
						weather station data, groundwater quality and level data and subsidence monitoring to identify whether further investigation is warranted. If an impact due to mining is identified progress to Level 3.	(see Level 3 reporting requirements). One to two months to complete depending on timing of review of second data period.	
					Level 3: Two consecutive readings outside of the trigger range of 3.7 to 6.5	<ol style="list-style-type: none"> 1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances (e.g. climatic, systemic, failure) 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting 	<ol style="list-style-type: none"> 1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval 	Russell Vale Colliery (Environmental Manager)

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
Hawkesbury Sandstone water levels	Existing open standpipes: NRE A, NRE C, NRE D, GW1A, RV18, RV19, RV21, RV22A	Water level	Monthly manual dipped water level in areas being actively undermined	Detection of potential impact to Hawkesbury Sandstone water due to mine activities	Level 1: No exceedance of Level 2 or Level 3 triggers	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)
					Level 2: One monthly water level reading below the water level trigger	1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review weather station data, groundwater quality and level data and subsidence monitoring to identify whether further investigation is warranted. If an impact due to mining is identified progress to Level 3.	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified (see Level 3 reporting requirements). One to two months to complete depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
					Level 3: Two consecutive monthly water level readings below the water level trigger	1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances (e.g. climatic, systemic, failure) 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting	1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval	Russell Vale Colliery (Environmental Manager)
Bulgo Sandstone water quality	Newly installed open standpipes, which may include: RV43A and RV44	EC	2 monthly – field analysis for open standpipes	Verification of characterisation of Bulgo Sandstone water quality and detection of changes in quality post mining and closure, outside of predicted impacts	Level 1: No exceedance of Level 2 or Level 3 triggers	Report negligible impact in routine reporting.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)
					Level 2: One reading above the trigger level of 376 µS/cm within the first 12 months of installation	1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review weather station data,	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified (see Level 3 reporting)	Russell Vale Colliery (Environmental Manager)

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
						groundwater quality and level data and subsidence monitoring to identify whether further investigation is warranted. If an impact due to mining is identified progress to Level 3.	requirements). One to two months to complete depending on timing of review of second data period.	
					Level 3: Two consecutive readings above the trigger level of 376 $\mu\text{S}/\text{cm}$ within the first 12 months of installation	1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting	1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval	Russell Vale Colliery (Environmental Manager)
Bulgo Sandstone water quality	Newly installed open standpipes, which may	pH	2 monthly – field analysis for open standpipes	Verification of characterisation of Bulgo Sandstone water quality	Level 1: No exceedance of Level 2 or Level 3 triggers	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)

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	include: RV43A and RV44			and detection of changes in quality post mining and closure, outside of predicted impacts	Level 2: One reading outside of the trigger range of 3.7 to 6.5 within the first 12 months of installation	1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review weather station data, groundwater quality and level data and subsidence monitoring to identify whether further investigation is warranted. If an impact due to mining is identified progress to Level 3.	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified (see Level 3 reporting requirements). One to two months to complete depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)
					Level 3: Two consecutive readings outside of the trigger range of 3.7 to 6.5 within the first 12 months of installation	1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances	1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval	Russell Vale Colliery (Environmental Manager)

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
						(e.g. climatic, systemic, failure) 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting		
Bulgo Sandstone water levels	Newly installed open standpipes, which may include: RV43A and RV44	Water level	Monthly manual dipped water levels	Detection of changes in Bulgo Sandstone groundwater level post mining and closure, outside of predicted impacts	Level 1: No exceedance of Level 2 or Level 3 triggers	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)
					Level 2: One monthly water level reading below the water level trigger	1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review weather station data, groundwater quality and level data and subsidence monitoring to identify whether further investigation is warranted.	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified (see Level 3 reporting requirements). One to two months to complete depending	Russell Vale Colliery (Environmental Manager)

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						If an impact due to mining is identified progress to Level 3.	on timing of review of second data period.	
					Level 3: Two consecutive monthly water level readings below the water level trigger	1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances (e.g. climatic, systemic, failure) 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting	1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval	Russell Vale Colliery (Environmental Manager)
Groundwater levels and vertical head profile	Existing VWP's: NRE1B, NRE1D, GW1, RV16, RV17, RV20, RV22, RV23, RV24, RV25, RV27, RV29, RV35 and RV36	Water level	Daily – water level monitoring with logger set at 6 hourly interval and downloaded monthly in areas being actively undermined	Impact on groundwater levels and vertical head profile due to mining impacts/subsidence impacts beyond those already predicted.	Level 1: No exceedance of Level 2 or Level 3 triggers	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)
					Level 2: Detection of a significant change in vertical head gradient at	1. Review condition of the VWP equipment. 2. If the data is representative, review climate trends, groundwater trends within	1. One week 2. Two weeks to assess whether further investigation is	Russell Vale Colliery (Environmental Manager)

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
					one VWP sensor, as indicated by movement of the head profile below (to the left) of the minimum predicted head profile and baseline observation data (refer Appendix H)	other sensors and nearby monitoring locations and subsidence monitoring to identify whether further investigation is warranted. If an impact due to mining is identified progress to Level 3.	required. Commence investigation if exceedance of Level 3 criteria identified (see Level 3 reporting requirements). One to two months to complete depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)
					Level 3: Detection of a significant change in vertical head gradient at more than one VWP sensor, as indicated by movement of the head profile below (to the left) of the minimum predicted head profile and baseline observation data across multiple sensor	<ol style="list-style-type: none"> 1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting 	<ol style="list-style-type: none"> 1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval 	

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
					levels (refer Appendix H)			
Groundwater levels and vertical head profile	Newly installed VWP's, which may include: RV43 and RV48	Water level	Daily – water level monitoring with logger set at 6 hourly interval and downloaded monthly	Impact on groundwater levels and vertical head profile due to mining impacts/subsidence impacts and recovery post mining, beyond those already predicted.	Level 1: No exceedance of Level 2 or Level 3 triggers	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)
					Level 2: Detection of a significant change in vertical head gradient at one VWP sensor, as indicated by movement of the head profile below (to the left) of the minimum predicted head profile.	1. Review condition of the VWP equipment. 2. If the data is representative, review climate trends, groundwater trends within other sensors and nearby monitoring locations and subsidence monitoring to identify whether further investigation is warranted. If an impact due to mining is identified progress to Level 3.	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified (see Level 3 reporting requirements). One to two months to complete depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
					Level 3: Detection of a significant change in vertical head gradient at more than one VWP sensor, as indicated by movement of the head profile below (to the left) of the minimum predicted head profile.	1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances (e.g. climatic, systemic, failure) 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting	1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval	Russell Vale Colliery (Environmental Manager)
Underground workings	Mine inflows	Inflow	Daily volumetric flow monitoring of mine inflow and discharge	Inflows volumes to underground workings is in line with predictions and captured by appropriate water licences.	Level 1: Mine pump volumes are within predicted mine inflow range (< 1ML/day) – excluding changes in dewatering volumes to manage inrush risk or due to equipment maintenance.	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)

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Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
					Level 2: Increase in flow rate of >1ML/day (above predictions) for 4 successive days from active mining areas - excluding changes in dewatering volumes to manage inrush risk or due to equipment maintenance.	1. Review equipment to verify if the reading is representative. If not, remeasure. 2. If the data is representative, review mine water quality and inflow data, ground water data and geotechnical/subsidence records to identify any adverse trends that may indicate any adverse trends that may indicate an impact beyond previous predictions. If an impact due to mining is identified progress to Level 3.	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified (see Level 3 reporting requirements). One to two months to complete depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)

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					Level 3: Increase in flow rate of >1ML/day (above predictions) for 7 successive days from active mining areas - excluding changes in dewatering volumes to manage inrush risk or due to equipment maintenance.	1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting	1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval	Russell Vale Colliery (Environmental Manager)
Underground workings	Mine inflows	pH	Monthly – field analysis Quarterly – discrete analysis	Underground mine water quality will not impact current beneficial use of groundwater in Permian coal measures	Level 1: No exceedance of Level 2 or Level 3 triggers	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)
					Level 2: One reading outside of the trigger range of 7.7 to 9.4	1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review mine water quality and inflow data, groundwater	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified	Russell Vale Colliery (Environmental Manager)

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						data and geotechnical/subsidence records to identify any adverse trends that may indicate an impact beyond previous predictions. If an impact due to mining is identified progress to Level 3.	(see Level 3 reporting requirements). One to two months to complete depending on timing of review of second data period.	
					Level 3: Two consecutive readings outside of the trigger range of 7.7 to 9.4	<ol style="list-style-type: none"> 1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances (e.g. climatic, systemic, failure) 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting 	<ol style="list-style-type: none"> 1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval 	Russell Vale Colliery (Environmental Manager)
Underground workings	Mine inflows	EC	Monthly – field analysis Quarterly – discrete analysis	Underground mine water quality will not impact current	Level 1: No exceedance of Level 2 or Level 3 triggers	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)

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Doc Title	GROUNDWATER MANAGEMENT PLAN		

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
				beneficial use of groundwater in Permian coal measures	Level 2: One reading above the trigger level of 5,226 $\mu\text{S}/\text{cm}$	1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review mine water quality and inflow data, groundwater data and geotechnical/subsidence records to identify any adverse trends that may indicate an impact beyond previous predictions. If an impact due to mining is identified progress to Level 3.	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified (see Level 3 reporting requirements). One to two months to complete depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)
					Level 3: Two consecutive readings above the trigger level of 5,226 $\mu\text{S}/\text{cm}$	1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances	1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval	Russell Vale Colliery (Environmental Manager)

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
Type	Plan	Date Published	17/11/2021
Doc Title	GROUNDWATER MANAGEMENT PLAN		

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
						(e.g. climatic, systemic, failure) 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting		
Underground workings	Mine inflows	Sulfate	Quarterly – discrete analysis	Underground mine water quality will not impact current beneficial use of groundwater in Permian coal measures	Level 1: No exceedance of Level 2 or Level 3 triggers	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)
					Level 2: One reading above the trigger level of 167 mg/L	1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review mine water quality and inflow data, groundwater data and geotechnical/subsidence records to identify any adverse trends that may indicate an impact beyond previous predictions. If an impact	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified (see Level 3 reporting requirements). One to two months to complete depending	Russell Vale Colliery (Environmental Manager)

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
Type	Plan	Date Published	17/11/2021
Doc Title	GROUNDWATER MANAGEMENT PLAN		

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
						due to mining is identified progress to Level 3.	on timing of review of second data period.	
					Level 3: Two consecutive readings above the trigger level of 167 mg/L	1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances (e.g. climatic, systemic, failure) 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting	1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval	Russell Vale Colliery (Environmental Manager)
Underground workings	Mine inflows	Dissolved Al	Quarterly – full metals analysis	Underground mine water quality will not impact current beneficial use of groundwater in Permian coal measures	Level 1: No exceedance of Level 2 or Level 3 triggers	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)
					Level 2: One reading above the trigger level of 0.11 mg/L	1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level	Russell Vale Colliery (Environmental Manager)

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
Type	Plan	Date Published	17/11/2021
Doc Title	GROUNDWATER MANAGEMENT PLAN		

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
						mine water quality and inflow data, groundwater data and geotechnical/subsidence records to identify any adverse trends that may indicate an impact beyond previous predictions. If an impact due to mining is identified progress to Level 3.	3 criteria identified (see Level 3 reporting requirements). One to two months or complete depending on timing of review of second data period.	
					Level 3: Two consecutive readings above the trigger level of 0.11 mg/L	<ol style="list-style-type: none"> 1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances (e.g. climatic, systemic, failure) 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting 	<ol style="list-style-type: none"> 1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval 	Russell Vale Colliery (Environmental Manager)
Underground workings	Mine inflows	Dissolved As	Quarterly – full metals analysis	Underground mine water quality will not impact current	Level 1: No exceedance of Level 2 or Level 3 triggers	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
Type	Plan	Date Published	17/11/2021
Doc Title	GROUNDWATER MANAGEMENT PLAN		

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
				beneficial use of groundwater in Permian coal measures	Level 2: One reading above the trigger level of 0.03 mg/L	1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review mine water quality and inflow data, groundwater data and geotechnical/subsidence records to identify any adverse trends that may indicate an impact beyond previous predictions. If an impact due to mining is identified progress to Level 3.	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified (see Level 3 reporting requirements). One to two months to complete depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)
					Level 3: Two consecutive readings above the trigger level of 0.03 mg/L	1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances	1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval	Russell Vale Colliery (Environmental Manager)

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
						(e.g. climatic, systemic, failure) 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting		
Underground workings	Mine inflows	Dissolved Mo	Quarterly – full metals analysis	Underground mine water quality will not impact current beneficial use of groundwater in Permian coal measures	Level 1: No exceedance of Level 2 or Level 3 triggers	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)
					Level 2: One reading above the trigger level of 0.09 mg/L	1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review mine water quality and inflow data, groundwater data and geotechnical/subsidence records to identify any adverse trends that may indicate an impact beyond previous predictions. If an impact	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level 3 criteria identified (see Level 3 reporting requirements). One to two months to complete depending	Russell Vale Colliery (Environmental Manager)

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
Type	Plan	Date Published	17/11/2021
Doc Title	GROUNDWATER MANAGEMENT PLAN		

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
						due to mining is identified progress to Level 3.	on timing of review of second data period.	
					Level 3: Two consecutive readings above the trigger level of 0.09 mg/L	1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances (e.g. climatic, systemic, failure) 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting	1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval	Russell Vale Colliery (Environmental Manager)
Underground workings	Mine inflows	Dissolved Sb	Quarterly – full metals analysis	Underground mine water quality will not impact current beneficial use of groundwater in Permian coal measures	Level 1: No exceedance of Level 2 or Level 3 triggers	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)
					Level 2: One reading above the trigger level of 0.03 mg/L	1. Review sampling methodology/ equipment to verify if the reading is representative. If not, resample and test within 7 days of the result. 2. If the data is representative, review	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level	Russell Vale Colliery (Environmental Manager)

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
Type	Plan	Date Published	17/11/2021
Doc Title	GROUNDWATER MANAGEMENT PLAN		

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
						mine water quality and inflow data, groundwater data and geotechnical/subsidence records to identify any adverse trends that may indicate an impact beyond previous predictions. If an impact due to mining is identified progress to Level 3.	3 criteria identified (see Level 3 reporting requirements). One to two months to complete depending on timing of review of second data period.	
					Level 3: Two consecutive readings above the trigger level of 0.03 mg/L	1. Inform DPIE and Water NSW 2. Investigate and report on the cause of the trigger exceedances (e.g. climatic, systemic, failure) 3. Inform DPIE and WaterNSW of investigation outcomes 4. Identify mitigation options 5. Review monitoring frequency and parameters 6. Report potential impact, and response, within six monthly reporting	1. Immediately 2. Commence within one week 3. One month 4. Commence works within 2 months 5. One month 6. Six monthly reporting in accordance with Extraction Plan approval	Russell Vale Colliery (Environmental Manager)

*Swamp Water Level Triggers: Water level trigger - (in mbgl)

PB4A: 1.29, PCc10A: 0.56, PCc10B: 0.90, PCc12A: 0.70, PCc2: 1.60, PCc4C: 1.05, PCc5B: 1.13, PCr1B: 0.68



Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
Type	Plan	Date Published	17/11/2021
Doc Title	GROUNDWATER MANAGEMENT PLAN		

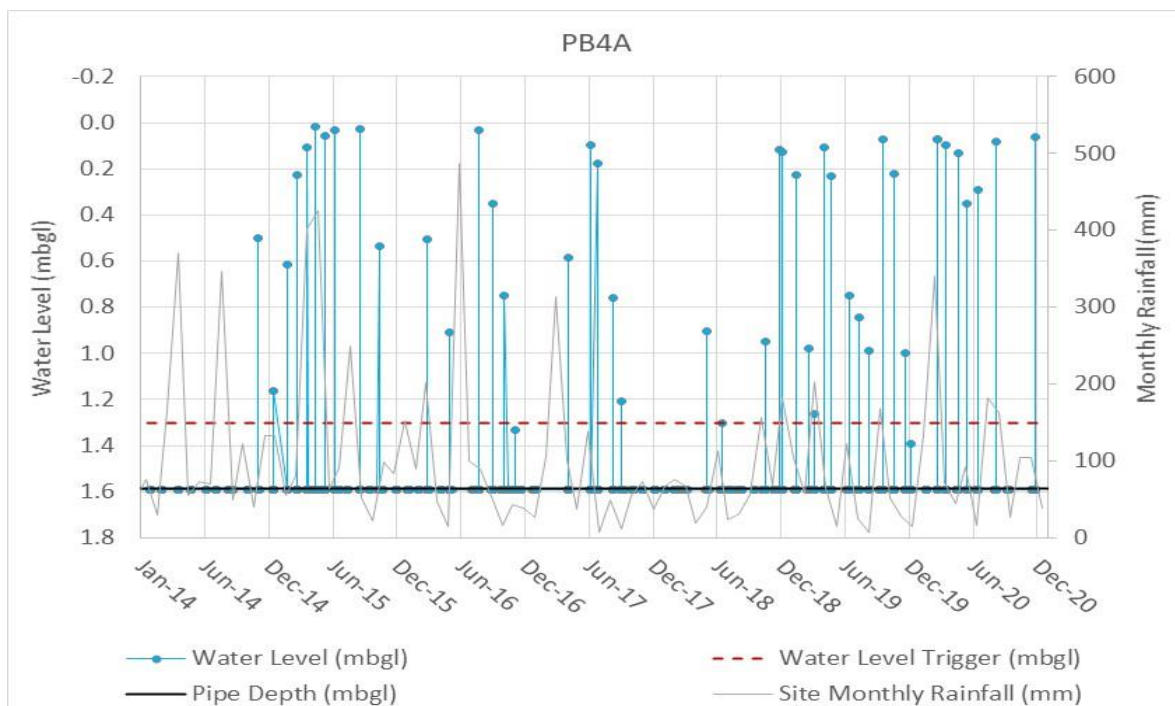
APPENDIX G – WATER LEVEL TRIGGERS

Swamp Water Level Trigger

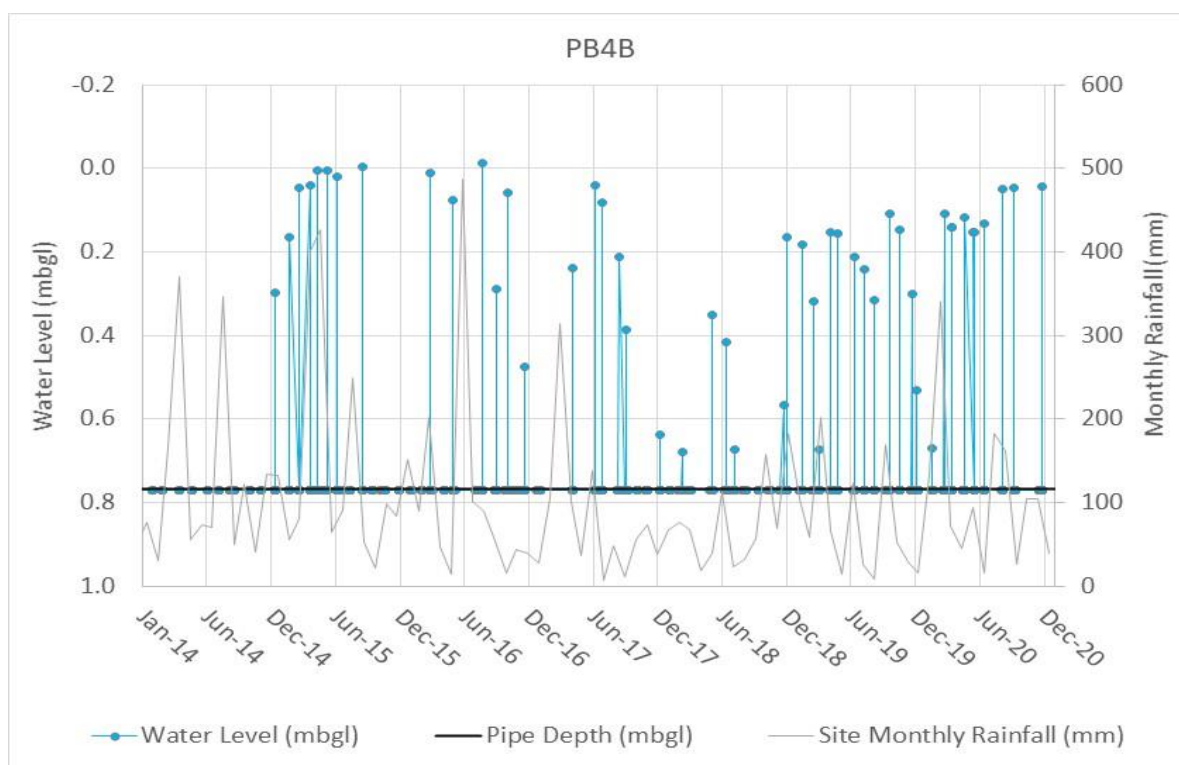
Swamp Trigger Site	Trigger Level			
	Field pH ¹	Field EC (µS/cm) ²	Standing Water Level ³ (mbTOC)	Standing Water Level (mbgl)
PB4A	3.8 – 6.3	193	2.64	1.29 ³
PCc10A			2.22	0.56 ³
PCc10B			2.57	0.90 ³
PCc12A			2.37	0.70 ³
PCc2			2.56	1.60 ³
PCc4C			2.98	1.05 ³
PCc5B			2.70	1.13 ³
PCr1B			2.26	0.68 ³

- Notes:**
1. pH trigger based on 5th and 95th percentile baseline data for RVE swamps. Trigger criteria of consecutive readings (based on criteria level) recorded outside trigger level for prescribed trigger bores
 2. EC trigger based on 95th percentile baseline data for RVE swamps. Trigger criteria of consecutive readings (based on criteria level) recorded outside trigger level for prescribed trigger bores
 3. Standing water level (water depth) trigger based on individual bore 95th percentile baseline depth to groundwater (below groundwater level and top of casing). Trigger criteria of consecutive manual readings recorded outside trigger level (based on criteria level) and not related to natural rainfall trends – as indicated by monthly rainfall of less than 20 mm
 4. Standing water level (water depth) trigger based on 50th percentile baseline data for RVE swamps water level (below groundwater level and top of casing). Trigger criteria of two consecutive manual readings recorded outside trigger level (based on criteria level) and not related to natural rainfall trends – as indicated by monthly rainfall of less than 20 mm

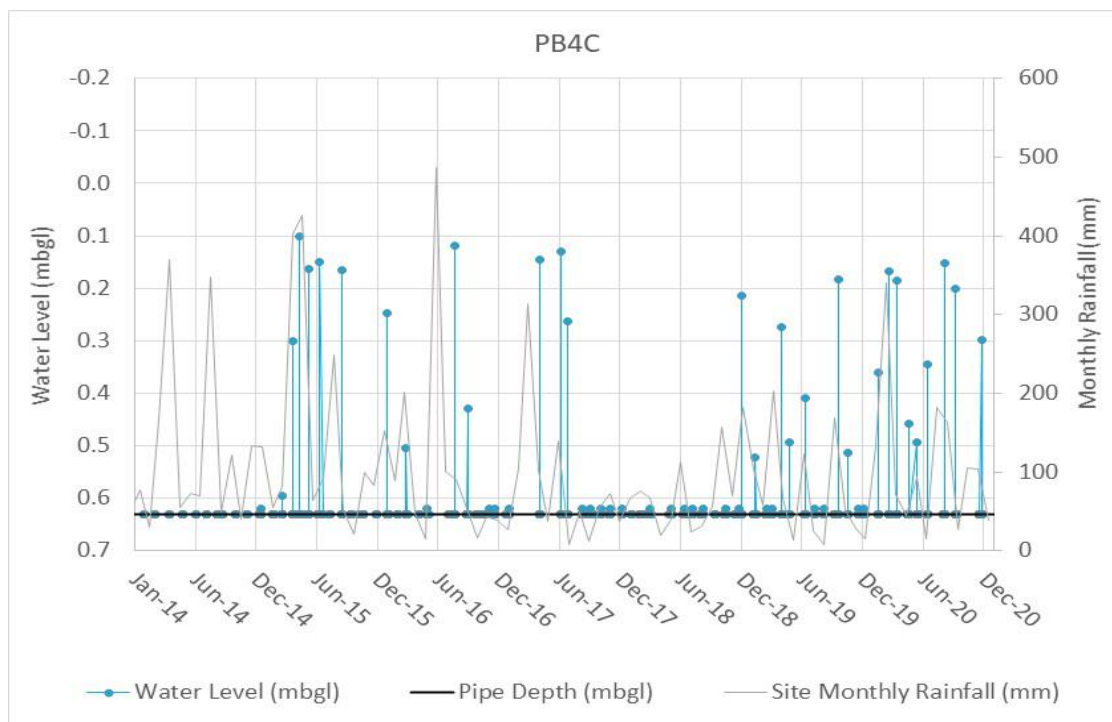
PB4A near BCUS4



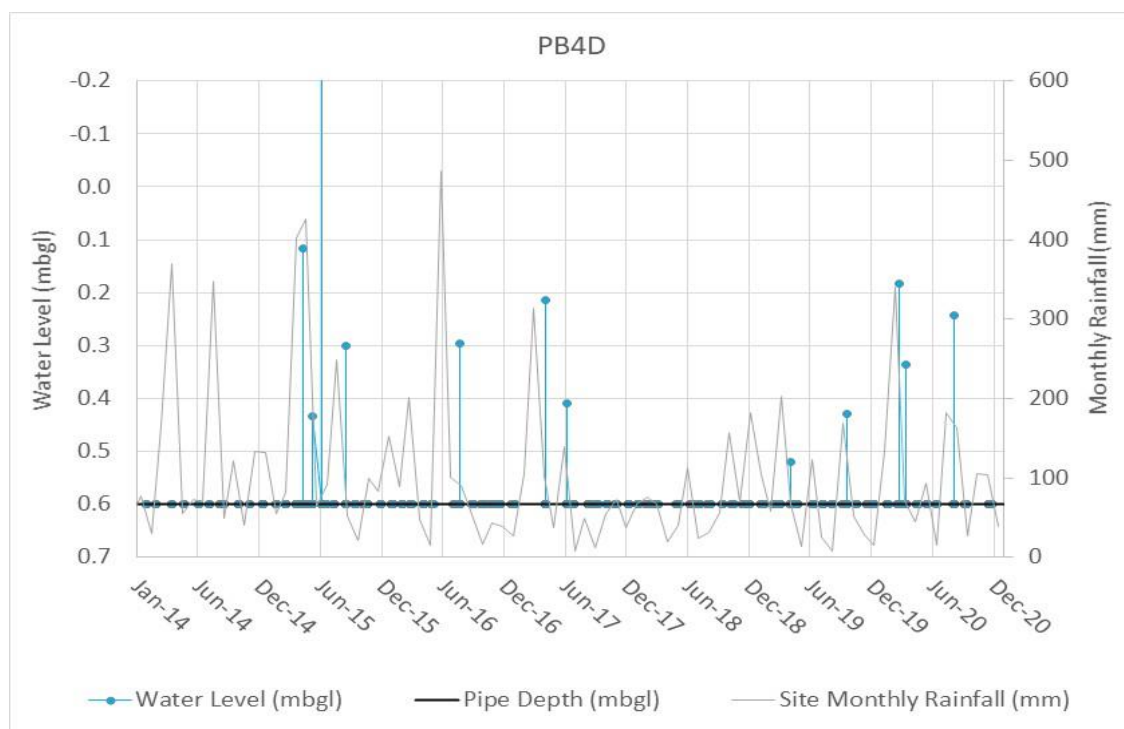
PB4B near BCUS4



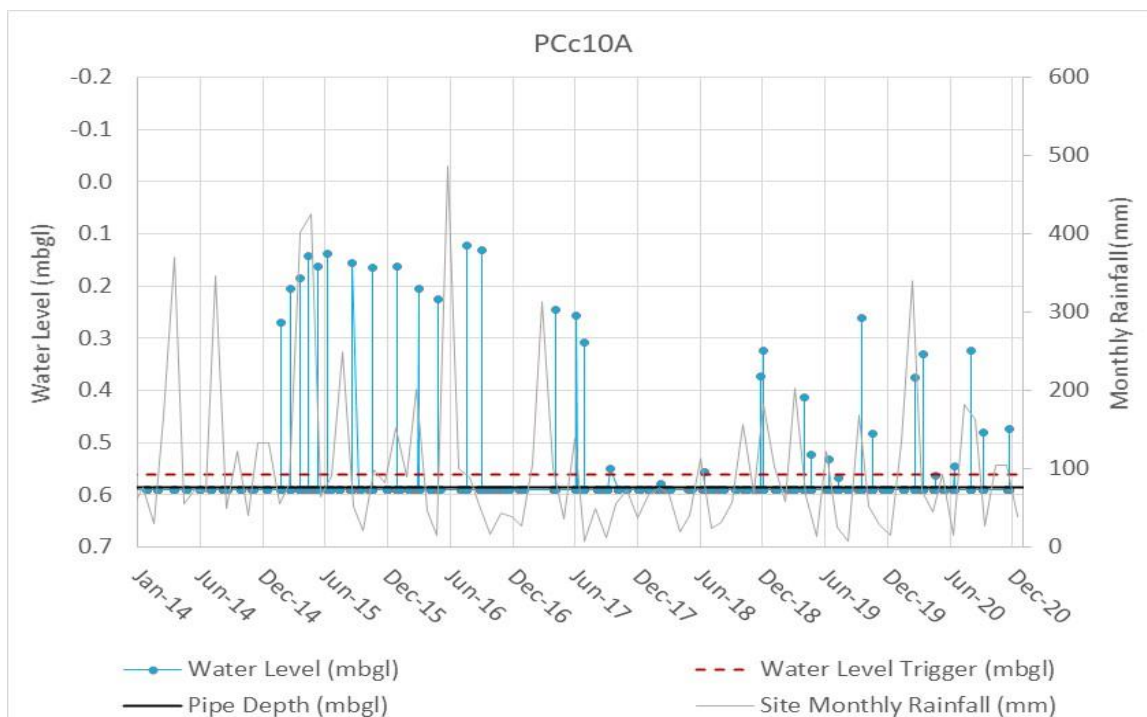
PB4C near BCUS4



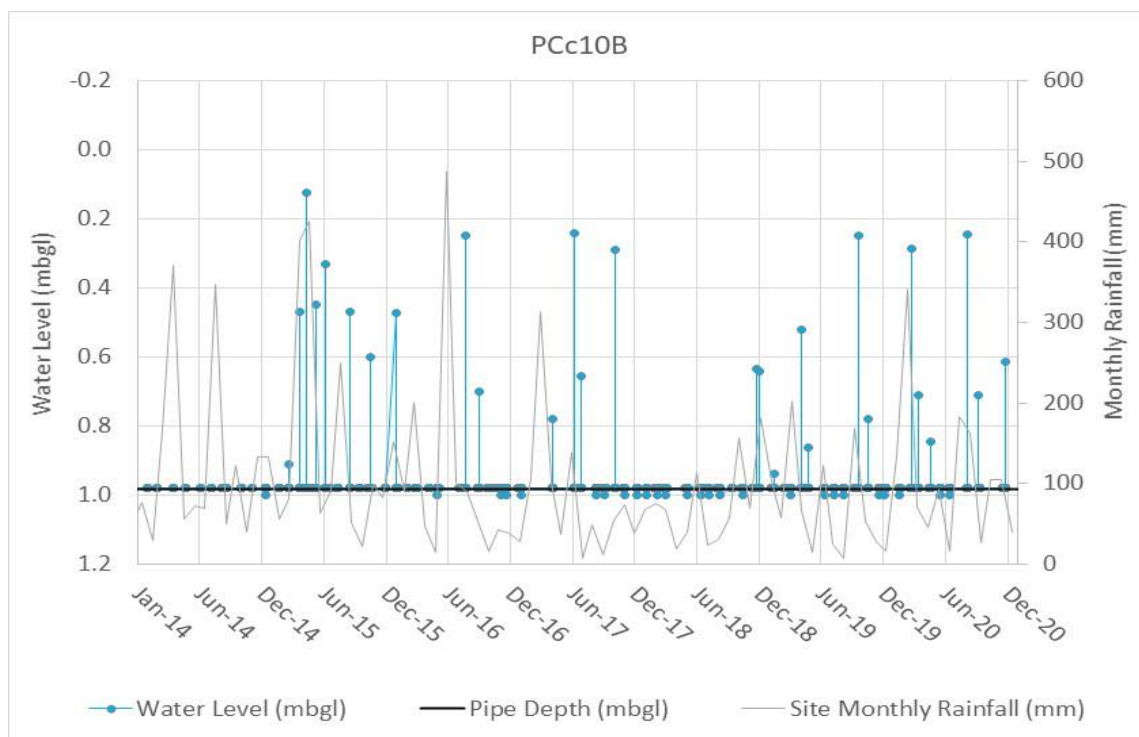
PB4D near BCUS4



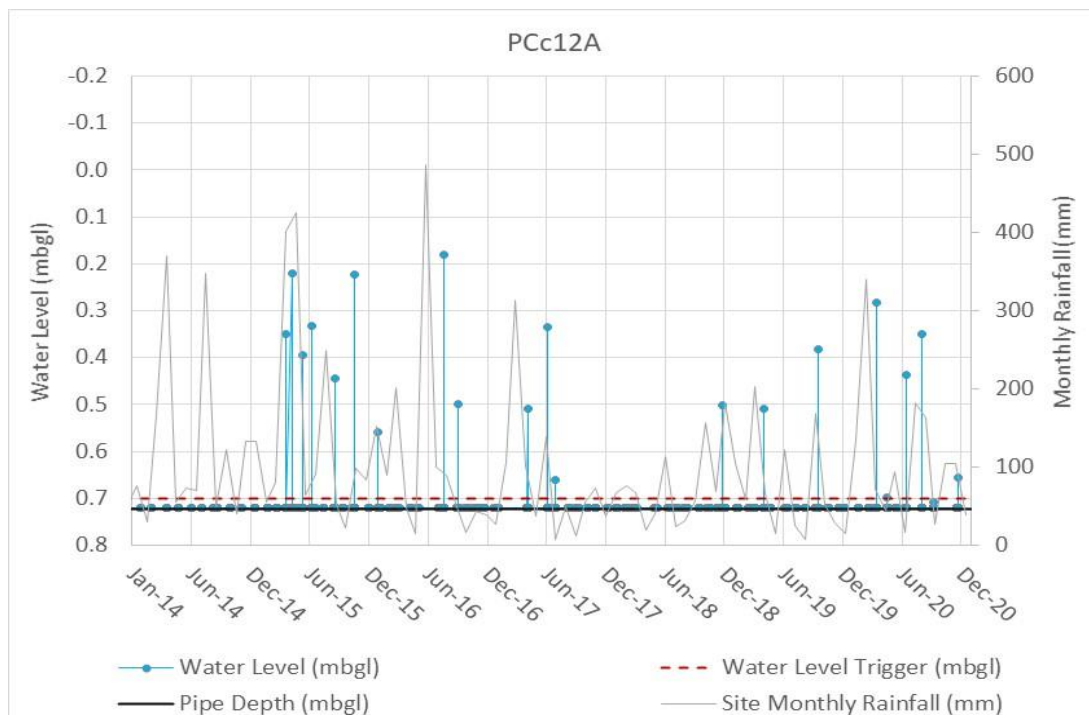
PCc10A near CCUS10



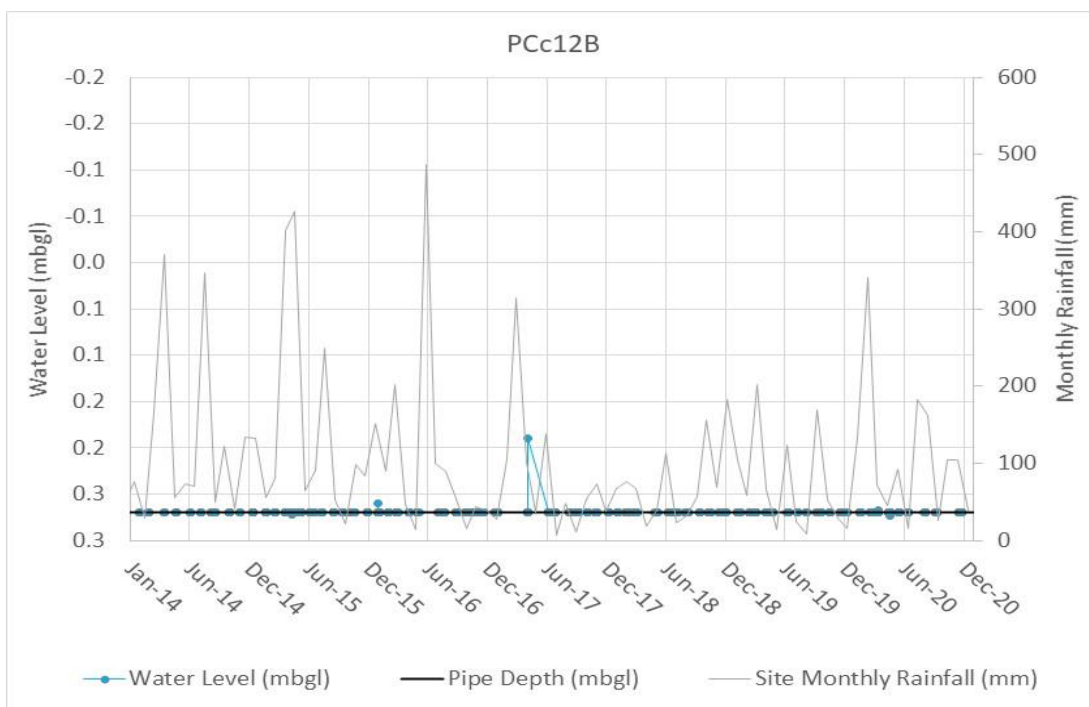
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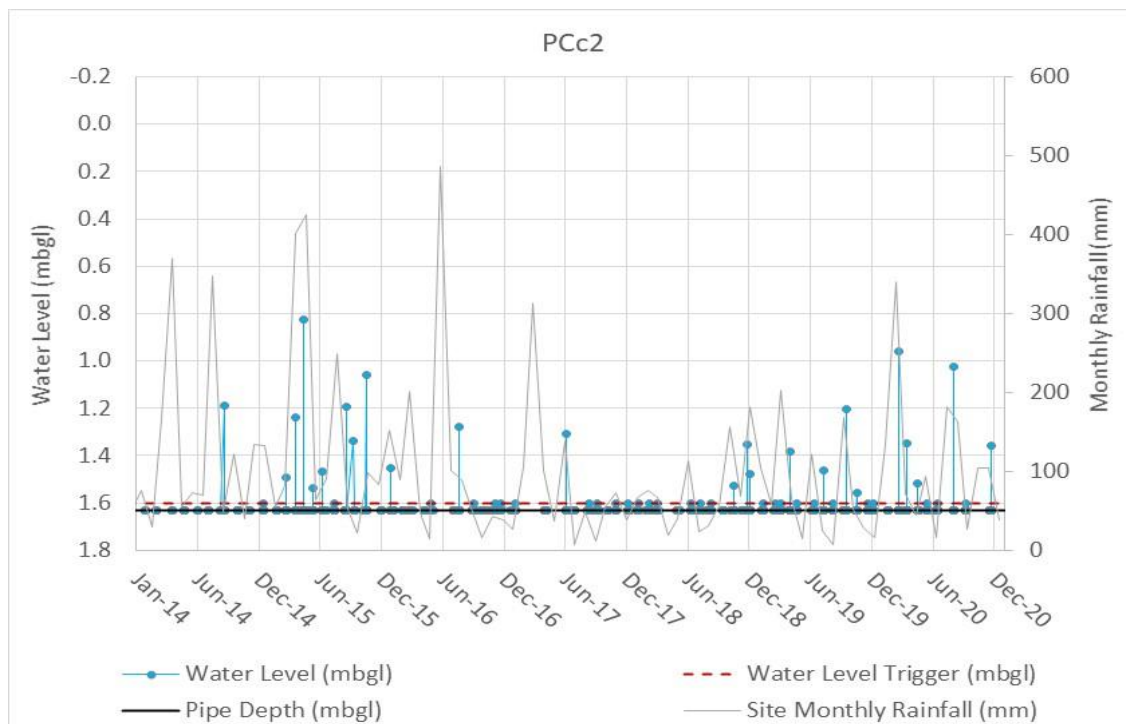
PCc12A near CCUS12



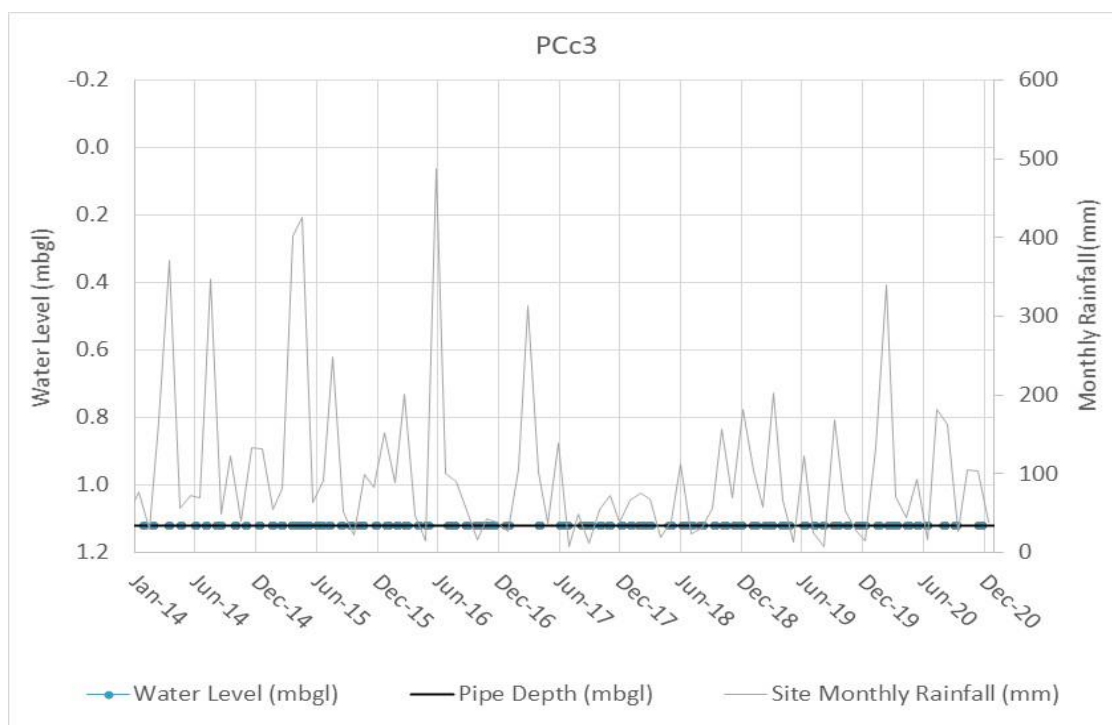
PCc12B near CCUS12



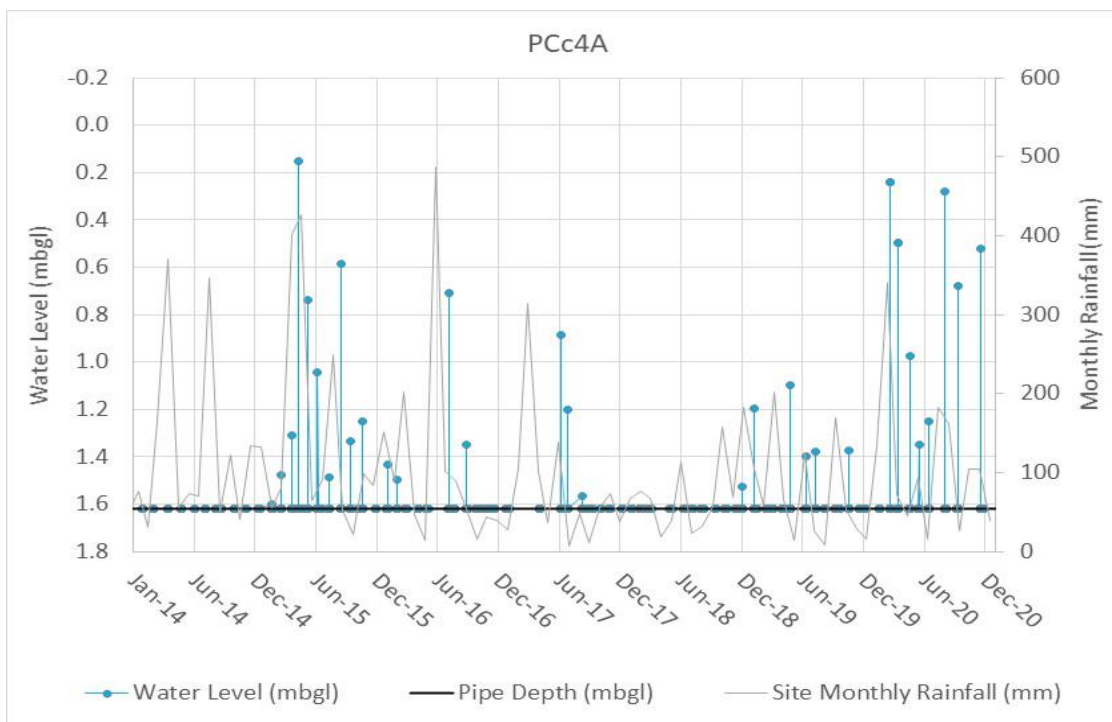
PCc2 near CCUS2



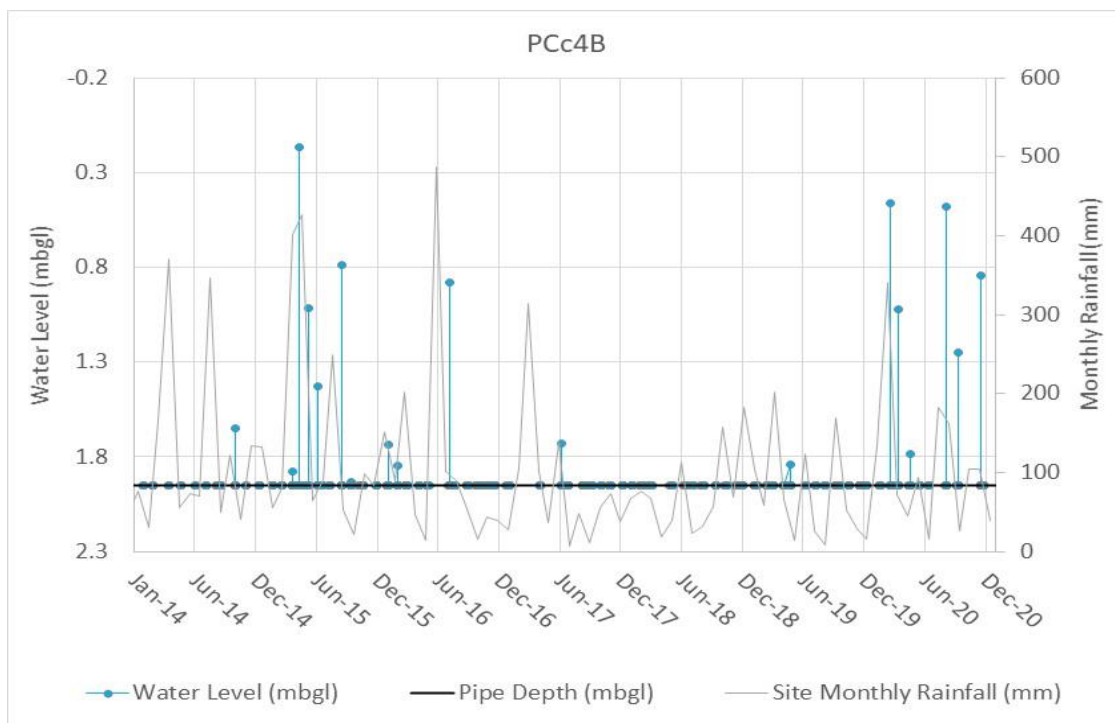
PCc3 near CCUS3



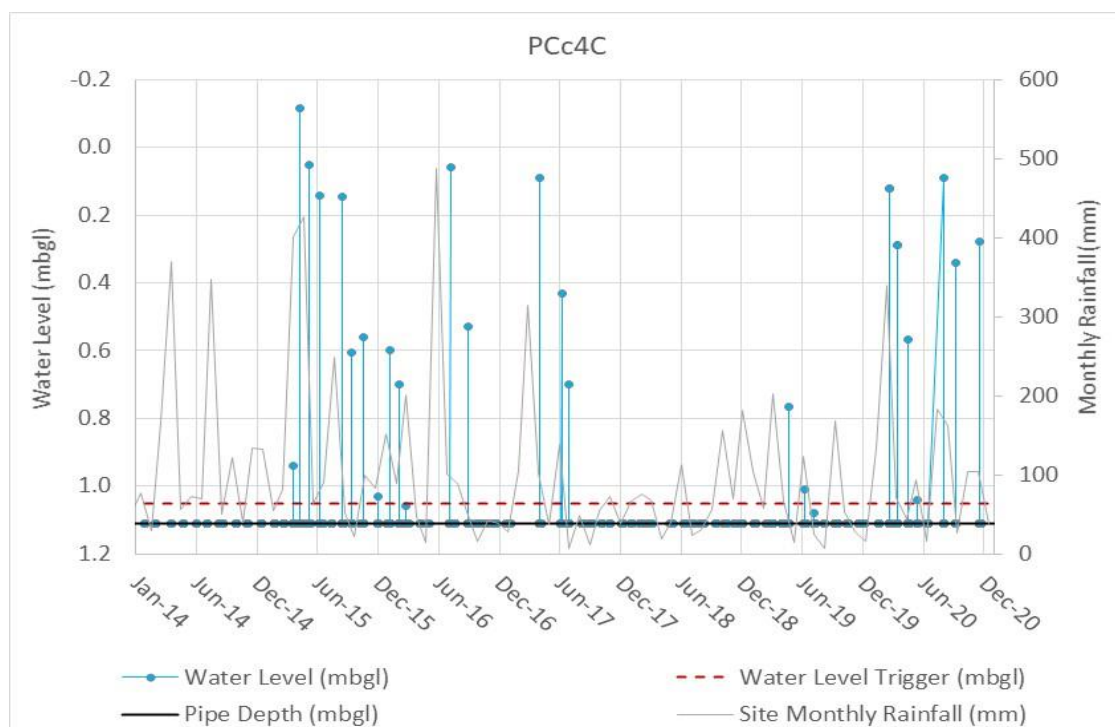
PCc4A near CCUS4



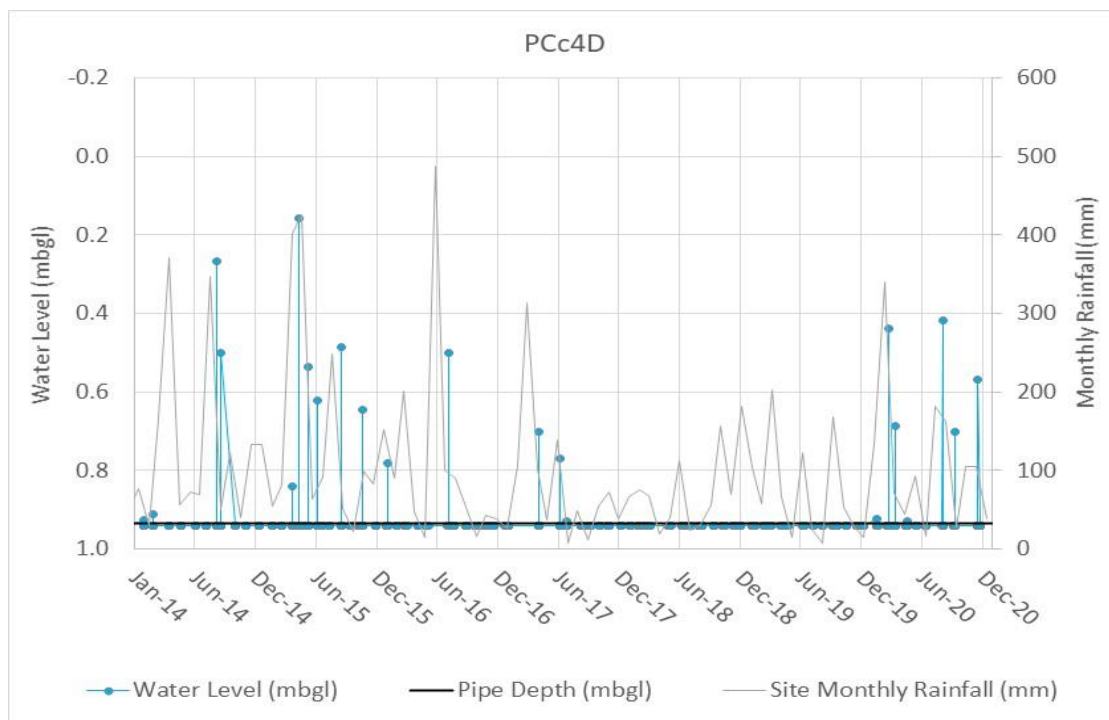
PCc4B near CCUS4



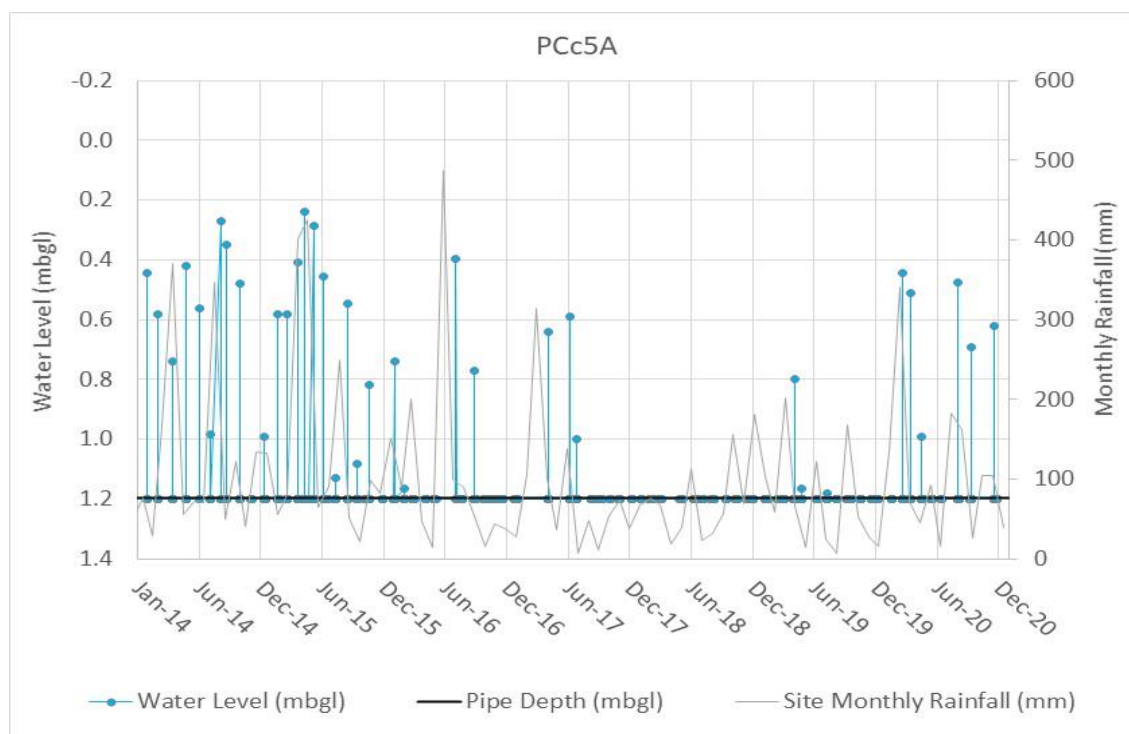
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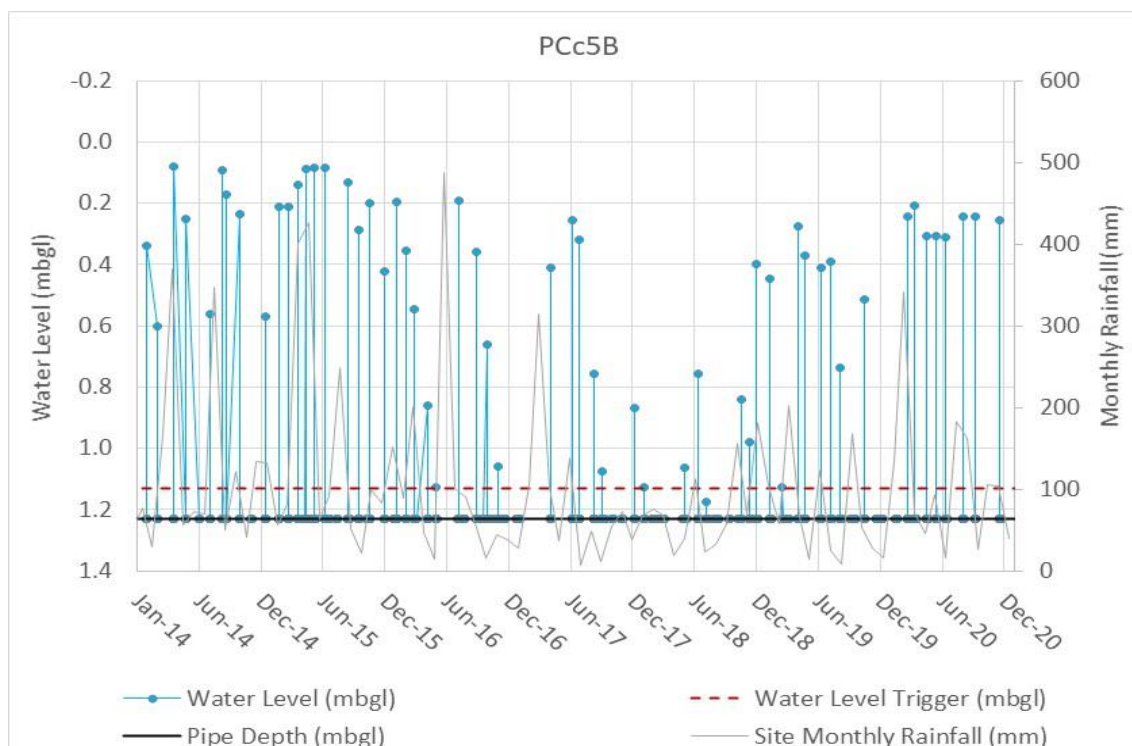
PCc4D near CCUS4



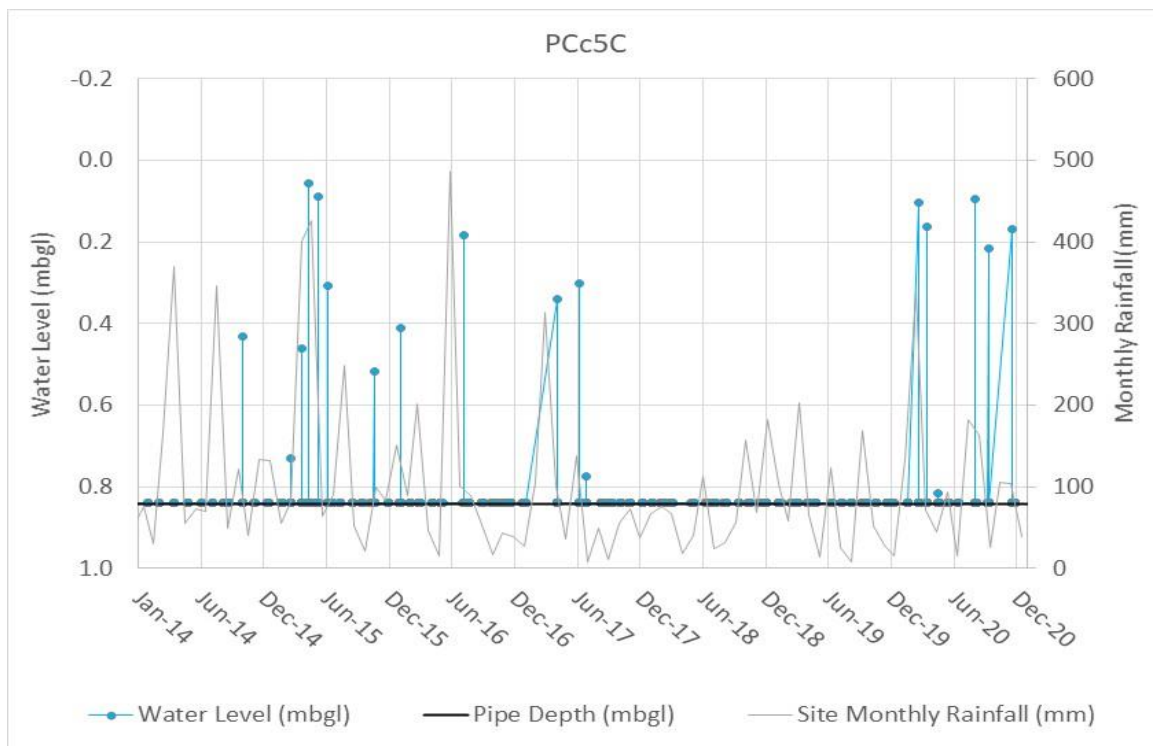
PCc5A near CCUS5



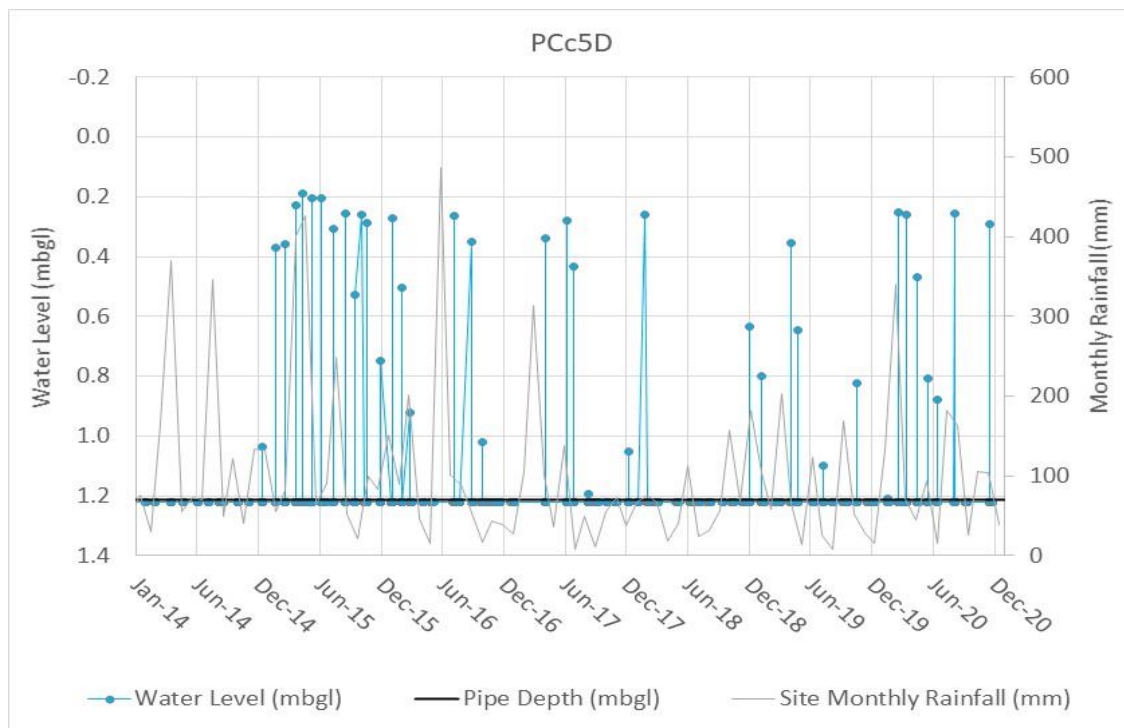
PCc5B near CCUS5



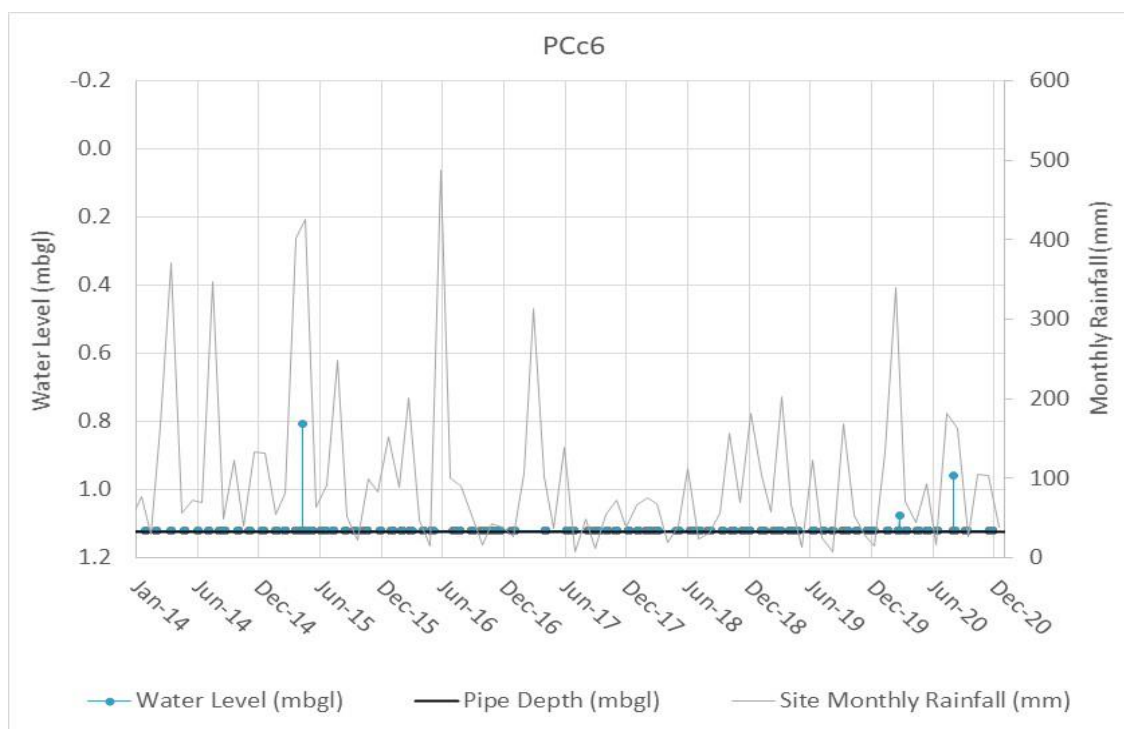
PCc5C near CCUS5



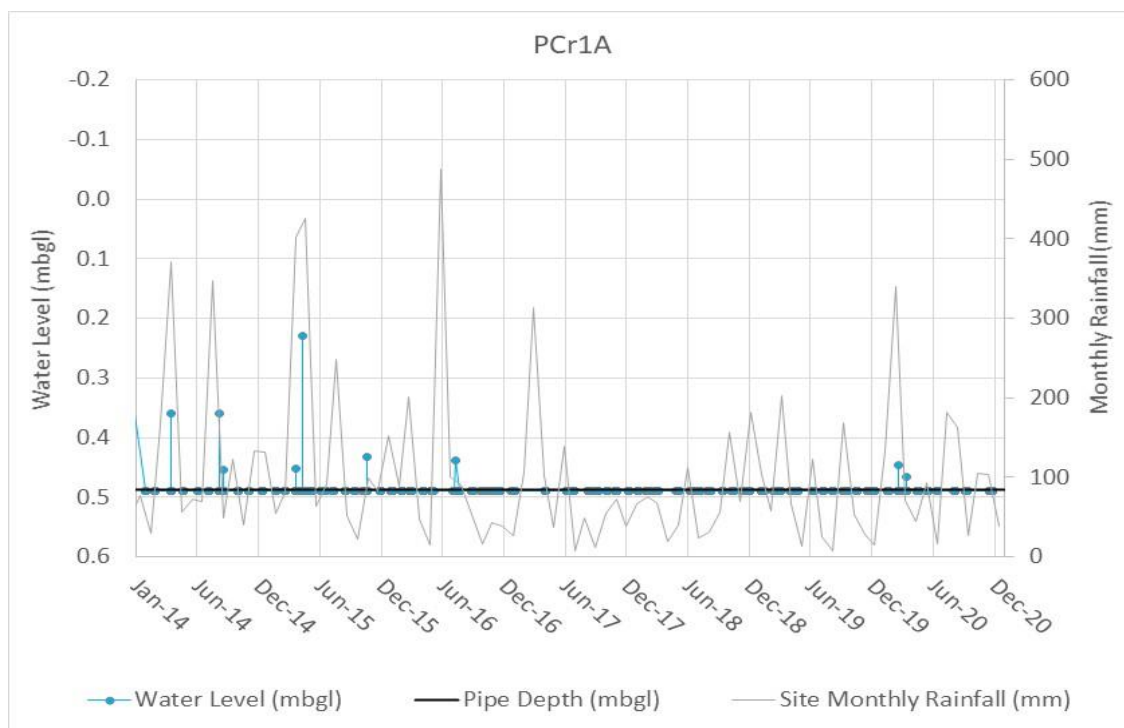
PCc5D near CCUS5



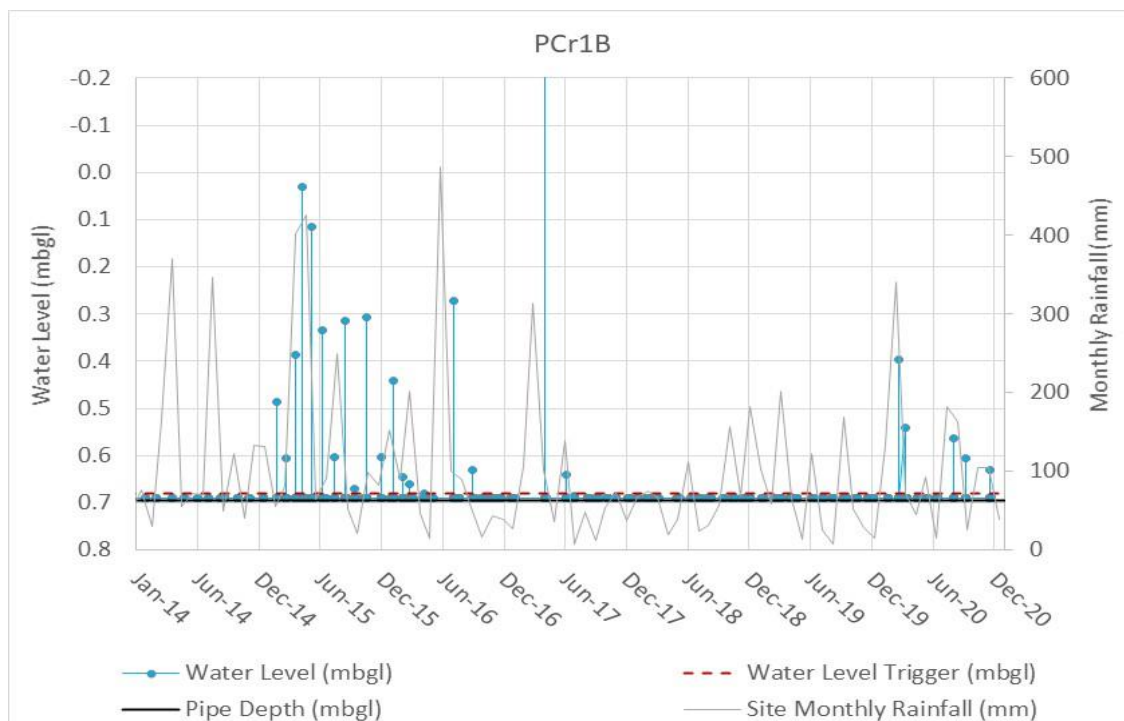
PCc6 near CCUS6



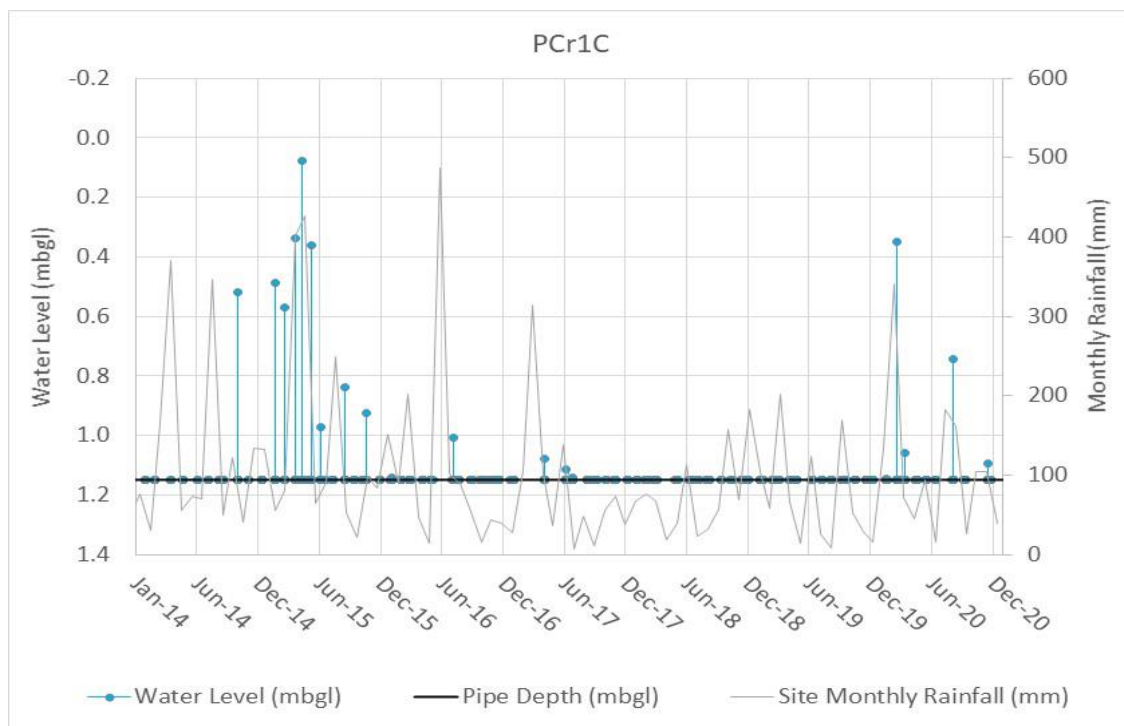
PCr1A near CRUS1



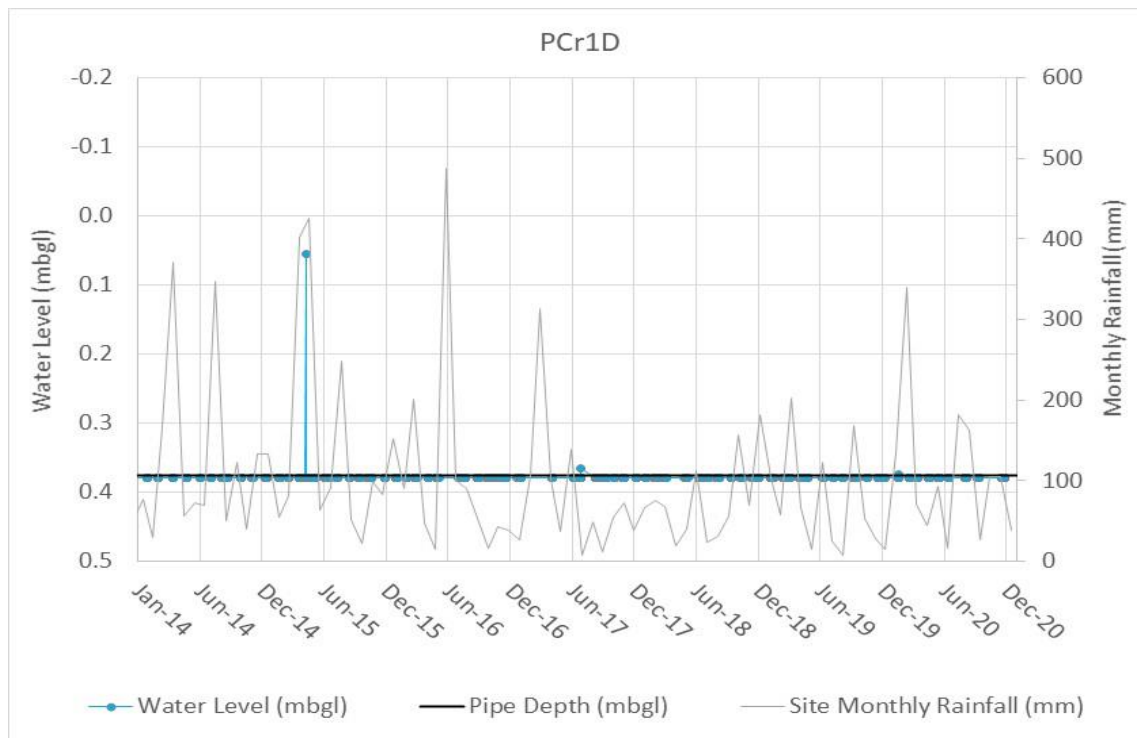
PCr1B near CRUS1



PCr1C near CRUS1



PCr1D near CRUS1

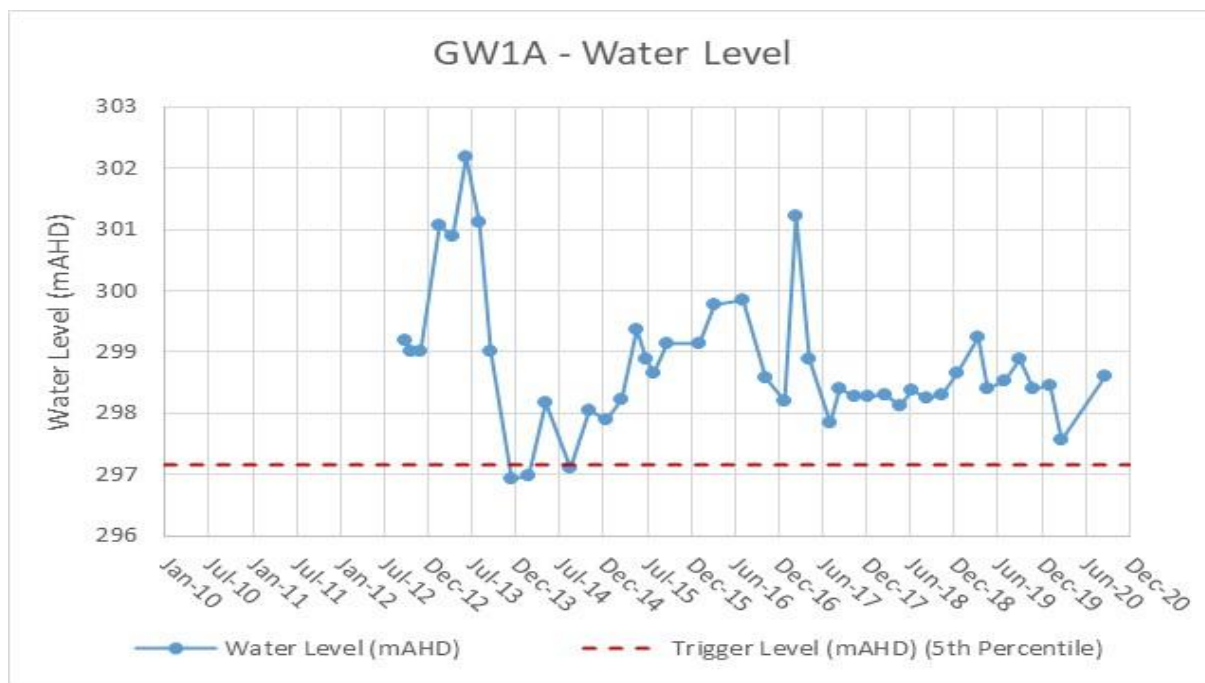


OPEN STANDPIPE GROUNDWATER TRIGGERS

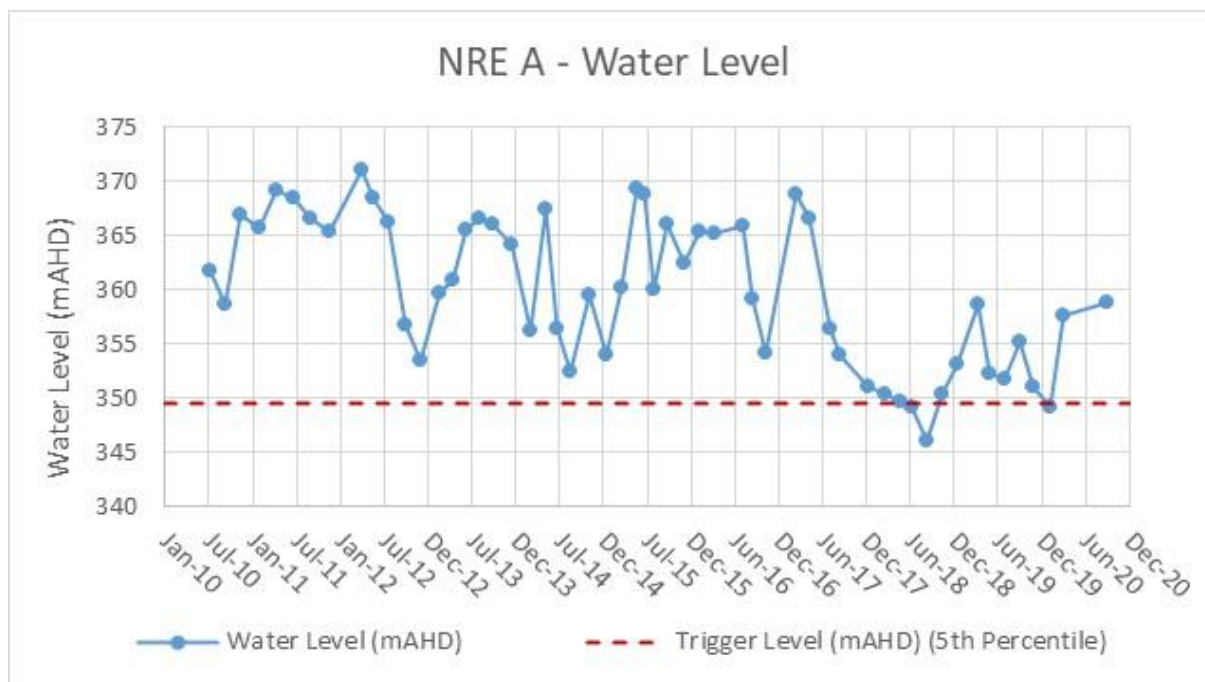
Hawkesbury Sandstone Bore	Trigger Level			
	Field pH ¹	Field EC (µS/cm) ²	Standing Water Level ³ (mbTOC)	Water Level ³ (mAHD)
GW1A	3.7 – 6.5	376	14.5	297.2
NRE A			26.7	349.5
NRE C			14.8	347.9
NRE D			10.9	338.0
RV18			12.0	327.6
RV19			11.9	300.2
RV21			13.9	336.0
RV22A			14.8	327.8

- Notes:**
1. pH trigger based on 5th and 95th percentile baseline data for RVE Hawkesbury Sandstone bores. Trigger criteria of two consecutive readings recorded outside trigger level for prescribed trigger bores
 2. EC trigger based on 95th percentile baseline data for RVE Hawkesbury Sandstone bores. Trigger criteria of two consecutive readings recorded outside trigger level for prescribed trigger bores
 3. Water level trigger based on individual bore 5th percentile baseline water level (elevation). Trigger criteria of two consecutive manual readings recorded outside trigger level.

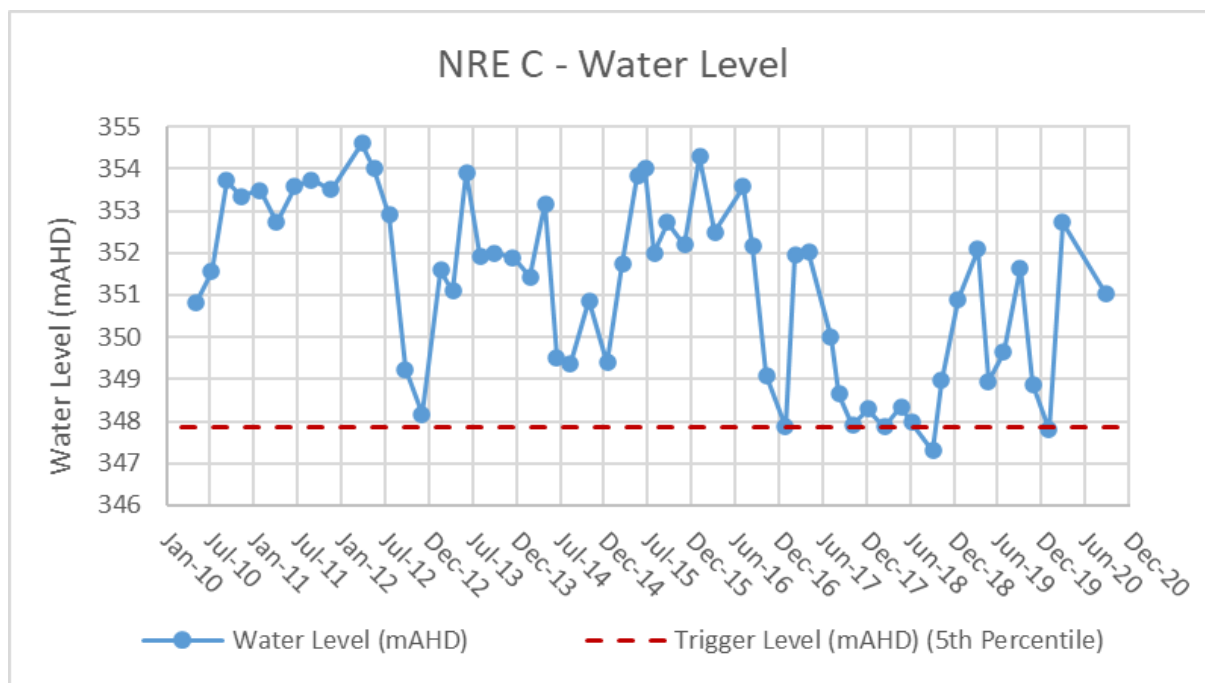
GW1A



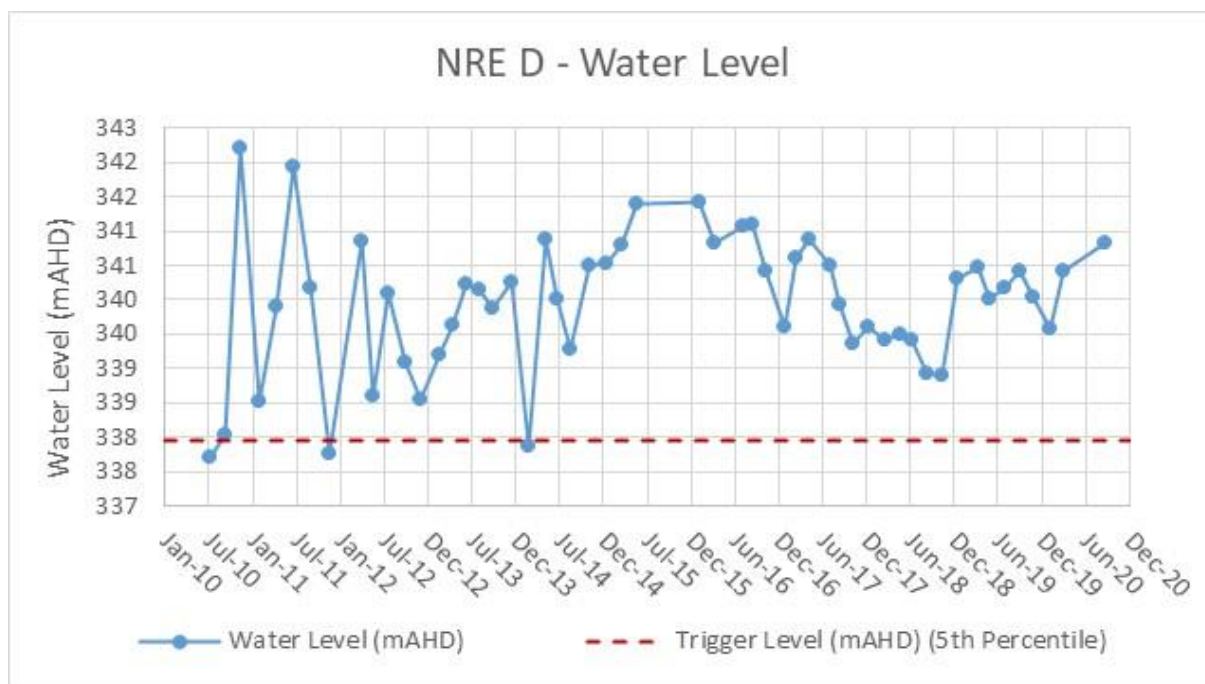
NRE A



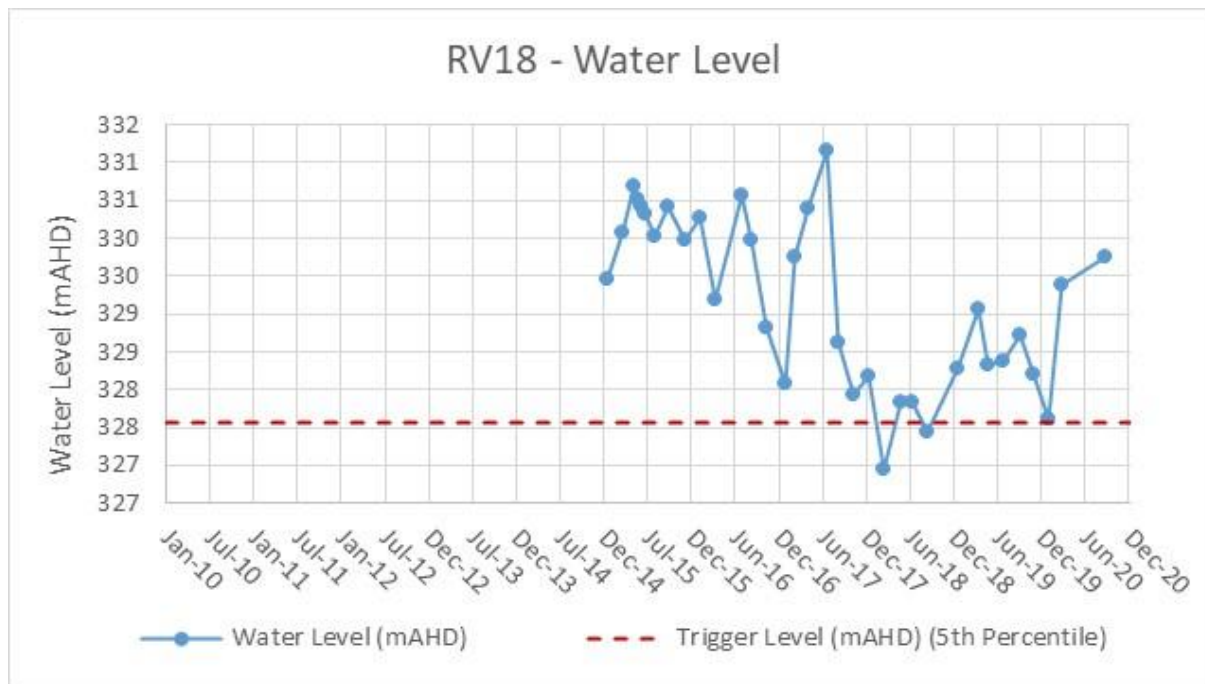
NRE C



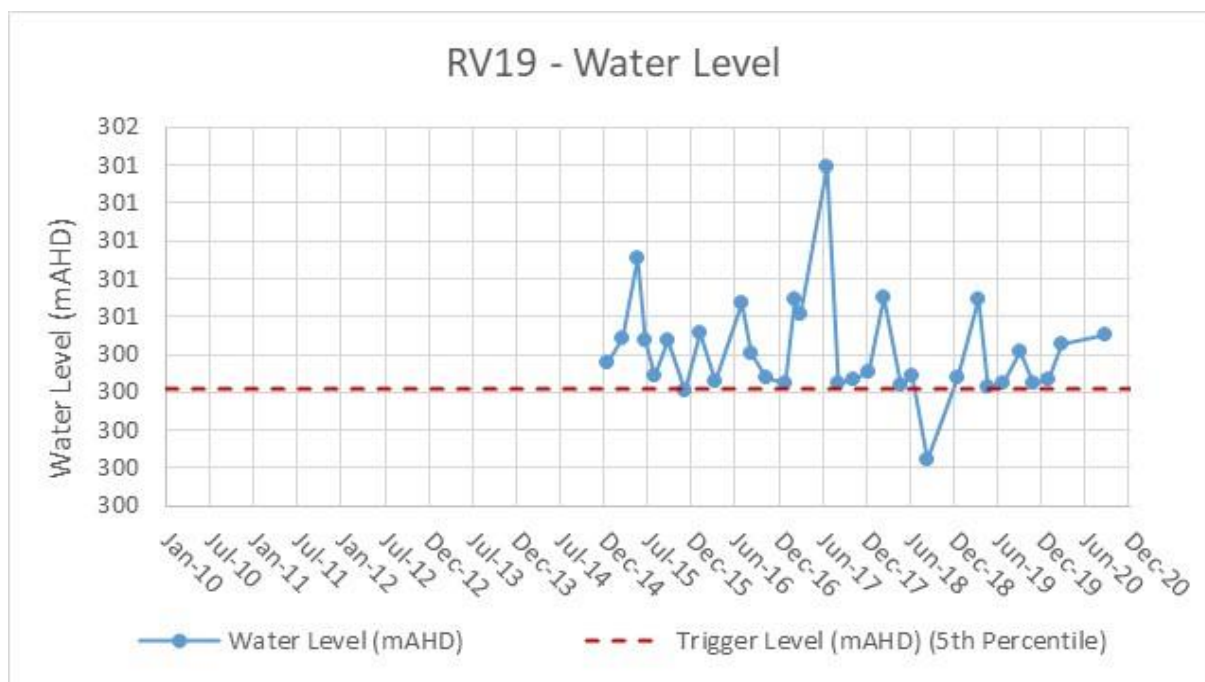
NRE D



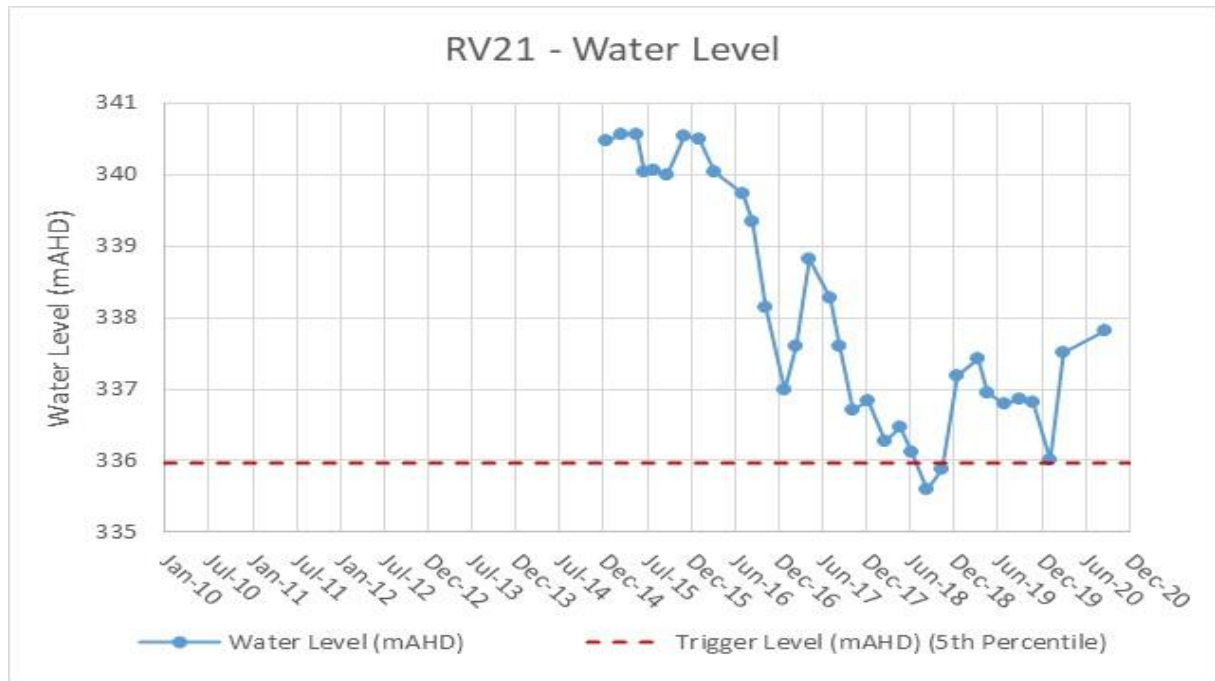
RV18



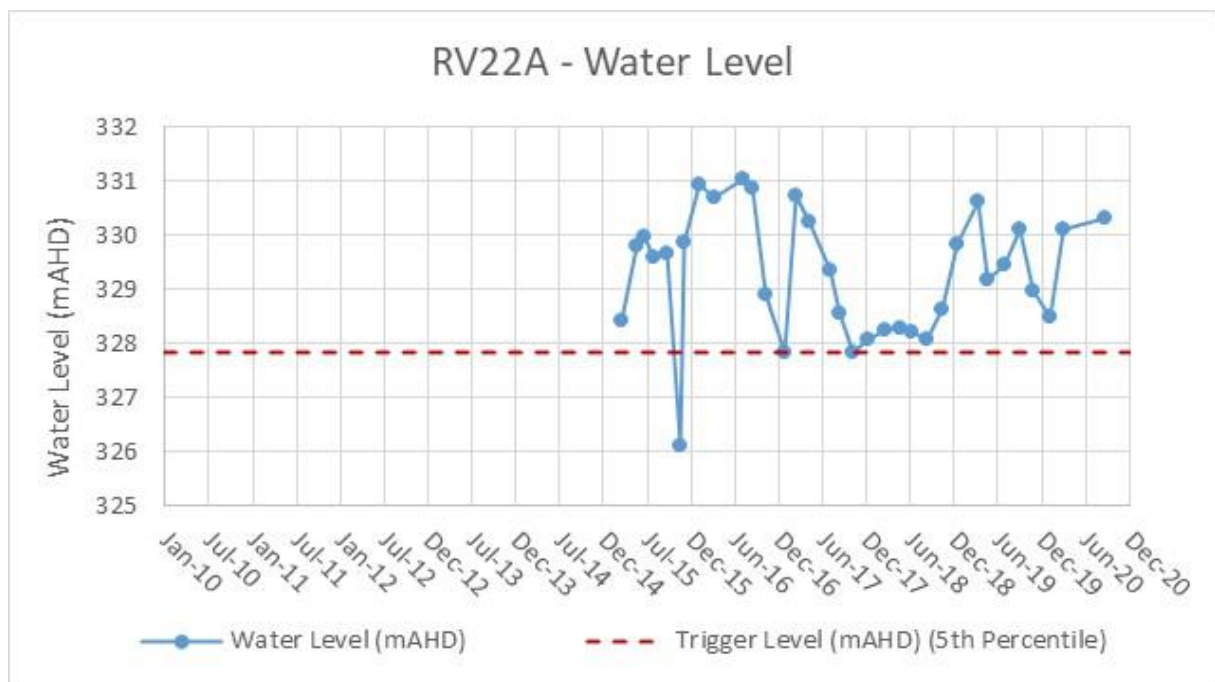
RV19



RV21



RV22A

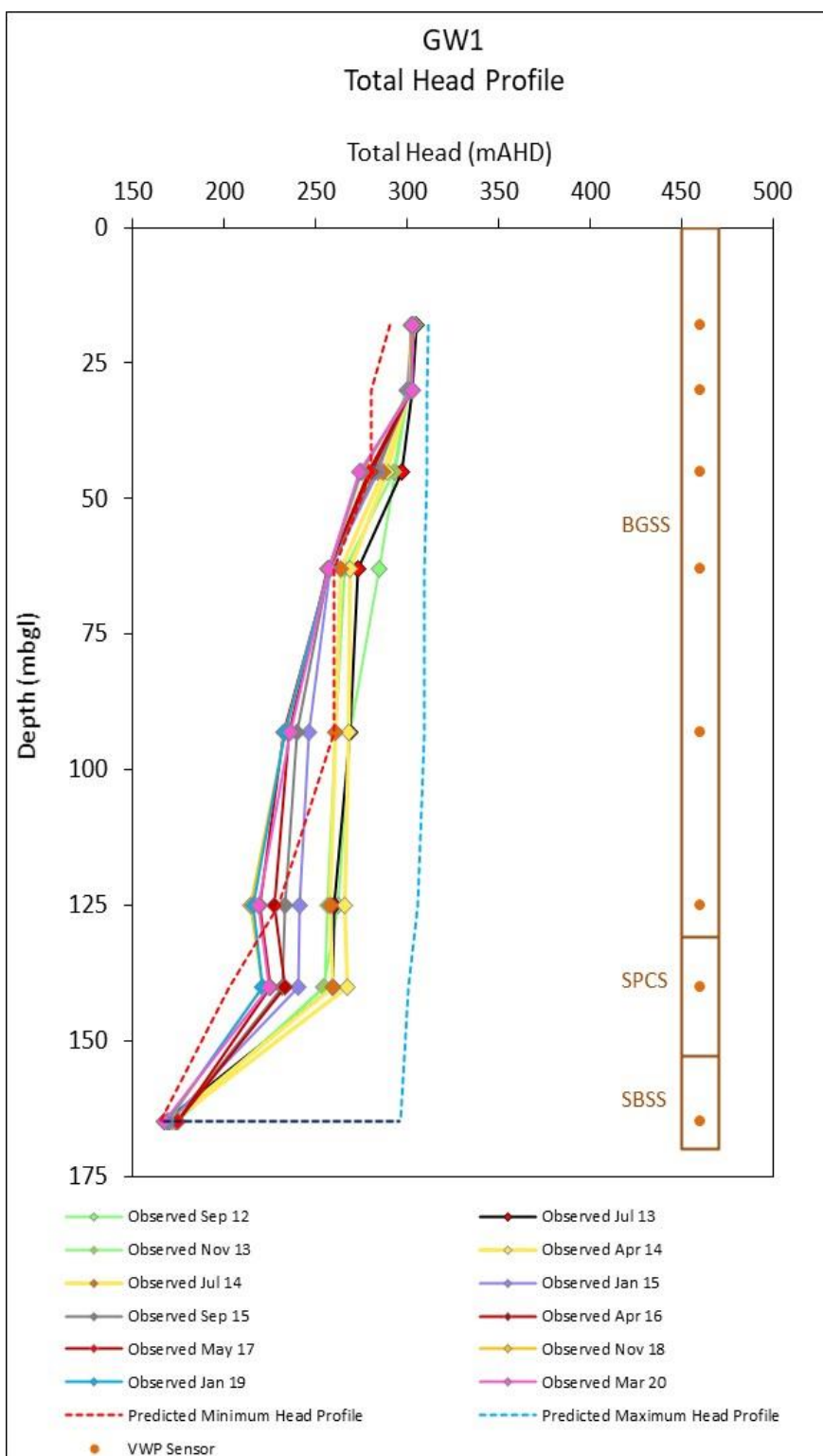




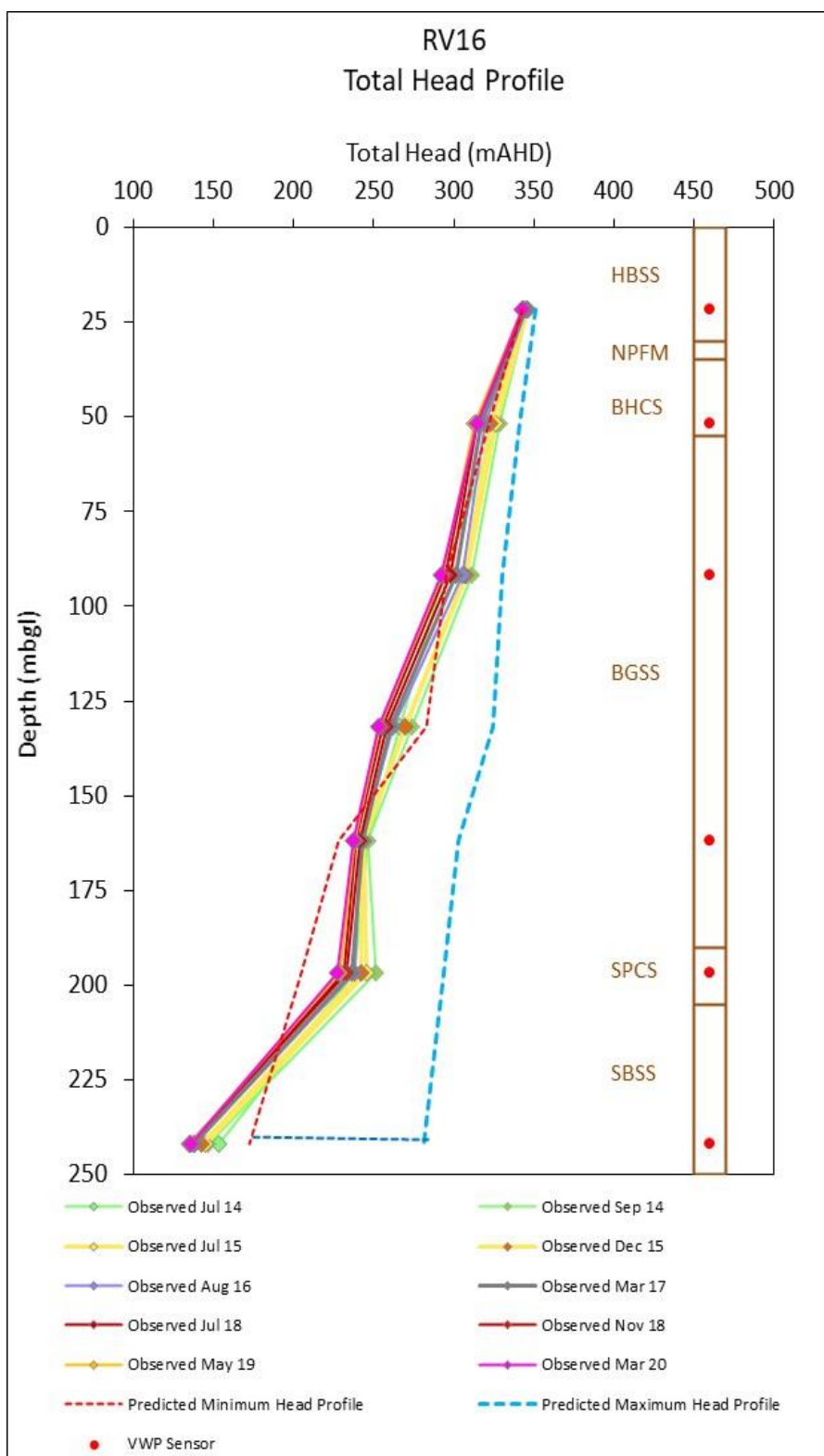
Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
Type	Plan	Date Published	17/11/2021
Doc Title	GROUNDWATER MANAGEMENT PLAN		

VWP GROUNDWATER LEVEL TRIGGERS

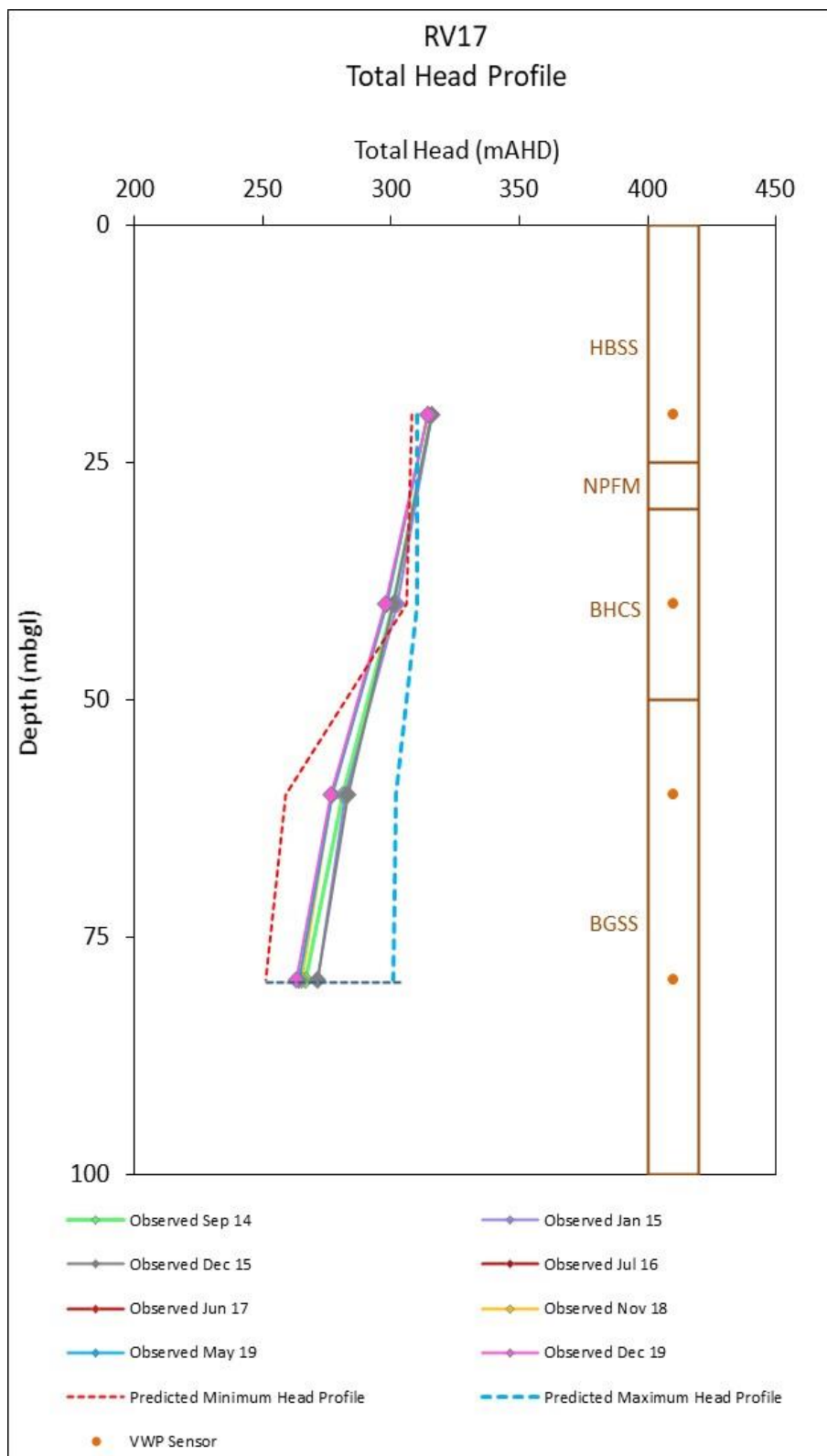
GW1 (VWP)



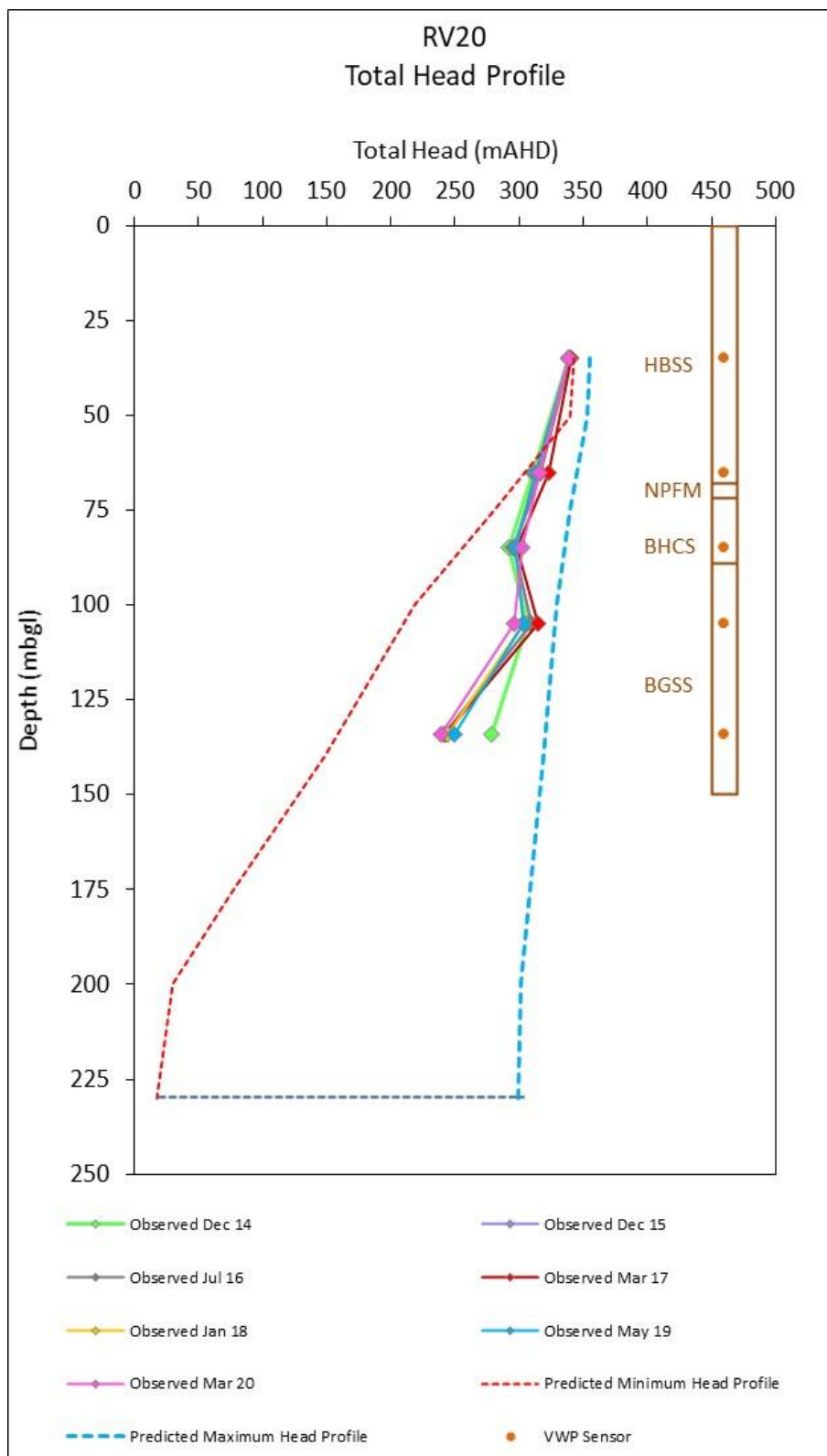
RV16 (VWP)



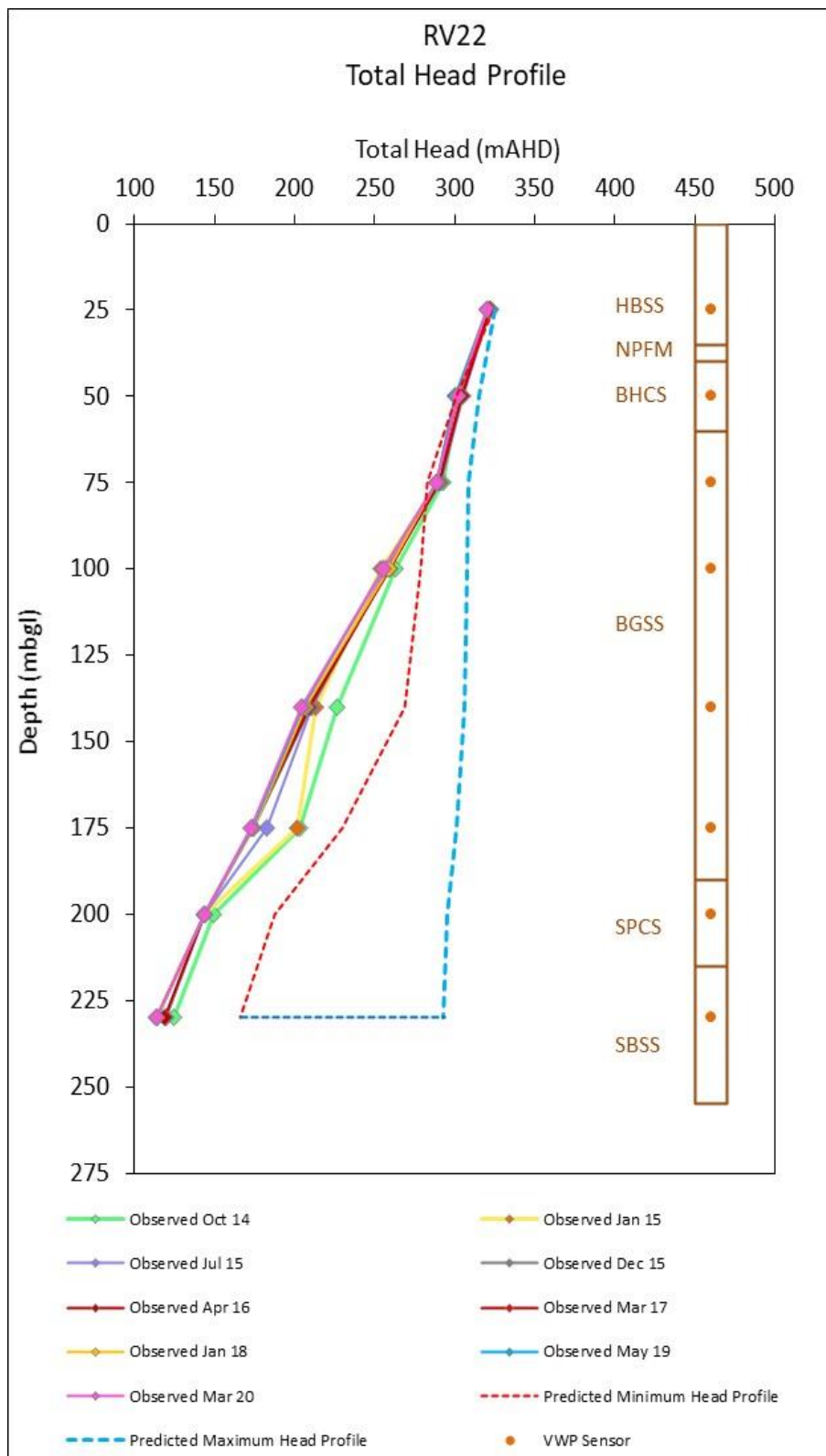
RV17 (VWP)



RV20 (VWP)



RV22 (VWP)



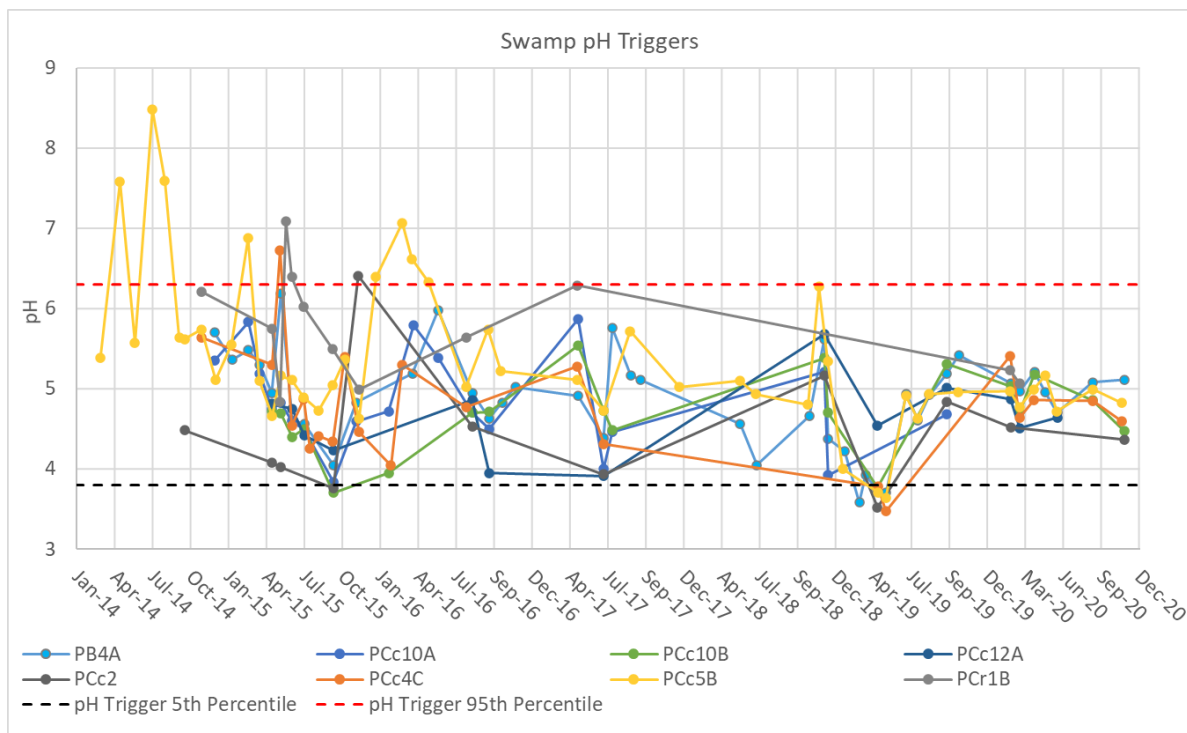


Site	Russell Vale Colliery	DOC ID	RVC EC PLN 006
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Doc Title	GROUNDWATER MANAGEMENT PLAN		

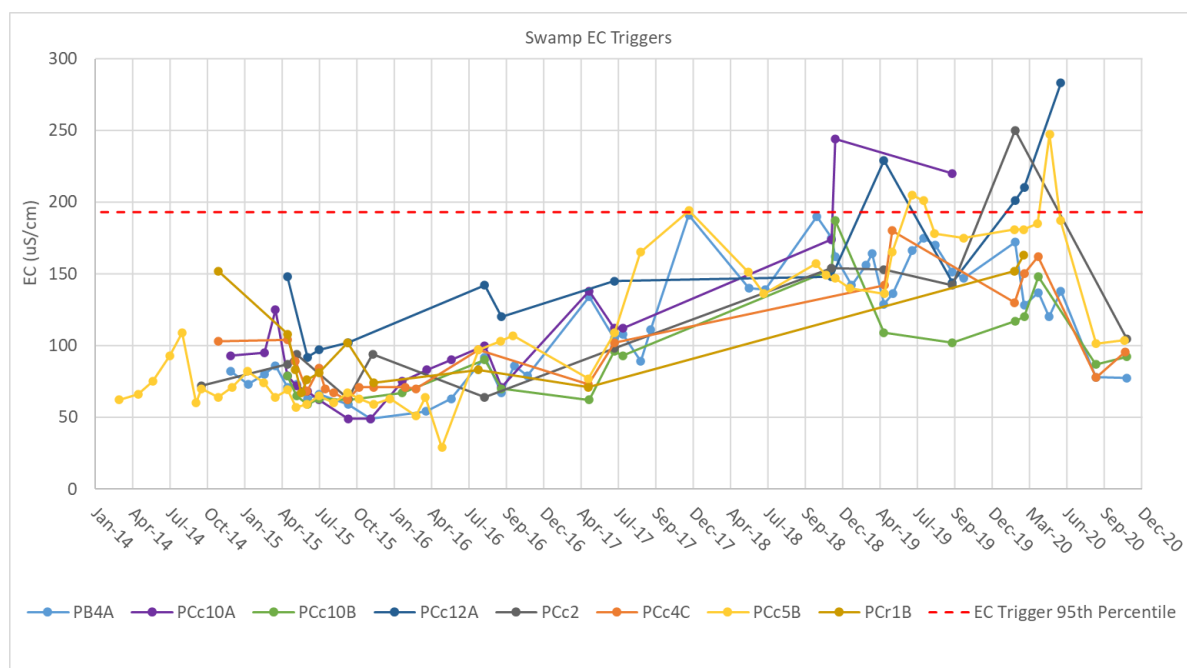
APPENDIX H – GROUNDWATER QUALITY TRIGGERS

SWAMP WATER QUALITY TRIGGERS

pH Triggers

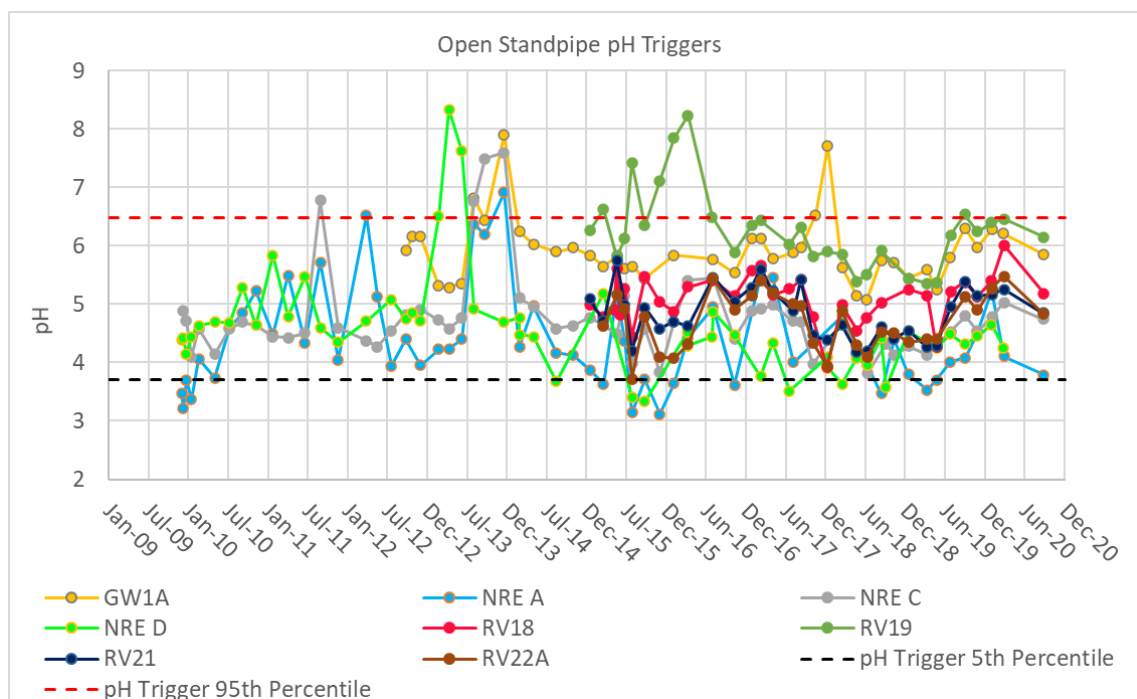


EC Triggers

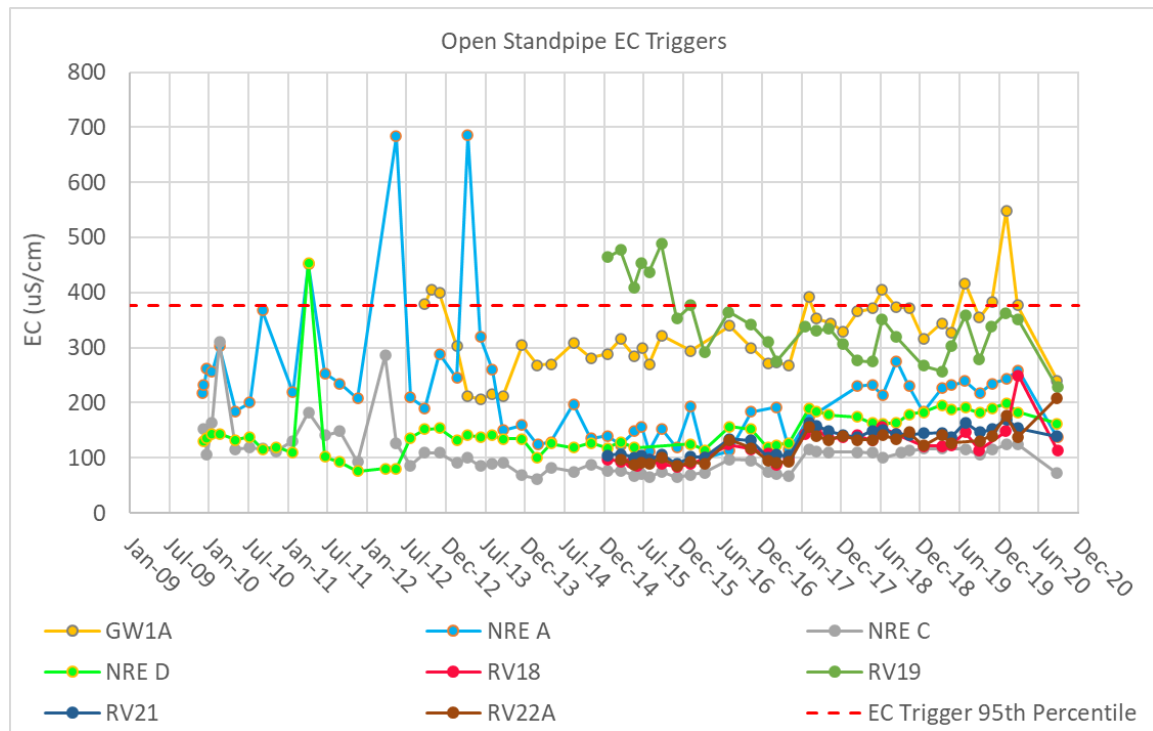


OPEN STANDPIPE WATER QUALITY TRIGGERS

pH Triggers



EC Triggers





Site	Russell Vale Colliery	DOC ID	RVE EC PLN 010
Type	Plan	Date Published	19/11/2021
Doc Title	Extraction Plan		

APPENDIX I: BIODIVERSITY MANAGEMENT PLAN



Site	Russell Vale Colliery	DOC ID	RVC EC PLN 004
Type	Management Plan	Date Published	18/11/2021
Doc Title	Extraction Plan - Biodiversity Management Plan		

RUSSELL VALE COLLIERY

REVISED UNDERGROUND EXPANSION PROJECT

Extraction Plan - Biodiversity Management Plan

RVC EC PLN 004

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 004
Type	Management Plan	Date Published	18/11/2021
Doc Title	Extraction Plan - Biodiversity Management Plan		

Revision

PROPERTY	VALUE
Approved by	
Document Owner	Richard Sheehan WCL Group Environment Manager
Effective Date	

Revision History

VERSION	DATE REVIEWED	REVIEW TEAM (CONSULTATION)	NATURE OF THE AMENDMENT
D1	05/02/2021	Luke Stone and Rebecca Dwyer (Biosis)	Initial draft plan for submission to WCL.
D2	13/04/2021	Luke Stone and Rebecca Dwyer (Biosis) Richard Sheehan (WCL) David Holmes (Umwelt)	Draft plan for consultation with BCD, WaterNSW, EPA and WCC.
D3	22/06/2021	Rebecca Dwyer, Luke Stone and Tony Cable (Biosis)	Update plan to incorporate consultation feedback from BCD for submission to DPIE for approval.
D4	14/09/2021	Rebecca Dwyer, Paul Price (Restoration Ecologist), Rebecca Dwyer (Team Leader – NSW Ecology). and Tony Cable Senior Ecologist (Biosis)	Minor amendments for consistency with DAWE Final approval
D5 Final for EP	06/10/2021	Tony Cable Senior Ecologist (Biosis) Richard Sheehan (WCL)	Minor amendments for consistency with DAWE, minor consistency changes to align with overall EP.
D6 Final	17/11/2021	Richard Sheehan (WCL)	Minor amendments following regulator comments

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 004
Type	Management Plan	Date Published	18/11/2021
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1 INTRODUCTION

1.1 Overview

This Biodiversity Management Plan as is a subplan of the Extraction Management Plan details the terrestrial and aquatic monitoring that is intended to continue in surface areas within the vicinity of the UEP area, with a focus on monitoring ecological values that have been determined to be most at risk as part of the UEP. A separate Upland Swamp Monitoring Program (*USMP RVC EC PLN 008*) has been prepared to manage potential subsidence and groundwater impacts on Coastal Upland Swamps present with the EP Area and associated biodiversity values, including threatened species which are associated with these swamps.

This Biodiversity Management Plan (BMP) has been prepared to satisfy **Condition C10 (g)(iv)** of the development consent MP09_0013 (the PA), which specifies that WCL are to prepare and implement a BMP to establish baseline data and provide for the management of potential impacts and/or consequences associated with the mining associated with the Stage 1 Extraction Plan (EP). This plan has been prepared by Paul Price (Restoration Ecologist) and Rebecca Dwyer (Team Leader – NSW Ecology).

1.2 Project Background

Wollongong Coal Limited (WCL) operates the Russell Vale Colliery (formerly the NRE No.1 Colliery) located in the Southern Coalfield of New South Wales (NSW). The mine is located at Russell Vale, approximately 8 km north of Wollongong and 70 km south of Sydney, within the local government areas (LGAs) of Wollongong and Wollondilly in the Illawarra region of NSW (refer to Figure 1).

Russell Vale Colliery operates under the current project approval Development Consent MP09_0013 (the project approval) granted by the NSW Independent Planning Commission (IPC) on 8 December 2020. The approval, known as the Underground Expansion Project (UEP), is based on the Revised Preferred Project Report and Response to Second PAC Review by Umwelt dated July 2019. Under the approval WCL may:

- Extract 1.2 Mt of Run of Mine (ROM) coal per annum, with a maximum of 1 Mt of ROM coal being processed from site in a calendar year; and
- Undertake mining operations for a period of 5 years from the date of commencement of mining operations.

The approved workings are contained within Consolidated Coal Lease 745 (CCL 745) and Mining Lease 1575 (ML 1575). This EP BMP has been prepared as part of the Extraction Plan, identified in Wollongong Coals environmental management structure (**Figure 3**). This BMP should be read in conjunction with the Extraction Plan (EP) and other related management plans including the Water Management Plan (WMP), subsidence monitoring program, Upland Swamp Monitoring Plan (USMP), and Land Management Plan (LMP).

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1.3 Purpose and Scope

The purpose and scope of this BMP is to:

- establish baseline data for the existing habitat on the site, including water table depth, vegetation condition, stream morphology and threatened species habitat; and
- provides for the management of potential impacts and/or environmental consequences of the proposed first workings on aquatic and terrestrial flora and fauna, with a specific focus on threatened species, populations and their habitats, EECs and water dependent ecosystems.

In accordance with Consent **Condition A21** and **A22**, the Extraction Plan (developed under **Condition C10**) is intended to be staged as outlined in **Table 1**. Timeframes for monitoring of Biodiversity Values are discussed in **Section 6**.

Section 2 of the main extraction plan, 'Project Description', provides a full summary of the project, including details on the:

- mine planning and design
- mining methodologies
- phasing of the surface infrastructure relating to the project over 2 stages, which are both wholly covered under the extraction plan
- staging of the extraction of pillars
 - stage 1(a) – PC21 to PC25
 - stage 1(b) – PC7 and PC08.

Table 1: Extraction Plan Staging and Relevance to this Plan

Stage	Timing and Description	Extraction Plan Relevance
Stage 1	Years 1-2 Stage 1(a) – Secondary extraction panels PC21 to PC25 Stage 1(b) – Secondary extraction panels of PC07, PC08.	Entirely covered by the Stage 1 EP and this Biodiversity Management Plan
Future Stages	Years 2 to 5 Further mining within the approved UEP. Panel configuration with schedule to be included within subsequent extraction plans.	Pre-mining monitoring referenced within the Stage 1 EP and this Biodiversity Management Plan

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1.4 Management Plan Structure

The remainder of this BMP is structured as follows:

- Section 2: Outlines the statutory requirements applicable to the BMP.
- Section 3: Outlines the baseline data and impact assessments undertaken which support this BMP.
- Section 4: Details the potential impacts to surface features that may result from the UEP first workings mining activities
- Section 5: Details the performance measures and criteria including indicators that will be used to assess the UEP performance.
- Section 6 Describes the Biodiversity monitoring program.
- Section 7: Describes the management, remediation and mitigation measures that will be implemented to reduce potential impacts as well as the Contingency Plan to manage any unpredicted impacts and their consequences.
- Section 8: Describes the protocols for the handling of incidents, complaints and non-conformances.
- Section 9: Details reporting
- Section 10: details how the Plan will be implemented, managed, reviewed and updated.
- Section 11: Details the audit and review program,

Figure 3 shows this Plan's position within the WCL's Environmental Management Structure.

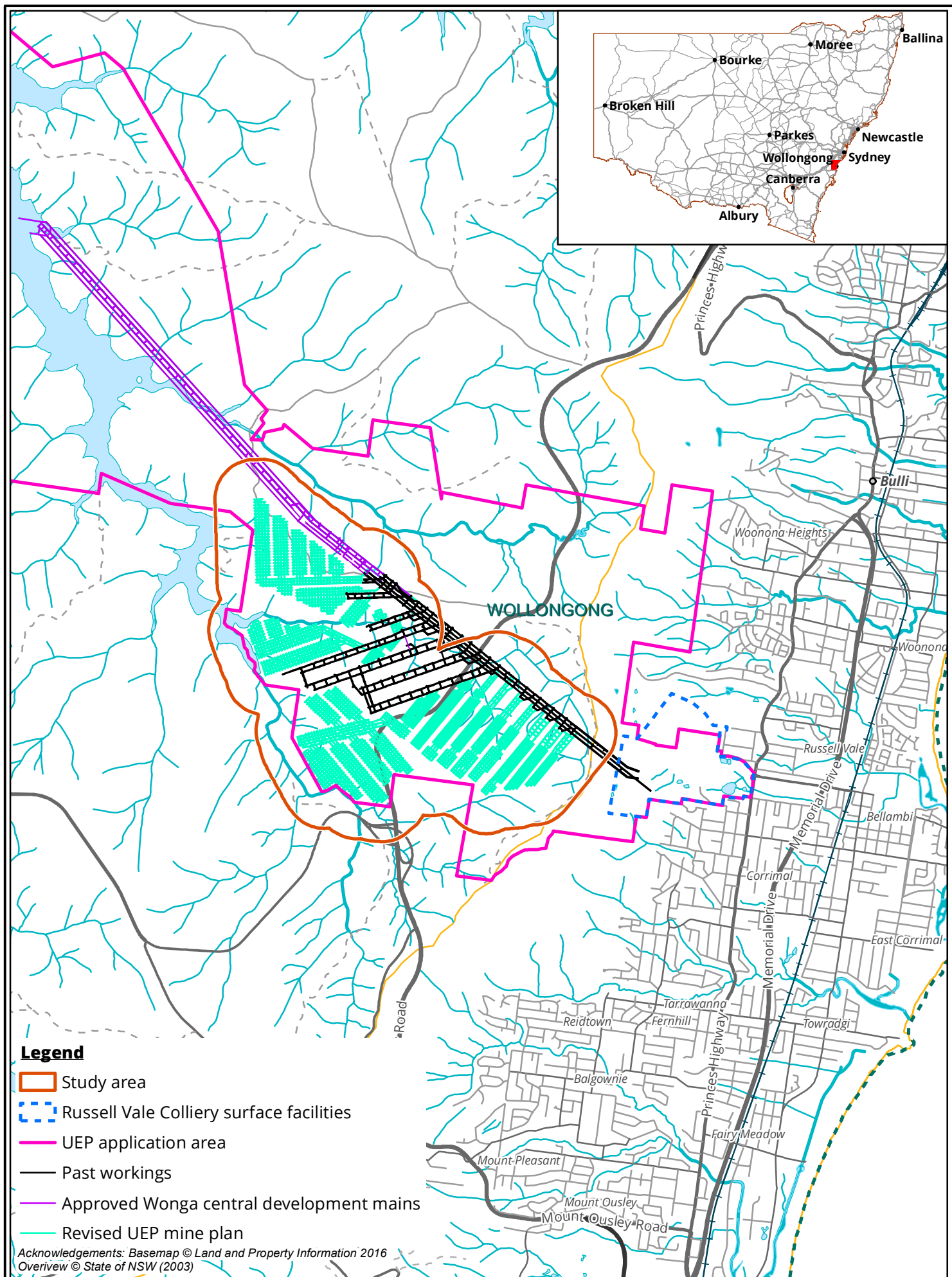
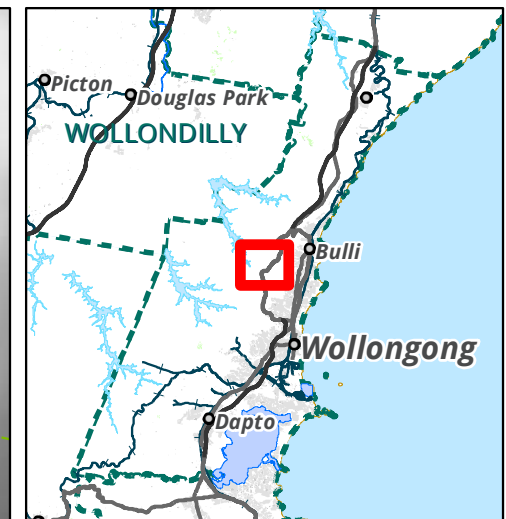
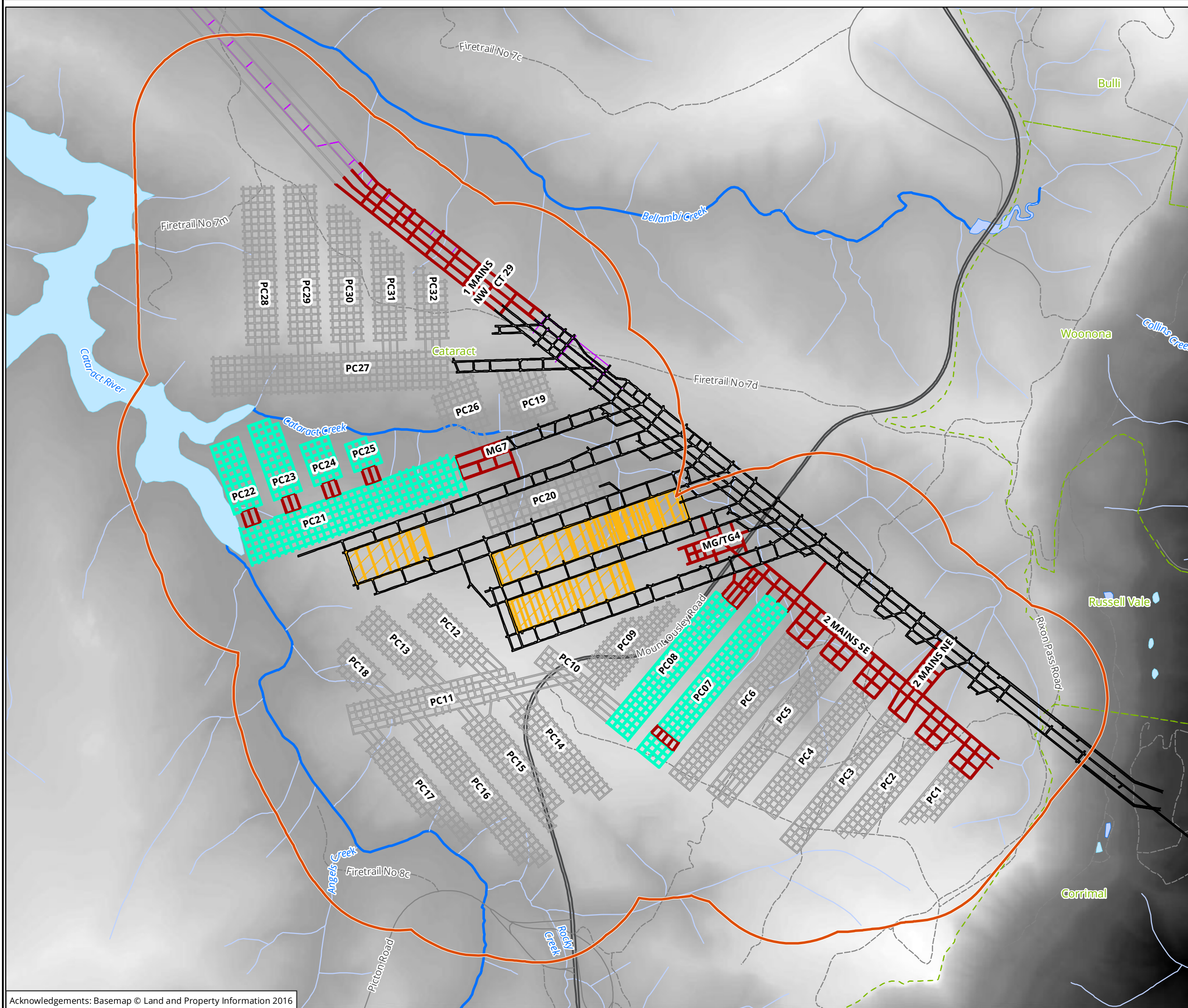


Figure 1 Location of the Russell Vale Colliery and UEP study area, New South Wales

Matter: 34330
 Date: 10 February 2021,
 Checked by: MEH, Drawn by: AEDM, Last edited by: amurray
 Location: P:\30900s\30999\Mapping\



Legend

- Study area
- Past workings
- Approved Wonga central development mains
- RV East old longwall workings
- RVE-No.3_Design (20210219)**
- Conforming pillars
- Nonconforming pillars (Year 1)
- Proposed Wonga workings (Years 2-5)
- SCT new

Figure 2 Study area

0 200 400 600 800

Metres

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

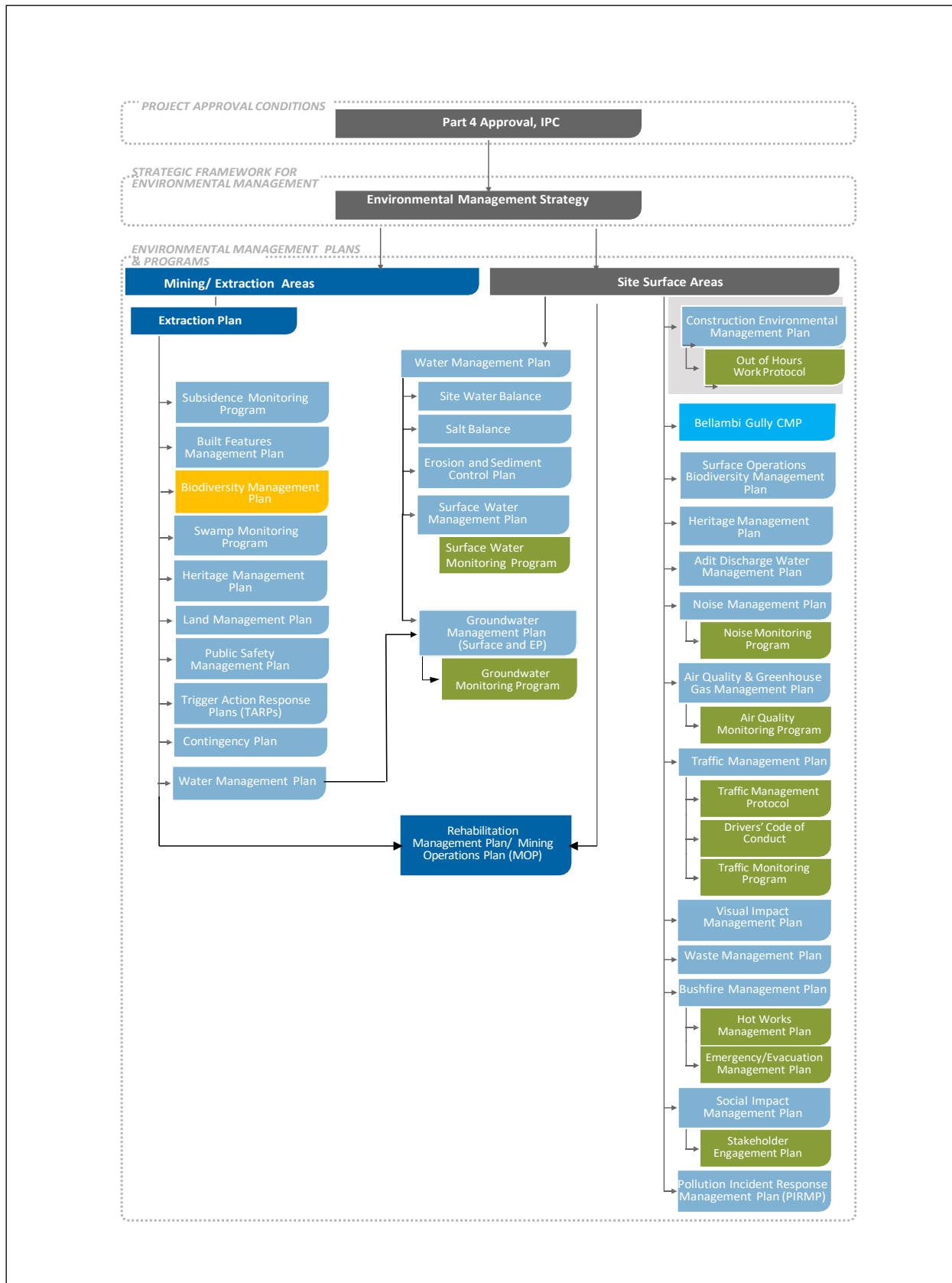


Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

Matter: 34553
Date: 30 September 2021
Checked by: SK, Drawn by: AM, Last edited by: Iharley
Location: P:\34500s\34553\Mapping\34553_F2_StudyArea

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Figure 3 WCL Environmental Management Structure



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2 STATUTORY REQUIREMENTS

2.1 Project Approval

Condition C10(g)(iv) of the PA MP09_0013 requires the preparation of a BMP in support of the Extraction Plan. The relevant consent conditions relevant to the BMP are specified in **Table 2**, with reference to where each component of the condition is addressed within this Plan. The Performance Measures set under **Condition C1** (Table 6) which are related to biodiversity features are detailed in **Section 5**.

In accordance with **Condition C10**, WCL will ensure implementation of this Management Plan as approved by the Secretary before carrying out any second workings.

Table 2: UEP Extraction Plan - Biodiversity Management Plan Requirements

Development consent	Plan Section
A1 - OBLIGATION TO MINIMISE HARM TO THE ENVIRONMENT In addition to meeting the specific performance measures and criteria established under this approval, the Applicant must implement all reasonable and feasible measures to prevent, and if prevention is not reasonable and feasible, minimise, any material harm to the environment that may result from the construction and operation of the project, and any rehabilitation required under this consent."	This plan
Schedule 2, Condition C10 – Extraction Plan The Applicant must prepare an Extraction Plan for all second workings on site to the satisfaction of the Secretary. The Extraction Plan must: <ul style="list-style-type: none"> (a) be prepared in consultation with RR, DPIE Water and WaterNSW and by suitably qualified and experienced person/s whose appointment has been endorsed by the Secretary; 	2.5.2
<ul style="list-style-type: none"> (b) be approved by the Secretary before the Applicant carries out any second workings covered by the plan; 	Section 2.1
<ul style="list-style-type: none"> (g) describe in detail the performance indicators that would be implemented to ensure compliance with the performance measures in Tables 5 and 6, and manage or remediate any impacts and/or environmental consequences to meet the rehabilitation objectives in Table 4; 	Section 5.1
(iv) Biodiversity Management Plan Biodiversity Management Plan <ul style="list-style-type: none"> • which has been prepared in consultation with BCD, 	Section 2.5.2
<ul style="list-style-type: none"> • which establishes a baseline data for the existing habitat on the site, including water table depth, vegetation condition, stream morphology and threatened species habitat, and 	Section 3.1
<ul style="list-style-type: none"> • provides for the management of potential impacts and/or environmental consequences of the proposed first workings on aquatic and terrestrial flora and fauna, with a specific focus on threatened species, populations and their habitats, EECs and water dependent ecosystems; 	Sections 4,5,6,and 6

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Development consent	Plan Section
<p>(viii) Trigger Action Response Plan/s addressing all features in Tables 5 and 6, which contain:</p> <ul style="list-style-type: none"> appropriate triggers to warn of increased risk of exceedance of any performance measure; specific actions to respond to high risk of exceedance of any performance measure to ensure that the measure is not exceeded; adaptive management where monitoring indicates that there has been an exceedance of any performance measure in Tables 5 and 6, or where any such exceedance appears likely; and an assessment of remediation measures that may be required if exceedances occur and the capacity to implement those measures; 	<p>Section 7.3 Section 7.3 Section 7.3.1, and Appendix C Section 7.5.1, and 7.5.2</p>
<p>(ix) Contingency Plan that expressly provides for:</p> <ul style="list-style-type: none"> adaptive management where monitoring indicates that there has been an exceedance of any performance measures in Tables 5 and 6, or where exceedance appears likely; and an assessment of remediation measures that may be required if exceedances occur and the capacity to implement those measures 	<p>Section 7.5</p>
<p>(xi) includes a program to collect sufficient baseline data for future Extraction Plans</p>	<p>Section 3 of this plan</p>
<p>Condition C4 - SUBSIDENCE - Offsets</p> <p>If the Applicant exceeds the performance measures in Table 6 and the Secretary determines that:</p> <ol style="list-style-type: none"> it is not reasonable or feasible to remediate the subsidence impact or environmental consequence; or "remediation measures implemented by the Applicant have failed to satisfactorily remediate the subsidence impact or environmental consequence; <p>then the Applicant must provide a suitable offset to compensate for the subsidence impact or environmental consequence, to the satisfaction of the Secretary."</p> <p>Notes:</p> <ul style="list-style-type: none"> Any offset required under this condition must be proportionate with the significance of the subsidence impact or environmental consequence. Any offset required under this condition does not limit other actions by the Department under the penalty powers or enforcement provisions of the EP&A Act." 	<p>Section 7.5.3</p>
<p>Condition C5- SUBSIDENCE – Offsets</p> <p>If required under Condition C4, any offsets for biodiversity and swamps must be undertaken in accordance with the Biodiversity Offsets Scheme of the BC Act.</p>	<p>Section 7.5.3</p>

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Development consent	Plan Section
<p>Condition C6- SUBSIDENCE - Offsets</p> <p>The offset must give priority to like-for-like physical environmental offsets, but may also consider other offsets under the Biodiversity Offsets Scheme of the BC Act, such as the Biodiversity Conservation Fund established by BCT, or funding or implementing supplementary measures, such as:</p> <ul style="list-style-type: none"> (a) actions outlined in threatened species recovery programs; (b) actions that contribute to threat abatement programs; (c) biodiversity research and survey programs; and/or (d) rehabilitating degraded habitat. 	Section 7.5.3

2.2 Statements of Commitments

Section 6.0 of the Revised Preferred Project Report included a Statement of Commitments for the Revised Preferred Project. As a result of submissions received, WCL committed to additional environmental management and monitoring measures as out lined in the Submission Report – Part A and Part B. **Table 3** presents an updated consolidated Statement of Commitments for the Revised Preferred Project.

Table 3: UEP Extraction Plan Statements of Commitment

Development consent	Timing	Plan Section
WCL will consult with the NSW Biodiversity and Conservation Division as part of the process to review and update the Biodiversity Management Plan and Upland Swamp Management Plan to reflect the Revised Preferred Project and associated management and monitoring measures.	Within 3 months of approval and ongoing	Section 2.5.2
<p>Given that no perceptible subsidence impacts are predicted to occur as a result of the Revised Preferred Project, monitoring of potential biodiversity impacts will be focussed on subsidence monitoring and monitoring required to detect primary impacts to groundwater systems associated with upland swamps, and surface water flow and quality in creeks.</p> <p>If subsidence impacts and/or primary impacts in excess of those predicted are detected, the monitoring program will be reassessed.</p>	Ongoing in accordance with the Biodiversity Management Plan	<p>Section 6</p> <p>Section 7.5</p>

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2.3 Management Plan Requirements

Part F, **Condition F5** of the Consent MP09_0013 requires the management plans under this consent to be prepared in accordance with the relevant guidelines as detailed. **Table 4** details where each component of the condition is addressed within this BMP.

In accordance with Condition C10, WCL will ensure implementation of this Management Plan as approved by the Secretary.

Table 4: Management Plan Requirements

Development consent	Plan Section
Schedule 2 Part F – Environmental Management, Reporting and Auditing Condition F5: a) a summary of relevant background or baseline data;	Appendices B and D Section 3
Condition F5: b) details of: (i) the relevant statutory requirements (including any relevant consent, licence or lease conditions); (ii) any relevant limits or performance measures and criteria; and (iii) the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures;	Section 2 Section 5 Section 5,
Condition F5: c) any relevant commitments or recommendations identified in the document/s listed in condition A2; d) a description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;	Sections 5, 6 and 7
Condition F5: e) a program to monitor and report on the: (i) impacts and environmental performance of the development; and (ii) effectiveness of the management measures set out pursuant to condition F5(c);	Section 6 and 11
Condition F5: f) a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible; g) a program to investigate and implement ways to improve the environmental performance of the development over time;	Section 7.4 (and Section 7 generally)
Condition F5: h) a protocol for managing and reporting any: (i) incident; non-compliance or exceedance of any impact assessment criterion or performance criterion; (ii) complaint; or (iii) failure to comply with other statutory requirements;	Section 8 and Section 9 The EP (Sections 4 and 5)
Condition F5: i) public sources of information and data to assist stakeholders in understanding environmental impacts of the development; and j) a protocol for periodic review of the plan.	Sections 11 and 12 The EP (Section 5)

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2.4 Relevant Legislation and Guidelines

WCL will conduct approved mining operations consistent with PA MP09_0013 conditions and any other legislation that is applicable. The following Acts are applicable to this plan:

- *Biosecurity Act 2015;*
- *Biodiversity Conservation Act 2016;*
- *Environmental Planning and Assessment Act 1979;*
- *Environment Protection and Biodiversity Conservation Act 1999(Commonwealth);*
- *Fisheries Management Act 1994;*
- *Mining Act 1992;*
- *Protection of the Environment Operations Act 1997;*
- *Water Management Act 2000;*
- *Water NSW Act 2014.*

Relevant licences or approvals required under these Acts will be obtained as required.

2.5 Consultation

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2.5.1 Consultation during the environmental assessment process

Extensive community and government consultation has been carried out prior to and during the preparation of the original environmental assessment, the Revised Project Report, the Submissions Report and other project-related assessment documentation. The primary objective of consultation was to keep the community, government agencies and other stakeholders informed and involved during project development process.

Community engagement was carried out in two phases and is summarised in Section 4.1.2 and Section 4.1.3 of the Revised Project Report.

A complete summary of previous and ongoing government agency and stakeholder consultation is provided in Table 4.5 of the Revised Project Report. Consulted parties of relevance to this BMP included:

- the Department of Planning, Industry and Environment (DPIE);
- NSW Biodiversity Conservation Department
- WaterNSW

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2.5.2 Consultation during the preparation of the Management Plan

This Plan has been prepared in consultation with:

- NSW Department of Planning, Industry and Environment (DPIE) Planning Division
- NSW Environment, Energy and Science (EES) and its Biodiversity Conservation Department;
- Commonwealth Department of Agriculture, Water and the Environment (DAWE) including Commonwealth Office of Water Science (OWS);

Details of the consultation are provided in **Table 5** below.

Table 5: Consultation undertaken as part of the preparation of this Management Plan

Agency name and timing of consultation	Subject of consultation	Where addressed
DPIE (Planning) 9 February 2021	Letter to the department advising on the proposed team for the development of the Extraction Plan including its subplans for Subsidence, Water, Biodiversity and Swamps.	Section 1.1
EES - BCD 5 March 2021 and 14 September 2021	Discussed information requirements of the plan to ensure adequacy for monitoring all threatened species and communities potentially affected by the UEP project. See Appendix A for the details of this feedback as addressed in detail in Appendix E .	Section 4 and 6 Appendix E – BCD EES RESPONSE
DAWE and OWS - 2 March 2021	Discussions in February 2021 IESC advice regarding potential impacts on water dependent ecosystems and coastal upland swamps.	Section 4.2 and 6.3
OWS – 9 April 2021	Discussions in April 2021 regarding approach to use of reference sites for Upland Swamp biodiversity Monitoring and TARP requirements for threatened species potentially impacted by subsidence or changes in hydrological processes.	Section 6 and Appendix C – TARPS
BCS – 12 November 2021	Letter recommended that the BMP be updated to include a monitoring program for the Giant Burrowing Frog.	Section 6.4 and Appendix E

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3 BASELINE DATA

3.1 Summary of Baseline Data Monitoring

Due to the extended history of mining in the UEP area and the assessment process for the UEP, there is a long period of baseline data collection which is relevant to the identification of potential impacts from the mining in the EP Area. While some of this monitoring has been undertaken in relation to the monitoring of impacts from LW4, LW5 and LW6, there have been no significant impacts identified to aquatic biodiversity, rocky habitats or other threatened species from this mining that precludes the use of this data as being suitable for setting a baseline for monitoring of impacts associated with the mining covered by this EP. A summary of this monitoring is provided in **Table 6** below with a summary of baseline conditions for aquatic ecology, and threatened species provided in **Sections 3.3** and **3.4**.

The EP Upland Swamp Monitoring Program (USMP) Section 3 provides details of baseline conditions for the Coastal Upland Swamps and associated threatened species and groundwater levels within swamps.

Aquatic ecological monitoring has been undertaken by Biosis within the UEP area between 2012 to 2020, however, there have been various iterations of monitoring locations due to modifications in the suitability of control sites. The aquatic ecological monitoring sites in **Table 6** have been the subject of monitoring since 2015. The most recent aquatic ecological monitoring report has been prepared by Biosis (2020).

Table 6: Aquatic ecological monitoring locations undertaken in reference to RVE

Site	Waterway	Impact/Control	Duration	Methods
RVE-AQ2	Cataract River	Impact	2010 to 2019	HABSCORE AUSRIVAS Water quality Photo-point monitoring
RVE-AQ3	Cataract Creek tributary	Impact	2013 to current	HABSCORE AUSRIVAS Water quality Photo-point monitoring
RVE-AQ4	Cataract Creek	Impact	2013 to current	HABSCORE AUSRIVAS Water quality Photo-point monitoring
RVE-AQ5	Cataract Creek	Impact	2012010 to current	HABSCORE AUSRIVAS Water quality Photo-point monitoring
RVE-AQ6	Cataract Creek	Impact	2010 to current	HABSCORE AUSRIVAS Water quality Photo-point monitoring

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Site	Waterway	Impact/Control	Duration	Methods
RVE-AQ9	Angels Creek	Impact	2014 to current	HABSCORE AUSRIVAS Water quality Photo-point monitoring
RVE-AQ11	Bellambi Creek tributary	Control	2014 to current	HABSCORE AUSRIVAS Water quality Photo-point monitoring
RVE-AQ14	Loddon Creek	Control	2015 to current	HABSCORE AUSRIVAS Water quality Photo-point monitoring
RVE-AQ15	Bellambi Creek	Control	2015 to current	HABSCORE AUSRIVAS Water quality Photo-point monitoring

Habitat for the Giant Burrowing Frog within the study area consists of small sections of upper tributaries. Detailed surveys undertaken have indicated that other than the tributary of Cataract River below CRUS2, other tributaries are unlikely to support these species, particularly given the survey effort undertaken. The Stuttering Frog is not known from localities with disturbed riparian vegetation or significant human impacts upstream, which may indicate that the species is highly sensitive to perturbations in the environment (Mahony, Knowles, & Pattinson 1997). Identified habitat in Cataract Creek shows was found to exhibit levels of pollution due to run-off from Mount Ousley Road, as well as high levels of iron flocculent from past mining. Although the habitat is suitable, these impacts result in sub-optimal conditions for the species, and habitat within the EP Area for the Giant Burrowing Frog has been identified along a 245 m section of a tributary of Cataract River below swamp CRUS2 only.

Adults, metamorphs and tadpoles of this species have been previously recorded over ten surveys between 2012 and 2016, across winter, autumn and summer seasons using visual encounter surveys. The species has been recorded from a total of ten pools along the 245 metre transect. A summary of the records are presented in **Table 7** below.

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Table 7: Giant Burrowing Frog records summary from CRUS2 transect

Survey date	Round	Adult	Metamorph	Tadpoles
28/08/2012	Winter	0	0	17
30/08/2012	Winter	0	0	11
17/04/2013	Autumn	0	0	130
27/05/2013	Autumn	0	0	50
27/08/2013	Winter	0	0	100
29/08/2013	Winter	0	0	127
20/12/2013	Summer	0	0	1
13/01/2014	Summer	0	9	8
21/01/2014	Summer	1	3	6
19/03/2014	Autumn	1	1	22
15/04/2014	Autumn	0	1	82
24/07/2014	Winter	0	0	49
29/07/2014	Winter	0	0	55
17/12/2014	Summer	0	18	23
13/01/2015	Summer	0	13	5
9/04/2015	Autumn	0	0	71
21/05/2015	Autumn	0	0	46
19/08/2015	Winter	0	0	59
9/09/2015	Winter	0	0	60
21/12/2015	Summer	3	2	29
18/02/2016	Summer	0	3	59

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 004
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3.2 Terrestrial vegetation

The plant community types (PCT's) within the UEP area, with the exception of Coastal upland swamps (Figure 4), were mapped using desktop mapping (DPIE 2010). The study area supports 905 hectares of native vegetation, across 10 PCT's being:

- PCT 694: *Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin;*
- PCT 881: *Hairpin Banksia - Kunzea ambigua - Allocasuarina distyla heath on coastal sandstone plateaux, Sydney Basin Bioregion;*
- PCT 882: *Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin Bioregion;*
- PCT 878: *Gully Gum - Sydney Peppermint - Yellow Stringybark moist open forest of coastal escarpments, southern Sydney Basin Bioregion;*
- PCT 905: *Lilly Pilly - Coachwood warm temperate rainforest on moist sheltered slopes and gullies, Sydney Basin Bioregion and South East Corner Bioregion;*
- PCT 1083: *Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux, Sydney Basin;*
- PCT 1256: *Tableland swamp meadow on impeded drainage sites of the western Sydney Basin Bioregion and South Eastern Highlands Bioregion;*
- PCT 1245: *Sydney Blue Gum X Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin;*
- PCT 1250: *Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin;*
- PCT 1803: *Banksia - Needlebush - Tea-tree damp heath swamps on coastal sandstone plateaus of the Sydney basin.*

Previously mapped Coastal upland swamp communities (Biosis 2012) historically recorded the following vegetation types: Upland Swamps: Banksia Thicket (MU42); Upland Swamps: Tea-tree Thicket (MU43); Upland Swamps: Restioid Heath (MU44b) and Upland Swamps: Cyperoid Heath (MU44c). Comparison to current PCT's has indicated that PCT 1078 *Prickly Tea-tree - sedge wet heath on sandstone plateaux, central and southern Sydney Basin Bioregion* may be present within the study area (**Figure 5**), however it has not been confirmed.

Assessment of the potential for the study area to support groundwater dependent ecosystems (GDEs) was undertaken using the Australian Government's Bureau of Meteorology, Groundwater Dependent Ecosystems Atlas (GDE Atlas) (BOM 2018), the download of metadata from State of NSW, and the NSW Office of Water Risk Assessment guidelines for groundwater dependent ecosystems (OEH 2012). No areas reliant on the surface expression of groundwater are mapped within the study area according to the GDE Atlas or metadata (DPIE 2016).

The GDE Atlas identified that the study area contains 10 PCTs (**Figure 4**), including:

- Two groundwater dependent wetland communities; and,
- Eight vegetation communities, identified as 'moderate to high Probability GDEs' (**Table 8**) in the risk assessment guidelines, and potentially reliant on subsurface expression of groundwater.

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 004
Type	Management Plan	Date Published	18/11/2021
Doc Title	Extraction Plan - Biodiversity Management Plan		

Table 8: PCT's and potential GDE's within the study area

PCT common names	PCT name	BC Act listing	EPBC Act Listing	GDE potential
Illawarra Escarpment Blackbutt forest	PCT 694 : <i>Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin</i>	Not listed	Not listed	High potential GDE
Coastal sandstone rock plate heath	PCT 881: <i>Hairpin Banksia - Kunzea ambigua - Allocasuarina distyla heath on coastal sandstone plateaux, Sydney Basin Bioregion.</i>	Not listed	Not listed	Moderate potential GDE
Gully Gum - Sydney Peppermint - Yellow Stringybark moist open forest of coastal escarpments, southern Sydney Basin Bioregion	PCT 878: <i>Gully Gum - Sydney Peppermint - Yellow Stringybark moist open forest of coastal escarpments, southern Sydney Basin Bioregion</i>	Not listed	Not listed	Moderate potential GDE
Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin Bioregion	PCT 882: <i>Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin Bioregion.</i>	Not listed	Not listed	Moderate potential GDE
Coastal warm temperate rainforest	PCT 905: <i>Lilly Pilly - Coachwood warm temperate rainforest on moist sheltered slopes and gullies, Sydney Basin Bioregion and South East Corner Bioregion</i>	Not listed	Not listed	High potential GDE
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	PCT 1083: <i>Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux, Sydney Basin</i>	Not listed	Not listed	Moderate potential GD

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PCT common names	PCT name	BC Act listing	EPBC Act Listing	GDE potential
Illawarra Escarpment Blue Gum wet forest	PCT 1245: <i>Sydney Blue Gum X Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin</i>	Not listed	Not listed	High potential GDE
Coastal sandstone gully forest	PCT 1250: <i>Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin</i>	Not listed	Not listed	High potential GDE
Tableland swamp meadow on impeded drainage sites of the western Sydney Basin Bioregion and South Eastern Highlands Bioregion	PCT 1256: <i>Tableland swamp meadow on impeded drainage sites of the western Sydney Basin Bioregion and South Eastern Highlands Bioregion</i>	Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions	Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions	High potential GDE
Coastal upland damp heath swamp	PCT 1803: <i>Banksia - Needlebush - Tea-tree damp heath swamps on coastal sandstone plateaus of the Sydney basin</i>	Coastal Upland Swamp in the Sydney Basin Bioregion	Coastal Upland Swamp in the Sydney Basin Bioregion	High potential GDE

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3.3 Aquatic ecological data

Annual reports have been provided to Wollongong Coal since the ecological monitoring program commenced in 2011. At the completion of the 2017 ecological monitoring program, 4.5 years of post-mining data had been collected for those sites that were at risk of impacts from LW4, LW5 and LW6 which was mined during the 2015 monitoring period. As a result three seasons (two and a half years) of post-mining data had been collected for those sites at risk of mining related impacts associated with that longwall.

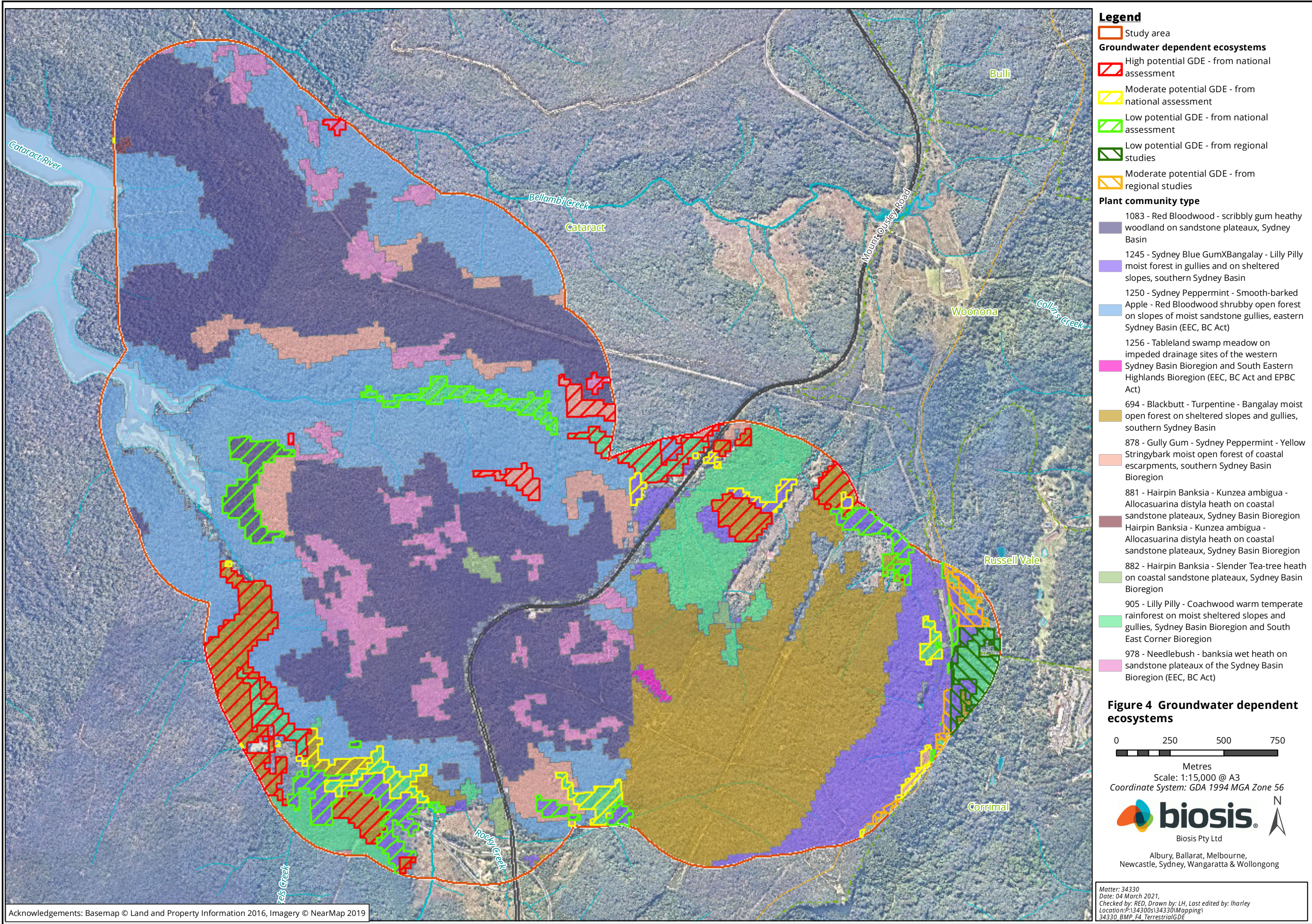
The most recent annual report addressing the 2019 monitoring period was provided in 2020 (Biosis 2020). This report evaluated the first year of the recommencement of the ecological monitoring in the Russell Vale East area including analysis of the previous years of data, and to assess the TARP trigger levels previously developed for longwall extraction that concluded in RVE in 2015.

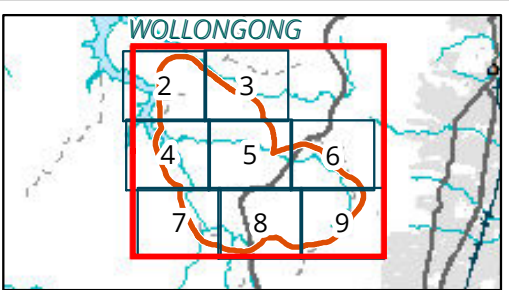
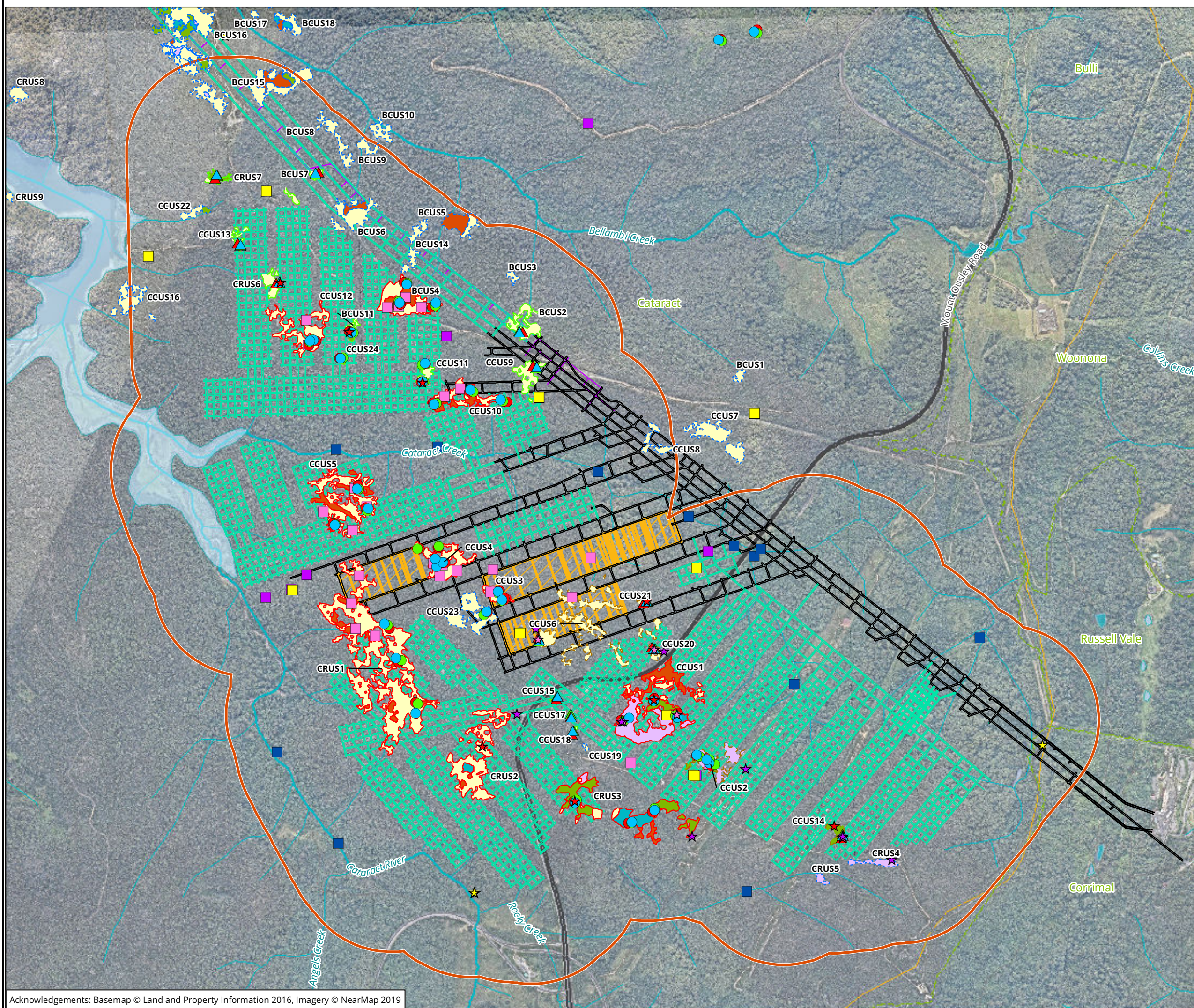
In order to establish pre-UEP baseline conditions and assess any ongoing levels of impacts following the completion of longwall mining, the results from the 2019 monitoring were reviewed. The results indicate that aquatic habitats and macroinvertebrate communities within the monitoring reaches did not exhibit any signs of disturbance that are attributed to longwall mining (Biosis 2020). As such all impact monitoring sites were considered to be within prediction (level 1).

All HABSCORE results were within the Optimal or Suboptimal category, attributed to nominal stream flows and diversity within the physical structure of the reaches. All impact monitoring sites recorded results above the trigger levels requiring immediate supplementary investigation. The AUSRIVAS analyses returned results that were typical of the assessments undertaken in previous years, with all results generally being within the ranges previously recorded, indicating stable water quality and macroinvertebrate communities at all reaches assessed in 2019. A trend of minor decreases in stream health and HABSCORE results was observed at a number of individual sites, however this trend was also observed in the control sites. Indicating this trend is occurring at the catchment scale and was attributed to the extended drought conditions observed up to and including 2020.

Macquarie Perch surveys identified 'young of the year' Macquarie Perch within Bellambi Creek and Cataract River, but not in Cataract Creek. While 'young of the year' Macquarie Perch have been recorded within Cataract Creek previously, breeding is unlikely to occur within Cataract Creek due to the lack of habitat features (riffles adjoining gravel runs) that are traditionally considered suitable for Macquarie Perch breeding. The species is widespread within the Cataract Reservoir catchment. The general fish community structure recorded in 2019 was noted to be consistent with that recorded in previous surveys. The somewhat reduced numbers of Macquarie Perch are likely to be, to a degree, related to the difference in survey method as well but also the extended period of drought contributing to reduced connectivity, habitat condition and availability.

Ongoing monitoring of Macquarie Perch is not recommended to be continued, as although the species is prolific within Cataract Reservoir and its tributaries, no breeding habitat has been identified as subject to impacts. Furthermore, the number of individuals recorded in Cataract Creek is very low, in comparison to the reservoir and other tributaries, which indicates a low reliance on Cataract Creek.





Legend

- Study area
- Past workings
- Approved Wonga central development mains
- RV East old longwall workings
- RVE-No.3_Design (20210219)
- Revised mine plan

Proposed bores

- OSP
- SM
- SP
- VWP

Existing groundwater locations

- Creek
- OSP
- SP
- VWP

Flora monitoring

- Photo Point
- Photo Point - proposed
- Transect End
- Transect End - proposed
- Transect Start
- Transect Start - proposed

Swamp survey status

- Category 1
- Category 2
- Category 3
- Category 4

Vegetation Sub-Communities

- MU42, Upland Swamps: Banksia Thicket
- MU43, Upland Swamps: Tea-Tree Thicket
- MU44a, Upland Swamps: Sedgeland-Heath Complex (Sedgeland)
- MU44b, Upland Swamps: Sedgeland-Heath Complex (Restioid Heath)
- MU44c, Upland Swamps: Sedgeland-Heath Complex (Cyperoid Heath)

Figure 5 Swamp monitoring sites

0 250 500 750

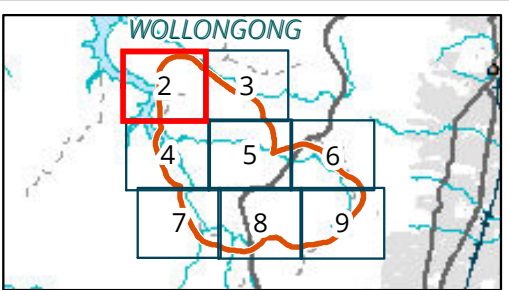
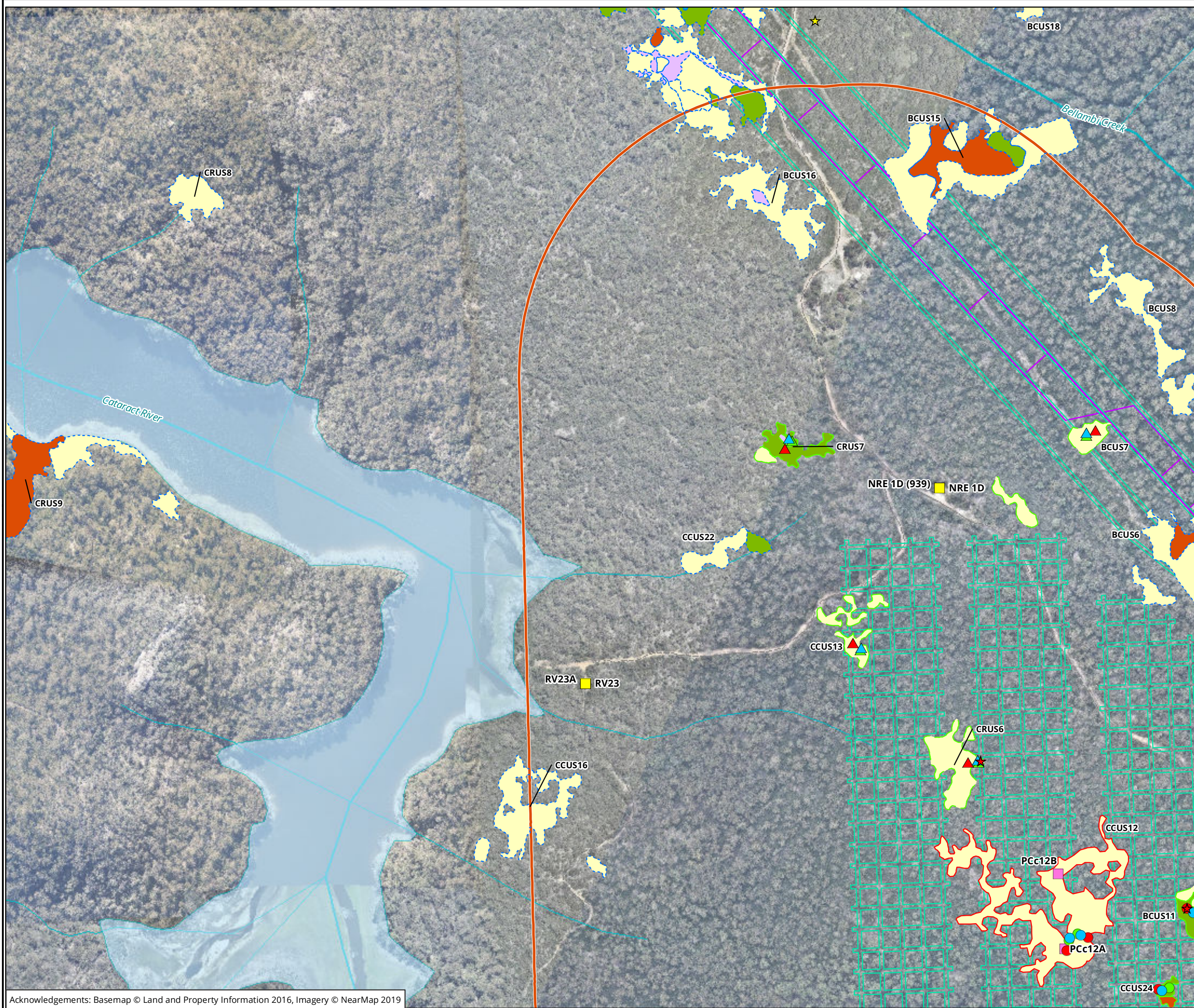
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Legend

- Study area
- Approved Wonga central development mains
- RVE-No.3_Design (20210219)
- Revised mine plan

Proposed bores

- SM
- VWP

Existing groundwater locations

- OSP
- SP
- VWP

Flora monitoring

- Photo Point
- Photo Point - proposed
- Transect End
- Transect End - proposed
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- MU44c, Upland Swamps: Sedgeland-Heath Complex (Cyperoid Heath)

Figure 5 Swamp monitoring

0 75 150 225

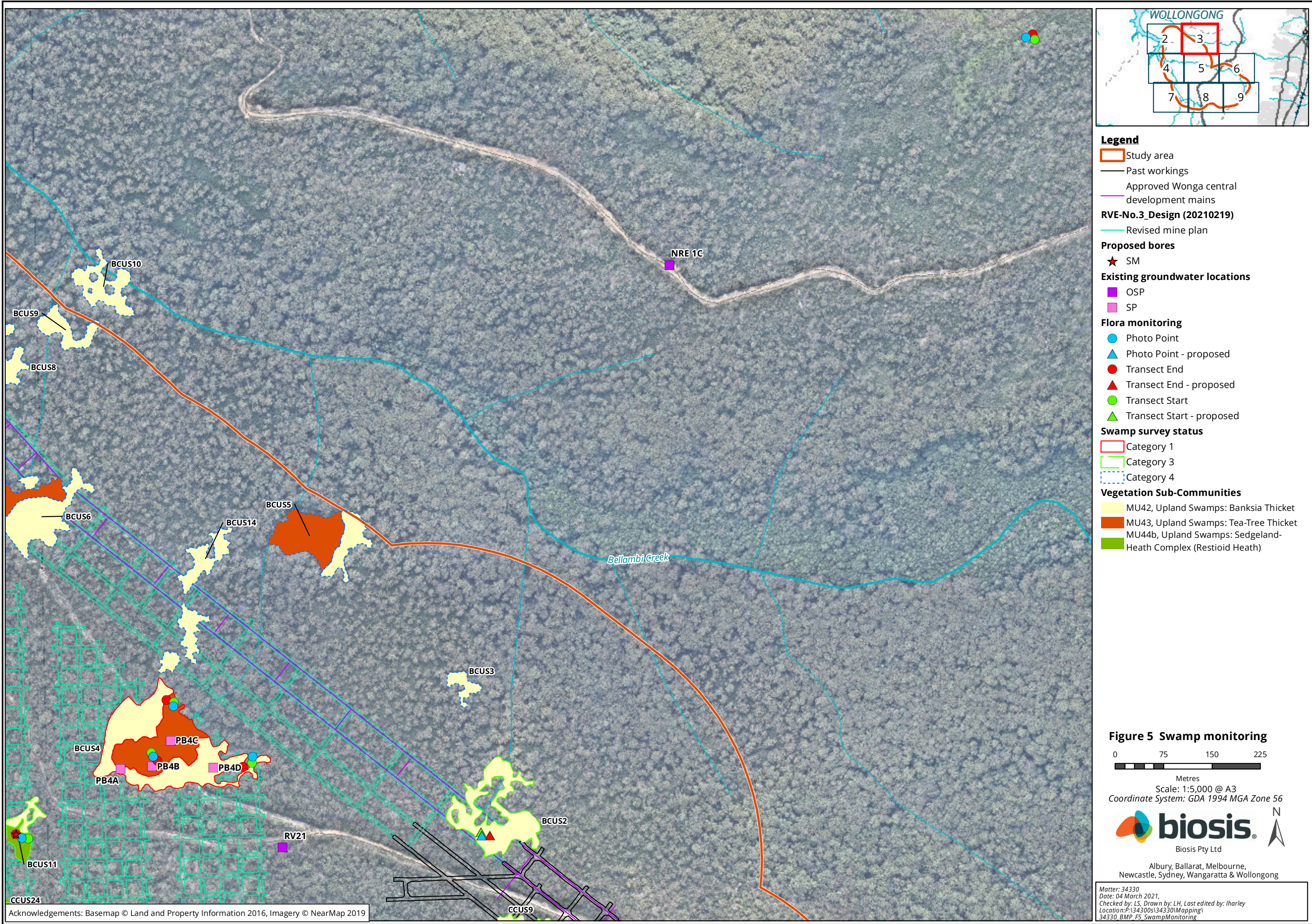
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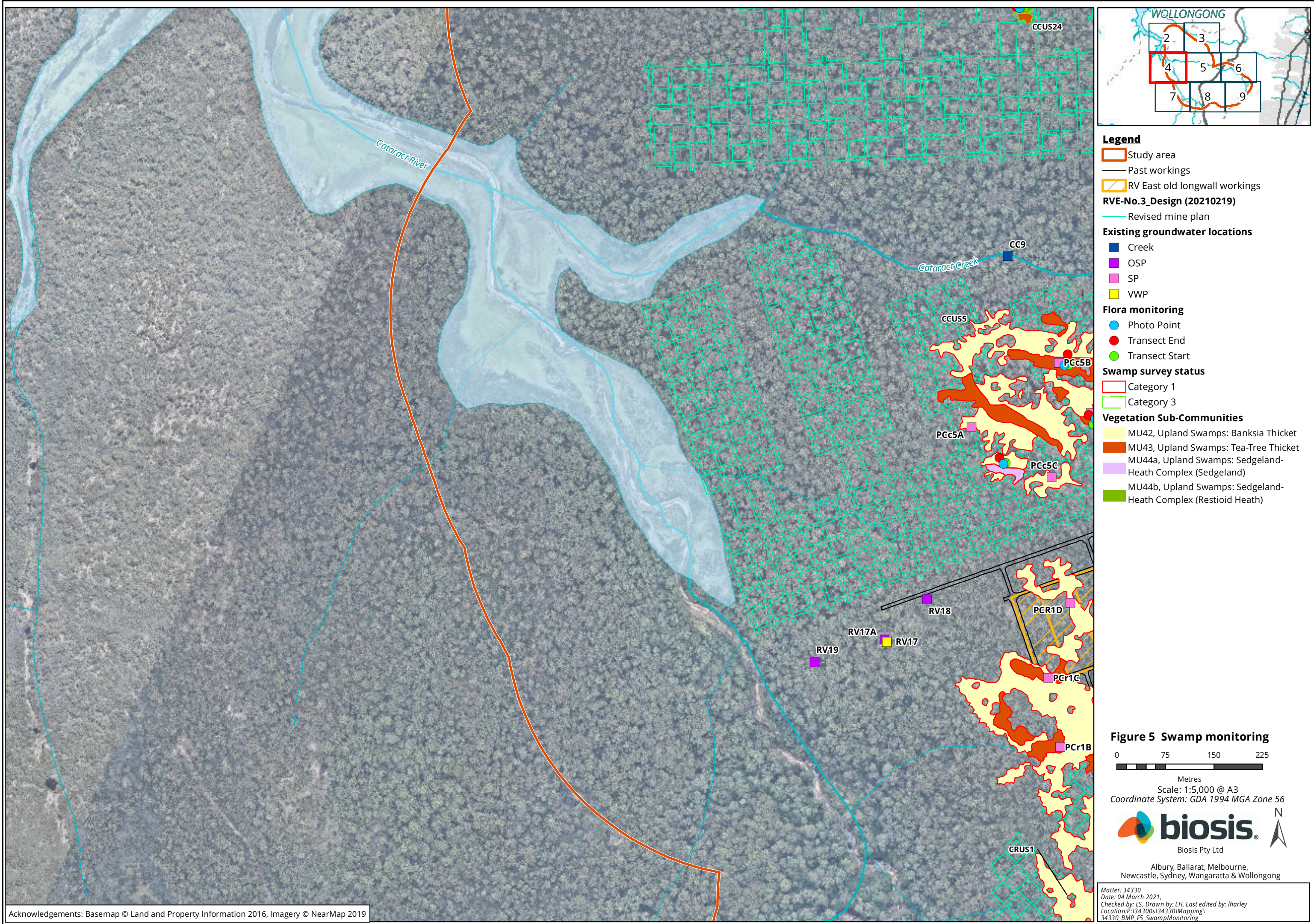
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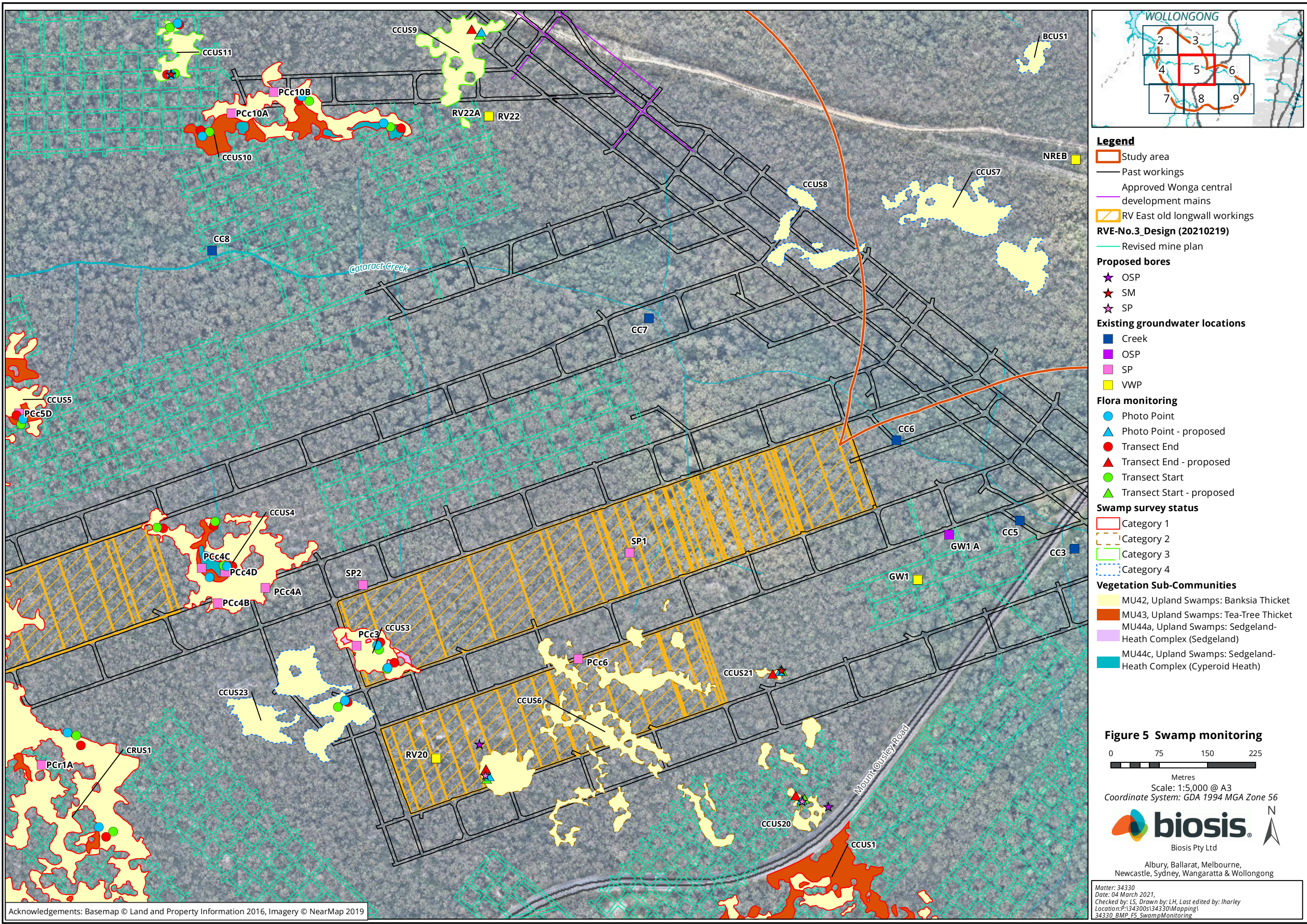


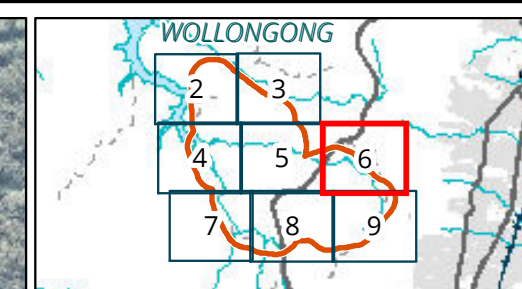
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- Legend**
- Study area
 - Past workings
 - RVE-No.3_Design (20210219)**
 - Revised mine plan
 - Existing groundwater locations**
 - Creek
 - VWP


Figure 5 Swamp monitoring

0 75 150 225

Metres

Scale: 1:5,000 @ A3

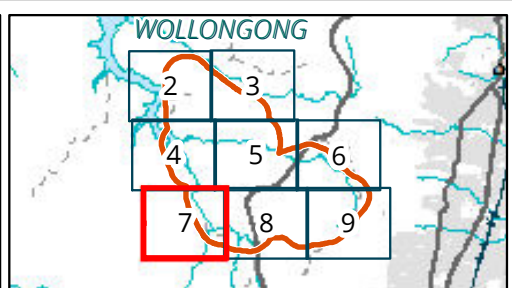
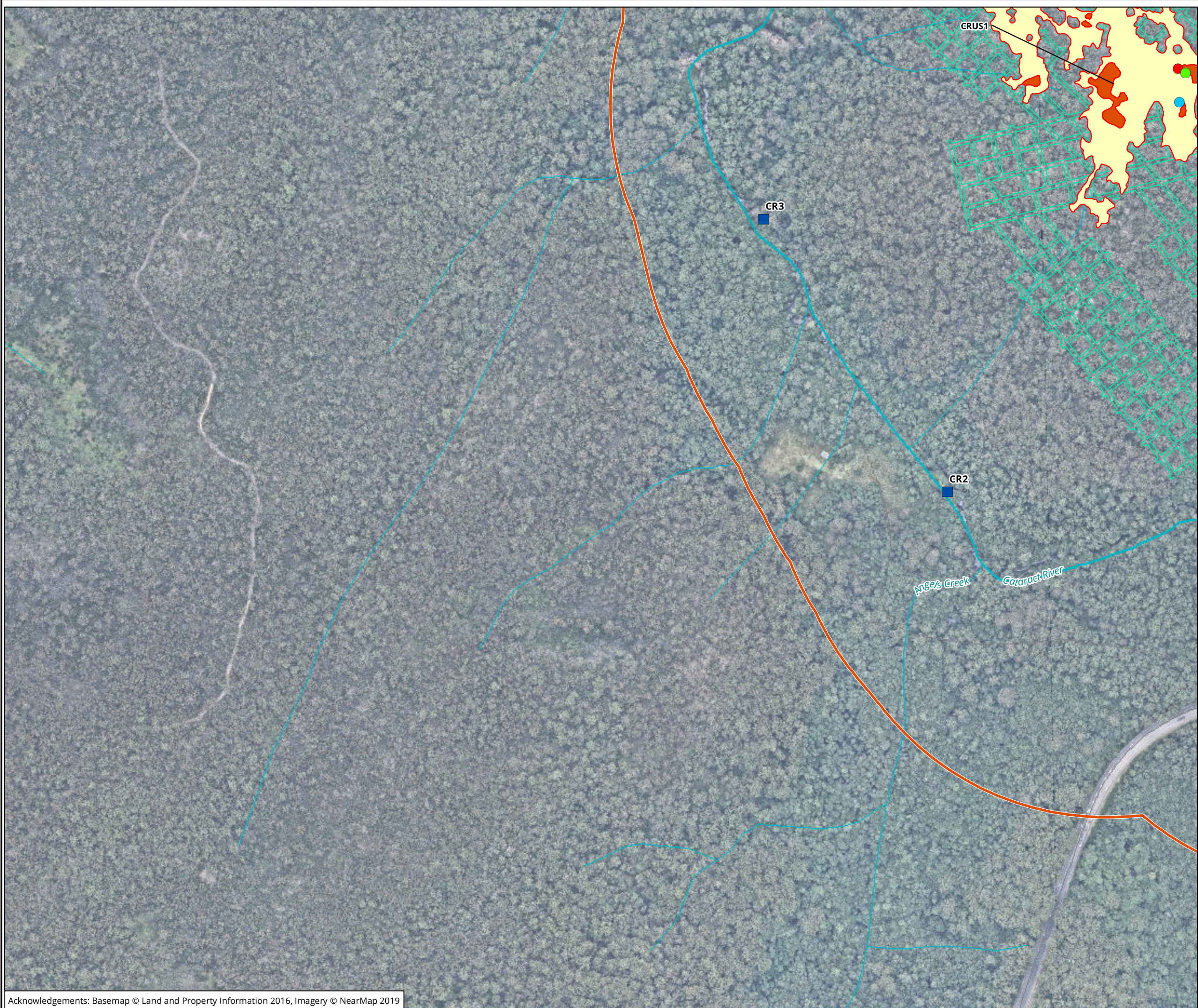
Coordinate System: GDA 1994 MGA Zone 56

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Location: P:\34300s\34330\Mapping\34330_BMP_F5_SwampMonitoring



- Legend**
- Study area
 - RVE-No.3_Design (20210219)**
 - Revised mine plan
 - Existing groundwater locations**
 - Creek
 - Flora monitoring**
 - Photo Point
 - Transect End
 - Transect Start
 - Swamp survey status**
 - Category 1
 - Vegetation Sub-Communities**
 - MU42, Upland Swamps: Banksia Thicket
 - MU43, Upland Swamps: Tea-Tree Thicket

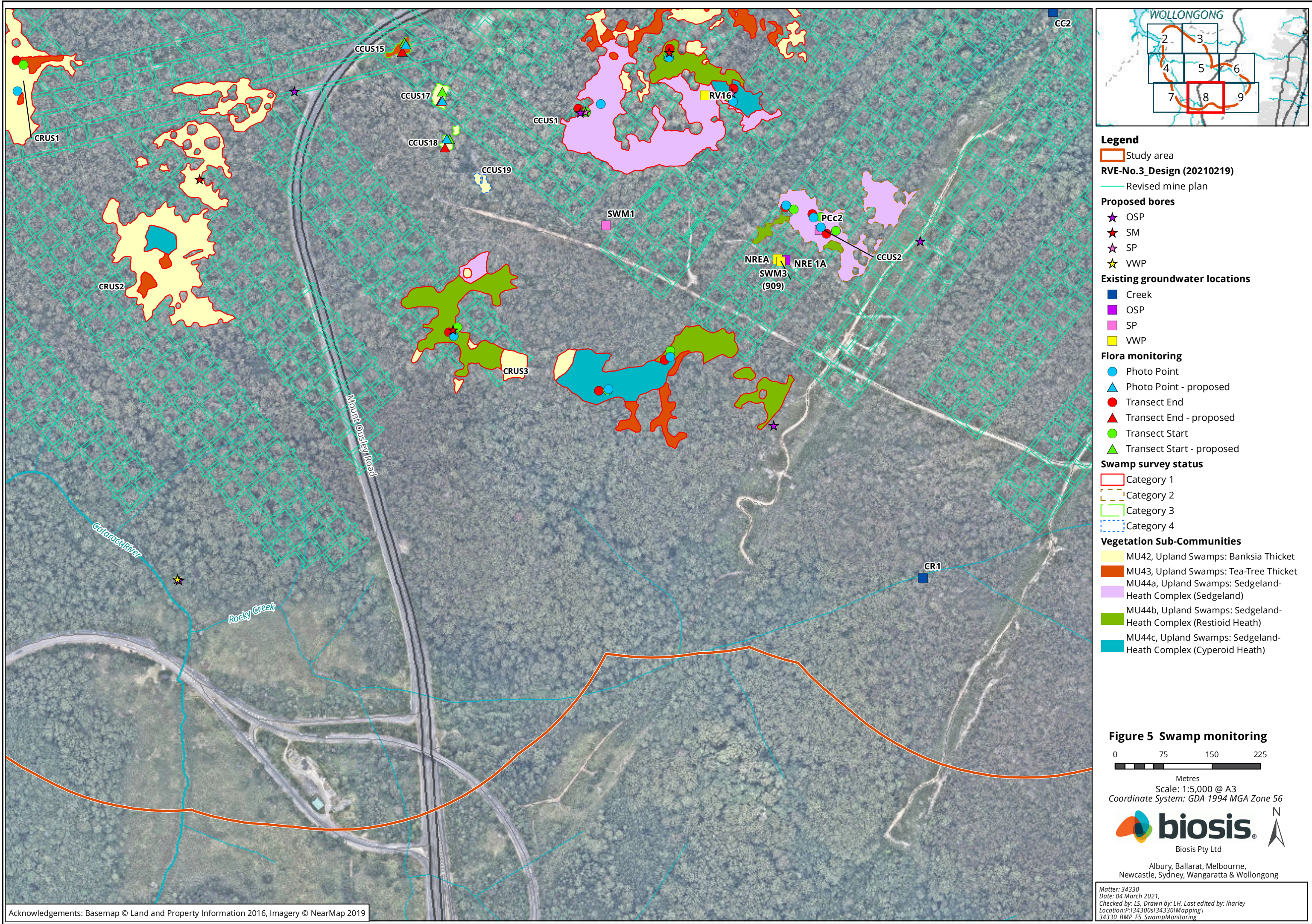
Figure 5 Swamp monitoring

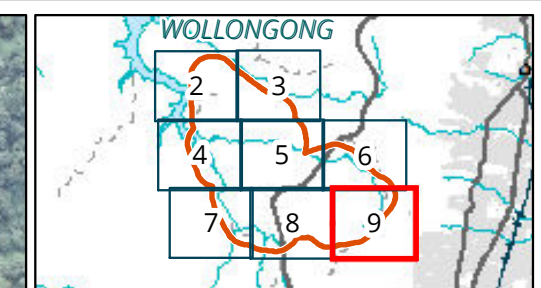
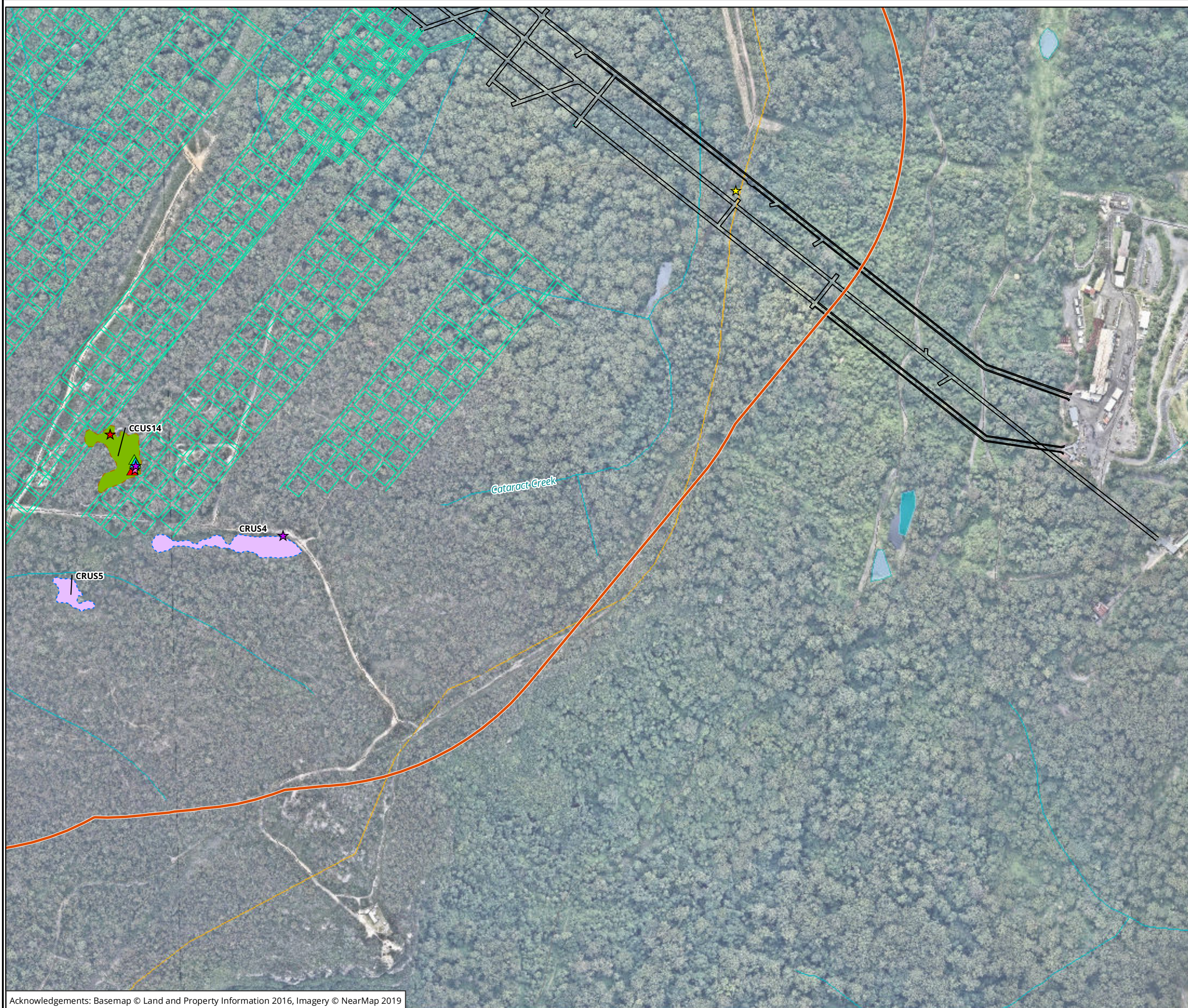
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- Legend**
- Study area
 - Past workings
- RVE-No.3_Design (20210219)**
- Revised mine plan
- Proposed bores**
- OSP
 - SM
 - SP
 - VWP
- Flora monitoring**
- Photo Point - proposed
 - Transect End - proposed
 - Transect Start - proposed
- Swamp survey status**
- Category 2
 - Category 4
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Figure 5 Swamp monitoring

0 75 150 225
Metres
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Coordinate System: GDA 1994 MGA Zone 56

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Site	Russell Vale Colliery	DOC ID	RVC EC PLN 004
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3.4 Threatened species

The desktop assessment confirmed that one EEC, *Coastal upland swamps in the Sydney Basin Bioregion* (Endangered, BC Act and EPBC Act), was previously mapped within the study area as part of the *Southeast NSW Native Vegetation Classification and Mapping project SCIVI VIS ID 2230* (DPIE 2010). Historical records also exist within the locality for 21 threatened flora and fauna species listed under the EPBC Act and BC Act (**Figure 6**). These records are outlined in **Appendix B – FLORA AND FAUNA**, along with those species and communities identified by the Protected Matters Search Tool and BioNet that are considered likely to occur in the study area due to the presence of potential habitat.

Not all of the threatened species and communities that have the potential to occur within the study area are considered to be susceptible to the subsidence related impacts. As there are no direct impacts associated with the UEP program (i.e. no threatened species habitat will be directly removed), this impact assessment focuses on the species and communities, and their habitats, which have potential to occur in the study area, and are considered susceptible to the indirect impacts resulting from subsidence (See **Appendix B – FLORA AND FAUNA** and **Table 9**). As a result some species have been excluded from requiring further assessment, being species reliant on terrestrial environments that are at negligible risk of impact.

The *Russell Vale Colliery – Underground Expansion Project: Preferred Project Report - Biodiversity* (Biosis 2014a) report identified one EEC, two flora species and nine fauna species (five terrestrial and four aquatic) listed under the EPBC Act and/or BC Act, that have the potential to occur or are known to occur in the study area (**Figure 6**), and are considered susceptible to subsidence impacts. An assessment of the likelihood of occurrence of these species, based on additional monitoring data collected since 2014, and the risk of impact from the approved UEP is provided in **Table 9**. Further impact assessment details are provided in **Section 4**.

The likelihood of occurrence for some species in this list has changed since Biosis (2014a) and Hansen Bailey (2015). These changes include:

- The likelihood of occurrence for the Large-eared Pied Bat has been downgraded to a low likelihood of occurrence. Although targeted surveys detected a single possible record, the study area does not support suitable roosting habitat.
- The Broad-headed Snake is now considered a low likelihood of occurrence. Suitable rocky habitat is highly limited in the study area and additional monitoring has not detected the species.
- Littlejohn's Tree Frog is now considered a low likelihood of occurrence based on the results of additional monitoring (Biosis 2017). Suitable habitat is limited in the study area and targeted surveys undertaken between August 2013 and February 2016 have not detected the species in the study area.
- Stuttering Frog is now considered a negligible likelihood of occurrence based on the results of additional monitoring (Biosis 2017). Targeted surveys undertaken between August 2013 and February 2016 have not detected the species in the study area.

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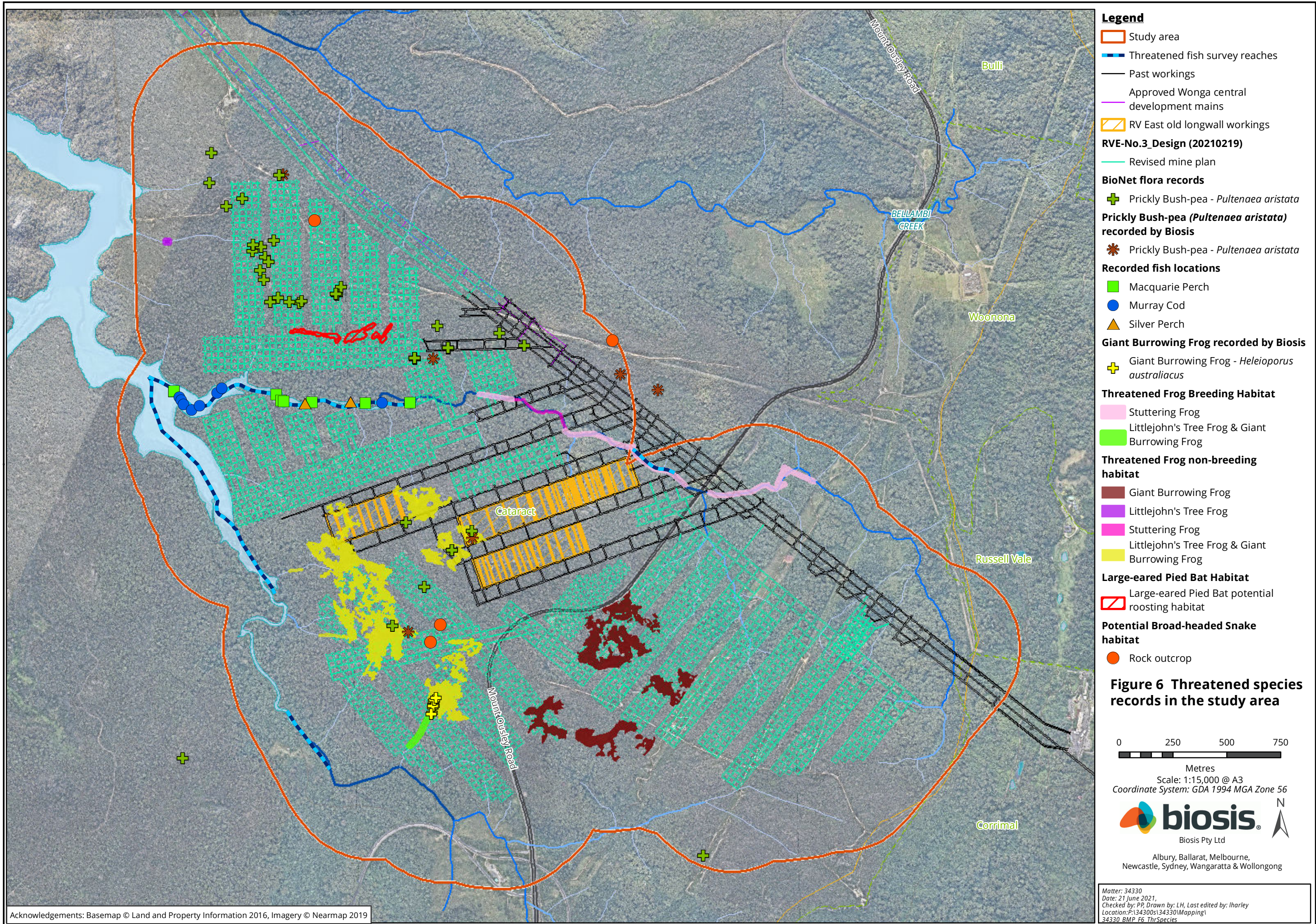
Table 9: Threatened species and communities likely to occur in the study area and previously assessed as susceptible to indirect subsidence impacts.

Scientific name	Common name	BC Act status	EPBC Act status	Sensitive habitat feature utilised	Likelihood of occurrence in the study area	Risk of impact from UEP workings
Threatened ecological community						
Coastal upland swamps in the Sydney Basin Bioregion		Endangered	Endangered	Coastal upland swamps	Recorded	Negligible
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions		Endangered	Endangered	Montane Peatlands and Swamps	Predicted- not validated (GDE PCT mapping)	Negligible
Flora						
<i>Cryptostylis hunteriana</i>	Leafless Tongue-orchid	Vulnerable	Vulnerable	Coastal upland swamps	Moderate	Negligible
<i>Leucopogon exolasius</i>	Woronora Beard-heath	Vulnerable	Vulnerable	Rocky environments	Moderate	Negligible
<i>Pultenaea aristata</i>	Prickly Bush-pea	Vulnerable	Vulnerable	Coastal upland swamps	Recorded	Negligible
Terrestrial fauna						
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	Vulnerable	Vulnerable	Rocky environments	Low	Negligible
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	Endangered	Vulnerable	Rocky environments	Low	Negligible
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	Vulnerable	Vulnerable	Rocky environments	High	Negligible



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Scientific name	Common name	BC Act status	EPBC Act status	Sensitive habitat feature utilised	Likelihood of occurrence in the study area	Risk of impact from UEP workings
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog	Vulnerable	Vulnerable	Coastal upland swamps / aquatic environments	Low	Negligible
<i>Mixophyes balbus</i>	Stuttering Frog	Endangered	Vulnerable	Coastal upland swamps / Aquatic environments	Low	Negligible
Aquatic fauna						
<i>Bidyanus bidyanus</i>	Silver Perch	-	Critically Endangered	Aquatic environments	Recorded	Negligible
<i>Maccullochella macquariensis</i>	Trout Cod	-	Endangered	Aquatic environments	Recorded	Negligible
<i>Macquaria australasica</i>	Macquarie Perch	-	Endangered	Aquatic environments	Recorded	Negligible
<i>Maccullochella peelii</i>	Murray Cod	-	Vulnerable	Aquatic environments	Recorded	Negligible



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4 POTENTIAL IMPACTS

4.1 Direct impacts

No direct impacts to surface features will result from the UEP secondary workings. The UEP secondary workings will not result in the direct removal or clearing of any vegetation.

As such there will be no direct impacts to terrestrial and aquatic biodiversity (threatened species and ecological communities), listed under the EPBC Act and/or BC Act, as a result of the UEP secondary workings.

4.2 Indirect impacts

The only potential impacts to terrestrial and aquatic biodiversity (threatened species and ecological communities), listed under the EPBC Act and/or BC Act, are limited to potential indirect impacts associated with subsidence (such as surface cracking) and hydrological changes affecting surface water regimes or near-surface groundwater.

The predicted subsidence impacts associated with the UEP area secondary workings are summarised below in **Section 4.3**. A description of the potential subsidence related indirect impacts on sensitive habitats is provided in **Section 4.2.1**.

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 004
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4.2.1 Sensitive habitats

The study area is located on the Woronora plateau in the Sydney Basin bioregion. The Woronora plateau supports a diverse range of vegetation communities and associated flora and fauna species, with disturbance, including weeds, limited to fire trails and infrastructure associated with water storage, electricity easements, transport and mining activities.

- Areas of sensitive habitat in the study area include (Biosis 2014a);
- Rocky environments;
- Coastal upland swamps (listed as an EEC);
- Ground Water dependent terrestrial vegetation communities; and
- Aquatic environments (Cataract Creek, Cataract River, Bellambi Creek and their tributaries).

Non-ground water dependent terrestrial vegetation communities will not be impacted by the secondary workings and no further assessment is required.

The secondary workings do not include any direct impacts to threatened species or ecological communities, listed under the EPBC Act and/or BC Act, as the secondary workings will not result in the direct removal of any vegetation or habitat. The main potential impact mechanism associated with the secondary workings is subsidence from mining. Subsidence can result in indirect impacts to biodiversity through associated impacts to geology, including shear cracking of the rock mass, buckling of strata from valley closure and upsidence (DoP 2008).

The potential environmental consequences of subsidence (DECC 2007, DoP 2008, PAC 2009, PAC 2010) include:

- Impacts to upland swamps, including:
 - Alteration of hydrological regimes through fracturing of bedrock beneath upland swamps or shearing;
 - Changes in concentration of water due to changes in water distribution resulting from changes in tilts; and
 - Increased scour and erosion potential due to changes in water distribution due to changes in tilts.
- Impact to aquatic environments, including:
 - Loss of surface flow to the subsurface;
 - Loss of aquatic or in-stream habitats, standing pools or changes in water level;
 - Loss of longitudinal connectivity between pools along streams;
 - Adverse impacts to water quality;
 - Simplification of remaining in-stream habitat due to the growth of iron-oxidising bacteria; and
 - Release of gas (methane) into the water column.
- Impacts to rocky environments, including:
 - Cliff falls and rock falls impacting on vegetation or fauna habitat; and
 - Fracturing of rocky outcrops impacting on vegetation or fauna habitat.

The location and extent of sensitive habitats within the study area are shown in **Figure 7**. The extent of each sensitive habitat type within the study area are detailed in the sections below.

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4.2.2 Coastal upland swamps

Detailed mapping and characterisation of Coastal Upland Swamps in the Sydney Basin Bioregion EEC (listed under the EPBC Act and BC Act) was undertaken by Biosis (2012) throughout the study area. A total of 29 upland headwater swamps (approximately 49 hectares in total) were recorded in the study area. All 29 swamps are considered to meet the requirements for listing under the EPBC Act and BC Act. The extent of this EEC in relation to the UEP is illustrated in **Figure 7**.

The upland swamps in the study area are markedly different to other upland swamps on the Woronora plateau in that they are predominantly drier, generally smaller with shallower soils, have less humic material, have more interspersed sandstone outcrops within their outlines, and are less spatially continuous than a "typical" humic, saturated swamp (Biosis 2014b). Refer to Biosis (2014b) for comprehensive details on the regional and local distribution of upland swamps, historic impacts of mining on upland swamps, including impacts to hydrogeological features.

Upland swamps in the study area also provide potential habitat for a number of threatened species listed under the EPBC Act and/or BC Act, that are susceptible to subsidence, including:

- Leafless Tongue-orchid;
- Prickly Bush-pea;
- Giant Burrowing Frog; and
- Littlejohn's Tree Frog.

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4.2.3 Aquatic environments

The revised mine plan is located within the catchment of three major streams and their tributaries; Cataract River, Cataract Creek and Bellambi Creek.

Cataract River is located to the south of the Wonga East area. Within the study area, Cataract River is a fourth order stream connecting to the south arm of Cataract Reservoir. In the study area, Cataract River is bordered by Coachwood Warm Temperate Rainforest vegetation (NPWS 2003). The secondary workings do not propose any secondary workings under the Cataract River, however secondary workings will be undertaken beneath some tributaries and the catchment of Cataract River.

Bellambi Creek, a third order stream, is located to the north of the Wonga East area. Vegetation surrounding Bellambi Creek consists of Coachwood Warm Temperate Rainforest (NPWS 2003), Bellambi Creek will not be mined under, however fist workings will be undertaken beneath some tributaries and the catchment of Bellambi Creek.

Cataract Creek is located within the Wonga East area, with bord and pillar workings located external to the south of the main channel on the eastern side. Within the study area Cataract Creek is a third order stream down to Mount Ousley Road, and a fourth order stream downstream of Mount Ousley Road.

The study area also supports a number of first, second and third order tributaries of Cataract Creek. Cataract Creek is bordered by upland swamps, dry sclerophyll forest, wet sclerophyll forest in the upper reaches and wet sclerophyll forest and rainforest vegetation in the lower reaches. In the lower reaches the canopy along Cataract Creek is closed and the creek is shaded, whilst in the upper reaches it is open. The channel morphology of the creek is characterised by sandstone benches and ephemeral pools in the upper reaches and an alternating series of long pools and shorter bars and riffles in the lower reaches. Bars and riffles are composed of various combinations of bedrock, boulders, cobble, pebble and gravel. Large woody debris is relatively common, forming dams and submerged snags in pools. There is natural variation in water levels both within and between seasons (Cardno Ecology Lab 2012a, Cardno Ecology Lab 2012c, Cardno Ecology Lab 2012b).

Second workings will occur beneath parts of Cataract Creek and beneath tributaries and parts of the broader catchment area of Cataract Creek. Streams in the study area provide potential habitat for a number of threatened species listed under the EPBC Act and/or BC Act, including:

- Littlejohn's Tree Frog (tributaries only);
- Giant Burrowing Frog (tributaries only);
- Stuttering Frog (downstream of Mount Ousley Road);
- Silver Perch (lower reaches adjacent to Lake Cataract);
- Trout Cod (lower reaches adjacent to Lake Cataract);
- Macquarie Perch; and
- Murray Cod (lower reaches adjacent to Lake Cataract).

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4.2.4 Rocky environments

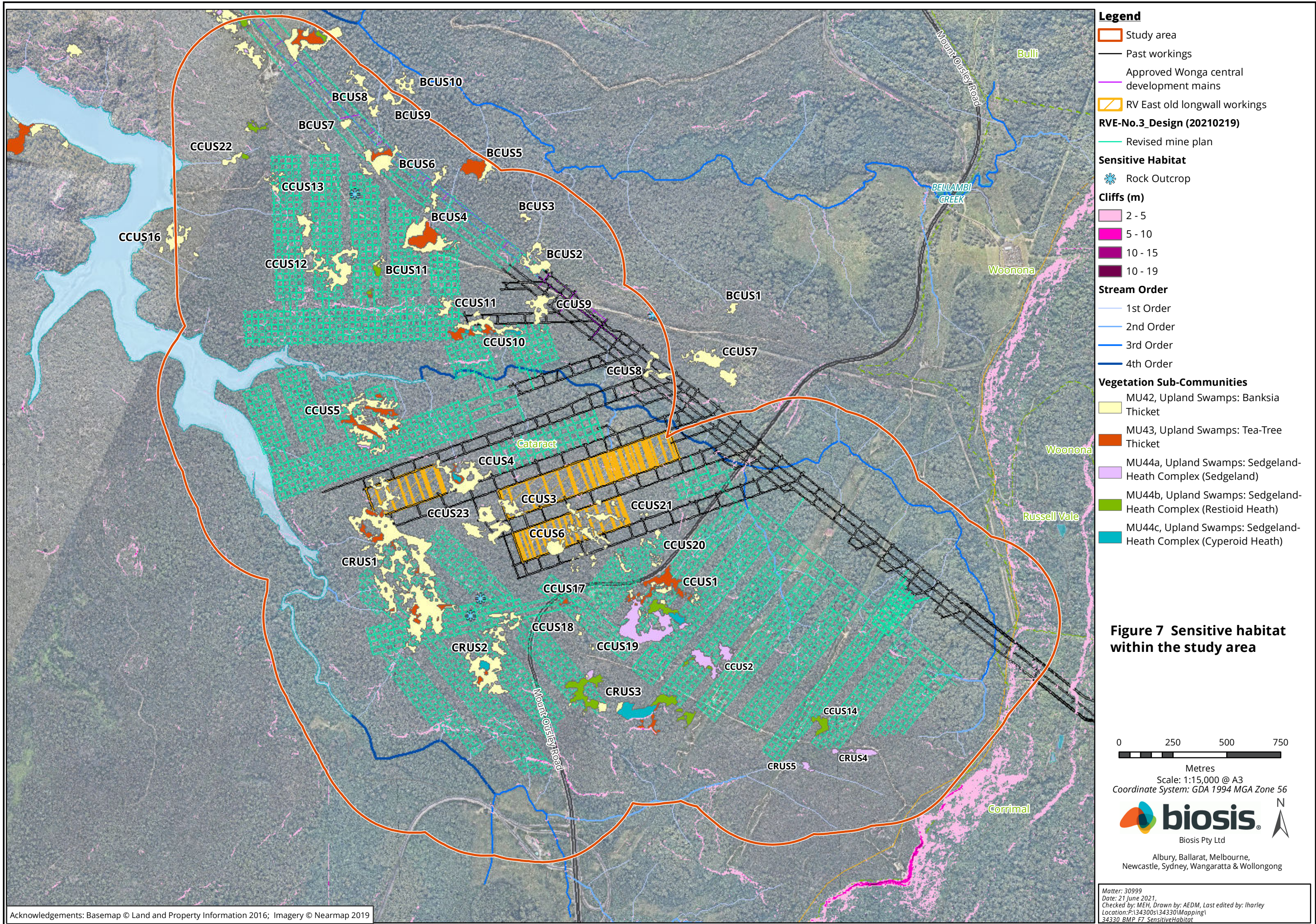
Rocky outcrops and sandstone outcrops in the study area provide potential habitat for a number of threatened species listed under the EPBC Act and/or BC Act, including:

- Woronora Beard-heath;
- Large-eared Pied Bat; and
- Broad-headed Snake.

There are no sandstone formations within the EP Areas that would be described as cliffs by current mining approval definitions for cliff and steep slopes. The sandstone outcrop formations within the EP Areas are all less than 10m high with no sandstone formations greater than 5m in height above the planned second working panels.

Rocky environments in the study area include cliffs and rocky outcrops. An inspection of cliff formations and steep slopes within Wonga East was undertaken by SCT Operations (2012). In Wonga East, cliff formations along Cataract Creek are typically less than a few metres high but do extend up to five to 10 metres high in some sections. An assessment of the cliff formations by Biosis did not identify any significant overhangs or caves and potential roosting habitat for microchiropteran bats is limited in extent and restricted to an area adjacent north of Cataract Creek.

The study area does not contain extensive north-western and western facing sandstone benches that could be considered critical wintering habitat for the threatened Broad-headed Snake (EcoLogical 2009). Whilst there are sandstone benches and overhangs present within the study area, the exfoliating slabs that provide isolated patches of habitat for Broad-headed Snake are largely absent due to the historical removal of 'bush rock'. Based on the limited extent of north-western and western facing sandstone benches in addition to absence of exfoliating slabs within the Extraction Plan Area and the presence of other suitable habitat in the region, potential impacts on the Broad-headed Snake, or other species dependent on rocky habitat are not likely to be significant.



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4.3 Predicted subsidence effects - General

The updated subsidence predictions for the bord and pillar mining covered by this EP (SCT 2021) found that, irrespective of the strength, load and behaviour of the proposed pillars being utilised in the proposed bord and pillar workings, some low-level deformation is expected within the Wongawilli seam, with elastic compression of the strata above and below the pillars. This strata compression has the potential to result in low-level subsidence movements (less than 100 millimetres and generally less than 30 millimetres), as well as some corresponding low levels of tilt and strain. Any such subsidence is likely to occur gradually and movement is expected to be generally imperceptible and insignificant for all practical purposes.

The assessment concluded that “the small subsidence movements that are forecast for the proposed mining layout are not expected to cause perceptible impacts to any natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir” (SCT 2019, SCT 2021). The proposed mining is not expected to have an impact on surface water dependent ecosystems or groundwater dependent ecosystems (Umwelt 2021).

A peer review of the Russel Vale Colliery subsidence assessment (SCT 2019) undertaken by BK Hebblewhite Consulting supported the claim that the proposed mining is not expected to result in any significant subsidence impacts on surface or sub-surface water regimes, and that proposed pillars are large enough to be long-term stable. The review also supported the claim that the UEP secondary workings are not considered to have any potential to perceptibly impact on any surface features such as escarpments, swamps, cliffs, creeks and drainage lines, or the Cataract Reservoir (B K Hebblewhite Consulting 2019).

The UEP mine plan has been designed to be long term stable. Should an unexpected pillar failure occur, the SCT Subsidence Assessment estimated the potential vertical subsidence associated with a pillar failure in the Wongawilli Seam as being up to 140 millimetres. The mine plan has been developed to ensure that pillars are long terms stable. The Pillar design has factors of safety exceeding 2.11 which implies a probability of instability of 1 in 1,000,000. The likelihood of an initiating event (pillar failure) occurring is therefore considered to be remote. Accordingly, the risk of pillar failure in the Wongawilli Seam is not considered further as a potential causal pathway.

The predicted levels of vertical subsidence from mining covered by the EP are in the order of up to 100mm directly over the proposed mining panels with very low or no vertical subsidence outside these areas. These low levels of subsidence are not predicted to result in any observable impacts to biodiversity outside the EP Area. As discussed in Section 3.112, impacts on downstream aquatic environments from mining in the form of either changes in water quality, flows, pool depth or sedimentation are also predicted to be negligible.

There are no sandstone formations within the EP Areas that would be described as cliffs by current mining approval definitions for cliff and steep slopes. The sandstone outcrop formations within the EP Areas are all less than 10m high with no sandstone formations greater than 5m in height above the planned bord and pillar panels.

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No significant, additional impacts to sandstone outcrop formations or instability of steeper ground is expected from the low level subsidence effects forecast. Impacts and consequences are expected to be negligible in the context of previous impacts. Cliff falls and rock falls are not anticipated from the low levels of subsidence predicted however it is noted that rock falls and cliff falls are a natural process associated with the weathering of these features.

4.4 Predicted Subsidence Effects - Cumulative

The EP area has previously been mined, including extraction of the overlying Balgownie Seam and Bulli Seam as well as the extraction of Longwall panels 4, 5 and part of LW 6 in the Wongawilli Seam. Subsidence associated with secondary extraction in these workings has already caused vertical subsidence over much of the proposed bord and pillar mining area.

It is noted by SCT (2019, 2020a and 2021) that there is the potential for further subsidence to occur from historical mining, including ongoing low level ground movements from mining in the Wongawilli Seam, the collapse of any marginally stable pillars in the Bulli Seam or the collapse of any remaining standing pillars within Bulli Seam goaf areas. These risks are discussed further in the Updated Subsidence Risk Assessment (SCT 2021)). Only one area of the Bulli Goaf areas occurs above the proposed EP extraction area (Area #11) which is noted as likely to have collapsed (WCT 2021). There are no creeks or coastal upland swamps located above Area #11 meaning the consequences of the failure of any remnant Bulli Seam pillars that may occur in this areas is unlikely to result in any breach of performance measures relevant to biodiversity features. Importantly, it is noted by SCT and the peer review process that this risk exists regardless of the whether the UEP project proceeds and the secondary workings do not materially change this existing risk or the environmental consequences associated with this occurring.

The detailed technical assessments prepared for the UEP have considered the potential cumulative impact of the secondary workings with historical mining operations within and surrounding the study area.

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5 PERFORMANCE MEASURES AND CRITERIA

5.1 Performance measures

Performance measures for the UEP are outlined in **Schedule 2 Condition C1** Table 5. Performance measures relevant to the biodiversity features are outlined in **Table 10** in addition to the performance criteria relevant to this performance measure.

The monitoring and management of potential impacts to Upland Swamps and associated threatened species is covered by the USMP. The monitoring and management of potential impacts to aquatic habitat are also covered in further detail in the EP WMP and GMP.

The performance criteria relevant to this performance measure are also outlined in the Trigger Action Response Plan (TARP) as outlined in **section 7.3** and **Appendix C – TARPS**.

To ensure compliance with the performance measures for biodiversity values, WCL has adopted the following performance objectives:

- No significant decline in species populations;
- No significant impact to habitats of threatened species; and
- No significant impacts to habitats of aquatic species.

Table 10: Biodiversity Performance Measures

Feature	Performance Measures	Performance Indicator	Proposed Monitoring
Swamps			
Upland swamps identified in the figure in Appendix 5 of DA MP09_0013.	Negligible environmental consequences including negligible change to the structural integrity of the bedrock base or any controlling rockbar of the swamp.	Refer to USMP	Refer to USMP
Biodiversity			
Threatened species, threatened populations, or endangered ecological communities	Negligible environmental consequences	Change in species abundance Change in vegetation condition Change in riparian habitat condition	Aquatic Macro Invertebrate monitoring Giant Burrowing Frog Monitoring# HABSCORE assessments of aquatic habitat and use of control sites. AUSRIVAS assessment of downstream creek systems and use of control sites.
Aquatic biodiversity:	Negligible environmental consequences	Change in species abundance	Re-direction of surface water flows and pool

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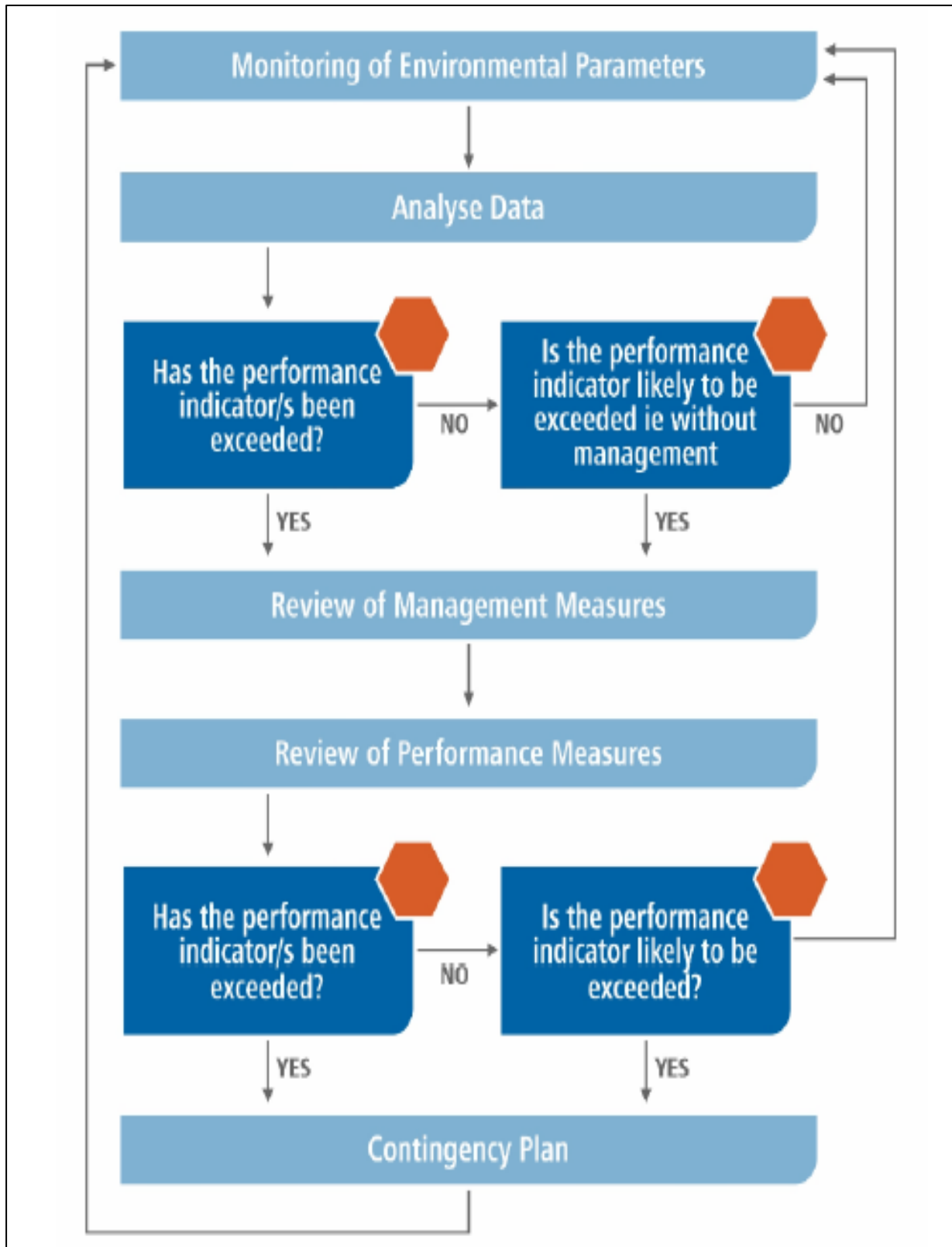
Feature	Performance Measures	Performance Indicator	Proposed Monitoring
		Change in vegetation condition Change in riparian habitat condition	level / flow decline >20% during mining compared to baseline for > 2months, considering rainfall /runoff variability. Observable increases in stream bed or bank erosion, turbidity, iron staining, algal growth, vegetation compared to pre-mining conditions.
Watercourses (Aquatic and Riparian Habitat)			
Watercourses, including Cataract River, Cataract Creek, and associated tributaries	Negligible diversion of flows or changes in the natural drainage behaviour of pools;	Reduced flow in creeks	Flow monitoring Depth monitoring at pools Visual inspection for cracking in stream bed at monitoring points
	Negligible gas releases;	Evidence of gas releases into creek water (bubbles)	Visual inspection of watercourse at monitoring locations
	Negligible increase in water cloudiness;	Increased cloudiness of water	Visual Inspection at creek monitoring points.
	Negligible increase in bank erosion;	Increased erosion in creek banks Elevated levels of total suspected solids (TSS)	Visual monitoring of stream banks at monitoring points Downstream monitoring of TSS
	Negligible increase in sediment load.	Total suspected solids	Downstream monitoring of TSS
Water Supply (Aquatic Habitat)			
Cataract Reservoir	Negligible leakage from reservoir	Increased inflow of water into underground workings	Visual monitoring of inflow rates to underground workings Measurement of dewatering volumes Monitoring of underground and Permian groundwater quality Groundwater modelling
	Negligible reduction in water quality of reservoir	Change in water quality within Reservoir	Monitoring of inflow water quality

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Feature	Performance Measures	Performance Indicator	Proposed Monitoring
			Monitoring of water quality within reservoir (WCL and WaterNSW)*
	No connective cracking between the reservoir surface and the underground workings	Increased inflow of water into underground workings	Visual monitoring of inflow rates to underground workings* Measurement of dewatering volumes Monitoring of underground and Permian groundwater quality* Groundwater modelling
Land (Rocky ecosystems)			
Cliffs, steep slopes and rock face features	Negligible environmental consequence (including subsidence induced rock falls, displacement or dislodgement of boulders or slabs, or fracturing)	Rock falls Fracturing of rock slabs Instability of steep slopes	LiDAR monitoring Visual inspections

#Not used for TARP triggers but data collected to enable assessment of potential impacts in event of observed changes on habitat associated with mining.

Figure 8 Environmental Management Process



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6 BIODIVERSITY MONITORING PROGRAM

The RVE UEP is not anticipated to have any significant impacts on terrestrial or aquatic biodiversity. Monitoring will therefore be designed around the monitoring of responses to higher than expected subsidence impacts and/or the investigation of the causes of any observed changes in groundwater levels and vegetation within the swamps complementing the baseline and ongoing regular seasonal monitoring. Baseline and ongoing monitoring will be important in monitoring compliance with biodiversity and upland swamp performance measures.

Groundwater monitoring and vegetation monitoring (qualitative and quantitative) will form the basis of the monitoring. Subsidence monitoring will also be used to identify whether additional monitoring may be required.

6.1 Monitoring period

Monitoring will occur over the following periods:

- Minimum 12 months of baseline monitoring prior to mining.
- Monitoring during mining.
- A minimum of 12 months of monitoring post-mining to confirm negligible environmental consequences as a result of the mining.

6.2 Water monitoring

Monitoring of groundwater levels within the upland swamps of the Russell Vale East (RVE) area has been undertaken since 2012 (**Figure 3**). Monitoring of the soil moisture is conducted in RVE UEP at swamps BCUS4, CCUS10, CCUS12, CCUS4, CCUS5 and CRUS1. Monitoring water levels in the shallow sandstone open standpipe piezometers SP1, SP2, paired with piezometers in upland swamps is also conducted in association with soil moisture monitoring at swamps BCUS4, CCUS10, CCUS12, CCUS4, CCUS5 and CRUS1 are currently used to assess surface water/shallow groundwater interactions and to monitor water depth in surficial lithologies in the Cataract Creek and Cataract River catchments. The EP WMP and GMP in addition to the USMP provides further details regarding monitoring in upland swamps.

There are four categories of surface water and groundwater monitoring undertaken which is relevant to aquatic biodiversity habitat:

- **Visual inspection of watercourses and swamps** to identify potential changes in: channel flows; stability (i.e. erosion and scouring); and downstream impacts from discharges (controlled and uncontrolled).
- **Flows at monitoring points** within the Cataract River and Cataract Creek – to identify potential impacts to flows as a result of underground mining operations.
- **Upland swamp monitoring** to identify potential changes to soil moisture and ponding depths within the upland swamps.
- **Groundwater levels and quality** throughout the underground mining area – to identify potential impacts to the regional groundwater levels and qualities as a result of the underground mining operations.

Details of swamp, surface water and ground water monitoring requirements and locations are provided the USMP, WMP and GMP.

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6.3 Upland Swamp Ecological Monitoring Approach

Given the sensitive nature of upland swamps, an Upland Swamp Monitoring Plan USMP (Wollongong Coal 2021a) has been prepared as a separate management plan in accordance with Condition C10(g)(v) of the development consent MP09_0013.

6.4 Giant Burrowing Frog monitoring

The Giant Burrowing Frog has been identified within a 245 metre section of a tributary of Cataract River below swamp CRUS2 during previous ecological monitoring in the Russell Vale East area. The species was detected consistently as tadpoles and is to be used as an indicator of breeding activity. The irregular records of adults and metamorphs does not provide any meaningful data and will not be part of any future monitoring, beyond incidental records.

While potential impacts to this species are considered to be negligible, a one year survey program will be undertaken covering both pre-mining and mining, with sampling undertaken during and after breeding (spring to autumn). Monitoring will focus on tadpole (or adults/egg masses) presence. Should the species be found to be present a review would be undertaken to determine the requirements for ongoing monitoring. Ongoing monitoring of potential impacts to habitat for this species will only occur in the event that subsidence monitoring indicates that there has been an impact to the identified habitat for this species or impacts to swamp water quality are detected.

6.5 Giant Dragonfly targeted surveys

Given the correlation with Giant Dragonfly habitat requirements and Upland Swamps, Giant Dragonfly monitoring methodology has been included in the Upland Swamp Monitoring Plan (Wollongong Coal 2021a).

6.6 Aquatic Ecological monitoring

The aquatic ecological monitoring program has been developed to provide a means of detecting decreases in aquatic ecological condition that may be attributable to subsidence related impacts and ensure impacts can be measured and managed in accordance with the Trigger Action Response Plans (TARPs).

A substantial aquatic ecological monitoring program has been in place within the Wonga East (now RVE) area since 2010. This program provides a substantial amount of aquatic ecological data for waterways within the RVE area that provides a useful dataset upon which to base any future comparisons for stream health monitoring.

Aquatic ecological monitoring of waterways is intended to focus on waterways considered to be most at risk from further mining (i.e. Cataract Creek, Cataract River and tributary CC6) and will include impact and control monitoring sites. The monitoring program is summarised in **Table 11** and **Figure 9** shows the location of the monitoring sites.

To ensure monitoring is capable of identifying impacts as specified in the TARPs, the following components are assessed as part of the aquatic monitoring program:

- Aquatic habitat assessments including HABSCORE assessments (Barbour et al. 1999);
- Aquatic macroinvertebrate community assessments using the NSW AUSRIVAS assessment and analysis methodology (Turak et al. 2004); and
- Supplementary water quality measurements.

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Aquatic ecological monitoring of waterways is intended to focus on waterways considered to be most at risk from UEP extraction and will include impact and control monitoring sites. The monitoring methodology is summarised in **Section 6.6.1** and locations provided as **Figure 9**.

Collated data is to be utilised for the comparison of ecological conditions between impact and control monitoring sites, as well as post-impact monitoring data to pre-impact monitoring data in order to detect any impacts associated with mining.

Table 11: Preliminary Aquatic Ecological Monitoring Program Summary

Monitoring	Impact Site	Control site	Survey timing	Methodology
AUSRIVAS monitoring surveys	RVE-AQ2 RVE-AQ3 RVE-AQ4 RVE-AQ5 RVE-AQ6	RVE-AQ9 RVE-AQ11 RVE-AQ14 RVE-AQ15	One year prior to extraction. During extraction. One year post extraction.	Each site is assessed bi-annually according to the NSW AUSRIVAS protocols. Including: <ul style="list-style-type: none"> Visual aquatic habitat assessments (HABSCORE), following Barbour et al. (1999). Supplementary water quality measurements for a basic suite of parameters including pH, dissolved oxygen, electrical conductivity. Photo point monitoring. These data are used to compare ecological condition between impact and control monitoring sites, as well as post-impact monitoring data to pre-impact monitoring data in order to detect any impacts associated with mining.

To ensure monitoring is capable of identifying impacts as specified in the TARPs, the following components are assessed as part of the aquatic monitoring program:

- Aquatic habitat assessments including HABSCORE assessments (Barbour et al. 1999);
- Aquatic macroinvertebrate community assessments using the NSW AUSRIVAS assessment and analysis methodology (Turak et al. 2004); and
- Supplementary water quality measurements.

Collated data is to be utilised for the comparison of ecological conditions between impact and control monitoring sites, as well as post-impact monitoring data to pre-impact monitoring data. In order to detect any impacts associated with mining.

The detection of changes in stream flow or water chemistry as a result of secondary workings at any waterway, would through the implementation of the EP WMP monitoring program TARPs trigger the need for additional ecological assessment and monitoring and or contingency options.

Any additional aquatic ecological monitoring will be tailored to the detected impact and will utilise previous baseline data as relevant. The method and duration of monitoring will be developed in consultation with relevant authorities.

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6.6.1 AUSRIVAS monitoring data analysis

The macroinvertebrate community data are analysed according to the assessment and analysis methodology (Turak et al. 2004). The results of each monitoring season are compared to the long-term aquatic ecological monitoring dataset for the RVE Area to identify any sites that are indicative of impacts to stream health or declining conditions. Comparisons of control and impact site results are made, along with comparisons between pre-impact baseline data and post-impact monitoring data. This allows for identification of any mining induced impacts. Trigger values for further investigation, based upon the long-term aquatic ecological monitoring dataset in the RVE Area have also been specifically developed to aid the assessment against the relevant TARPs. The macroinvertebrate data analysis methods are described below.

Results are analysed using the AUSRIVAS software package, which contains predictive models that assess the ecological health of a site by comparing its macroinvertebrate community with those of similar 'reference sites within the model. The macroinvertebrates recorded at these reference sites are considered to be a strong representation of what macroinvertebrate communities would be expected to occur at a study site, if it is in a 'reference' or undisturbed condition. If a site does not contain the taxa expected by the model, then its condition is described as being 'lower than reference'.

The AUSRIVAS model provides several outputs, including a ratio of the macroinvertebrates recorded at a study site to those predicted by the model. This is a ratio of observed taxa versus expected taxa and is called an 'O/E score' (Observed/Expected). Many macroinvertebrates are very rare, so the full list of expected taxa will often contain animals that have only been recorded once and typically at only one control site. If these were expected by the model to be present at a study site the result would often be very low O/E scores, so the most commonly used ratio is the 'O/E50' score which only gives the ratio of observed/expected taxa that have a greater than 50% chance of occurring at a site (that is, the taxa which were recorded at more than 50% of matching control sites within the model). The second output from the model is a 'Band' rating of each study site. Band ratings are a simple description of stream condition and indicate the level of impairment detected.

The Signal2 (Stream Invertebrate Grade Number Average Level) biotic index score (Chessman 2003) applies a revised sensitivity grade to macroinvertebrate families, based upon the original Signal grade (Chessman 1995) and is considered a more accurate grading. The Signal2 index describes the tolerance of macroinvertebrate taxonomic families to pollution. The index provides a comprehensive ecological indicator that produces an average Signal2 score for each monitoring site as an indication of the macroinvertebrate community's overall tolerance to pollution or disturbance.

These macroinvertebrate data analyses are supported by and assessment of physiochemical conditions at each site during the surveys, including an examination of the HABSCORE assessments, providing an indication of the physical condition of instream and riparian habitats, and water quality readings indicating the prevailing water quality conditions at each site at the time of survey.

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6.6.2 HABSCORE assessments

HABSCORE assessments were completed at each site to provide a relative measure of aquatic habitat health even when the site is dry and no AUSRIVAS assessment can be completed. HABSCORE is a visually based habitat assessment that evaluates the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community (Barbour et al. 1999). The application of the HABSCORE assessments provide site context for the AUSRIVAS analysis.

HABSCORES range from Poor to Optimal condition and reflect the current category condition of the water resource. Categories are derived from the sum of scores divided by the sum of the characters assessed. This provides an ecological indicator that produces information on the water resource when AUSRIVAS assessments cannot be undertaken (i.e. dry conditions).

HABSCORE assessments are based on the presence and condition of the following features:

- Pool substrate characterisation
- Pool variability
- Channel flow status
- Bank vegetation (score for each bank)
- Bank stability (score for each bank)
- Width of riparian zone (score for each bank)
- Epifaunal substrate / available cover

The aquatic habitat within the study area was described in terms of four category types (Barbour et al. 1999). The four categories used to evaluate habitat value were Optimal, Suboptimal, Marginal or Poor, as detailed below:

- **Optimal:** Watercourses that contain numerous large, permanent pools and generally have flow connectivity except during prolonged drought. They provide extensive and diverse aquatic habitat for aquatic flora and fauna.
- **Suboptimal:** Watercourses that contain some larger permanent and semi-permanent refuge pools, which would persist through prolonged drought although, become greatly reduced in extent. These watercourses should support a relatively diverse array of aquatic biota including some fish, freshwater crayfish and aquatic macroinvertebrates. There may also be some aquatic plant species present.
- **Marginal:** Watercourses that contain some small semi-permanent refuge pools which are unlikely to persist through prolonged drought. Flow connectivity would only occur during and following significant rainfall. These pools may provide habitat for some aquatic species including aquatic macroinvertebrates and freshwater crayfish.
- **Poor:** Watercourses or drainages that only flow during and immediately after significant rainfall. Permanent or semi-permanent pools that could provide refuge for aquatic biota during prolonged dry weather are absent.

6.7 Rocky ecosystem biodiversity monitoring

Monitoring of potential impacts to rocky ecosystem biodiversity features will only occur in the event that subsidence monitoring indicates that there has been subsidence above predictions.

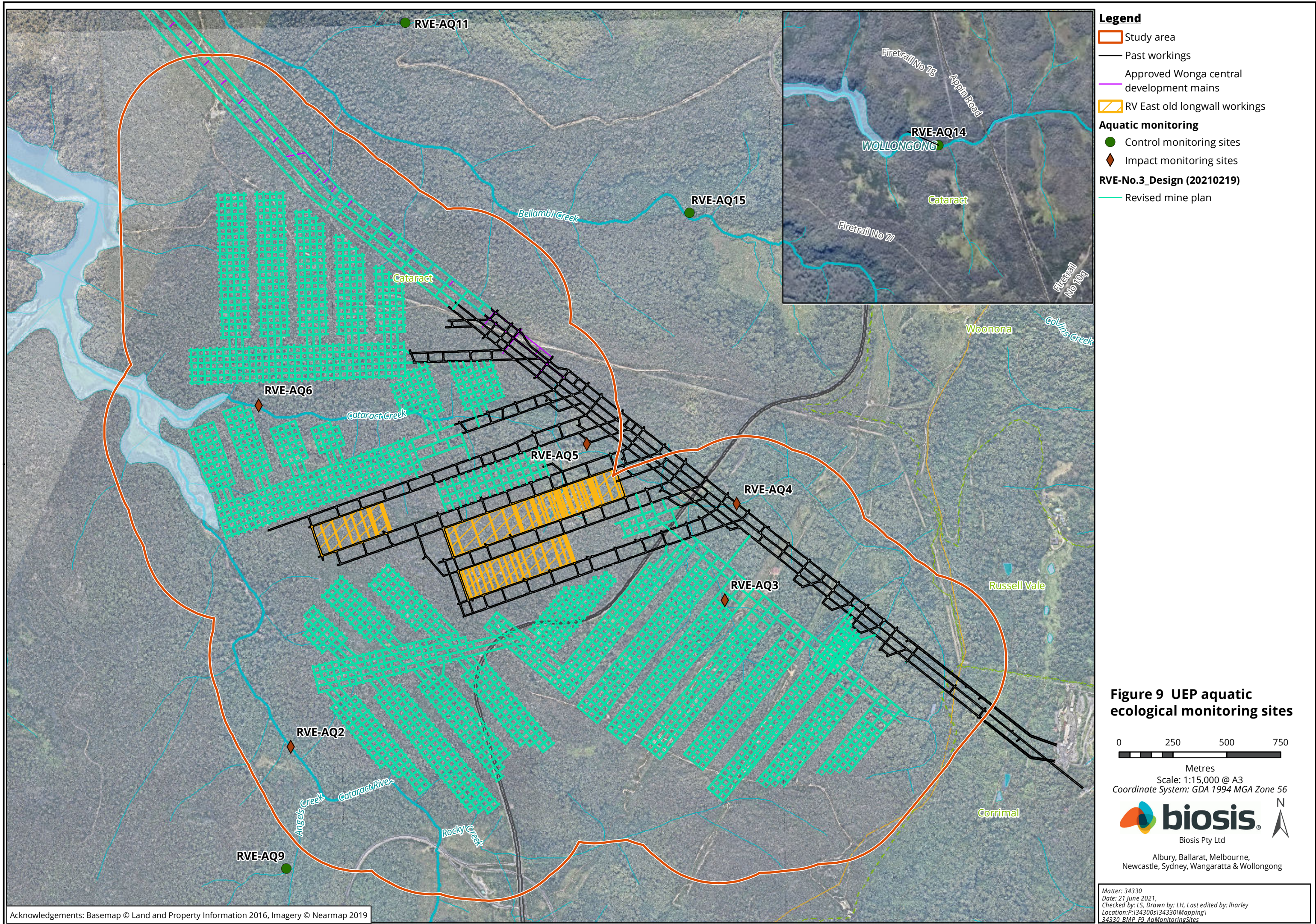


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As there are no significant cliff lines within this EP Area, this monitoring is not anticipated to be required.

No cracking of rock slabs is considered likely to occur hence there are not expected to be any significant impacts on fauna that may be reliant on these features.

Accordingly, no additional monitoring is considered to be required in relation to potential impacts to rock slab feature.



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7 MITIGATION AND MANAGEMENT STRATEGIES

The secondary workings will not result in any direct impacts to the ecological features identified in the study area other than minor impacts associated with the installation of monitoring equipment. The management of these minor impacts will be undertaken through the approval process from Water NSW associated with activities carried out in the WaterNSW special Area.

In addition, any potential indirect impacts to biodiversity have been avoided by careful mine planning with the current mine plan unlikely to result in significant or detectable impacts to any threatened species or community listed under the EPBC Act or BC Act. It should be noted that the bord and pillar mining method is flexible, can be adapted to different strata conditions and be revised to mitigate or avoid potential surface impacts in response to ongoing hazard assessments and monitoring of strata conditions.

Rehabilitation and remediation measures to remedy subsidence impacts have been outlined in NSW Planning Assessment Commission (2010) and NSW Department of Planning (2008). In creeks or watercourses with naturally high sediment loads it is likely that fracture networks will fill naturally and require little if any intervention. However, creeks, watercourses or swamps without naturally high sediment loads will require intervention. Rehabilitation and remediation options for upland swamps are further outlined in the USMP.

7.1 RVC Environmental Management System

RVC operate under the RVC Environmental Management Strategy (RVC EMS) (RVC EC STD 001) which provides a framework to ensure activities at WCL are undertaken in an environmentally responsible manner and in general accordance with the following:

- Russell Vale Revised Preferred Underground Expansion Project development consent MP09_0013;
- ISO14001 Environmental Management Standard; and
- Legislative and other requirements

While the EMS includes general requirements for the reporting and management of incidents, the EP provides specific requirements in relation to the management of subsidence related impacts associated with the mining covered by the EP and the EP requirements (including the requirements set out in this management plan) prevail to the extent of any inconsistency between documents.

7.2 Proposed measures to avoid or reduce impacts on terrestrial biodiversity

The proposed measures to avoid and reduce potential impacts on terrestrial biodiversity from the secondary workings include:

- Selected mining methodology (revision from longwall to bord and pillar mining methods) and a pillar design that is long term stable;
- Flexibility in bord and pillar mining method allows for rapid response to changes in loading and other circumstances, providing a more responsive adaptive management system to protect environmental values; and
- Monitoring and implementation of contingency actions and remediation measures as detailed if observed impacts are greater than predicted.

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7.3 TARPS

In accordance with Schedule 2, **Condition C10(g)(viii)** of the Development Consent, the Extraction Plan and associated sub plans will identify TARPs to be implemented to manage potential impacts associated with underground mining.

These TARPS include the following:

- monitoring requirements (may include different locations);
- trigger levels that indicate a potential non-compliance or flag implementation of contingency measures;
- management and contingency actions (i.e. corrective and preventative actions) and reporting requirements;
- responsibilities; and
- timing.

These TARPS detail how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements. They also form the framework for and contingency actions.

The Trigger Action Response Plan (TARP), as presented in **Appendix C – TARPS**, has been designed specifically for this EP BMP to illustrate how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for adaptive management and contingency actions.

The TARP system provides a simple, transparent and useable record of the monitoring of environmental performance and the implementation of management and/or contingency measures. Due to the nature of predicted impacts associated with the proposed second workings, Performance Measure TARPS have been established under this EP BMP.

Triggers that indicate a greater than negligible impact to aquatic threatened species, threatened populations or endangered ecological communities are outlined below:

- Extraction Plan Aquatic ecology:
 - Reduction in aquatic habitat at impact sites illustrated by a short term (one year) reduction in aquatic habitat, as shown by:
 - A decline in OE50Taxa Score since mining commenced compared to control sites; or
 - Change in AUSRIVAS Band since mining commenced compared to control sites.
 - Reduction in aquatic habitat at impact sites only for an extended timeframe (>2 years), as shown by:
 - A decline in OE50Taxa Score since mining commenced compared to control sites; or
 - Change in AUSRIVAS Band since mining commenced compared to control sites.

If monitoring indicates a Level 2 or 3 trigger has been reached, an investigation will occur in all circumstances. The nature of the investigation will depend on the feature being monitored, the location of the trigger exceedance and Trigger level exceeded among other matters. Different

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investigation options are discussed in detail in the management plans specific to the feature being monitored.

Note: Level 3 Performance Measure TARP triggers do not, of themselves, constitute an incident or non-compliance under the Development Consent. Investigations following a Level 3 trigger will determine whether an exceedance or non-compliance of the performance measures or Development Consent conditions is likely or has occurred.

In the unlikely event that investigations of Level 3 Performance Measure TARP trigger exceedances determine that material harm has occurred *and* is attributable to the development approved under the Development Consent, the contingency plan and adaptive management measures outlined within **Section** Error! Reference source not found. will be implemented. In certain cases, management measures may be implemented in the absence of any clear link between the approved development and the observed impact to mitigate adverse environmental outcomes. Response to matters which are identified as Incidents or Non-Compliances will be implemented in consultation with relevant stakeholders.

Figure 10 provides a flow chart covering the Performance Measure TARP Process. Note TARPS for subsidence (EP subsidence monitoring program), land management i.e.: cliffs, rock outcrops and slabs and steep slopes (EP Land Management Plan), upland swamps (upland swamp monitoring plan), surface water and groundwater (EP Water Management Plan) as contained in other EP component plans will also be relevant to the assessment of potential impacts on threatened species, threatened populations or endangered ecological communities.

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7.3.1 Adaptive Management

Where investigations triggered by the Performance Measure TARPS indicate that the changed conditions of sites have been, or are likely to have been, caused by mining operations, the response to these impacts include adaptive management measures to ensure further impacts to the site will not occur or be mitigated or that impacts to future sites do not occur in the future. Due to the nature of the proposed mining and low likelihood of underground mining resulting in any impacts to the site provided subsidence impacts remain within predictions, these adaptive management measures that will be implemented, will be considered in the investigation process. Adaptive management measures to be implemented in the event of a clear linkage between the mining authorised under the development consent and Biodiversity values in the UEP area will include a review of the design and layout of future mining within areas that may potentially impact on such items to avoid a recurrence of any such impacts.

These adaptive management measures include:

- stop mining and investigate causes of the exceeding of subsidence predictions.
- undertake a review of the panel design parameters in consultation with the resource regulator.

The Contingency Planning process set out in **Section 7.5** also covers this process.

The TARPS in **Appendix C** contain adaptive management measures for subsidence which inform decisions regarding underground mining operations, should higher than predicted vertical subsidence effects be observed. The purpose of this adaptive management measures are to implement additional measures where necessary to:

- enable potential impacts associated with higher than predicted subsidence impacts to be monitored; and/or
- the implementation of changes in mining operations to prevent performance criteria from being exceeded.

WCL will assess and manage development-related risks to ensure that there are no exceedances of the criteria and/or performance measures in this consent in accordance with **Condition F4** of Schedule 2. Any exceedance of the Subsidence criteria and/or performance measures constitutes a breach of this consent and may be subject to penalty or offence provisions under the EP&A Act or EP&A Regulation, notwithstanding offsetting actions taken. Where any exceedance of these criteria and/or performance measures has occurred, WCL will at the earliest opportunity:

- take all reasonable and feasible steps to ensure the exceedance ceases and does not re-occur;
- consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action;
- within 14 days of the exceedance occurring, submit a report to the Secretary describing these remediation options and any preferred remediation measures or other course of action; and
- implement remediation measures as directed by the Planning Secretary,

to the satisfaction of the Secretary.

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7.4 Potential Incident Notifications

Level 3 triggers in Performance Measure TARP are set at a level that may indicate more than trivial environmental harm. Where monitoring indicates a Level 3 Performance Measure TARP trigger related to biodiversity values has been exceeded but the cause of the trigger being exceeded is unclear, DPIE and BCD will be notified of a *potential* Incident in accordance with the processes described in **Figure 10**. All *potential* incident notifications related to biodiversity features will be sent to DPIE and BCD. *Potential* incident notifications related to surface or groundwater impacts or which may have consequent impacts of groundwater or surface water will also be provided to Water NSW.

The notification will include the same matters required to be included in an Incident Notification as required by **Condition F9** including the development (including the development application number and name) and set out the location and nature of the potential incident.

Unless the cause of the exceedance is clearly identifiable at the time the exceedance, the first step will be to investigate the likely cause or causes of the exceedance. A preliminary investigation plan will be developed to guide this investigation process and a copy provided to DPIE and other relevant stakeholders.

The investigation process will also consider any remedial action that may be required.

7.5 Contingency Plan

In the event that the observed parameters or impacts exceed or are considered likely to exceed the performance measures detailed in **Section 6** of this **EP BMP**, WCL will implement the following Contingency Plan:

- The observation will be reported to the Group Environmental Manager as soon as possible.
- The observation will be recorded.
- An investigation will be undertaken to identify the cause of the observed impacts (noting that the proposed Development is not anticipated to have any more than negligible impacts on biodiversity values).
- WCL will report any exceedances of the performance measure to the Secretary of DIPE and other relevant stakeholders including BCD as soon as practicable after WCL becomes aware of the exceedances.
- WCL will assess the exceedances referred to in the TARP (outlined in **Section 7.3**) and where appropriate, implement safety measures in accordance with the appropriate Management Plan/s.
- The Group Environmental Manager will investigate any potential contributing factors and identify an appropriate action plan to manage the identified impact(s), in consultation with specialists and/or relevant agencies if necessary.
- WCL will identify an appropriate action plan to manage the identified impact(s), in consultation with other specialists and/or key stakeholders.
- WCL will submit the proposed course of action to DPIE for approval.
- WCL will implement the approved course of action to the satisfaction of DPIE.

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- WCL will continue to monitor performance with the new action plan in place and, if successful will formalise these actions as part of the Management Plan. Contingency measures will be developed in consideration of the specific circumstances of the issue and the assessment of consequences.

Contingency measures will be developed in consideration of the specific circumstances of the issue and the assessment of consequences.

If either it is not reasonable or feasible to remediate the impact, or remediation measures implemented by WCL have failed to satisfactorily remediate the impact, WCL will provide a suitable offset to compensate for the impact, to the satisfaction of the Secretary of DPE in accordance with **section 7.5.3**.

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7.5.1 Investigation Tools

In the event that Level 2 or 3 TARP Triggers are exceeded, an investigation into the potential cause of trigger exceedances will be undertaken.

Unless the cause of the exceedance is clearly identifiable at the time the exceedance, the first step will be to investigate the likely cause or causes of the exceedance.

A preliminary investigation plan will be developed to guide this investigation process and a copy provided to DPIE and other relevant stakeholders.

There is a suite of monitoring undertaken that can inform the investigation into potential causes of level 2 and 3 trigger exceedances including:

- subsidence monitoring, including review of historical LIDAR/ GNSS data;
- groundwater monitoring;
- water quality and flow monitoring; and
- observation of underground mining conditions.

Additional monitoring as outlined in this plan for Biodiversity can also be implemented either following the exceedance of Level 2 or 3 Adaptive Management TARP triggers (e.g. higher than predicted groundwater or surface water impacts) or exceedances of Level 2 or 3 Performance Management (as per the Consent) TARP triggers. This additional monitoring may include ecological survey of areas around cliff falls or additional riparian and aquatic habitat survey locations in the event of higher than predicted vertical subsidence below creek lines.

Environmental water tracing studies can also be utilised to assist in the investigation of whether changes in groundwater or surface water quality is associated with mining related groundwater impacts or increased inflows or changes of 'fresher' groundwater inflow quality is the result of increased connectivity between Permian groundwater systems and the Cataract Reservoir.

Water balances models of pools within Cataract Creek can also be developed if there are indications that mining related impacts have affected the level of water in pools or baseflow within the creek.

Additional investigation tools such as the use of swamp specific water balances can be used to investigate potential causes of observed changes in swamp systems.

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7.5.2 General mitigation measures

Due to the absence of any likely causal impact pathways the identification of specific management measures as would be implemented under specific scenarios is not reasonable or feasible.

The specific mitigation of any impacts will depend on a range of factors to be investigated at the time of any identified impact and confirmation of causation attributable to mining including:

- the location of the impact
- nature and magnitude of the impact
- risk of further adverse impacts (including downstream impacts) that may arise from the observed impact and potential mitigation options
- approval requirements and timeframe for different mitigation options

These factors will be considered as part of the impact mitigation process discussed with stakeholder as a part of the Incident and investigation processes.

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7.5.3 Offsets

In accordance with **Condition C4** of the PA, if the secondary workings exceeds the performance measures in **Table 10** and the Secretary determines the following:

- It is not reasonable or feasible to remediate the subsidence impact or environmental consequence; or
- Remediation measures implemented by the Applicant have failed to satisfactorily remediate the subsidence impact or environmental consequence;

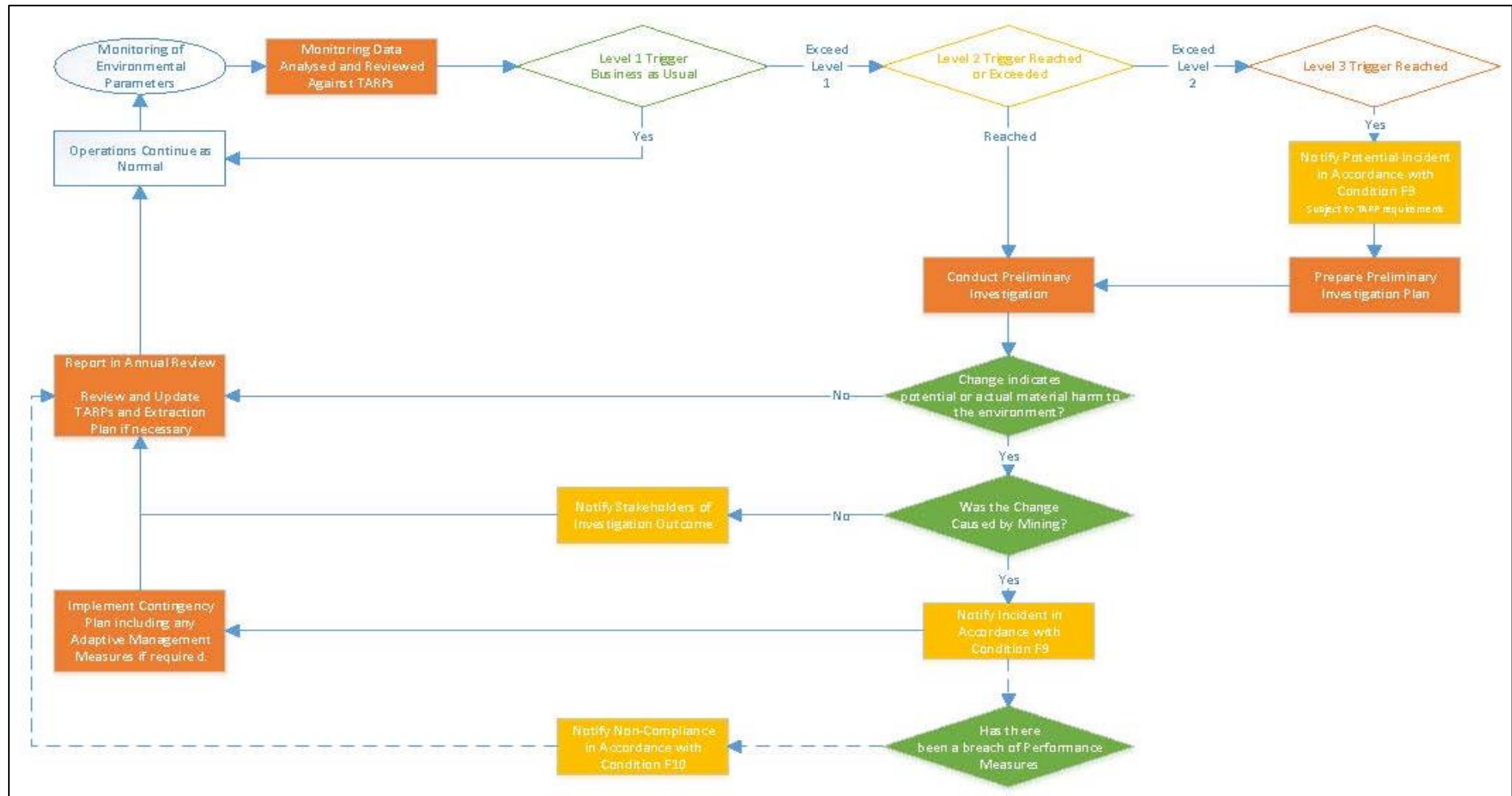
then the Applicant must provide a suitable offset to compensate for the subsidence impact or environmental consequence, to the satisfaction of the Secretary.

It is be noted that, as per the PA, **Conditions C4 – C6**:

- Any offsets for biodiversity and swamps must be undertaken in accordance with the Biodiversity Offsets Scheme of the BC Act.
- The offset must give priority to like-for-like physical environmental offsets, but may also consider other offsets under the Biodiversity Offsets Scheme of the BC Act, such as the Biodiversity Conservation Fund established by BCT, or funding or implementing supplementary measures, such as:
 - Actions outlined in threatened species recovery programs;
 - Actions that contribute to threat abatement programs;
 - Biodiversity research and survey programs; and/or
 - Rehabilitating degraded habitat.

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Figure 10 Flow Chart Covering Performance Measures TARP Process



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8 INCIDENTS, COMPLAINTS AND NON-CONFORMANCES

8.1 Incidents

The Consent defines an 'incident' to be "An occurrence or set of circumstances that causes or threatens to cause material harm and which may or may not be or cause a non-compliance". Incidents will be managed through established WCL procedures. In accordance with **Condition F9** WCL must "immediately notify the DPIE and any other relevant agencies immediately after it becomes aware of an incident". The notification must identify the following items:

- The development application number and name
- The location and nature of the incident.
- A detailed report of the incident shall be provided to DPIE within 7 days of the incident occurring.

As discussed in **Section 3**, the proposed 'second workings' which trigger the requirement for this extraction plan are long term stable bord and pillar workings which are predicted to have only negligible subsidence effects.

Incidents and associated reporting requirements will be managed through established procedures set out in Section 4.2 of the EP.

The Performance Management TARP Process will be implemented with a *Potential Incident* notification being made and an investigation being carried out to determine whether the impacts has been caused by development approved under the Development Consent. Formal incident notification, as required by **Condition F9** will occur if the investigation indicates that the event has likely been cause by the development and has caused material harm (i.e. more than trivial) to the feature).

Specifically, all incident notification related to biodiversity features will be sent to DPIE and BCD Incident notifications related to surface or groundwater impacts, or which may have consequent impacts of groundwater or surface water will also be provided to Water NSW.

8.2 Non-Compliance Protocol

The consent defines a non-compliance as an occurrence or set of circumstances that is a breach of this consent. Except in the case where a non-compliance has been notified as an incident, WCL will within seven days of becoming aware of the non-compliance, notify DPIE of the non-compliance.

The notification must set out:

- the condition of this consent that the development is non-compliant with,
- why it does not comply, and the reasons for the non-compliance (if known), and
- what actions have been, or will be, undertaken to address the non-compliance.

WCL will manage and report non-compliances against statutory requirements in accordance with an established protocol developed as a component of the EMS (in the case of pit top and associate activities) and/or the Extraction Plan.

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8.3 Complaints Handling

Complaints will be managed through established WCL procedures as described in section 4.7 of the EMS as required by **Condition F5(h)** of the Consent. All complaints will be logged with the Environmental Manager responsible for ensuring that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary. A copy of a complaints register (updated on a Monthly basis) will be kept on the WCL website.

A summary of complaints will be available to regulatory authorities on request and provided in the Annual Environmental Management Reports (AEMRs).

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9 REPORTING

The Reporting Framework set out in Section 5.2 of the EP will apply to the implementation of this plan.

This reporting framework includes:

- Incident reporting;
- Six Monthly reporting;
- Impact reporting (in the event of an observed impact associated with the development covered by the EP); and
- Annual Review reporting requirements.

This annual ecological monitoring report will be provided to WCL by their ecological consultants in July each year for incorporation into annual reporting as required below.

An annual review of the environmental performance of the project is required under **Condition F11** of the Development Consent. This review is to include a comprehensive assessment of monitoring results to date and analyses of data collected to date.

Within three months of the submission of the annual report a review of the management plans, including this BMP, must be undertaken. This review will be used to modify any monitoring requirements of the project, including outlining monitoring locations for terrestrial and aquatic species.

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10 PLAN ADMINISTRATION

10.1 Roles and Responsibilities

Environment and community management is regarded as part of the responsibilities of all Colliery personnel. The roles and function of the main personnel responsible for the implementation of environmental and community management including the plans, procedures and action plans contained in this EMP are outlined in WCL's Management Operating System.

10.2 Resources Required

In accordance with the WCL SYS POL 003 Environmental Policy, Management shall ensure that the appropriate resources are made available to achieve the implementation of this Plan.

It is the role of the Group Environment Manager to ensure that these requirements are communicated to WCL Management.

10.3 Training

All training and inductions that relate to this Management Plan are to be undertaken as per the WCL training procedures.

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10.3.1 Staff training

Staff training will be undertaken as detailed in the EMS. This consists of three levels of training applicable to different types of staff:

- Level 1 – High level training on air quality and GHG requirements (management staff);
- Level 2 – Operational level training (project managers, supervisors, surface personnel, control room operators); and
- Level 3 – Basic awareness of air quality and GHGs (underground staff, all personnel).

Targeted air quality and GHG awareness training will be provided to individuals or groups of workers with a specific authority or responsibility for operational environmental management, or those undertaking an activity with a high risk of air quality or GHG impacts.

Training will be provided as deemed necessary to contractors to provide them with the knowledge, skills and awareness to minimise air quality and GHG impacts. At a minimum this will include:

- contractors whose activities are not directly supervised by Colliery personnel; and
- contractors whose activities are ongoing and have the potential to result in an air quality incident (e.g., stockpile contractors).

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10.3.2 Inductions

All personnel, including contractors, sub-contractors and staff, are required to attend a compulsory site induction that includes an environmental component prior to commencement on site. The Environment Manager/Site Environment Representative, or delegate, will conduct the environmental component of the site induction.

The environmental component will include an overview of:

- Relevant details of this Management Plan, including purpose and objectives;
- Key environmental issues (i.e. activities generating dust, and impacts of particulate matter);
- Conditions of environmental licences, permits and approvals;
- Specific air quality/GHG management requirements and responsibilities;
- Mitigation measures for the control of air quality; and
- Incident response and reporting requirements.

A record of all environment inductions will be maintained and kept on site. The Site Environment Representative may authorise amendments to the induction where required to address project modifications, legislative changes or amendments to this Management Plan or related documentation.

The Environment Manager or delegate will review and endorse the induction program and monitor its implementation.

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11 AUDIT AND REVIEW

11.1 Annual Review

In accordance with Part F – Environmental management, reporting and auditing of the PA, an Annual Review of the environmental performance of the UEP BMP is prepared.

The Annual Review will:

- Describe the works carried out in the past year, and the works proposed to be carried out over the next year.
- Include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
 - relevant statutory requirements, limits or performance measures/criteria;
 - monitoring results of previous year/s; and
 - relevant predictions in the EA(s).
- Identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance.
- Identify any trends in the monitoring data over the life of the Project.
- Identify any discrepancies between the predicted and actual impacts and analyse the potential cause of any significant discrepancies.
- Describe what measures will be implemented over the next year to improve the environmental performance of the Project.

11.2 Auditing

In accordance with Part F of the PA an Independent Environmental Audit will be undertaken by a suitably qualified auditor and include experts in any field specified by the Secretary within 12 months of the approval and every three years after that.

This audit must:

- Be conducted by a suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Planning Secretary.
- Include consultation with the relevant agencies.
- Assess the environmental performance of the project and assess whether it is complying with the requirements in the PA and any relevant EPL or Mining Lease (including any assessment, plan or program required under these approvals).
- Review the adequacy of strategies, plans or programs required under the abovementioned approvals.
- Recommend measures or actions to improve the environmental performance of the project, and/or any strategy, plan or program required under these approvals.

In accordance with **Condition F14** of the PA, WCL would submit a copy of the audit report, along with responses to any recommendations contained within the report to the Planning Secretary.

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The audit and response to recommendations would be submitted within 3 months of the completion of the audit unless otherwise agreed by the Planning Secretary.

11.3 Plan Revision

In accordance with **Condition F7** of the PA, this BMP will be reviewed within three months of:

- The submission of an incident report.
- The submission of an annual review.
- The submission of an Independent Environmental Audit
- Any modification to the conditions of approval (unless the conditions require otherwise or as otherwise agreed with DPIE).

The revision status of this plan is indicated in the front of each copy. Revisions to any documents listed within this Plan will not necessarily constitute a revision of this document.

The distribution of controlled copies is described in **Section 2.5**.

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12 RECORDS AND DOCUMENT CONTROL

12.1 Document control

Any revisions undertaken will be the responsibility of WCL and any notifications will be sent accordingly to Heritage NSW, WCC, WSC, the registered aboriginal groups, and DPIE.

During the next major update of the plan as would likely be associated with subsequent extraction plans, further consultation with the identified stakeholders will be sought and the plan will be amended accordingly.

WCL will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on WCL's computer system, website, and hard copy at the Russell Vale Colliery, 7 Princes Highway, Corrimal NSW 2518.

12.2 Record Keeping and Control

Environmental records are to be managed in accordance with the WCL SYS PRO 001 Document and Data Control procedure.

All records of the EMS will be stored so that they are readily retrievable and suitably protected from deterioration or loss. Archiving will be managed in accordance with the WCL SYS PRO 001 Document and Data Control procedure.

A master copy of each EMS document including all appendices and supporting information is to be held in the office of the E&C Department.

12.3 Information Access

Before the commencement of construction until the completion of all rehabilitation required under this consent WCL will ensure the information and documents as stipulated in **Condition F17** and the EMS, are made publicly available on its website as they are obtained, approved or as otherwise stipulated within the conditions of this consent.

This information must be kept up to date to the satisfaction of the planning secretary.

12.4 Public sources of Information

To assist the public and other stakeholders understand the impacts from the development, including monitoring results, newsletters and updates, and in accordance with Condition F5 (i), WCL will:

- publish information on the company website;
- notify the local community through the Russell Vale CCC;
- contact individuals by direct notification (email subject to registration of interest) where relevant.

Information required to be published in accordance with **Condition F17**, such as CCC minutes, current statutory approvals and complaints register will also be included on the company website.

This information will be updated as required.

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13 REFERENCES

B K Hebblewhite Consulting 2019. *Peer Review - Russell Vale Colliery Subsidence Assessment (SCT Report UMW4609, 10 July 2019)*, Report prepared for Wollongong Coal Ltd. B K Hebblewhite Consulting, Balgowlah NSW. Report no. 1907/01.1.

Biosis 2009. *NRE Gujarat Targeted Herpetological Surveys*, Report prepared for ERM Australia. Authors: Charlton. J, Biosis Research Pty Ltd, Melbourne, VIC. Project no. s2365.

Biosis 2012. *NRE No. 1 Colliery Major Expansion: Upland Swamp Impact Assessment, Report prepared for Gujarat NRE Coking Coal Ltd.* Authors: Garvey. N, Biosis Research Pty Ltd, Wollongong, NSW. Project no. 10594.

Biosis 2013. Wonga East and V-Mains Ecological Monitoring Program. Autumn 2011 through to autumn 2013, Report prepared for Gujarat NRE Coking Coal Ltd. Authors: Reed. K, Biosis Research Pty Ltd, Wollongong, NSW. Project no. 14511 and 16015.

Biosis 2014a. Russell Vale Colliery – Underground Expansion Project: Preferred Project Report - Biodiversity, Report prepared for Wollongong Coal Ltd. Authors: Garvey. N, Beyer. K, Biosis Pty Ltd, Wollongong, NSW. Project no. 16646.

Biosis 2014b. Underground Expansion Project EPBC Referral (EPBC2014/7268): Coastal Upland Swamp Impact Assessment Report, Report prepared for Wollongong Coal Ltd. Authors: Garvey. N, Biosis Pty Ltd, Wollongong, NSW. Project no. 14860.

Biosis 2017. Russell Vale East terrestrial ecological monitoring program annual report 2015, Report for Wollongong Coal Limited. Authors: Reed K & Dunne C, Biosis Pty Ltd, Wollongong, New South Wales. Project no. 20492.

Biosis 2019a. Russell Vale Colliery – Underground Expansion Project: Updated Ecological Impact Assessment, Report for Umwelt. Authors: B. Klein & N. Garvey, Biosis Pty Ltd. 24737.

Biosis 2019b. Russell Vale East - Terrestrial ecological monitoring program: Annual report 2017, Report for Wollongong Coal Limited. Authors: McCann, S, Stone, L, Cable, T. Biosis Pty Ltd, Wollongong, New South Wales. Project no. 26657.

Biosis 2020. Russell Vale East Aquatic Ecological Monitoring Program 2019, Report for Wollongong Coal Limited. Author: Stone, L. Biosis Pty Ltd, Wollongong, New South Wales. Project no. 29876.

BOM 2018. Summary statistics Albion Park (Shellharbour Airport), Climate statistics for Australian locations, Bureau of Meteorology, accessed 7 November 2018, http://www.bom.gov.au/climate/averages/tables/cw_068241.shtml.

Cardno Ecology Lab 2009. *NRE No 1 mine V Mains Area: Effects of Mine Subsidence on Aquatic Habitats and Biota*, Report prepared for ERM Australia Pty Ltd.

Cardno Ecology Lab 2010. *Aquatic Ecology Monitoring for Gujarat No 1 mine 2009-2010*, Report for Gujarat NRE Coking Coal Limited.

Cardno Ecology Lab 2012a. *NRE No 1 mine: Assessment of Subsidence Impacts on Aquatic Habitat and Biota*, Report for Gujarat NRE Coking Coal Limited. November 2012.

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Cardno Ecology Lab 2012b. NRE No 1mine - Aquatic Ecology Monitoring Autumn 2012 Data Report, Report for Gujarat NRE Coking Coal Limited.

Cardno Ecology Lab 2012c. NRE No 1mine: Aquatic Ecology Monitoring 2011-2012, Report for Gujarat NRE Coking Coal Limited.

Chessman, B.C. 1995. Rapid assessment of rivers using macroinvertebrates: A procedure based on habitat specific sampling, family level identification and a biotic index. Australian Journal of Ecology, vol 20, pp. 122-129.

Chessman, B.C. 2003. SIGNAL 2 – A Scoring System for Macro-invertebrate ('Water Bugs') in Australian Rivers, Monitoring River Heath Initiative Technical Report no 31, Commonwealth of Australia, Canberra.

DECC 2007. Submission of the strategic review of the impacts of underground mining in the Southern Coalfield, NSW Department of Environment and Climate Change.

DoE 2013. Matters of National Environmental Significance, Significant Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999, accessed 19 May 2019, Australian Government Department of the Environment. Canberra, Australian Capital Territory.

DoP 2008. Impacts of underground coal mining on natural features in the Southern Coalfield: Strategic review, State of NSW through the NSW Department of Planning.

DoP 2009. The Metropolitan coal project review report, State of NSW through the NSW Planning and Assessment Commission.

DoP 2010. The PAC review of the Bulli Seam Operations Project, State of NSW through the NSW Planning and Assessment Commission.

DPIE 2010. Southeast NSW Native Vegetation and Mapping - SCIVI. VIS_ID 2230, State Government of NSW Department of Planning, Industry & Environment.

DPIE 2016. Illawarra Plant Community Type Vegetation Map VIS_ID 4678, State Government of NSW Department of Planning, Industry & Environment.

EcoLogical 2009. Wonga East and Wonga West: Threatened fauna habitat assessment, Report for ERM Australia.

ERM 2013a. NRE No. 1 Colliery Stage 2 Terrestrial Flora and Fauna Assessment, Report to Gujarat NRE Coking Coal Ltd. ERM Australia Pty Ltd.

ERM 2013b. NRE No. 1 Colliery Project Application (09-0013) Environmental Assessment, Report to Gujarat NRE Coking Coal Ltd. ERM Australia Pty Ltd.

Hansen Bailey 2015. Russell Vale Colliery Underground Expansion Project. Response to the Planning Assessment Commission Review Report – Part 2, Report prepared by Hansen Bailey for Wollongong Coal.

IAPUM 2020. Advice Re: Russell Vale underground expansion project, Report prepared by Independent Advisory Panel for Underground Mining.

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Mahony M, Knowles R, & Pattinson L 1997. Stuttering Barred Frog, *Mixophyes balbus*. In Threatened Frogs of New South Wales: Habitats, Status and Conservation pp 66-71. Ed H Ehmann.

NPWS 2003. Native vegetation of the Woronora, O'Hares and Metropolitan catchments, New South Wales National Parks and Wildlife Service.

OEH 2012. Risk assessment guidelines for groundwater dependent ecosystems: volume 1.

PAC 2009. The Metropolitan coal project review report, State of NSW through the NSW Planning and Assessment Commission.

PAC 2010. The PAC review of the Bulli Seam Operations Project, State of NSW through the NSW Planning and Assessment Commission.

RBGDT 2020. PlantNET - The Plant Information Network System of the Royal Botanic Gardens and Domain Trust (Version 2), New South Wales Office of Environment and Heritage, Sydney, NSW. <http://plantnet.rbgsyd.nsw.gov.au>.

SCT 2019. Russell Vale Colliery: Subsidence Assessment for Proposed Workings in Wongawilli Seam at Russell Vale East, SCT report number: UMW4609. SCT Operations Pty Ltd, Wollongong.

SCT 2020a. IESC 2019-108: Quantitative Assessment of Risk of Pillar Failure in Russell Vale East Area.

SCT 2020b. Peer review of SCT response to IAPUM Advice, Report prepared by BK Hebblewhite Consulting. Hebblewhite, B, Sydney, NSW.

SCT Operations 2012. Assessment of Mining Impacts on Cliffs and Steep Slopes for NRE No. 1 Colliery Underground Expansion Project (MP 09_0013), Report prepared for Gujarat NRE Coking Coal Ltd.

Turak T, Johnstone G, & Waddell N 2004. New South Wales (NSW) AUSRIVAS Sampling and Processing Manual 2004. <http://AUSRIVAS.canberra.edu.au/man/NSW/>.

Umwelt 2020. Draft Public Environment Report. Russell Vale Colliery Revised Underground Expansion Project (EPBC 2020/8702). Final report prepared by Umwelt (Australia) Pty Limited on behalf of Wollongong Coal Limited.

WaterNSW & OEH 2015. Special Areas Strategic Plan of Management 2015, WaterNSW and Office of Environment and Heritage.

Wollongong Coal 2012. NRE No.1 Colliery Russell Vale East – Longwalls 4 & 5 EP/SMP. LW5 Biodiversity Management Plan. Gujarat NRE Coking Coal Limited.

Wollongong Coal 2015a. Russell Vale Colliery. Russell Vale East – Longwalls 6 & 7 Biodiversity Management Plan Rev06, Wollongong Coal Ltd, Russell Vale.

Wollongong Coal 2015b. Russell Vale Colliery. Russell Vale East – Longwalls 6 & 7 Upland Swamp Management Plan Rev06, Wollongong Coal Ltd, Russell Vale.

Wollongong Coal 2019. Russell Vale Colliery – Underground Expansion Project – Biodiversity Management Plan.

Wollongong Coal 2021a. *Russell Vale Colliery – Russell Vale East – Revised Underground Expansion Project – Upland Swamp Monitoring Plan.*



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Wollongong Coal 2021b. Russell Vale Colliery – Russell Vale East Pit Top – Revised Underground Expansion Project - Biodiversity Management Plan.

Wollongong Coal 2021c. Russell Vale Colliery Russell Vale East – Revised Underground Expansion Project – Groundwater Management Plan.

Wollongong Coal 2021d. Russell Vale Colliery Russell Vale East – Revised Underground Expansion Project – Surface Water Management Plan.

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14 GLOSSARY OF TERMS AND ABBREVIATIONS

Abbreviations	
BACI	Before After Control Impact
BCD	Biodiversity Conservation Division within the DPIE
BMP	Biodiversity Management Plan
DAWE	Commonwealth Department of Agriculture, Water and the Environment
DPIE	Department of Planning, Industry & Environment
EEC	Endangered Ecological Community
E&C	Environment and Community
EM	Environment Manager
EMS	Environmental Management System
EP	Extraction Plan
EP&A Act	Environmental Planning and Assessment Act 1979
EPA	Environmental Protection Authority
EPL	Environmental Protection Licences
GDE	Groundwater Dependent Ecosystems
IPC	Independent Planning Commission
LGA	Local Government Area
Mtpa	Million tonnes per annum
NRAR	Natural Resources Access Regulator
PA	Project Approval
PCT	Plant Community Type
ROM	Run of Mine
TARP	Trigger Action Response Plan
WCC	Wollongong City Council
WCL	Wollongong Coal Limited

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Terms	
Environmental consequences	The environmental consequences of subsidence impacts, including damage to built features, loss of surface flows to the subsurface, loss of standing pools, slope changes to streams, adverse water quality impacts, development of iron bacterial mats, cliff falls, rock falls, landslides, damage to aboriginal heritage sites, impacts on aquatic ecology, and ponding.
First Workings	Development of main headings, gate roads, related cut throughs, and other workings for mine access and ventilation
Incident	An occurrence or set of occurrences that causes or threatens to cause material harm and which may or may not cause a non-compliance.
Mining operations	The carrying out of mining, including the extraction, processing, stockpiling and transportation of coal on the site and the associated removal, storage, and/or emplacement of vegetation, topsoil, overburden and reject material.
Non-Compliance	An occurrence or set of occurrences or development that is in breach of this consent
the Colliery	Russell Vale Colliery
the Planning Secretary	The Planning Secretary of the Department of Planning, Industry and Environment (DPIE)
Reasonable	Mean applying judgement in arriving at a decision, taking into account mitigation benefits, cost of mitigation versus benefits provided, community views and the nature of and extent of potential contamination.
Secondary workings	Extraction of coal from board and pillar workings
Subsidence	The totality of subsidence impacts and environmental consequences of subsidence impacts.
Subsidence effects	Deformation of the ground mass due to mining, including all mining induced ground movements, such as vertical and horizontal displacement, tilt, strain, and curvature.
Subsidence impacts	Physical changes to the ground and its surface caused by subsidence effects including tensile and shear cracking of the rock mass, localised buckling of strata caused by valley closure and upsidence and surface depressions or troughs
the Project	the Revised Preferred Project



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Appendix A – AGENCY CONSULTATION



Our ref: DOC21/447952

Senders ref: RVC EC PLN 004

Richard Sheahan
Group Environmental & Approvals Manager
Wollongong Coal
E-mail: Richard.sheehan@wcl.net.au

9/6/2021

Dear Mr Sheahan

Subject: Russell Vale Underground Expansion Project – Extraction Plan – Biodiversity Management Plan (MP 09_0013)

Thank you for your referral dated 11 May 2021 via the NSW Major Projects Planning Portal, as required by Condition C10(g)(4) of the Russell Vale UEP project approval. In response, the following comments are provided:

Terrestrial biodiversity

- **Sections 3 & 4** - Whilst we concur that the impact on rocky ecosystems is unlikely to be significant, we recommend the likelihood of occurrence (Table 6) for Large-eared Pied Bat and Broad-headed Snake be amended. There are nearby records of Broad-headed Snake in the area and Large-eared Pied Bat utilises habitat such as rocky areas, mines and tunnels which appear to be available. We recommend the likelihood of occurrence for these two species be updated, and the Plan ensures adequate monitoring occurs in the case of greater than expected impacts.
- We suggest that the potential impact assessment in this section also be supported by photographic evidence depicting terrestrial biodiversity habitats, particularly for the Broad-headed Snake and Large-eared Pied Bat as discussed above.
- There are several records of the Giant Burrowing Frog in the area and we consider there is “high” potential for this species to occur as opposed to “low” as stated in Table 6. We recommend the Plan update the likelihood of occurrence for this species.
- The BMP does not currently provide evidence that previous surveys for threatened frogs were adequate to establish presence/absence in the area. The Plan should include a summary of existing records and extent of habitat, demonstrating that adequate surveys were carried out to establish baseline data which can be used for monitoring species in the case of greater than expected impacts.
- The Plan needs to quantify and map breeding habitat of giant burrowing frogs given this species is known to occur in the area and its sensitivity to loss of pools.
- We are unclear how vertebrate monitoring is to occur and what data is to be collected in the case of greater than expected impacts. These details should be elaborated in Table 7.
- The Plan should confirm an appropriate subsidence monitoring period, such as 2 years post-mining, to confirm that “negligible environmental consequences” upon terrestrial biodiversity will occur, as required under Conditions C1-C6 of the project approval.

- **Figures 6 and 7** - Please provide updated figures, as the current versions of Figure 6 and 7 are incomplete and do not appear to include a base map, drainage lines or creek lines.

Coastal Upland Swamps

- **Sections 6.1-6.4** - We suggest you ensure that the Plan's references to Coastal Upland Swamps (including Figure 5) remains consistent with any forthcoming revisions to the Upland Swamp Ecological Monitoring Plan (USEMP), for which we provided comments on 12/5/21 (our ref DOC21/369991).
- This advice should be also read in conjunction with our detailed previous advice on the USEMP, particularly selection of control sites, monitoring periods for baseline data and clarity regarding TARPs. Forthcoming groundwater advice on the USEMP from DPIE Water will also be critical in this regard.

Aquatic ecology

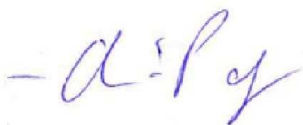
- **Section 6.4 Aquatic Monitoring** – There appears to be insufficient data being monitored to confirm “negligible environmental consequences” as required by Condition C1, specifically the known occurrence of several threatened aquatic species and amphibious taxa listed in Table 6.
- We suggest that DPI Fisheries and DPIE Water be consulted with regards to impacts on aquatic ecology, particularly regarding the discontinuation of Macquarie Perch monitoring. The monitoring plan recommends discontinuing Macquarie Perch monitoring due to unlikely impacts and lack of breeding habitat within Cataract Creek, notwithstanding its previous detection in this watercourse.

Monitoring design

- The in-text references to tables and figures in Section 6.4 do not match the tables provided and should be corrected. We suggest including a section which clearly outlines the criteria for selection of control sites and how these will be validated, including justification for the limited number of aquatic monitoring sites proposed in the impact area. An overview of statistical methods is also recommended, outlining how pre-mining and post-mining comparisons between such small sample sizes will be conducted.
- **Section 7.3 TARPs** - TARPs for aquatic ecology need to include an assessment of pre-mining to post-mining impacts as a trigger. These triggers should be based on contrasts within the impacted treatments only before and after impacts (not comparing impact to control groups). Control treatments are used to check against background changes such as seasonal and environmental change, not to detect impacts of the proposed action.
- The short term and long-term TARPs should be adjusted to:
 - A statistically significant decline in OE50Taxa Score since mining commenced in impacted sites; or
 - Change in AUSRIVAS Band since mining commenced in impacted sites.

If you have any questions about this advice, please do not hesitate to contact me on chris.page@environment.nsw.gov.au or 4224 4180.

Yours sincerely



Chris Page

9 June 2021

**Senior Team Leader, Planning (Illawarra)
Biodiversity & Conservation Division
Environment, Energy and Science**

Richard Sheehan

From: no-reply@majorprojects.planning.nsw.gov.au
Sent: Friday, 12 February 2021 8:36 AM
To: richard.sheehan@wcl.net.au
Cc: richard.sheehan@wcl.net.au; daniel.martin@dpie.nsw.gov.au
Subject: Russell Vale Underground Expansion - Russel Vale Colliery Extraction Plan Authors
Attachments: __Appointment of Experts_09022021_061146.pdf__.dat

Dear Richard ,

The Department has completed its assessment of the Russel Vale Colliery Extraction Plan Authors for the Russell Vale Underground Expansion

The Department's comments are attached.

If you have any enquiries, please contact Daniel Martin at daniel.martin@dpie.nsw.gov.au.

To sign in to your account click [here](#) or visit the [Major Projects Website](#).

Please do not reply to this email.

Kind regards

The Department of Planning, Industry and Environment



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Richard Sheehan
Environmental Manager
NRE NO. 1 Colliery 7
Princes Highway
Corrimal, NSW, 2518

09/02/2021

Dear Mr Sheehan

**Russell Vale Underground Expansion (MP09_0013)
Extraction Plan**

I refer to your request (MP09_0013-PA-3) for the Planning Secretary's approval of suitably qualified persons to prepare the Extraction Plan for the Russell Vale Underground Expansion (MP09_0013).

The Department has reviewed the nominations and information you have provided and is satisfied that these experts are suitably qualified and experienced. Consequently, I can advise that the Planning Secretary approves the appointment of the experts to prepare the Extraction Plan.

Accordingly, the following experts are approved as authors for the Extraction Plan.

Consent Condition	Extraction Plan Requirement	Expert/Author
Schedule C Condition 10	Extraction Plan	Warwick Lidbury – RVC Mine Manager Luke Bettridge – Umwelt David Holmes – Umwelt
Schedule C Condition 10 (g)(i)	Subsidence Monitoring Plan	Dr Ken Mills – SCT Stephen Wilson - SCT
Schedule C Condition 10 (g)(ii)	Built Features Management Plan	Dr Ken Mills – SCT Stephen Wilson - SCT
Schedule C Condition 10 (g)(iii)	Water Management Plan	Susan Shield – Engeny Clare Stephenson - Umwelt
Schedule C Condition 10 (g)(iv)	Biodiversity Management Plan	Paul Price - Biosis
Schedule C Condition 10 (g)(v)	Swamp Monitoring Plan	Luke Stone - Biosis
Schedule C Condition 10 (g)(vi)	Land Management Plan	Luke Bettridge – Umwelt David Holmes – Umwelt
Schedule C Condition 10 (g)(vi)	Heritage Management Plan	Dr Amanda Markham - Biosis
Schedule C Condition 10 (g)(vii)	Public Safety Management Plan	Warwick Lidbury – RVC Mine Manager
Schedule C Condition 10 (g)(viii)	Trigger Action Response Plan/s	Warwick Lidbury – RVC Mine Manager Luke Bettridge – Umwelt David Holmes – Umwelt
Schedule C Condition 10 (g)(ix)	Contingency Plan	Warwick Lidbury – RVC Mine Manager Luke Bettridge – Umwelt David Holmes – Umwelt

If you wish to discuss the matter further, please contact Daniel Martin at daniel.martin@dpie.nsw.gov.au

Yours sincerely

A handwritten signature in black ink, appearing to be 'S O'Donoghue', written in a cursive style.

Stephen O'Donoghue
Director
Resource Assessments
As nominee of the Planning Secretary



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APPENDIX B – FLORA AND FAUNA

Threatened flora, ecological communities and fauna

The following table includes a list of the threatened flora species that have potential to occur within the study area. The list is based on database searches outlined in **Section 3.1**

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 004
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Table 12: Endangered Ecological communities predicted to occur within 10km of the study area

Scientific name	BC Act status	EPBC Act Status	Does the community occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Coastal Swamp Oak (<i>Casuarina glauca</i>) Forest of New South Wales and South East Queensland ecological community	Endangered	Endangered	No. Restricted to coastal floodplains. Not recorded within study area.
Coastal Upland Swamp in the Sydney Basin Bioregion	Endangered	Endangered	Yes. Community occurs within the study area and is susceptible to subsidence.
Illawarra and south coast lowland forest and woodland ecological community	Endangered	Critically Endangered	No. Not recorded within study area.
Illawarra-Shoalhaven Subtropical Rainforest of the Sydney Basin Bioregion	Endangered	Critically Endangered	No. Not recorded within study area.
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Endangered	Critically Endangered	No. Restricted to within 2 km of the coast or adjacent to a large salt water body. Suitable habitat not present within study area
Shale Sandstone Transition Forest of the Sydney Basin Bioregion	Endangered	Critically Endangered	No Restricted to coastal areas under regular or intermittent tidal influence. Suitable habitat not present within study area.
Subtropical and Temperate Coastal Saltmarsh.	Endangered	Vulnerable	No Restricted to coastal areas under regular or intermittent tidal influence. Suitable habitat not present within study area.



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Scientific name	BC Act status	EPBC Act Status	Does the community occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Turpentine-Ironbark Forest of the Sydney Basin Bioregion	Endangered	Critically Endangered	No Restricted to Cumberland lowlands. Not recorded within study area
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion	Endangered	Endangered	No Found on basalt and basalt-like substrates. Suitable habitat not present within the study area.

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Table 13: Threatened flora predicted to occur within 10km of the study area

<i>Scientific name</i>	<i>Common name</i>	<i>EPBC status</i>	<i>Most recent record</i>	<i>No. of records</i>	<i>Distance of closet record to study area (m)</i>	<i>Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?</i>
<i>Acacia bynoeana</i>	Bynoe's Wattle	VU	2017	1	9,576	No Species commonly found in sandstone and gravel based soils, occasionally on rock platforms. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Allocasuarina glareicola</i>		EN	#	-	-	No Grows on tertiary alluvial gravels, with yellow clayey subsoil and lateritic soil. Suitable habitat not present.
<i>Caladenia tessellata</i>	Thick Lip Spider Orchid	VU	#	-	-	No Perennial terrestrial orchid found in grassy Sclerophyll woodland on clay loam or sandy soils. Suitable habitat not present.
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	VU	#	-	-	Yes Moderate likelihood of occurrence. One confirmed record outside of the 10km.
<i>Cynanchum elegans</i>	White-flowered Wax Plant	EN	2017	11	1,939	No Known from ecotone between dry rainforest and grassy woodland communities on coastal plain. Suitable habitat not present.

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<i>Scientific name</i>	<i>Common name</i>	<i>EPBC status</i>	<i>Most recent record</i>	<i>No. of records</i>	<i>Distance of closet record to study area (m)</i>	<i>Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?</i>
<i>Genoplesium baueri</i>	Bauer's Midge Orchid	EN	#	-	-	No Grows in dry sclerophyll forest and moss gardens over sandstone. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	VU	#	-	-	No Occurs in sandy or light clay soils, usually over thin shales, in a wide range of vegetation types. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Haloragis exalata</i> subsp. <i>exalata</i>	Square Raspwort	VU	#	-	-	No Requires protected and shaded damp situations in riparian habitats. Outside known distribution.
<i>Leucopogon exolasius</i>	Woronora Beard-heath	VU	2019	8	8,419	No Occurs in a wide range of habitat types, including woodland, rocky hillsides and creeks. Potential habitat is present. Not currently recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Melaleuca biconvexa</i>	Biconvex Paperbark	VU	#	-	-	No Occurs in damp places, often near streams and rivers or low-lying areas on alluvial soils of low slopes or sheltered aspects. Suitable habitat not present.

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<i>Scientific name</i>	<i>Common name</i>	<i>EPBC status</i>	<i>Most recent record</i>	<i>No. of records</i>	<i>Distance of closet record to study area (m)</i>	<i>Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?</i>
<i>Melaleuca deanei</i>	Deane's Melaleuca	VU	#	-	-	No Occurs in heath communities on sand, and has been recorded from ridgetops, dry ridges and slopes. Strongly associated with sandy loam soils low in nutrient. Potential habitat is present. Not recorded within the study area. Species is not considered to be reliant on microhabitats that are at risk of impact due to subsidence
<i>Persoonia acerosa</i>	Needle Geebung	VU	2007	1	6,082	No Grows in heath, scrubby low-woodland or dry sclerophyll forest. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Persoonia hirsuta</i>	Hairy Geebung	EN	2009#	6	1,689	No Occurs in dry sclerophyll forest and woodland with a shrubby understory. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Persoonia nutans</i>	Nodding Geebung	EN	#	-	-	No Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Pomaderris brunnea</i>	Brown Pomaderris	VU	1957	2	9,771	No Occurs in open forest often on sandstone, clay and alluvial soils of floodplains and creek lines. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.

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<i>Scientific name</i>	<i>Common name</i>	<i>EPBC status</i>	<i>Most recent record</i>	<i>No. of records</i>	<i>Distance of closet record to study area (m)</i>	<i>Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?</i>
<i>Pterostylis gibbosa</i>	Illawarra Greenhood	EN	#	-	-	No Occurs on soils derived from Permian sedimentary rocks of the Berry formation at an altitude of 10 to 20m. Outside known altitudinal range.
<i>Pterostylis saxicola</i>	Sydney Plains Greenhood	EN	#	-	-	No Grows in heathy forest, sclerophyll forest or woodland in shallow sandy soil over flat sheets of sandstone rock shelves or boulders at altitudes of 10 to 60m. Outside known altitudinal range.
<i>Pultenaea aristata</i>	Prickly Bush-pea	VU	2017#	130	Species is present within study area	Yes Occurs in open habitats, including upland swamps and adjacent woodland, where drainage is impeded. Previously located within study area. Fracturing of bedrock may result in changes in hydrology and result in impacts to the species.
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	VU	2014#	2	8,233	No Found in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Thelymitra kangaloonica</i>	Kangaloon Sun Orchid	CR	#	-	-	No Endemic to the Fitzroy Falls / Robertson / Kangaloon area occurring in swampy sedgeland. Outside known distribution. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Thesium australe</i>	Austral Toadflax	VU	#	-	-	No Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.

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Table 14: Threatened fauna predicted to occur within 10km of the study area

Scientific name	Common name	EPBC status	Most recent record	No. of records	Distance of closet record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Birds						
<i>Anthochaera phrygia</i>	Regent Honeyeater	CR	1995	1	2,994	No Potential foraging habitat present in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Botaurus poiciloptilus</i>	Australasian Bittern	EN	2001	3	2,119	No Found in terrestrial freshwater wetlands and, rarely, estuarine habitats. Suitable habitat not present.
<i>Calidris canutus</i>	Red Knot	EN	#	-	-	No Occurs in marine environment.
<i>Calidris ferruginea</i>	Curlew Sandpiper	CR	#	-	-	No Found in terrestrial freshwater wetlands and, estuarine habitats. Suitable habitat not present.
<i>Calidris tenuirostris</i>	Great Knot	CR	1999	1	4,970	No Occurs in marine environment.
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	EN	2018	55	Species is recorded within study area	No Potential habitat is present. Not recorded within the study area.

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Scientific name	Common name	EPBC status	Most recent record	No. of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Diomedea exulans</i>	Wandering Albatross	EN	2010	57	5,078	No Occurs in marine environment.
<i>Diomedea gibsoni</i>	Gibson's Albatross	VU	1979	1	9,488	No Occurs in marine environment.
<i>Grantiella picta</i>	Painted Honeyeater	VU	1991	1	7,662	No Potential foraging habitat in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Lathamus discolor</i>	Swift Parrot	CR	2018	19	1,660	No Potential foraging habitat in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Macronectes giganteus</i>	Southern Giant Petrel	EN	2009	12	4,987	No Occurs in marine environment.
<i>Macronectes halli</i>	Northern Giant-Petrel	VU	2009	2	9,003	No Occurs in marine environment.

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 004
Type	Management Plan	Date Published	18/11/2021
Doc Title	Extraction Plan - Biodiversity Management Plan		

Scientific name	Common name	EPBC status	Most recent record	No. of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Neophema chrysogaster</i>	Orange-bellied Parrot	CR	#	-	-	No Potential foraging habitat in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Numenius madagascariensis</i>	Eastern Curlew	CR	#	-	-	No Found in terrestrial freshwater wetlands and estuarine habitats. Suitable habitat not present.
<i>Phoebastria fusca</i>	Sooty Albatross	VU	1975	1	4,400	No Occurs in marine environment.
<i>Polytelis anthopeplus monarchoides</i>	Regent Parrot (eastern subspecies)	VU	1990	1	3,447	No Potential foraging habitat in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Pterodroma leucoptera leucoptera</i>	Gould's Petrel	EN	1985	1	8,876	No Occurs in marine environment.
<i>Rostratula australis</i>	Australian Painted Snipe	EN	#	-	-	No Found in terrestrial freshwater wetlands and estuarine habitats. Suitable habitat not present.

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 004
Type	Management Plan	Date Published	18/11/2021
Doc Title	Extraction Plan - Biodiversity Management Plan		

Scientific name	Common name	EPBC status	Most recent record	No. of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Thalassarche bulleri</i>	Buller's Albatross	VU	2009	2	5,981	No Occurs in marine environment.
<i>Thalassarche cauta</i>	Shy Albatross	VU	2013	4	7,697	No Occurs in marine environment.
<i>Thalassarche impavida</i>	Campbell Albatross	VU	1998	2	3,574	No Occurs in marine environment.
<i>Thalassarche melanophrys</i>	Black-browed Albatross	VU	2013	11	4,507	No Occurs in marine environment.
<i>Thalassarche salvini</i>	Salvin's Albatross	VU	1960	1	5,078	No Occurs in marine environment.
<i>Thinornis rubricollis</i>	Hooded Plover	VU	2012	3	3,534	No Occurs in marine environment.
Mammals						
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	VU	#	-	-	Yes Species may roost in caves and overhangs in study area. Potential habitat is present in the study area. Species not recorded. Subsidence may result in collapse of cliffs that provide potential roosting habitat for this species.

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 004
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Scientific name	Common name	EPBC status	Most recent record	No. of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	EN	2019	7	769	No Species habitat present in the study area. Potential habitat is present in the study area. Species not recorded. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Eubalaena australis</i>	Southern Right Whale	EN	1998	1	5,416	No Occurs in marine environment.
<i>Isoodon obesulus obesulus</i>	Southern Brown Bandicoot (eastern)	EN	2009	2	8,861	No Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Petauroides volans</i>	Greater Glider	VU	2017	60	37	No Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	VU	#	-	-	No Thought to be locally extinct in Southern Coalfield (DECC 2007).
<i>Phascolarctos cinereus</i>		VU	2018	33	807	No Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.



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Type	Management Plan	Date Published	18/11/2021
Doc Title	Extraction Plan - Biodiversity Management Plan		

Scientific name	Common name	EPBC status	Most recent record	No. of records	Distance of closet record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	VU	#	-	-	No Potential habitat is present in the study area. Species not recorded. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	VU	2019#	302	Species is recorded within study area	No Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 004
Type	Management Plan	Date Published	18/11/2021
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Scientific name	Common name	EPBC status	Most recent record	No. of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Reptiles						
<i>Caretta caretta</i>	Loggerhead Turtle	EN	2010	1	4,432	No Occurs in marine environment.
<i>Chelonia mydas</i>	Green Turtle	VU	2009	4	3,940	No Occurs in marine environment.
<i>Eretmochelys imbricata</i>	Hawksbill Turtle	VU	2002	1	5,385	No Occurs in marine environment.
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	VU	2019	47	1,192	Yes Potential habitat is present in the study area. Subsidence may result in fracturing of rocky outcrops providing habitat for this species.
Frogs						
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	VU	2016	47	Species is recorded within study area	Yes Known to inhabit ephemeral and intermittent streams in the locality. Subsidence can result in impacts to breeding habitat for this species through draining of pools.
<i>Litoria aurea</i>	Green and Golden Bell Frog	VU	2016	47	580	No Inhabits still, shallow water bodies. Restricted to several key known populations. No populations exist within the study area.

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Scientific name	Common name	EPBC status	Most recent record	No. of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog	VU	2018	488	1,270	Yes Known to inhabit ephemeral and intermittent streams in the locality. Potential habitat is present in the study area. Subsidence can result in impacts to breeding habitat for this species through draining of pools.
<i>Mixophyes balbus</i>	Stuttering Frog	VU	#	-	-	Yes Known to inhabit streams in the locality. Species rare in locality. Potential habitat is present in the study area. Subsidence can result in impacts to breeding habitat for this species through draining of pools.
Fish						
<i>Bidyanus bidyanus</i>	Silver Perch	CE	#	-	-	Yes Inhabits freshwater streams. Potential habitat is present. Species may have been recorded previously. Subsidence may result in impacts to aquatic environments.
<i>Epinephelus daemeli</i>	Black Rockcod	VU	#	-	-	No Occurs in marine environment.
<i>Maccullochella macquariensis</i>	Trout Cod	EN	#	-	-	Yes Inhabits freshwater streams. Potential habitat is present. Species may have been recorded previously. Subsidence may result in impacts to aquatic environments.

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Scientific name	Common name	EPBC status	Most recent record	No. of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Maccullochella peelii</i>	Murray Cod	VU	#	-	-	Yes Inhabits freshwater streams. Potential habitat is present. Species may have been recorded previously. Subsidence may result in impacts to aquatic environments.
<i>Macquaria australasica</i>	Macquarie Perch	EN	#	-	-	Yes Inhabits freshwater streams. Potential habitat is present. Species may have been recorded previously. Subsidence may result in impacts to aquatic environments.
<i>Prototroctes maraena</i>	Australian Grayling	VU	#	-	-	No Requires connectivity with marine environment.

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Doc Title	Extraction Plan - Biodiversity Management Plan		

APPENDIX C – TARPS

14.1 EP Biodiversity TARP

Table 15: Current TARP trigger levels for the aquatic biodiversity monitoring program

Aspect	Monitoring				Trigger			
	Location	Parameters	Timing/Frequency	Purpose	Level	Action/Reporting	Responsibility	Timing
Aquatic biodiversity	Monitoring of water quality and aquatic macroinvertebrate rate at five impact sites in Cataract Creek and Cataract River. Monitoring of water quality and aquatic Macroinvertebrates at four control sites.	A comprehensive visual inspection and photographic record of each monitoring site will be collected each time a site is visited. Physico-chemical water quality parameters, including temperature, conductivity, pH, Oxidation, dissolved oxygen and turbidity. Physicochemical properties of waterways are compared to	Minimum 12 months of baseline monitoring prior to mining. Monitoring during mining. A minimum of one year of monitoring post-mining. Macroinvertebrate monitoring is undertaken in spring and autumn.	To determine if subsidence effects resulting from mining result in impacts to aquatic habitats or threatened species. Inform stakeholders of baseline assessment and monitoring. Identify, investigate and report on impacts to aquatic ecology.	Within prediction (Level 1): Negligible environmental consequences for creeks, as illustrated by no significant changes in water quality or data collected during macroinvertebrate sampling.	Continue monitoring. Report negligible impact in six monthly reports.	Russell Vale Colliery (Environmental Manager)	Six monthly reporting in accordance with Extraction Plan approval.
					Within prediction (Level 2): Negligible environmental consequences for creeks, as illustrated by a short term (1 year) reduction in	Continue monitoring. Review frequency and location of monitoring and determine if additional		Six monthly reporting in accordance with Extraction Plan approval Monitoring plan reviewed within one month of potential

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Aspect	Monitoring				Trigger			
	Location	Parameters	Timing/Frequency	Purpose	Level	Action/Reporting	Responsibility	Timing
		ANZECC AMRANZ (2000) guidelines. Condition of aquatic habitats based on AUSRIVAS method. Upper and lower limits of aquatic habitat will be established using OE50TaxaScores and SIGNAL2 scores.			aquatic habitat, as shown by: <ul style="list-style-type: none"> • Water quality data exceeding upper or lower limits of baseline monitoring; or • Change in OE50Taxa Score; or • Change in AUSRIVAS Band. 	monitoring is required. Inform BCD, and DAWE of potential impact. Report potential impact in six monthly reports.		impact being identified. BCD, and DAWE notified of potential impact within one week of potential impact being identified.
					Exceeding prediction (Level 3): Reduction in aquatic habitat at impact sites only for an extended timeframe (>2 years), as shown by: <ul style="list-style-type: none"> • Water quality data exceeding upper or lower limits of baseline monitoring; or • Change in OE50Taxa Score; or 	Engage ecologist to investigate and report on the cause of trigger exceedances and advise of potential impacts. Inform BCD and DAWE of investigation outcomes. Review monitoring program,	Russell Vale Colliery (Environmental Manager)	BCD, and DAWE notified of potential impact within one week of impact being identified. Investigation initiated within one week of impact being identified. Investigation results reported to BCD and DAWE within one week of completion.

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Aspect	Monitoring				Trigger			
	Location	Parameters	Timing/Frequency	Purpose	Level	Action/Reporting	Responsibility	Timing
					<ul style="list-style-type: none"> Change in AUSRIVAS Band 	<p>including frequency and location, and modify if necessary.</p> <p>Develop and implement impact mitigation and remediation measures in consultation with BCD and DAWE.</p> <p>Develop a monitoring plan to determine the success of mitigation / remediation measures.</p> <p>If mitigation /Remediation measures are unsuccessful or not feasible, determine whether offsets will be required.</p>		<p>Monitoring plan reviewed within one week of impact being identified.</p> <p>Commence preparation of mitigation/ action and monitoring plan within one week of impact being identified, if required.</p> <p>Monthly updates of investigation progress to BCD and DAWE, if required.</p> <p>Six monthly reporting in accordance with Extraction Plan approval.</p>



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Aspect	Monitoring				Trigger			
	Location	Parameters	Timing/Frequency	Purpose	Level	Action/Reporting	Responsibility	Timing
						An offset strategy/offset management plan will be developed in consultation with BCD and DAWE. Report in annual reviews and six monthly reports to inform relevant agencies of results of monitoring.		



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14.2 Other Biodiversity Related EP TARPs

In addition to the specific EP Biodiversity TARP, the TARPS as below as noted to also be relevant to the assessment of potential impacts on threatened species, threatened populations or endangered ecological communities contained in other EP specific management plans are listed with reference to the EP specific plan to avoid duplication:

- Subsidence – Extraction Plan subsidence monitoring program (RVC EC PLN 003) as prepared in accordance with Condition C10(g)(i)
- Upland Swamps - Extraction Plan Upland swamps monitoring program (RVC EC PLN 008) as prepared in accordance with Condition C10(g)(v)
- Surface water and groundwater – Extraction Plan Water Management Plan (RVC EC PLN 010) as prepared in accordance with Condition C10(g)(iii)
- Land management including cliffs, rock outcrops and slabs and steep slopes – Extraction Plan Land Management Plan (RVC EC PLN 035) as prepared in accordance with Condition C10(g)(vi)

Site	Russell Vale Colliery	DOC ID	RVC EC PLN 004
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APPENDIX D – THREATENED FISH SURVEY DATA

Table 16: Collated fish data collected from Cataract Creek by Biosis between 2013 and 2019

Site	Date	Effort (seconds)	Native species							Exotic species	
			Silver Perch	Broad-finned Galaxias	Mountain Galaxias	Galaxias species	Murray Cod	Macquarie Perch	Eel-tailed Catfish	Goldfish	Eastern Gambusia
			<i>Bidyanus bidyanus</i>	<i>Galaxias brevipinnis</i>	<i>Galaxias olidus</i>	<i>Galaxias</i> spp.	<i>Maccullochella peelii</i>	<i>Macquaria australasica</i>	<i>Tandanus tandanus</i>	<i>Carassius auratus</i>	<i>Gambusia holbrooki</i>
Cataract Creek downstream	22/02/2013	1,545	0	0	9	0	0	0	0	0	0
Cataract Creek downstream	21/02/2013	1,145	0	0	0	0	7	4	0	1	3
Cataract Creek downstream	18/07/2013	Fyke nets*	0	0	0	0	1	0	0	8	0
Cataract Creek downstream	15/04/2013	1,289	0	0	7	0	8	10	0	0	4
Cataract Creek downstream	20/02/2013	1,005	0	0	1	0	1	0	0	0	1
Cataract Creek downstream	12/03/2014	1,412	0	0	2	0	24	18	0	45	118
Cataract Creek downstream	26/05/2014	745	0	0	16	0	0	0	0	0	0
Cataract Creek downstream	10/06/2014	1,599	0	5	2	0	28	12	0	0	200

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Site	Date	Effort (seconds)	Native species							Exotic species	
			Silver Perch	Broad-finned Galaxias	Mountain Galaxias	Galaxias species	Murray Cod	Macquarie Perch	Eel-tailed Catfish	Goldfish	Eastern Gambusia
			<i>Bidyanus bidyanus</i>	<i>Galaxias brevipinnis</i>	<i>Galaxias olidus</i>	<i>Galaxias</i> spp.	<i>Maccullochella peelii</i>	<i>Macquaria australasica</i>	<i>Tandanus tandanus</i>	<i>Carassius auratus</i>	<i>Gambusia holbrooki</i>
Cataract Creek downstream	13/06/2014	1,006	0	0	5	0	16	3	0	0	0
Cataract Creek upstream	14/03/2014	948	0	5	2	0	9	2	0	0	0
Cataract Creek downstream	9/02/2015	1,300	0	60	34	0	7	3	0	50	>1000
Cataract Creek downstream	12/02/2015	360 (Boat)	4	0	0	0	15	39	0	0	0
Cataract Creek downstream	13/02/2015	1,236	0	12	0	0	3	0	0	54	>1000
Cataract Creek downstream	24/07/2019	2,407	5	12	17	0	2	0	1	2	50
Cataract Creek downstream	3/09/2019	2,637	0	28	3	8	1	0	0	1	300

**3 fyke nets set over 5 hours at the confluence of Cataract Creek and the Cataract River



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APPENDIX E – BCD EES RESPONSE

29 September 2021

Mr Chris Page
Senior Team Leader
Planning (Illawarra)
Biodiversity & Conservation Division
Environment, Energy and Science

Russell Vale Underground Expansion Project – Extraction Plan – Biodiversity Management Plan (MP 09_0013)

Thank you for providing feedback on the Russell Vale Underground Expansion Project – Extraction Plan – Biodiversity Management Plan (MP 09_0013), dated 9 June 2021. Responses to specific comments are provided in Table 1 below. It is noted that many of the comments centre on the assessment of likelihood of occurrence of terrestrial biota. As such, a statement clarifying the scope of the management plan and providing relevant detail upon the ecological assessment phase of the project is included below.

This Biodiversity Management Plan (BMP) has been prepared to establish baseline data and provide for the management of potential impacts and/or consequences associated with the mining of the bord and pillar panels PC7-8 and PC 21-25. The BMP details the terrestrial and aquatic monitoring undertaken during previous longwall extraction that is intended to continue in surface areas. Due to the minimal potential for the project to perceptibly impact on natural surface features, the BMP focuses on monitoring ecological values that have been determined to be most at risk as part of the UEP.

The likelihood of occurrence and potential impacts to species identified in the BCD comments have been addressed in prior reports completed during the project assessment phase. This includes the preparation of an *EPBC Act Matters of National Environmental Significance Report – Ecology* (Biosis 2020), which is included as an appendix to this letter. This report describes in detail the potential impacts of the action, the environments within the study area and includes an assessment of potential impacts upon threatened biota. This report draws together the findings of numerous previous ecological assessments and monitoring surveys, detailing the relevant survey effort, habitat mapping and summarising relevant previous data collection. Sections 3 and 4 of the BMP identify threatened species most likely to occur and potential impacts, as relevant to the scope of the BMP. If required, further information regarding survey and assessment for those species not determined to be most at risk can be found in the *EPBC Act Matters of National Environmental Significance Report – Ecology* (Appendix 1).

Monitoring for Broad-headed Snake, Large-eared Pied Bat, Littlejohns Tree Frog and Stuttering Frog is not proposed on the basis of the limited extent of habitats for these species identified and lack of records for these species in the study area, despite targeted survey effort (Biosis 2020). This is in addition to the fact that there is minimal potential for the project to perceptibly impact on natural surface features that represent habitats for these species. Summaries of the findings of environmental assessments or monitoring surveys relevant to these species are provided in the responses below, based upon the detail compiled in *EPBC Act Matters of National Environmental Significance Report – Ecology* (Appendix 1).

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Table 1 BCD Comment Responses	
BCD comment	Response
Terrestrial biodiversity	
<p>Whilst we concur that the impact on rocky ecosystems is unlikely to be significant, we recommend the likelihood of occurrence (Table 6) for Large-eared Pied Bat and Broad-headed Snake be amended. There are nearby records of Broad-headed Snake in the area and Large-eared Pied Bat utilises habitat such as rocky areas, mines and tunnels which appear to be available. We recommend the likelihood of occurrence for these two species be updated, and the Plan ensures adequate monitoring occurs in the case of greater than expected impacts.</p>	<p>Bionet records for the Broad-headed Snake are outside of the study area. Previous environmental assessment surveys in the area have only identified minor areas of suitable habitat for this species, with these areas generally being void of exfoliating sandstone and lacking extensive north-western and western facing sandstone benches. Monitoring of potential habitats were undertaken over a period of two years and was discontinued following no individuals being recorded in areas of potential habitat identified. Based on these factors the likelihood of occurrence for this species is considered low. Further detail is available in sections 4.3.4 and 5.3.1 of Biosis (2020) (Appendix 1).</p> <p>Targeted Microchiropteran bat surveys have failed to record the Large-eared Pied Bat within the study area. Habitat assessment undertaken by Biosis identified that cliffs providing suitable roosting habitat for Large-eared Pied Bat are limited in extent within the study area and no evidence of occupation of cliffs by the Large-eared Pied Bat was observed during the habitat assessment The Large-eared Pied Bat was also not recorded during harp trapping by Biosis in 2015. Further detail is available sections 4.3.5 and 5.3.2 of Biosis (2020) (Appendix 1).</p> <p>Monitoring for these species has not been proposed. This is based upon the lack of species detection and limited extent and quality of habitats identified through ecological assessments, targeted survey and monitoring surveys. In addition to the minimal potential for the project to perceptibly impact on natural surface features that represent habitats for these species.</p>
<p>We suggest that the potential impact assessment in this section also be supported by photographic evidence depicting terrestrial biodiversity habitats, particularly for the Broad-headed Snake and Large-eared Pied Bat as discussed above.</p>	<p>Please see above.</p>
<p>There are several records of the Giant Burrowing Frog in the area and we consider there is “high” potential for this species to occur as opposed to</p>	<p>This has been amended and addressed. Omission was related to the previous mine plan. Species is relevant to the project and further detail has been provided.</p>

Table 1 BCD Comment Responses	
BCD comment	Response
“low” as stated in Table 6. We recommend the Plan update the likelihood of occurrence for this species.	
The BMP does not currently provide evidence that previous surveys for threatened frogs were adequate to establish presence/absence in the area. The Plan should include a summary of existing records and extent of habitat, demonstrating that adequate surveys were carried out to establish baseline data which can be used for monitoring species in the case of greater than expected impacts.	<p>The revised mine plan is not considered to have any perceptible surface subsidence. The Proposed Action is therefore considered to have minimal potential to perceptibly impact on natural surface features, including upland swamps, creeks, and drainage lines which represent potential breeding habitat for threatened frogs. As a result it is unlikely that the Proposed Action will result in any significant impacts to threatened frogs likely to occur within the study area. The BMP focuses on monitoring of ecological values that have been determined to be most at risk as part of the UEP.</p> <p>Details of previous ecological assessments and monitoring surveys for threatened frog species have been previously incorporated the <i>EPBC Act Matters of National Environmental Significance Report – Ecology</i> at the project assessment phase. Suitable habitat within the study area has been identified for the Littlejohns Tree Frog and Stuttering Frog. However, monitoring surveys in excess of the relevant EPBC survey guidelines have not detected any Littlejohn's Tree Frog or Stuttering Frog individuals within these areas of suitable habitat. Further detail is available in sections 4.3.3, 5.1.3 and 5.2.1 of Biosis (2020) (Appendix 1).</p> <p>The Giant Burrowing Frog has only been identified within a 245 metre section of a tributary of Cataract River below swamp CRUS2. Section 6.5 of the BMP has been updated to include details of previous Giant Burrowing Frog survey data. Further detail is available in sections 4.3.3, 5.1.3 and 5.2.1 of Biosis (2020) (Appendix 1). While the habitat that has been mapped for this species is not considered likely to be significantly impacted by the proposal, the requirement for one pre-extraction survey to confirm their continued presence and identify triggers for further monitoring, if required, has been included in the BMP.</p>
The Plan needs to quantify and map breeding habitat of giant burrowing frogs given this species is known to occur in the area and its sensitivity to loss of pools	<p>Section 6.5 of the BMP has been updated to include details of previous Giant Burrowing Frog survey data. Previous records and habitat mapping are included in Figure 6 of the BMP. Previous surveys have identified habitat and presence of the Giant Burrowing Frog within a 245 metre section of a tributary of Cataract River, below swamp CRUS2. Other tributaries are considered unlikely to support this species, particularly given the previous survey effort undertaken at all sites being in excess of the relevant EPBC survey guidelines. Further detail is available in sections 4.3.3, 5.1.3 and 5.2.1 of Biosis (2020) (Appendix 1).</p>

Table 1 BCD Comment Responses	
BCD comment	Response
We are unclear how vertebrate monitoring is to occur and what data is to be collected in the case of greater than expected impacts. These details should be elaborated in Table 7.	<p>The Proposed Action is therefore considered to have minimal potential to perceptibly impact on natural surface features, including potential breeding habitat for threatened frogs. The BMP focuses on monitoring of ecological values that have been determined to be most at risk as part of the UEP. As such, no regular ongoing monitoring is proposed for Littlejohn's Tree Frog, Giant Burrowing Frog or the Stuttering Frog:</p> <p>Monitoring surveys in excess of the relevant EPBC survey guidelines have not detected any Littlejohn's Tree Frog or Stuttering Frog individuals within areas of suitable habitat identified during previous surveys. Due to the negligible level of impacts predicted to habitats and low likelihood of occurrence based upon extensive survey effort no monitoring for these species is proposed.</p> <p>Potential impacts to identified habitats for the Giant Burrowing Frog have been considered as negligible. However, given the known occurrence of this species, the BMP has been updated to include one survey to be completed prior to extraction to confirm the continued presence of the species in the area of previously identified habitat, and identify triggers for further monitoring, if required in section 6.5.</p>
The Plan should confirm an appropriate subsidence monitoring period, such as 2 years post-mining, to confirm that "negligible environmental consequences" upon terrestrial biodiversity will occur, as required under Conditions C1-C6 of the project approval	Section 6.1- Monitoring period has been added to the BMP.
Figures 6 and 7 - Please provide updated figures, as the current versions of Figure 6 and 7 are incomplete and do not appear to include a base map, drainage lines or creek lines.	Updated and addressed.
Terrestrial biodiversity	
We suggest you ensure that the Plan's references to Coastal Upland Swamps (including Figure 5) remains consistent with any forthcoming revisions	Updated.

Table 1 BCD Comment Responses	
BCD comment	Response
to the Upland Swamp Ecological Monitoring Plan (USEMP), for which we provided comments on 12/5/21 (our ref DOC21/369991).	
This advice should be also read in conjunction with our detailed previous advice on the USEMP, particularly selection of control sites, monitoring periods for baseline data and clarity regarding TARPs. Forthcoming groundwater advice on the USEMP from DPIE Water.	A briefing note and presentation to the BCD has been subsequently provided by WCL to discuss the timing of monitoring and requirements of baseline data, based on the relevance of the Upland Swamp Offset Policy and associated commentary of Authorities.
Aquatic Ecology	
There appears to be insufficient data being monitored to confirm “negligible environmental consequences” as required by Condition C1, specifically the known occurrence of several threatened aquatic species and amphibious taxa listed in Table 6.	<p>Amphibious taxa have been addressed in the terrestrial biodiversity section responses above.</p> <p>It is noted that the Development Consent (MP09_0013) does not identify any specific monitoring requirements for threatened fish species listed under the EPBC Act or FM Act.</p> <p>Previous targeted surveys for threatened fish have recorded Macquarie Perch, Murray Cod and Silver Perch in the lower reaches of Cataract Creek, up to 120 metres upstream of the full supply level of Lake Cataract. Fish catch data from previous surveys are included in Appendix D of the BMP. Further detail is available in sections 4.3.6 and 5.2.1 of Biosis (2020) (Appendix 1). The Proposed Action is considered to have minimal potential to perceptibly impact on natural surface features including small creeks and tributaries, Cataract Creek, and Cataract Reservoir. Given this, the Proposed Action will not significantly impact this sensitive habitat, and is therefore not predicted to directly or indirectly impact the threatened fish species that may utilise these habitats.</p> <p>The detection of any potential impacts to these species will be achieved through comprehensive monitoring of the pathways of potential impact to these species and their habitats, which are declines in water quality or quantity. This monitoring includes:</p> <ul style="list-style-type: none"> Twice-annual biological stream health monitoring in accordance with AUSRIVAS protocols, including: <ul style="list-style-type: none"> AUSRIVAS sampling and analysis Supplementary water quality readings Photo-point monitoring Aquatic habitat assessments

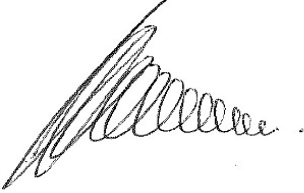
Table 1 BCD Comment Responses	
BCD comment	Response
	<ul style="list-style-type: none"> Fortnightly physicochemical water quality sampling by Wollongong Coal at a number of sites to determine if mining operations are impacting surface water quality within Cataract Creek and Cataract River. Flow monitoring by Wollongong Coal. <p>Ongoing targeted survey for threatened fish species is therefore not considered necessary on the basis of the low likelihood and scale of any potential impacts to habitats for these species, and the fact that comprehensive monitoring of the pathways of any potential impacts to these species is undertaken through the BMP. The monitoring approach is considered comprehensive to the predicted likelihood and magnitude of potential impacts, and suitable to the objectives of the BMP.</p>
We suggest that DPI Fisheries and DPIE Water be consulted with regards to impacts on aquatic ecology, particularly regarding the discontinuation of Macquarie Perch monitoring. The monitoring plan recommends discontinuing Macquarie Perch monitoring due to unlikely impacts and lack of breeding habitat within Cataract Creek, notwithstanding its previous detection in this watercourse.	<p>Biosis understands Wollongong Coal is undertaking consultation with DPIE Water and WaterNSW on the management plans as required by Development Consent (MP09_0013) and that the Development Consent does not require consultation with NSW DPI Fisheries.</p> <p>Macquarie perch in reservoirs undertake migrations into tributaries to spawn. As noted in the BMP Macquarie Perch are prolific within Cataract Reservoir and its tributaries, however no breeding habitat has been identified as subject to impacts in the study area. In addition, habitat features (pool and riffle sequences adjoining gravel runs) that are traditionally considered suitable for Macquarie Perch breeding are absent from the study area. Furthermore, the number of individuals recorded in Cataract Creek is very low in comparison to the reservoir and other tributaries, which indicates a low reliance on Cataract Creek.</p>
Monitoring Design	
The in-text references to tables and figures in Section 6.4 do not match the tables provided and should be corrected. We suggest including a section which clearly outlines the criteria for selection of control sites and how these will be validated, including justification for the limited number of aquatic monitoring sites proposed in the impact area. An overview of statistical methods is also recommended, outlining how pre-mining	<p>The number of monitoring sites and comprehensive nature of monitoring proposed at these sites is considered suitable to the minimal potential of the project to perceptibly impact on natural surface features including small creeks and tributaries, Cataract Creek, and Cataract Reservoir. In particular the monitoring proposed draws on the long term datasets available at these sites through past monitoring which extends back to 2010. The monitoring sites provide a significant long term dataset upon which to base analysis, for example 15 seasons of previous data collection are available at site RVE-AQ6. It should also be noted that each site includes assessment along a reach rather than a point, typically 100 metres in length.</p> <p>The aquatic monitoring sites are strategically located along sections of waterways suitable for assessment</p>

Table 1 BCD Comment Responses	
BCD comment	Response
and post-mining comparisons between such small sample sizes will be conducted.	<p>utilising the AUSRIVAS methodology. The sites are selected to represent the habitats present within these key waterways and detect any potential impacts to stream health or water quality, with consideration of potential sources of impacts. Control sites have also been carefully selected to represent water quality conditions in comparable habitats to impact monitoring reaches, as available within the locality.</p> <p>In addition to the control sites utilised in the BMP, the AUSRIVAS predictive models utilise data from reference sites to provide a comparison of the monitoring site results to the predicted condition of 'undisturbed reaches'. This provides a further level of comparison and assessment, in addition to the control sites.</p> <p>A number of widely accepted and utilised stream health assessment methods are utilised at each site including biological sampling for aquatic macroinvertebrates, supplementary collection of water readings for a standard suite of parameters, photo-point monitoring and assessments of aquatic habitat conditions using both AUSRIVAS and HABSCORE pro-forma recording forms. This allows for the comprehensive evaluation of stream health conditions along each sample reach.</p> <p>Statistical analysis is not to be undertaken and inaccurate wording has been amended. As the outputs of AUSRIVAS model are the product of predictive mathematical analysis that rely on both qualitative and quantitative data, subsequent statistical analyses on these outputs are not considered appropriate or valid. The proposed monitoring program also draws upon other metrics of stream health in addition to the most commonly used outputs of the AUSRIVAS model (OE50, OOSignal and Band outputs) to assess any impacts to stream health or water quality. These include the number of taxa and number of EPT taxa (that is number of taxa from the Trichoptera, Ephemeroptera, and Plecoptera groups that are considered sensitive to pollution).</p> <p>This biological monitoring is completed in the context of regular physicochemical water quality sampling and water flow reading collection by Wollongong Coal, which is undertaken in addition to other monitoring actions including subsidence monitoring. This is considered comprehensive to the predicted likelihood and magnitude of potential impacts, and suitable to the objectives of the BMP.</p>
TARPs for aquatic ecology need to include an assessment of pre-mining to post-mining impacts as a trigger. These triggers should be based on contrasts within the impacted treatments only	<p>The comment is in fact what is being proposed, as stated in section 6.6., in line with a standard BACI design approach. Consideration of Pre-UEP and post-UEP data comparisons will be used in these analyses and interpretations as stated in section 6.6. However a pre-post comparison alone is over-simplistic and does not</p>

Table 1 BCD Comment Responses	
BCD comment	Response
before and after impacts (not comparing impact to control groups). Control treatments are used to check against background changes such as seasonal and environmental change, not to detect impacts of the proposed action.	<p>recognise the importance of seasonal change and variability in these datasets. Removing the control-impact comparison from the TARP as suggested deviates from a standard BACI design. The wording has been re-phrased to avoid confusion on this point.</p> <p>Impact sites will be influenced by catchment scale drivers (e.g. drought) just as control sites will be, as has been observed throughout the monitoring that has occurred in the area since 2010. As such the TARPS will need to consider trending changes in stream health results beyond that observed at control sites. This why the term change has been used in the TARPs and is not an attempt to obfuscate results, but follow processes to deliver valid results.</p> <p>Rivers are dynamic systems that are in constant states of change and renewal. As such variability in macroinvertebrate dataset is inherent as conditions flux and microhabitats are constantly removed and created. With catchment scale drivers resulting in changes in the balance of hydrological and geomorphological processes. This is part of the reason why AUSRIVAS outputs are often placed into bands and why longer term datasets incorporating control site data over a number of seasons are important.</p>
<p>The short term and long-term TARPs should be adjusted to:</p> <ul style="list-style-type: none"> • A statistically significant decline in OE50Taxa Score since mining commenced in impacted sites; • Change in AUSRIVAS Band since mining commenced in impacted sites. 	<p>As above, regarding statistical significance of AUSRIVAS modelling. Revised TARPs have been included throughout the BMP to better assess the data than those carried over from previous monitoring.</p> <ul style="list-style-type: none"> • A change in OE50Taxa score since mining commenced, with reference to any pattern of change observed at control sites; or • Decline in Signal2 score since mining commenced, with reference to any pattern of change observed at control sites. <p>A change has been used as some increases in OE50 can in fact be due to negative environmental factors. A decline in Signal2 has been used in place of AUSRIVAS Band as the Band grouping is directly related to the OE50 score (concerned with macroinvertebrate community impairment), whereas Signal2 is more direct measure of pollution influence. Together these provide a more robust assessment of stream health conditions and reflect the current monitoring approach being undertaken in the study area.</p>

Please contact me if you have any enquiries.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Tony Cable', with a stylized, cursive script.

Tony Cable
Senior Ecologist – Technical Lead Zoology

Appendix 1 EPBC Act Matters of National Environmental Significance Report – Ecology

Russell Vale Colliery – Underground
Expansion Project:
EPBC Act Matters of National Environmental
Significance Report - Ecology

FINAL REPORT

Prepared for Umwelt (Australia) Pty Ltd

15 December 2020

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Glossary

CBD	Central Business District
DEE	Department of Energy and Environment
DPE	NSW Department of Planning and Environment (replaced by DPIE)
DPIE	NSW Department of Planning, Industry and Environment
EEC	Endangered Ecological Community
EES	NSW Environment, Energy and Science Group
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
GIS	Geographic Information System
IAPUM	Independent Advisory Panel on Underground Mining
IPC	Independent Planning Commission
IRAP	Independent risk assessment panel
LGA	Local Government Area
MNES	Matters of National Environmental Significance
MTPA	million tonnes per annum
NSW	New South Wales
PAC	Planning Assessment Commission
PCT	Plant Community Type
PER	Public Environment Report
PPR	Preferred Project Report
PWP	Preliminary Works Project
ROM	run of mine (coal)
RVE	Russel Vale east
SCA	Sydney Catchment Authority
study area	The area covered by the Proposed Action and area within which the influence of proposed mining is considered
UEP	Underground Expansion Project

Summary

The Russell Vale Colliery is an existing underground coal mine located in Russel Vale, north of Wollongong in New South Wales (NSW). The Revised Underground Expansion Project (UEP) is a proposed expansion of Wollongong Coal's mining operations to include extraction of coal from the Wongawilli Coal seam using bord and pillar mining methods, over a project life of five years (the Proposed Action).

Wollongong Coal submitted a referral for the Proposed Action to the Department of Agriculture, Water and the Environment (DAWE) in June 2020. The Proposed Action was determined to be a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for listed threatened Species and communities, and a water resource, in relation to coal seam gas development and large coal mining development.

This report has been prepared to support the assessment of the Proposed Action under the EPBC Act, and provides an impact assessment for ecological Matters of National Environmental Significant (MNES) (i.e. flora, fauna, and ecological communities listed under the EPBC Act and ecological communities potentially impacted by changes to surface and groundwater systems associated with the Proposed Action). This impact assessment is based on the bord and pillar workings mine plan and associated subsidence and groundwater predictions, and biodiversity values as previously identified within the study area.

The Proposed Action does not include any additional direct disturbance of vegetation. The only potential impacts on biodiversity values from the Proposed Action are indirect impacts associated with subsidence impacts and changes to surface and groundwater regimes.

The subsidence assessment undertaken for the Proposed Action (SCT 2019) indicates that the proposed bord and pillar mining methods that will be used for the Proposed Action are not expected to cause any perceptible surface subsidence nor cause any significant interaction with the overlying seams that might in turn become destabilised and lead to additional subsidence. The proposed bord and pillar workings are not considered to have any potential to perceptibly impact on natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir, even taking into consideration cumulative impacts from past mining.

A Quantitative Assessment of Risk of Pillar Failure in Russell Vale East Area prepared by (SCT 2020a) and advice commissioned by the NSW Independent Planning Commission (IPC) from the Independent Advisory Panel on Underground Mining (IAPUM) (IAPUM 2020) have also informed the assessment of potential subsidence impacts, particularly potential impacts on Coastal Upland Swamps. This advice states that for the majority of swamps, the incremental impact in tensile strain associated with potential subsidence is unlikely to threaten swamp integrity. However four swamps (CCUS1, CCUS6, CCUS20, and CCUS21) that are predicted to have already experienced high levels of tensile strains from historical subsidence will need careful consideration during detailed design to restrict further vertical subsidence..

The proposed bord and pillar mining method is flexible and can adapt to different strata conditions and be revised to mitigate or avoid potential surface impacts. Through judicious mine design, it is expected the Proposed Action will also be able to meet the overall objective of negligible environmental consequences.

The Proposed Action is not expected to significantly increase interactions between the mine and surface water systems, nor impact water dependent ecosystems beyond levels currently experienced or predicted to occur as a result of existing approved and historical operations (which do not form part of the Proposed Action).

Potential cumulative impacts (which include consideration of the predicted incremental impacts or changes in timing of predicted impacts) are unlikely to have a significant impact on any water dependent ecosystems.

Based on the findings of the subsidence and groundwater assessments completed for the Proposed Action, impacts to identified biodiversity values are predicted to be negligible. As such the Proposed Action will not result in any direct or any significant indirect impacts to threatened species and communities.

Ongoing monitoring of threatened biodiversity values within the study area is recommended so in the unlikely event subsidence does occur, impacts to these species can be quantified and further impact mitigation measures can be developed. The timing and duration of monitoring should be proportionate to the timing of potential indirect impacts which may impact on the focus of the monitoring.

1 Introduction

Biosis Pty Ltd was commissioned by Umwelt (Australia) Pty Ltd to provide a MNES report for ecological values associated with the Russell Vale Colliery UEP (the Proposed Action). This report supports the assessment of the Proposed Action under the EPBC Act.

1.1 Project background and NSW Approval

The Russell Vale Colliery is located approximately 8 kilometres north of Wollongong Central Business District (CBD) in New South Wales (NSW), and is owned and operated by Wollongong Coal Ltd (Figure 1). Wollongong Coal purchased the Colliery in December 2004, but extensive underground mining has been undertaken at the mine, dating from the late nineteenth century. A substantial volume of high quality coking coal resource remains within the Colliery lease holding.

The Colliery holding comprises a number of sub-leases between Wollongong Coal and surrounding mine operators, including Consolidated Coal Lease (CCL) 745, Mining Purposes Lease (MPL) 271 and Mining Lease (ML) 1575, and covers a total area of approximately 6,973 hectares (Figure 1).

The current Proposed Action is the culmination of a protracted approvals process that commenced in 2009. The broader project covered by the NSW approvals process is referred to as the Underground Extension Project.

The original UEP application, submitted by Gujarat NRE Coking Coal Ltd, involved a substantial expansion of longwall mining in the Wongawilli Seam across the Wonga East area (a total of 11 longwall panels) and Wonga West area (a total of seven longwall panels) to extract 31 million tonnes (Mt) of run-of-mine (ROM) coal over a project life of 18 years. In response to concerns from the public and government agencies, the original UEP application was revised, and a Preferred Project was exhibited in 2014 based on a reduced longwall mine plan of eight longwalls in the Wonga East area only.

In order to address residual uncertainty regarding the impacts of longwall mining raised by the NSW Planning Assessment Commission (PAC) in their Second Review Report, a revised mine design has been developed based on a non-caving bord and pillar mining system (Figure 2). The revised mine plan has been designed to be long term stable, to address potential subsidence-related mining impacts on groundwater, surface water and biodiversity within the Cataract Reservoir catchment.

The UEP has recently been approved under the NSW *Environment Planning and Assessment Act 1979* (EP&A Act) by the IPC. As part of the NSW assessment, the NSW Department of Planning, Industry and Environment (DPIE) sought advice from the Independent Expert Scientific Committee on the revised mine plan which is now approved.

It is noted that the broader UEP project covered by the NSW development consent (MP06_0013) includes components that do not form part of the Proposed Action.

Details of the current Proposed Action are outlined in Section 2.

1.2 Scope of MNES report

This report provides an ecological impact assessment for nationally threatened species and ecological communities based on impacts arising from the Proposed Action. This report also provides an ecological impact assessment of indirect impacts associated with changes to surface water and groundwater systems

impacted by the Proposed Action. The report has been prepared with consideration of the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE 2013) (Significant Impact Guidelines).

The objectives of this report are to:

- Provide a description of the Proposed Action (Section 2) and study area (Section 2.1).
- Provide a description of the environment, including identification of any nationally threatened species and ecological communities, or sensitive habitat for such, at risk of impact from the Proposed Action (Section 4).
- Provide an assessment of potential impacts to nationally threatened species and ecological communities resulting from extraction of coal using first working mining methods (Section 5).
- Discuss proposed impact mitigation measures (Section 6).
- Provide a conclusion as to whether the Proposed Action will result in a significant impact to any nationally threatened species and communities (Section 7).

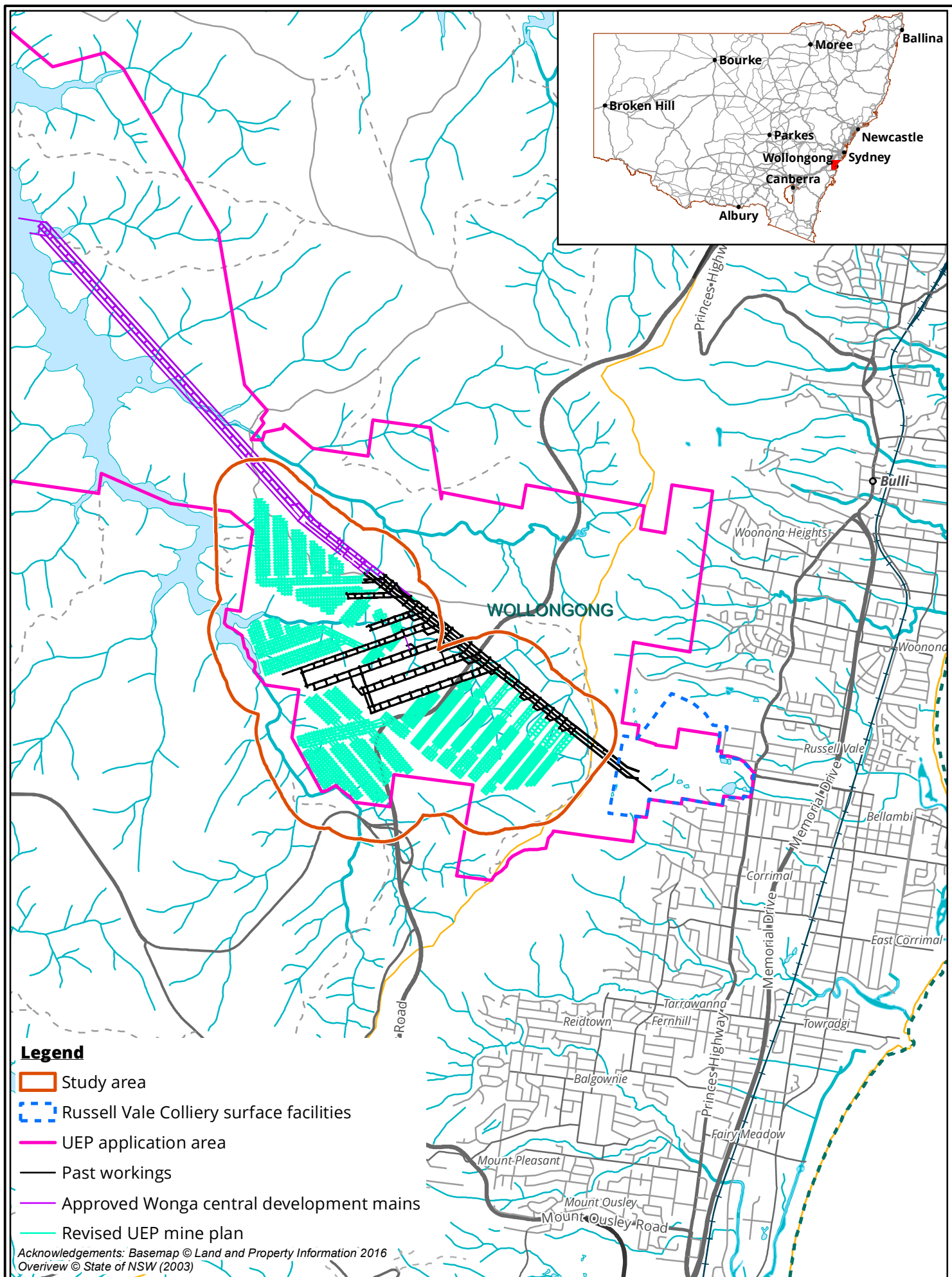
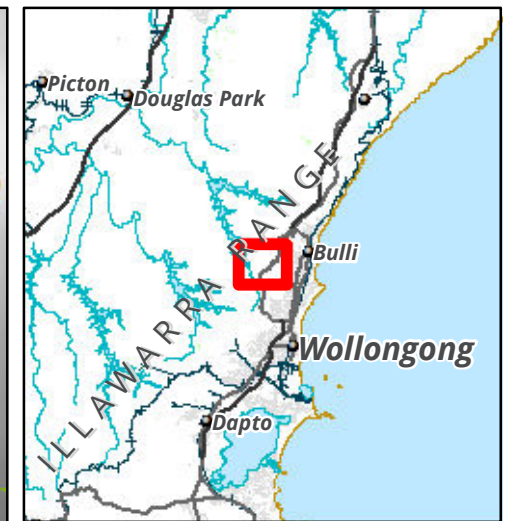
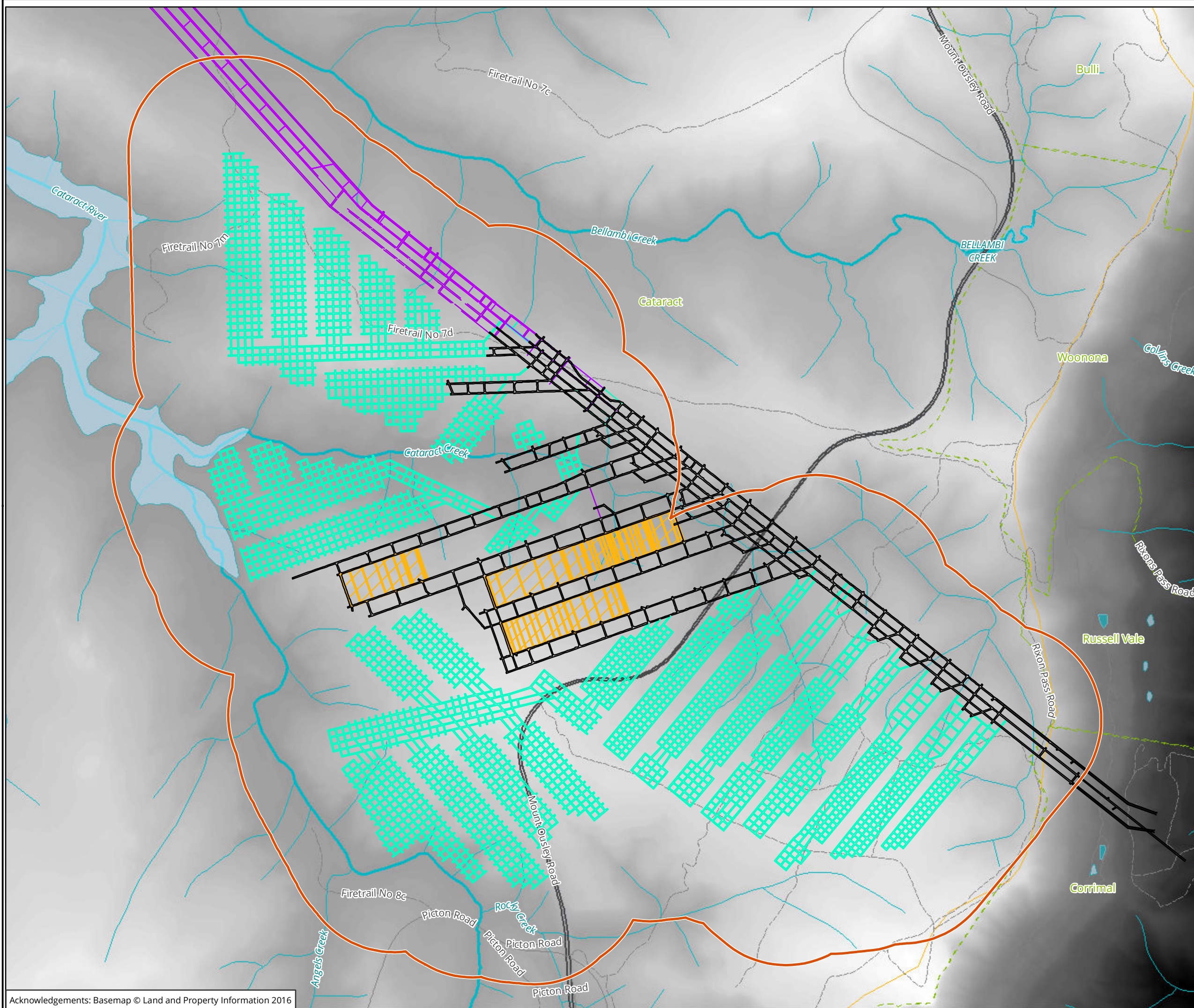


Figure 1 Location of the Russell Vale Colliery, New South Wales



Legend

- Study area
- Past workings
- Approved Wonga central development mains
- Revised UEP mine plan
- RV East old longwall workings

Figure 2 Revised UEP mine plan

0 200 400 600 800
Metres

Scale: 1:15,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56



Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

Matter: 30999
Date: 10 February 2020,
Checked by: MEH, Drawn by: AEDM, Last edited by: amurray
Location: P:\30900s\30999\Mapping\30999_F2_MinePlan

2 The Proposed Action

2.1 Description of the Proposed Action

The key elements of the Proposed Action are:

- Mining using bord and pillar mining techniques only, with the workings designed to be long-term stable with minimal subsidence impacts (Figure 2). No longwall mining is proposed as part of the ongoing mine plan.
- Extraction of approximately 3.7 million tonnes (Mt) of ROM coal over a period of 5 years at a reduced production rate that will not exceed 1 Mt of product coal per year.
- Mining within the Wongawilli seam within the Wonga East area only, with no mining proposed within the Wonga West area or underneath the full supply level of Cataract Reservoir.

The Proposed Action consists only of the underground bord and pillar mining aspects of the UEP and excludes proposed Pit Top upgrades associated with the UEP, as well as all works, or continued operation of works, currently authorised by existing approvals.

2.2 Definition of the Proposed Action study area

The Wonga East area is located approximately 8 kilometres north-west of Wollongong NSW, within the Local Government Areas (LGAs) of Wollongong and Wollondilly. It is located beneath the Woronora plateau and the Metropolitan Special Areas, administered by WaterNSW for Sydney's drinking water supply. The Metropolitan Special Area is managed in accordance with the *Special Areas Strategic Plan of Management 2015* (WaterNSW & OEH 2015), to ensure protection of water quality and quantity, the conservation of many threatened plant and animal species, and the protection of natural and cultural values.

Substantial modifications to Wollongong Coal's original UEP have been undertaken to avoid and minimise impacts to surface features, as described in the Preferred Project UEP (and outlined in Section 1.1). These changes involved the removal of Wonga West from the application as well as the change in coal extraction methodology, from secondary extraction to bord and pillar (first workings), in Wonga East.

The study area is defined as the area located within 400 metres of the proposed bord and pillar workings and provides an area within which the influence of proposed mining is considered (Figure 2). Along with other special areas and National Parks to the northwest and south, the study area forms part of the large band of native vegetation surrounding the Sydney Metropolitan Area, providing a largely connected corridor of vegetation that supports a diverse range of vegetation communities and associated flora and fauna species.

Coal handling facilities are situated at the Russell Vale Colliery Pit Top, located at the corner of the Princes Highway and Bellambi Lane, approximately 7.2 kilometres north of Wollongong, NSW (Figure 1 and Figure 2).

3 Potential impacts of the Proposed Action

3.1 Direct impacts

No direct impacts to surface features will result from the Proposed Action. The Proposed Action will not result in the direct removal or clearing of any vegetation.

As such there will be no direct impacts to ecological MNES as a result of the Proposed Action.

3.2 Indirect impacts

The only potential impacts to ecological MNES are limited to potential indirect impacts associated with subsidence (such as surface cracking) and hydrological changes affecting surface water regimes or near-surface groundwater.

The predicted subsidence impacts associated with the Proposed Action are summarised below in Section 3.2.1 with a more detailed summary of potential subsidence impacts included in the main text of the Public Environment Report (PER). A description of the potential subsidence related indirect impacts on sensitive habitats is provided in Section 4.2.

3.2.1 Subsidence Effects, Impacts and Consequences

The IAPUM in their advice to the IPC on the UEP (IAPUM 2020) includes a concise summary of the factors to be considered in assessing the potential consequences associated with mining resulting in subsidence:

The report "Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield: Strategic Review" (the Southern Coalfield Report, DoP (2008)) drew a distinction between subsidence effects, subsidence impacts and subsidence consequences. The concept is now embedded in subsidence engineering in NSW, with the three subsidence factors being defined as:

- *Effect - the nature of mining-induced deformation of the ground mass. This includes all mining-induced ground movements such as vertical and horizontal displacements and their expression as ground curvatures, strains and tilts.*
- *Impact - any physical change caused by subsidence effects to the fabric of the ground, the ground surface, or a structure. In the natural environment these impacts are, principally, tensile and shear cracking of the rock mass, localised buckling of the strata and changes in ground profile.*
- *Consequence - any change caused by a subsidence impact to the amenity, function or risk profile of a natural or constructed feature. Some consequences may give rise to secondary consequences. For example, the redirection of surface water to the subsurface through mining-induced fractures may be a primary consequence for water inflow to a reservoir and result in secondary consequences for ecology."*

The following sections summarise the predicted subsidence effects, impacts and consequences associated with the Proposed Action and its interaction with past mining activities in the area.

Subsidence impacts

Subsidence effects have the *potential* to impact on biodiversity values through the following impacts:

- Tensile cracking has potential to cause cracking of strata below upland swamps or rock bars associated with swamps which results in changes to the integrity of the swamp.

- Incremental strain on existing cracks causing them to become wider and deeper.
- Cracks in stream beds resulting in loss of surface flows
- Modification of sensitive sandstone and rocky environments including cliff failures and/or surface rock cracking due to changes in underlying bed rock.

Subsidence Consequences

The effects of subsidence can have the following ecological consequences:

- Reduction in swamp capacity to retain water table and soil moisture content.
- Changes in floristic species composition from characteristic swamp species to dry heath or woodland flora species.
- Redirection or loss of surface water leading to a loss of surface pools in creeks removing aquatic habitat.
- Damage to sensitive rocky environments, including loss of habitat for threatened Microbat species and Broad-headed Snake habitat. Also potential for damage to ecosystems located below cliff falls.

3.2.2 Predicted subsidence effects from bord and pillar workings in the Wongawilli seam

The subsidence assessment of the proposed extraction undertaken by SCT (2019) found that irrespective of the strength, load and behaviour of the proposed pillars being utilised in the proposed bord and pillar workings, some low-level deformation is expected within the Wongawilli seam, with elastic compression of the strata above and below the pillars. This strata compression has the potential to result in low-level subsidence movements (less than 100 mm and generally less than 30 mm), as well as some corresponding low levels of tilt and strain. Any such subsidence is likely to occur gradually and movement is expected to be generally imperceptible and insignificant for all practical purposes.

The assessment concluded that *“the small subsidence movements that are forecast for the proposed mining layout are not expected to cause perceptible impacts to any natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir”* (SCT 2019). The proposed mining is not expected to have an impact on surface water dependent ecosystems or groundwater.

A peer review of the Russel Vale Colliery subsidence assessment (SCT 2019) undertaken by BK Hebblewhite Consulting supported the claim that the proposed mining is not expected to result in any significant subsidence impacts on surface or sub-surface water regimes, and that proposed pillars are large enough to be long-term stable. The review also supported the claim that the proposed workings are not considered to have any potential to perceptibly impact on any surface features such as escarpments, swamps, cliffs, creeks and drainage lines, or the Cataract Reservoir (B K Hebblewhite Consulting 2019).

The Proposed Action mine plan has been designed to be long term stable. Should an unexpected pillar failure occur, the SCT Subsidence Assessment estimated the potential vertical subsidence associated with a pillar failure in the Wongawilli Seam as being up to 140 millimetres. A risk analysis undertaken by (SCT 2020a) quantifies the risk of such a pillar failure occurring as less than 1 in 100,000 (0.001 % over the life of the project and therefore less than 0.01 % per year). The likelihood of initiating event occurring is considered to be remote. Accordingly, the risk of pillar failure in the Wongawilli Seam is not considered further as a potential causal pathway in this assessment.

Predicted Cumulative Subsidence Effects

The study area has previously been mined, including extraction of the overlying Balgownie Seam and Bulli Seam as well as the extraction of Longwall panels 4, 5 and 6 in the Wongawilli Seam. Subsidence associated

with secondary extraction in these workings has already caused vertical subsidence over much of the proposed bord and pillar mining area.

It is noted by SCT (2019 and 2020a) that there is the potential for further subsidence to occur from historical mining, including ongoing low level ground movements from mining in the Wongawilli Seam, the collapse of any marginally stable pillars in the Bulli Seam or the collapse of any remaining standing pillars within Bulli Seam goaf areas. These risks are discussed further in the SCT Subsidence Assessment (2019) and SCT Subsidence Risk Analysis (2020a). Importantly, it is confirmed by SCT and the peer review process that this risk exists regardless of whether the Proposed Action proceeds and the Proposed Action does not materially change this existing risk or the environmental consequences associated with this occurring.

The detailed technical assessments prepared for the Proposed Action have considered the potential cumulative impact of the Proposed Action with historical mining operations within and surrounding the study area.

Table A.1 in Appendix 1 provides a summary of predicted existing vertical subsidence and tensile strains associated with extraction of the Bulli and Balgownie Seams for Coastal Upland Swamps located over the proposed bord and pillar workings. These subsidence and strain predictions are based on a range of studies undertaken by SCT over the past decade. Recent work undertaken by SCT indicates that predicted tilts and strains in multi seams environments are likely to be less than that stated in Table A.1. The Proposed Action's incremental vertical subsidence impact is conservatively assumed to be 100 millimetres with an assumed incremental tensile strain of 0.5 millimetres/metre for the purposes of this assessment.¹

The predictions in Table A.1 assume that all Bulli Seam Goaf areas have fully collapsed however features above any remnant standing pillars in goaf areas may yet to experience the modelled levels of subsidence and the consequences associated with the almost certain subsidence that would occur when these standing pillars eventually fail. As noted above, the failure of these pillars and associated impacts is not caused by the Proposed Action in that both the failure of the pillars and the resulting consequences are inevitable irrespective of whether or not the Proposed Action proceeds. However, the subsidence from such a failure may occur during the life of the Proposed Action and the causal factors in any observed subsidence associated with such a failure needs to be taken into consideration in monitoring.

¹ For the purposes of this assessment, a linear relationship of incremental tensile strains of 0.5 mm/m for every 100 mm of vertical subsidence has been assumed based on the approach taken in the IAPUM Advice (see also [SCT 2020](#)). However, as noted in the SCT Response to the IAPUM Advice (SCT 2020b), this is likely to be conservative in the context of the Wonga East area.

3.3 Proposed measures to avoid or reduce impacts on ecological MNES

The proposed measures to avoid and reduce potential impacts on ecological MNES from the Proposed Action include:

- Selected mining methodology (revision from longwall to bord and pillar mining methods) and a pillar design that is long term stable.
- Flexibility in bord and pillar mining method allows for rapid response to changes in loading and other circumstances, providing a more responsive adaptive management system to protect environmental values.
- Monitoring and implementation of remediation measures if observed impacts are greater than predicted.

4 Description of the environment

4.1 Literature and database review

In order to provide a context for the study area, information about flora and fauna from within 10 kilometres (the locality) was obtained from relevant public databases. Records from the following databases were collated and reviewed:

- Department of Agriculture, Water, and Environment (DAWE) Protected Matters Search Tool for matters protected by the EPBC Act.
- NSW BioNet - *the database for the Atlas of NSW Wildlife*, EES
- PlantNET (RBGDT 2020).
- The NSW Department of Primary Industries (DPI) Spatial Data Portal for *Fisheries Management Act 1994* (FM Act) listed threatened species, populations and communities.
- BirdLife Australia, the New Atlas of Australian Birds 1998-2013 (BA).

Previous ecological assessments of the Wonga East areas provide a comprehensive inventory of the terrestrial and aquatic biodiversity values of the study area. These include reports produced by ERM (ERM 2013a), Cardno Ecology Lab (2009, 2010, 2012a, 2012b, 2009), and Biosis (2012, 2012, 2013, 2019a, 2019b). This section provides a summary of these assessments.

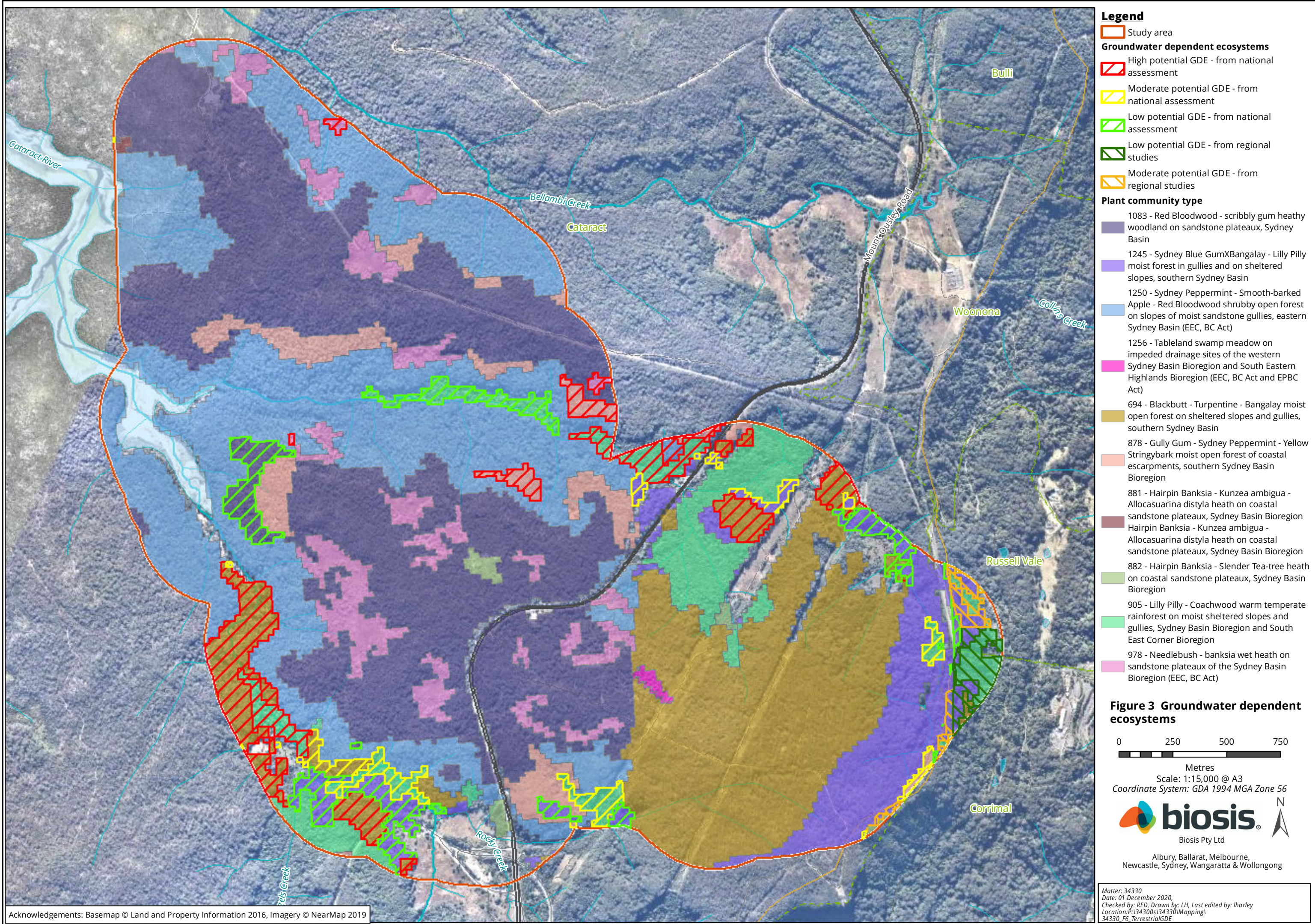
4.1.1 Vegetation communities within the study area

The plant community types (PCT's) within the study area, with the exception of Coastal upland swamps, were mapped using desktop mapping (DPIE 2010). The study area supports 905 hectares of native vegetation, across 10 PCT's. Assessment of the potential for the study area to support groundwater dependent ecosystems (GDEs) was undertaken using the Australian Government's Bureau of Meteorology, Groundwater Dependent Ecosystems Atlas (GDE Atlas) (BOM 2018), the download of metadata from State of NSW, and the NSW Office of Water Risk Assessment guidelines for groundwater dependent ecosystems (OEH 2012). No areas reliant on the surface expression of groundwater are mapped within the study area according to the GDE Atlas or metadata (DPIE 2016). Ten PCTs, two groundwater dependent wetland community and eight vegetation communities (all identified as 'moderate to high Probability GDEs' in the risk assessment guidelines, and potentially reliant on subsurface expression of groundwater) are mapped within the study area (Table 1 and Figure 3).

Table 1 PCT's and potential GDE's within the study area

Vegetation formation	PCT name	EPBC Act Listing	GDE Potential	Area (ha)
Coastal Rock Plate Heath	PCT 881 Hairpin Banksia - Kunzea ambigua - Allocasuarina distyla heath on coastal sandstone plateaux, Sydney Basin Bioregion	Not listed	Moderate potential GDE	0.48
Coastal Sandstone Gully Forest	PCT 1250 Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin	Not listed	High potential GDE	236.39

Vegetation formation	PCT name	EPBC Act Listing	GDE Potential	Area (ha)
Coastal Sandstone Plateau Heath	PCT 882 Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin Bioregion	Not listed	Moderate potential GDE	3.95
Coastal Sandstone Ridgetop Woodland	PCT 1083 Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux, Sydney Basin	Not listed	Moderate potential GDE	280.24
Coastal Upland Swamp	PCT 978 Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion	Coastal Upland Swamp in the Sydney Basin Bioregion EEC	High potential GDE	47.42
Coastal Warm Temperate Rainforest	PCT 905 Lilly Pilly - Coachwood warm temperate rainforest on moist sheltered slopes and gullies, Sydney Basin Bioregion and South East Corner Bioregion	Not listed	High potential GDE	63.44
Escarpment Foothills Wet Forest	PCT 878 Gully Gum - Sydney Peppermint - Yellow Stringybark moist open forest of coastal escarpments, southern Sydney Basin Bioregion	Not listed	Moderate potential GDE	37.51
Illawarra Gully Wet Forest	PCT 694 Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin	Not listed	High potential GDE	165.69
Tableland Swamp Meadow	PCT 1256 Tableland swamp meadow on impeded drainage sites of the western Sydney Basin Bioregion and South Eastern Highlands Bioregion	Coastal Upland Swamp in the Sydney Basin Bioregion EEC	High potential GDE	1.32
Warm Temperate Layered Forest	PCT 1245 Sydney Blue Gum X Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin	Not listed	High potential GDE	68.78
Total				905.22



4.1.2 Candidate species requiring assessment

The desktop assessment confirmed that one threatened ecological community (TEC), *Coastal upland swamps in the Sydney Basin Bioregion* (Endangered, EPBC Act), was previously mapped within the study area as part of the *Southeast NSW Native Vegetation Classification and Mapping project SCIVI VIS ID 2230* (DPIE 2010). Historical records also exist within the locality for 21 threatened flora and fauna species listed under the EPBC Act. These records are outlined in Appendix 2 (flora) and Appendix 3 (fauna) along with those species and communities identified by the Protected Matters Search Tool, that are considered likely to occur in the study area due to the presence of potential habitat.

Not all of the threatened species and communities that have the potential to occur within the study area are considered to be susceptible to subsidence related impacts. As there are no direct impacts associated with the Proposed Action (i.e. no threatened species habitat will be directly removed), this impact assessment focuses on the species and communities, and their habitats, which have potential to occur in the study area and are considered susceptible to indirect impacts resulting from subsidence. As a result some species have been excluded from requiring further assessment, being species reliant on terrestrial environments that are at negligible risk of impact.

The *Russell Vale Colliery – Underground Expansion Project: Preferred Project Report - Biodiversity* (Biosis 2014a) report identified one ecological community, one flora species and nine fauna species (five terrestrial and four aquatic) listed under the EPBC Act that have the potential to occur or are known to occur in the study area, and are considered susceptible to subsidence impacts. An assessment of the likelihood of occurrence of these species, based on additional monitoring data collected since 2014, and the risk of impact from Proposed Action is provided in Table 2. Further impact assessment details are provided in Section 5.

The likelihood of occurrence for some species in this list has changed since Biosis (2014a) and Hansen Bailey (2015). These changes include:

- The likelihood of occurrence for the Large-eared Pied Bat has been downgraded to a low likelihood of occurrence. Although targeted surveys detected a single possible record, the study area does not support suitable roosting habitat.
- The Broad-headed Snake is now considered a low likelihood of occurrence. Suitable rocky habitat is highly limited in the study area and additional monitoring has not detected the species, or even suitable prey species.
- Littlejohn's Tree Frog is now considered a low likelihood of occurrence based on the results of additional monitoring (Biosis 2017). Suitable habitat is limited in the study area and targeted surveys undertaken between August 2013 and February 2016 have not detected the species in the study area.
- Stuttering Frog is now considered a negligible likelihood of occurrence based on the results of additional monitoring (Biosis 2017). Targeted surveys undertaken between August 2013 and February 2016 have not detected the species in the study area.

Table 2 Threatened species and communities likely to occur in the study area and previously assessed as susceptible to indirect subsidence impacts.

Scientific name	Common name	EPBC Act status	Sensitive habitat feature utilised	Likelihood of occurrence in the study area	Risk of impact from Proposed Action
Threatened ecological community					
-	<i>Coastal upland swamps in the Sydney Basin Bioregion</i>	E	Coastal upland swamps	Recorded	Negligible
Flora					
<i>Pultenaea aristata</i>	Prickly Bush-pea	V	Coastal upland swamps	Recorded	Negligible
Terrestrial fauna					
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	Rocky environments	Low	Negligible
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	V	Rocky environments	Low	Negligible
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	V	Coastal upland swamps / aquatic environments	Recorded	Negligible
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog	V	Coastal upland swamps / Aquatic environments	Low	Negligible
<i>Mixophyes balbus</i>	Stuttering Frog	V	Aquatic environments	Negligible	Negligible
Aquatic fauna					
<i>Bidyanus bidyanus</i>	Silver Perch	CR	Aquatic environments	Recorded	Negligible
<i>Maccullochella macquariensis</i>	Trout Cod	E	Aquatic environments	Recorded	Negligible
<i>Macquaria australasica</i>	Macquarie Perch	E	Aquatic environments	Recorded	Negligible
<i>Maccullochella peelii</i>	Murray Cod	V	Aquatic environments	Recorded	Negligible

4.2 Sensitive habitats

The study area is located on the Woronora plateau in the Sydney Basin bioregion. The Woronora plateau supports a diverse range of vegetation communities and associated flora and fauna species, with disturbance, including weeds, limited to fire trails and infrastructure associated with water storage, electricity easements, transport and mining activities.

Areas of sensitive habitat in the study area include (Biosis 2014a):

- Rocky environments.
- Coastal upland swamps (listed as an endangered ecological community).
- Ground Water dependent terrestrial vegetation communities.
- Aquatic environments (Cataract Creek, Cataract River, Bellambi Creek and their tributaries).

Non-ground water dependent terrestrial vegetation communities will not be impacted by the Proposed Action and no further assessment is required.

As discussed in Section 3 the Proposed Action does not include any direct impacts to nationally threatened species or ecological communities as the Proposed Action will not result in the direct removal of any vegetation or habitat. The main potential impact mechanism associated with the Proposed Action is subsidence from mining. Subsidence can result in indirect impacts to biodiversity through associated impacts to geology, including shear cracking of the rock mass, buckling of strata from valley closure and upsidence (DoP 2008).

The potential environmental consequences of these subsidence impacts (DECC 2007, DoP 2008, PAC 2009, PAC 2010), include:

- Impacts to upland swamps, including:
 - Alteration of hydrological regimes through fracturing of bedrock beneath upland swamps or shearing.
 - Changes in concentration of water due to changes in water distribution resulting from changes in tilts.
 - Increased scour and erosion potential due to changes in water distribution due to changes in tilts.
- Impact to aquatic environments, including:
 - Loss of surface flow to the subsurface.
 - Loss of aquatic or in-stream habitats, standing pools or changes in water level.
 - Loss of longitudinal connectivity between pools along streams.
 - Adverse impacts to water quality.
 - Simplification of remaining in-stream habitat due to the growth or iron-oxidising bacteria.
 - Release of gas (methane) into the water column.
- Impacts to rocky environments, including:
 - Cliff falls and rock falls impacting on vegetation or fauna habitat.
 - Fracturing of rocky outcrops impacting on vegetation or fauna habitat.

The location and extent of sensitive habitats within the study area are shown in Figure 4. The extent of each sensitive habitat type within the study area are detailed in the sections below.

4.2.1 Coastal upland swamps

Detailed mapping and characterisation of *Coastal Upland Swamps in the Sydney Basin Bioregion* TEC (listed as Endangered under the EPBC Act) was undertaken by Biosis (2012) throughout the study area. A total of 39 upland headwater swamps (approximately 49 hectares in total) were recorded in the study area. All 39 swamps are considered to meet the requirements for listing under the EPBC Act. The extent of this TEC in relation to the Proposed Action is illustrated in Figure 4.

The upland swamps in the study area are markedly different to other upland swamps on the Woronora plateau in that they are predominantly drier, generally smaller with shallower soils, have less humic material, have more interspersed sandstone outcrops within their outlines, and are less spatially continuous than a “typical” humic, saturated swamp (Biosis 2014b). Refer to Biosis (2014b) for comprehensive details on the regional and local distribution of upland swamps, historic impacts of mining on upland swamps, including impacts to hydrogeological features.

Upland swamps in the study area also provide potential habitat for a number of threatened species listed under the EPBC Act that are susceptible to subsidence, including:

- Prickly Bush-pea
- Giant Burrowing Frog
- Littlejohn's Tree Frog

These species are considered further in Section 5.

4.2.2 Aquatic environments

The proposed Wonga East bord and pillar workings are located within the catchment of three major streams and their tributaries; Cataract River, Cataract Creek and Bellambi Creek.

Cataract River is located to the south of the Wonga East area. Within the study area, Cataract River is a fourth order stream connecting to the south arm of Cataract Reservoir. In the study area Cataract River is bordered by Coachwood Warm Temperate Rainforest vegetation (NPWS 2003). The Proposed Action does not proposed any bord and pillar workings under Cataract River. However, bord and pillar workings will be undertaken beneath some tributaries and the catchment of Cataract River.

Bellambi Creek, a third order stream, is located to the north of the Wonga East area. Vegetation surrounding Bellambi Creek consists of Coachwood Warm Temperate Rainforest (NPWS 2003), Bellambi Creek will not be mined under, however fist workings will be undertaken beneath some tributaries and the catchment of Bellambi Creek.

Cataract Creek is located within the Wonga East area, with bord and pillar workings located external to the south of the main channel on the eastern side. Within the study area Cataract Creek is a third order stream down to Mount Ousley Road, and a fourth order stream downstream of Mount Ousley Road.

The study area also supports a number of first, second and third order tributaries of Cataract Creek. Cataract Creek is bordered by upland swamps, dry sclerophyll forest, wet sclerophyll forest in the upper reaches and wet sclerophyll forest and rainforest vegetation in the lower reaches. In the lower reaches the canopy along Cataract Creek is closed and the creek is shaded, whilst in the upper reaches it is open. The channel morphology of the creek is characterised by sandstone benches and ephemeral pools in the upper reaches and an alternating series of long pools and shorter bars and riffles in the lower reaches. Bars and riffles are composed of various combinations of bedrock, boulders, cobble, pebble and gravel. Large woody debris is

relatively common, forming dams and submerged snags in pools. There is natural variation in water levels both within and between seasons (Cardno Ecology Lab 2012a, Cardno Ecology Lab 2012c, Cardno Ecology Lab 2012b).

Bord and pillar workings will occur beneath parts of Cataract Creek and beneath tributaries and parts of the broader catchment area of Cataract Creek.

Streams in the study area provide potential habitat for a number of threatened species listed under the EPBC Act, including:

- Littlejohn's Tree Frog (tributaries only)
- Giant Burrowing Frog (tributaries only)
- Stuttering Frog (downstream of Mount Ousley Road)
- Silver Perch (lower reaches adjacent to Lake Cataract)
- Trout Cod (lower reaches adjacent to Lake Cataract)
- Macquarie Perch and Murray Cod (lower reaches adjacent to Lake Cataract)

These species are considered further in Section 5.

4.2.3 Rocky environments

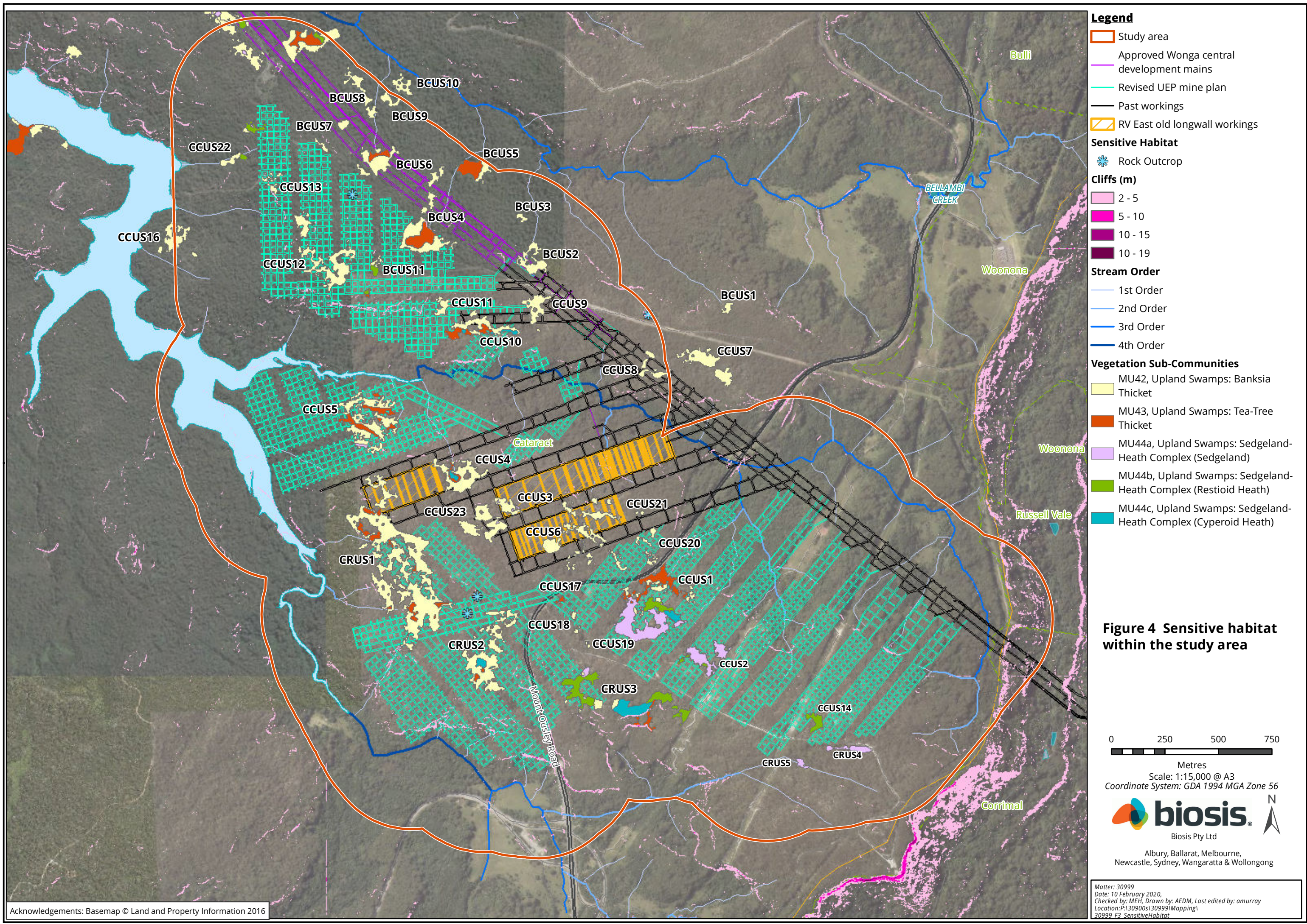
Rocky environments in the study area include cliffs and rocky outcrops. An inspection of cliff formations and steep slopes within Wonga East was undertaken by SCT Operations (2012). In Wonga East, cliff formations along Cataract Creek are typically less than a few metres high, but do extend up to five to 10 metres high in some sections. An assessment of the cliff formations by Biosis did not identify any significant overhangs or caves. Potential roosting habitat for microchiropteran bats is limited in extent and restricted to an area adjacent north of Cataract Creek.

The study area does not contain extensive north-western and western facing sandstone benches that could be considered critical wintering habitat for the threatened Broad-headed Snake (EcoLogical 2009). Whilst there is sandstone benches and overhangs present within the study area, the exfoliating slabs that provide isolated patches of habitat for Broad-headed Snake are largely absent due to the historic removal of bush rock.

Rocky outcrops and cliff lines in the study area provide potential habitat for a number of threatened species listed under the EPBC Act, including:

- Large-eared Pied Bat
- Broad-headed Snake

These species are considered further in Section 5.



4.3 Field survey summary

This section provides a summary of the results of field surveys undertaken within the study area. Survey results are focused on those candidate species and communities listed under the EPBC Act, as identified in Table 2, which are considered likely to occur within the Wonga East area and for which the suitable habitat for these species is deemed susceptible to impacts from subsidence. The methodologies employed during field surveys are provided in Appendix 4 and field survey locations and effort are shown in Figure 5 (flora) and Figure 6 (fauna).

4.3.1 Coastal upland swamps

The mapping of coastal upland swamps completed by (Biosis 2012) is presented in Figure 4, with the extent of this community within the Wonga East area also discussed in Section 4.2. This assessment identified 39 upland headwater swamps within the Wonga-east area, with a total area of 49 hectares. No valley fill swamps were identified as being present.

The majority of upland swamps in the study area (i.e. 34 of 39) support Banksia Thicket (MU42), with 20 upland swamps supporting only this vegetation sub-community. Ten upland swamps support Tea-tree Thicket (MU43). Six upland swamps support a complete range of upland swamp vegetation sub-communities (MU42 Banksia Thicket, MU43 Tea-tree Thicket, MU44 Sedgeland-Heath Complex).

Coastal upland swamp monitoring

Reports detailing the results of the upland swamp floristic monitoring have been provided to Wollongong Coal since the ecological monitoring program commenced in 2011. To date the assessment against upland swamp vegetation monitoring TARPs (WCL 2012, WCL 2015b) in each report have identified that conditions have been consistent with the 'within prediction' TARP levels, consistent with 'Negligible change to the composition or distribution of species within swamps' (WCL 2015b). No 'exceeding prediction' TARP levels for upland swamp vegetation monitoring have been triggered. Monitoring of coastal upland swamps has been undertaken within Russell Vale East since 2011. The existing monitoring undertaken sets an important baseline against which to compare monitoring observations undertaken during the life of the UEP.

The findings of the most recent (2019) iteration of the terrestrial ecological monitoring program (Biosis 2020) were made in the context of extended drought conditions across the region that have continued and intensified since 2017. The 2019 report includes statistical analysis of swamp vegetation across the whole monitoring dataset collected since 2011 and has been collected as to inform pre-UEP baseline conditions, with the findings summarised below.

The 2019 monitoring report found that impact monitoring swamps CCUS1, CCUS5 and CRUS1 were consistent with the within prediction (level 1) TARP level, on the basis of no statistically significant change in TSR or species composition being attributable to longwall mining and no observations of swamp vegetation dieback being recorded. During 2019, two areas of vegetation dieback were observed in swamps CCUS3 and CCUS4. The observed dieback was determined to be consistent with the 'within prediction' (level 2) TARP level for upland swamp vegetation monitoring. Similar areas of dieback were observed at control swamps BCUS12 and BCUS13, however the areas of dieback at the impact monitoring sites were identified to be more acute than that at the control sites, indicating that swamps CCUS3 and CCUS4 may have a reduced level of resilience to environmental stressors such as drought (with no mining occurring since 2015). While no statistically significant change in TSR or species composition was detected at these sites, at CCUS3 transects that had been mined beneath appeared to show lower TSR values than transects that had not been mined beneath. Also at CCUS4, the test for yearly trends in species composition at swamp CCUS4 was approaching the adopted significance level in 2019. Indicating that while not meeting the significance level of the statistical analyses, these swamps may be to a degree reflecting differing responses to the environmental conditions

than other swamps. Preliminary field observation findings made during the 2020 iteration of the monitoring program indicate a degree of dieback recovery following a relative increase in rainfall during 2020. It is important to consider these observational findings as no pre-mining data exists with which to compare the current data to on the basis of pre and post mining comparisons at swamps CCUS and CCUS4. The within prediction (level 2) TARP level for upland swamp vegetation monitoring identified at swamp CCUS4 in 2020 is consistent with 'negligible change to the composition or distribution of species within swamps' performance criteria detailed in the Upland Swamp Management Plan (Wollongong Coal 2015). It should be noted that neither swamp CCUS3 or CCUS4 will be undermined by the UEP.

Upland swamp ecological monitoring will continue in 2020 and include assessment against the relevant TARPs. The full floristic monitoring data set is provided as Appendix 5.

4.3.2 Prickly Bush-pea

Prickly Bush-pea has been recorded broadly throughout the study area during targeted surveys, follow up assessments, and during ecological monitoring. During targeted surveys this species was recorded at upland swamps CRUS1, CCUS3, CCUS10, CCUS8 and BCUS7 (ERM 2013a). The species is known to be widely distributed throughout the study area and locality, and occurs in a variety of vegetation communities, particularly drier margins of upland swamps and surrounding sandstone woodland.

The species has not been recorded from wet environments subject to permanent or even intermittent water logging. Rather, it has been recorded from environments where surface water run-off is impeded by low gradient slopes. Soils are generally shallow and consist of mineral sands. The critical habitat component appears to be areas where low gradients result in the impediment of drainage.

Throughout the upland swamp floristic monitoring program (2012 – 2019), this species has not been recorded at any of the impact monitoring transects. The species has only been recorded at one of the control sites, BCUS12, at monitoring transect two. The number of records for this species recorded during the monitoring program is provided in Table 3. The full floristic monitoring data set is provided in Appendix 5.

Table 3 Prickly Bush-pea record summary from transect BCUS12-V2

Survey date	Round	Number of individuals
5/07/2012	Round 2 (Autumn)	2
7/11/2012	Round 1 (Spring)	3
15/05/2013	Round 2 (Autumn)	4
22/05/2014	Round 2 (Autumn)	2

4.3.3 Threatened frogs

Surveys undertaken by Biosis (2009), EcoLogical (2009) and ERM (2013a) did not record Littlejohn's Tree Frog, Giant Burrowing Frog or Stuttering Frog in the study area during initial surveys.

Habitat assessment undertaken by Biosis (2013) identified suitable breeding habitat for these species along Cataract Creek (Stuttering Frog) and tributaries of Cataract Creek and Cataract River (Littlejohn's Tree Frog and Giant Burrowing Frog) (see Figure 6).

The Giant Burrowing Frog has only been recorded from monitoring transect CRUS2 during targeted surveys as part of the ecological monitoring program, and has been reported on in Biosis (2013, 2017) Adults, metamorphs and tadpoles of this species has been recorded over ten surveys between 2012 and 2016, across winter, autumn and summer seasons. The species has been recorded from a total of ten pools along the 245 metre transect. The Giant Burrowing Frog records from the CRUS2 transect are summarised in Table 4, with the raw records provided in Appendix 5.

Table 4 Giant Burrowing Frog records summary from CRUS2 transect

Survey date	Round	Adult	Metamorph	Tadpoles
28/08/2012	Winter	0	0	17
30/08/2012	Winter	0	0	11
17/04/2013	Autumn	0	0	130
27/05/2013	Autumn	0	0	50
27/08/2013	Winter	0	0	100
29/08/2013	Winter	0	0	127
20/12/2013	Summer	0	0	1
13/01/2014	Summer	0	9	8
21/01/2014	Summer	1	3	6
19/03/2014	Autumn	1	1	22
15/04/2014	Autumn	0	1	82
24/07/2014	Winter	0	0	49
29/07/2014	Winter	0	0	55
17/12/2014	Summer	0	18	23
13/01/2015	Summer	0	13	5
9/04/2015	Autumn	0	0	71
21/05/2015	Autumn	0	0	46
19/08/2015	Winter	0	0	59
9/09/2015	Winter	0	0	60
21/12/2015	Summer	3	2	29
18/02/2016	Summer	0	3	59

No other threatened frog species listed under the EPBC Act have been recorded elsewhere within the study area.

Habitat for the Giant Burrowing Frog and Littlejohn's Tree Frog within the study area consists of small sections of upper tributaries. Detailed surveys undertaken have indicated that other than the tributary of Cataract River below CRUS2, other tributaries are unlikely to support these species, particularly given the survey effort undertaken. The Stuttering Frog is not known from localities with disturbed riparian vegetation or significant human impacts upstream, which may indicate that the species is highly sensitive to perturbations in the environment (Mahony, Knowles, & Pattinson 1997). Identified habitat in Cataract Creek shows was found to exhibit levels of pollution due to run-off from Mount Ousley Road, as well as high levels of iron flocculent from past mining. Although the habitat is suitable, these impacts result in sub-optimal conditions for the species.

4.3.4 Broad-headed Snake

Habitat assessments undertaken by Biosis (2009), EcoLogical (2009) and ERM (2013a) concluded that habitat for the Broad-headed Snake within the Wonga East area is limited. Although a few areas of potential habitat were identified, these areas were generally void of exfoliating sandstone that provide habitat for the species due to historic removal of bedrock. Those areas of habitat identified were monitored across two years (Biosis 2013), however surveys ceased in 2012 due to a lack of detection of the species (or prey species) and a lack of predicted impacts to these areas.

In general, the Wonga East area lacks extensive areas of north to northwest facing sandstone benching with exfoliating sandstone that provide important habitat for this species. Targeted surveys and habitat

assessments did not record the species in the study area. We conclude that although the Broad-headed Snake may occur in the study area, the study area does not support important habitat for this species.

4.3.5 Large-eared Pied Bat

Targeted Microchiropteran bat surveys undertaken during the initial assessment (ERM 2013b) did not record the Large-eared Pied Bat within the study area. The Large-eared Pied Bat was also not recorded during harp trapping by Biosis in 2015 (Biosis 2017).

Habitat assessment undertaken by Biosis identified that cliffs providing suitable roosting habitat for Large-eared Pied Bat are limited in extent within the study area, with suitable cliffs restricted to an area in the northern section of the study area, just north of Cataract Creek (Figure 7). No evidence of occupation of cliffs by Large-eared Pied Bat was observed during the habitat assessment.

4.3.6 Threatened fish

Targeted surveys by Cardno Ecology Lab (2009, 2010, 2012c, 2012b, 2012a) and Biosis (2013, 2014a, 2017, 2019a, 2019b) for threatened fish undertaken in the Wonga East area have confirmed the presence of Macquarie Perch and Silver Perch, and an unidentified freshwater cod, which was assumed to be either Murray Cod or Trout Cod, within the lower reaches of Cataract Creek (Cardno Ecology Lab 2010, 2012c).

The numbers of Macquarie Perch, Silver Perch and Murray Cod/Trout Cod recorded between 2009 and 2012 by Cardno Ecology Lab are presented in Table 5. Fish were captured in Cataract Creek between the confluence of Cataract Creek and the Cataract River, up to 120 metres upstream of the full supply level of Lake Cataract (Figure 7). Targeted surveys further upstream have not recorded Macquarie Perch or Silver Perch in these more upstream reaches.

Table 5 Numbers of threatened fish captured in Cataract Creek (2009 to 2012)

Species	2009/2010	2010/2011	2011/2012
Macquarie Perch	30	90	18
Murray Cod/Trout Cod	65	53	6
Silver Perch	9	9	0

Targeted surveys completed by Biosis as part of annual monitoring for threatened fish have also recorded the EPBC listed Macquarie Perch, Murray Cod and Silver Perch in the lower reaches of Cataract Creek, up to 120 metres upstream of the full supply level of Lake Cataract and reached within the Cataract River. Fish data collected by Biosis between 2014 and 2019 from Cataract Creek, including survey effort, is summarised in Table 6 and Table 7 below.

Table 6 Numbers of threatened fish captured in Cataract Creek (2013 to 2019)

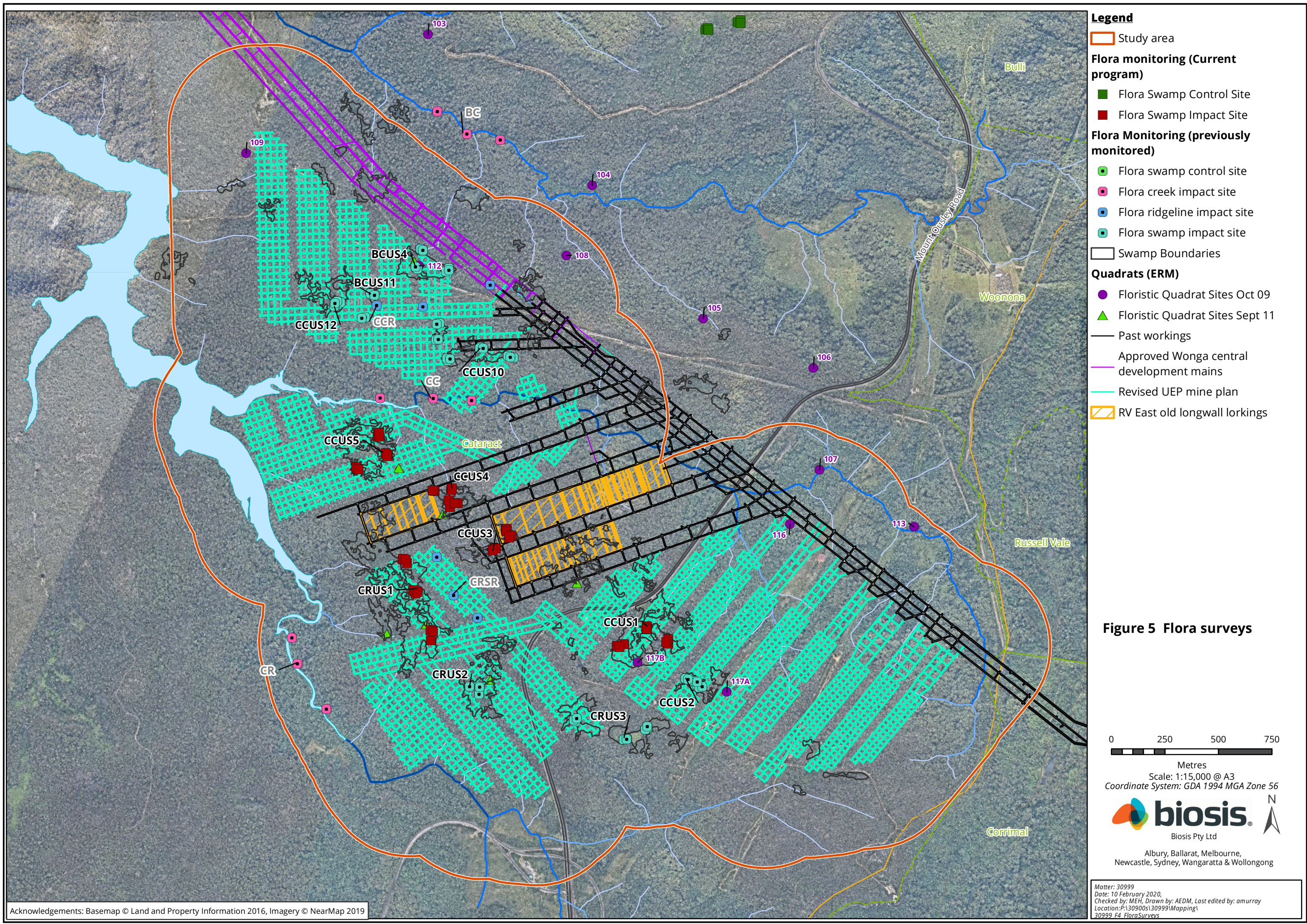
Date	Effort (seconds)	Silver Perch	Macquarie Perch	Murray Cod
		<i>Bidyanus bidyanus</i>	<i>Macquaria australasica</i>	<i>Maccullochella peeli</i>
22/02/2013	N/A	0	0	0
21/02/2013	N/A	0	4	7
18/07/2013	Fyke net*	0	0	1
15/04/2013	N/A	0	10	8
20/02/2013	N/A	0	0	1

Date	Effort (seconds)	Silver Perch	Macquarie Perch	Murray Cod
		<i>Bidyanus bidyanus</i>	<i>Macquaria australasica</i>	<i>Maccullochella peelii</i>
12/03/2014	1412	0	18	24
26/05/2014	745	0	0	0
10/06/2014	1,599	0	12	28
13/06/2014	1,006	0	3	16
14/03/2014	948	0	2	9
9/02/2015	1,300	0	3	7
12/02/2015	360 (boat)	4	39	15
13/02/2015	1,236	0	0	3
24/07/2019	2,407	5	0	2
3/09/2019	2,637	0	0	1

*3 fyke nets set over 5 hours at the confluence of Cataract Creek and the Cataract River

Table 7 Numbers of threatened fish captured in the Cataract River (2013 to 2019)

Date	Effort (seconds)	Silver Perch	Macquarie Perch	Murray Cod
		<i>Bidyanus bidyanus</i>	<i>Macquaria australasica</i>	<i>Maccullochella peelii</i>
22/03/2013	N/A	0	4	0
12/03/2014	1,029	0	5	8
14/03/2014	727	0	1	4
10/02/2016	475 (boat)	9	84	20
12/02/2016	780	1	1	1
24/07/2019	1,515	1	0	0
3/09/2019	1,756	0	1	1



Legend

Study area

Flora monitoring (Current program)

- Flora Swamp Control Site
- Flora Swamp Impact Site

Flora Monitoring (previously monitored)

- Flora swamp control site
- Flora creek impact site
- Flora ridgeline impact site
- Flora swamp impact site

Swamp Boundaries

Quadrats (ERM)

- Floristic Quadrat Sites Oct 09
- Floristic Quadrat Sites Sept 11

Past workings

Approved Wonga central development mains

Revised UEP mine plan

RV East old longwall workings

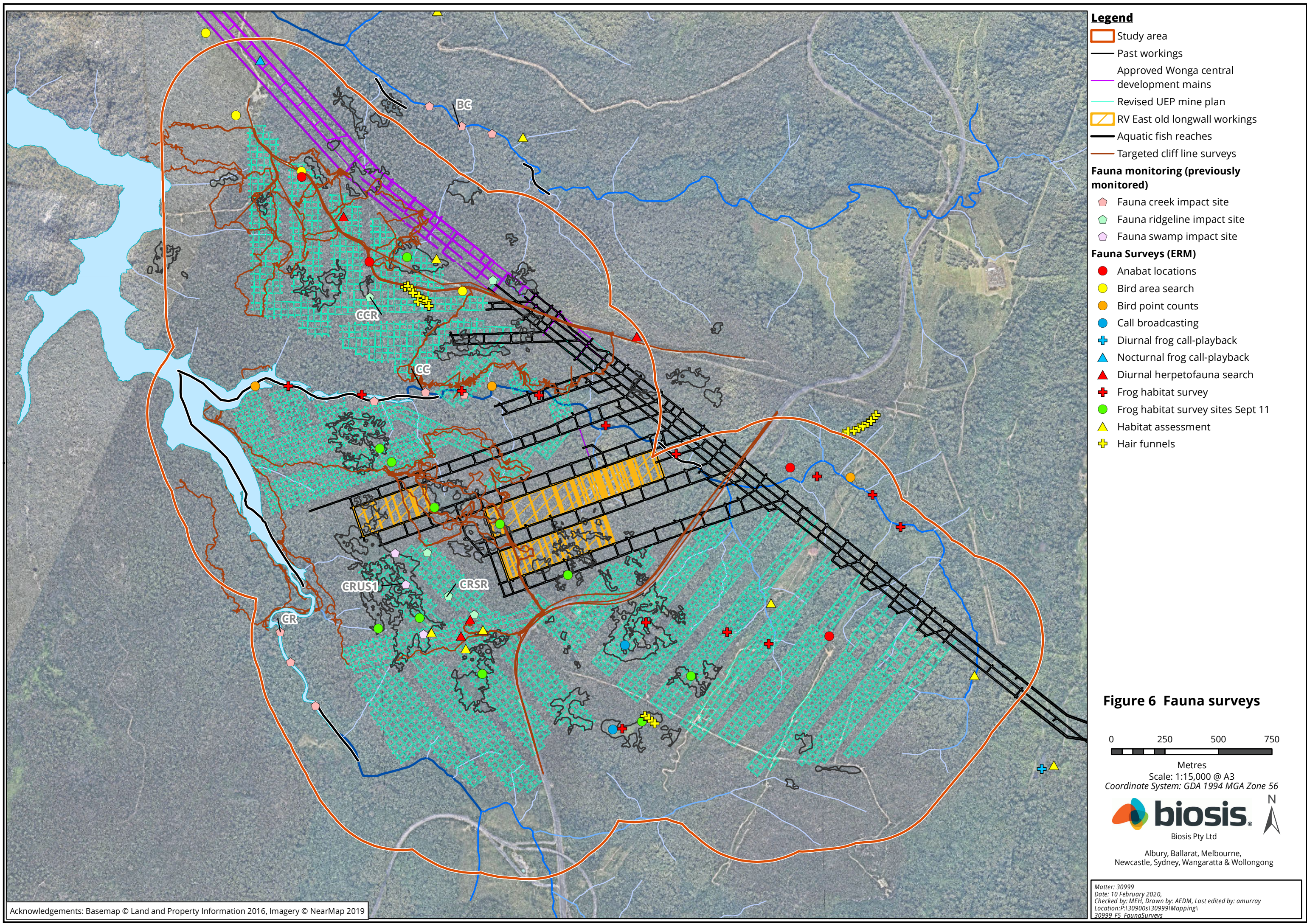
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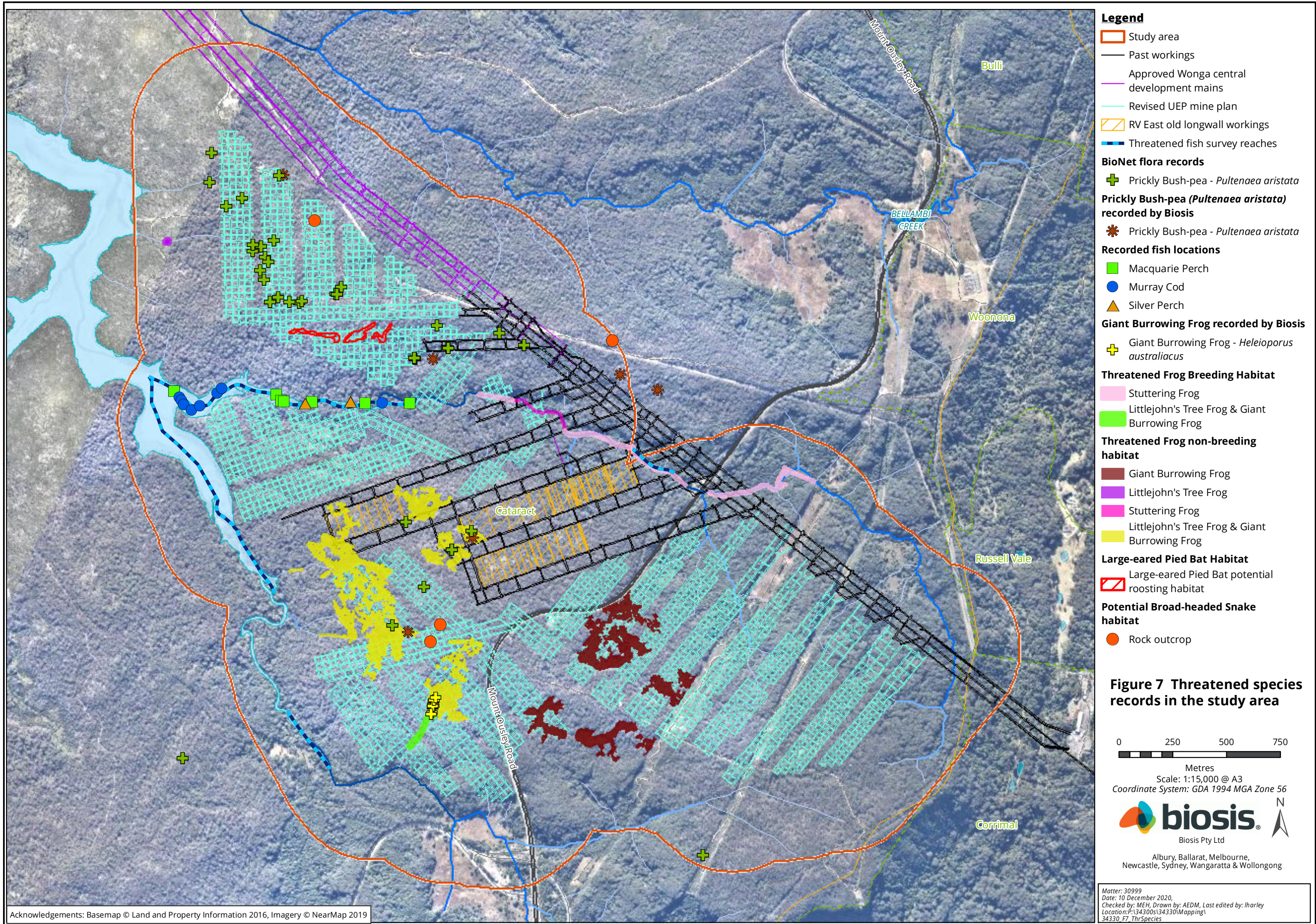
Scale: 1:15,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

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Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

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5 Impact assessment

This section includes an assessment of potential impacts from the Proposed Action on those threatened species and communities listed under the EPBC Act that are considered susceptible to subsidence impacts (as identified in Table 2 of Section 4.1.2). The assessment considers historic and cumulative impacts from past mining within and surrounding the study area in conjunction with impacts from the Proposed Action. .

Section 4.2 identified three sensitive habitats supporting threatened biota (including flora, fauna, and ecological communities) listed under the EPBC Act. The impacts to each of these sensitive habitats as a result of the Proposed Action are detailed below.

5.1 Coastal upland swamps

5.1.1 Coastal Upland Swamp in the Sydney Basin Bioregion

One EEC has been recorded within the study area that is considered susceptible to impacts from subsidence, *Coastal Upland Swamp in the Sydney Basin Bioregion*.

Tensile strains are a key subsidence effect that has potential to result in environmental consequences for coastal upland swamps. Tensile cracking can cause a loss of soil moisture that can result in a changes in species composition within swamps (IAPUM 2020).

The IAPUM conclude that the 100 millimetres of incremental vertical subsidence that has potential to occur as a result of the Proposed Action is expected to increase maximum tensile strain by around 0.5 millimetres/metre. As indicated by Table A1 (Appendix 1), swamps across the Study Area are predicted to have already experienced varying degrees of cumulative vertical subsidence and tensile strains from mining in the Bulli and Balgownie Seams, ranging from 0.4 millimetres/metre to 10.7 millimetres/metre (Appendix 1). 17 of the 33 swamps are estimated to have experienced more than 3 millimetres/metre tensile strain, and four swamps (CCUS1, CCUS6, CCUS20, and CCUS21) are estimated to have experienced more than 10 millimetres/metre of tensile strain. Given the existing low levels of tensile strain at the majority of swamps, IAPUM concluded that it is implausible that a 0.5 millimetres/metre increase in tensile strain will lead to a catastrophic loss of swamp (defined as the reduction in a swamp's capacity to retain its water table and soil moisture that is so severe as to cause swamp flora species to be replaced by species representative of dry heath of woodland) (IAPUM 2020) .

The IAPUM (2020) note however that the amount of additional vertical subsidence that can be tolerated by the four swamps (CCUS1, CCUS6, CCUS20, and CCUS21) that are estimated to have already experienced the highest tensile strains from historical mining is unknown. Therefore the proposed bord and pillar workings in the Wongawilli Seam beneath these areas needs to be designed judiciously and conservatively in order to restrict vertical subsidence (IAPUM, 2020).

The relevant performance measure for the Proposed Action in relation to coastal upland swamps under the UEP development consent is for negligible environmental consequences. On this basis, Wollongong Coal has committed to undertake swamp specific risk assessments for each of the four swamps that are predicted to have already experienced tensile strains in excess of 10mm/m as part of the NSW Extraction Plan process. Where an unacceptable risk is identified through the risk assessment process, additional mitigation measures will be utilised to avoid subsidence related impacts and maintain negligible environmental consequence from the Proposed Action for these swamps. This may include measures such as installation of additional roof supports or amendments to the mine plan or panel design to reduce the risk of vertical subsidence effects to these swamps.

With the implementation of a swamp specific risk assessment process for CCUS1, CCUS6, CCUS20, and CCUS21 and implementation of any additional mitigation measures identified, impacts to these four upland swamps (and the remaining upland swamps within the Study Area) from the Proposed Action are predicted to be negligible. The Proposed Action is therefore unlikely to have in a significant impact on *Coastal Upland Swamp in the Sydney Basin Bioregion*.

5.1.2 Prickly Bush-pea

One EPBC Act listed flora species, Prickly Bush-pea, is considered likely to occur in the study area and is considered susceptible to impacts from subsidence. Prickly Bush-pea is restricted to the Woronora Plateau, and has been recorded within the study area in open habitats, including upland swamps and adjacent woodland (Biosis 2014a). Despite this species' restricted distribution, it is known to be common and widely distributed in the study area (Biosis 2014a) (Figure 7). Amendments to the mining methodology in the current UEP proposal have addressed the issue of subsidence-related impacts. The first-workings mining method will not result in perceptible levels of subsidence and upland swamp habitat is considered at negligible risk of impact. In addition, the species grows in sandstone areas, on the edges of swamp habitats necessitating a shallow root depth which would be unaffected by changes in water table at depths greater than five metres. Prickly Bush-pea is therefore considered at negligible risk of impact. As such the Proposed Action is unlikely to result in a significant impact on the Prickly Bush-pea.

5.1.3 Threatened frogs

Targeted habitat assessment for threatened frogs identified potential breeding and non-breeding habitat for Littlejohn's Tree Frog, Giant Burrowing Frog and the Stuttering Frog (Figure 7).

Impacts to terrestrial ecosystems that provide non-breeding habitat for these threatened frogs are generally considered to be at negligible risk of impact from subsidence (DoP 2008, 2009, 2010). Thus, this assessment focuses on impacts to breeding habitat for these species.

The revised mine plan is not considered to have any perceptible surface subsidence (SCT 2019). The Proposed Action is therefore considered to have minimal potential to perceptibly impact on natural surface features, including upland swamps, creeks, and drainage lines which represent potential breeding habitat for threatened frogs. As a result it is unlikely that the Proposed Action will result in any significant impacts to EPBC Act listed threatened frogs likely to occur within the study area.

Given the following factors, no further survey/assessment required for Littlejohn's Tree Frog, Giant Burrowing Frog and the Stuttering Frog:

- Survey has been completed in excess of the guidelines – with no individuals recorded.
- Suitable habitat has been mapped but is not considered likely to be significantly impacted by the proposal.
- These areas of suitable structural habitat are likely subject to levels of disturbance and pollution that render it suboptimal for the species.

5.2 Aquatic environments

5.2.1 Threatened fish and frogs

Targeted surveys for threatened fish have recorded Macquarie Perch, Murray Cod and Silver Perch in the lower reaches of Cataract Creek, up to 120 metres upstream of the full supply level of Lake Cataract. Aquatic habitats within the study area also provide potential habitat for some threatened frog species (namely Littlejohn's Tree Frog, Giant Burrowing Frog and the Stuttering Frog).

The proposed bord and pillar workings mine plan is not predicted to have any perceptible surface subsidence, is not predicted to cause subsidence cracking in stream beds that would result in the loss of surface flows, and will not significantly impact baseflows of the drainage lines (SCT 2019, Geoterra/GES, 2020, HydroAlgorithms 2020). The Proposed Action is therefore considered to have minimal potential to perceptibly impact on natural surface features including small creeks and tributaries, Cataract Creek, and Cataract Reservoir.

Given this, the Proposed Action will not significantly impact this sensitive habitat, and is therefore not predicted to directly or indirectly impact the threatened fish or frog species that may utilise these habitats.

5.3 Rocky environments

As noted in Section 3, the Proposed Action is not considered to have any perceptible surface subsidence which may cause cliff failures and/or surface rock cracking due to changes in underlying bedrock, and is therefore unlikely to impact natural surface features including cliff and steep slope habitats potentially utilised by threatened species.

Therefore the Proposed Action will not significantly impact this sensitive habitat, and will therefore not directly or indirectly impact the threatened species that may utilise these habitats (as described below).

5.3.1 Broad-headed Snake

Habitat assessments concluded that habitat suitable for the species is limited in extent as the Wonga East area lacks extensive areas of north to northwest facing sandstone benching with exfoliating sandstone that provide important habitat for this species (see Section 4.3.4).

Targeted surveys undertaken as part of the ecological monitoring program did not record the species in the study area, therefore the limited available habitat not considered to be important for the survival of the species.

The revised mine plan is not considered to have any perceptible surface subsidence (SCT 2019). The Proposed Action is therefore considered to have minimal potential to perceptibly impact on natural surface features including cliff and steep slope habitats potentially utilised by Broad-headed Snake.

Given the limited extent of habitat, the species not being recorded within the study area, and the imperceptible subsidence expected from the Proposed Action we conclude that the species is unlikely to be significantly impacted by the Proposed Action.

5.3.2 Large-eared Pied Bat

Targeted surveys did not record the Large-eared Pied Bat within the study area (see Section 4.3.5), however subsequent habitat assessments of cliff lines did identify suitable roosting habitat for this species. These sites are limited in extent within the study area, with suitable cliffs restricted to an area north of Cataract Creek (Figure 7). No evidence of occupation of cliffs by Large-eared Pied Bat was observed during the habitat assessment.

The revised mine plan is not considered to have any perceptible surface subsidence (SCT 2019). The Proposed Action is therefore considered to have minimal potential to perceptibly impact on natural surface features including cliff habitats that represent potential roosting habitat for Large-eared Pied Bat.

Furthermore, given the limited extent of suitable roosting sites for Large-eared Pied Bat the risk of impact is considered low, particularly when compared with the availability of suitable habitat in the local area.

The species is considered unlikely to be significantly impacted by the Proposed Action.

6 Impact management

The Proposed Action will not result in any direct impacts to the ecological features identified in the study area. No direct removal of native vegetation or fauna habitat will be undertaken.

In addition, any potential indirect impacts to biodiversity have been avoided by careful mine planning (see Section 3), with the current mine plan unlikely to result in significant or detectable impacts to any threatened species or community listed under the EPBC Act. It should be noted that the bord and pillar mining method is flexible, can be adapted to different strata conditions and be revised to mitigate or avoid potential surface impacts in response to ongoing hazard assessments and monitoring of strata conditions.

As a precautionary measure, Wollongong Coal will undertake swamp specific risk assessment for the four swamps (CCUS1, CCUS6, CCUS20 and CCUS21) that are predicted to have already been subject to estimated cumulative tensile strains in excess of 10mm/m as part of the NSW Extraction Plan process. The risk assessment will be informed by subsidence monitoring data collated during mining of the Proposed Action, with mining to commence in panels well removed from this group of swamps. Where an unacceptable risk to the ecological functioning of the swamp is identified through the risk assessment process, additional mitigation measures will be utilised to reduce the level of risk to an acceptable level. This may include measures such as installation of additional roof supports or amendments to the mine plan or panel design to reduce the risk of additional subsidence effects to these swamps.

Impacts to biodiversity values within the study area are currently managed and monitored in accordance with the Biodiversity Management Plan (WCL 2015a) and Upland Swamp Management Plan (WCL 2015b). These management plans were developed to manage and monitor impacts arising from longwall mining of Longwalls 4, 5 and 6. Wollongong Coal is currently preparing an updated Biodiversity Management Plan and Upland Swamp Monitoring Program in accordance with the UEP NSW Development Consent.

The monitoring design focusses on upland swamps and ecological values that have been identified to be most at risk of cumulative impacts due to extraction (swamps CCUS1, CCUS6, CCUS20 and CCUS21).. All of these swamps are located over Area 6 which is one of the Bulli Seam goaf areas confirmed as having been fully collapsed (SCT 2020a). This monitoring is in line with the impact management recommendations detailed in the *Russell Vale Colliery – Underground Expansion Project: Updated Ecological Impact Assessment* (Biosis 2019a). On this basis, the following monitoring is recommended:

- It is intended that the up to date baseline monitoring will follow the same methodology:
 - Upland swamps considered to be most at risk (CCUS1, CCUS6, CCUS20 and CCUS21); one year prior to extraction, during extraction, and one year post extraction. Monitoring surveys are conducted once in spring and once in autumn.
 - Collection of baseline data at higher value upland swamps proposed to be undermined (BCUS4, CCUS2, CCUS5, CCUS10, CCUS12, CRUS1, CRUS2 and CRUS3); One year prior to extraction. Previous ecological monitoring data has previously been collected at each of these sites which will also assist in the understanding of baseline conditions.
- Relevant control sites will also be monitored during these periods of baseline data collection to assist in distinguishing any effects of environmental conditions from historic mining in the baseline data (ACUS, BCUS12, BCUS13, WACUS, WCUS, S22, S33 and S15A).
- Baseline analysis of swamp extents using LiDAR analyses is recommended prior to UEP extraction for all swamps in the Wonga East area. It is intended that the LiDAR analyses of swamp extents be

undertaken once, prior to UEP extraction occurring. This will provide an accurate and up to date basis for analysis of change over time if any impacts associated with UEP extraction are identified and follow up monitoring is required.

- The detection of changes to soil moisture, shallow groundwater or swamp vegetation as a result of UEP extraction at any upland swamp would trigger the need for additional ecological assessment and monitoring. It is intended that, if triggered, swamp vegetation transect, Giant Dragonfly and observational monitoring will continue (as applicable) for a suitable duration to be determined in consultation with DAWE, the NSW Department of Planning Industry and Environment Biodiversity Conservation Division and any other relevant Authorities.
- Visual inspection of the rock formation that forms the base of upland swamps CCUS1, CCUS4, CCUS5, CCUS6, CCUS10, CCUS20, CCUS21, BCUS4 and BCUS6 also be undertaken during routine monitoring.
- Monitoring of surface water levels and water quality in Cataract Creek and tributaries using the network of existing sites.
- Biodiversity monitoring is to continue in surface areas within the vicinity of the Proposed Action in accordance with (WCL 2018). This will ensure that in the unlikely event that subsidence impacts do impact on threatened species or communities under the EPBC Act, those impacts can be quantified and further management actions prescribed.
- Aquatic monitoring using AusRivas methodology (Turak, Johnstone, & Waddell 2004) is to be undertaken at Cataract Creek one year prior to extraction, during extraction, and one year post extraction. Additional monitoring may be required if trigger thresholds are exceeded.

7 Conclusion

This report provides an outline of biodiversity values associated with the Proposed Action. The report takes the following hierarchical approach to impact assessment:

- Identification of threatened species and communities listed under the EPBC Act with potential to occur within the study area that are susceptible to subsidence impacts. Particular attention has been made to sensitive water-dependent ecosystems that are susceptible to subsidence impacts.
- Outlining surveys that have been undertaken for those species within the study area.
- Outlining potential impacts and assessing the likelihood of those impacts.

In summary, the following species were considered likely to occur within the Wonga East area, and were considered susceptible to impacts due to their reliance on certain habitats for various lifecycle stages, and the susceptibility of these habitats to impacts from subsidence:

- Prickly Bush-pea.
- Threatened frogs, including Littlejohn's Tree Frog, Giant Burrowing Frog and Stuttering Frog.
- Broad-headed Snake.
- Large-eared Pied Bat.
- Threatened fish, including Macquarie Perch, Silver Perch and Murray Cod/Trout Cod.
- Coastal Upland Swamps in the Sydney Basin Bioregion TEC.

Subsidence advice from the IAPUM (2020) has indicated that apart from four swamps that are predicted to have already experienced high levels of tensile strain (i.e. CCUS1, CCUS6, CCUS20, and CCUS21), a significant impact from the Proposed Action to sensitive swamp habitats seems “implausible”. For the remaining four swamps, Wollongong Coal has committed to a precautionary swamp-specific risk assessment process to identify any additional mitigation measures necessary to avoid subsidence related impacts and maintain negligible environmental consequence from the Proposed Action for these swamps. Greater than negligible environmental consequences to swamps are therefore not expected as a result of the Proposed Action.

Due to the lack of subsidence impacts and associated impacts to surface water and groundwater regimes, and based on the completed habitat assessment and targeted surveys, the following conclusions are made for these candidate species:

- The Prickly Bush-pea is widely distributed throughout the Wonga East area, with critical habitat component being areas where low gradient slopes result in impediment of surface water run-off. Impacts to this habitat are unlikely to result from the Proposed Action.
- No threatened frog species habitat is likely to be subject to subsidence, or associated impacts. Impacts to these threatened frog species are therefore unlikely to result from the Proposed Action;
- Habitat for the Broad-headed Snake in the Wonga East area is limited in extent. Targeted surveys did not record this species. Subsidence is expected to be imperceptible and therefore impacts to habitat potentially utilised by this species is negligible. For these reasons the Proposed Action is considered unlikely to impact Broad-headed Snake.
- The Large-eared Pied Bat was not recorded within the study area. Although cliffs located north of Cataract Creek provide potential roosting habitat for this species, subsidence is expected to be imperceptible and therefore impacts to these cliff habitats will be negligible. Given the lack of impact

to potential roosting habitat, and the extent of more suitable habitat in the locality, the Proposed Action is considered unlikely to impact this species.

- Three threatened fish species (Macquarie Perch, Silver Perch and Murray Cod/Trout Cod) have been recorded in Cataract Creek. As the proposed workings will result in imperceptible subsidence, there will be no perceptible impacts to small creek and streams, Cataract Creek, or Cataract Reservoir. The Proposed Action is therefore considered unlikely to impact habitat for these species.

The Proposed Action presents a low risk of impacts to threatened species and communities known or predicted to occur in habitats sensitive to subsidence.

Biosis concludes that the Proposed Action will not result in a significant impact to threatened species and communities listed under the EPBC Act.

References

- B K Hebblewhite Consulting 2019. *Peer Review - Russell Vale Colliery Subsidence Assessment (SCT Report UMW4609, 10 July 2019)*, Report prepared for Wollongong Coal Ltd. B K Hebblewhite Consulting, Balgowlah NSW. Report no. 1907/01.1.
- Biosis 2009. *NRE Gujarat Targeted Herpetological Surveys*, Report prepared for ERM Australia. Authors: Charlton. J, Biosis Research Pty Ltd, Melbourne, VIC. Project no. s2365.
- Biosis 2012. *NRE No. 1 Colliery Major Expansion: Upland Swamp Impact Assessment*, Report prepared for Gujarat NRE Coking Coal Ltd. Authors: Garvey. N, Biosis Research Pty Ltd, Wollongong, NSW. Project no. 10594.
- Biosis 2013. *Wonga East and V-Mains Ecological Monitoring Program. Autumn 2011 through to autumn 2013*, Report prepared for Gujarat NRE Coking Coal Ltd. Authors: Reed. K, Biosis Research Pty Ltd, Wollongong, NSW. Project no. 14511 and 16015.
- Biosis 2014a. *Russell Vale Colliery – Underground Expansion Project: Preferred Project Report - Biodiversity*, Report prepared for Wollongong Coal Ltd. Authors: Garvey. N, Beyer. K, Biosis Pty Ltd, Wollongong, NSW. Project no. 16646.
- Biosis 2014b. *Underground Expansion Project EPBC Referral (EPBC2014/7268): Coastal Upland Swamp Impact Assessment Report*, Report prepared for Wollongong Coal Ltd. Authors: Garvey. N, Biosis Pty Ltd, Wollongong, NSW. Project no. 14860.
- Biosis 2017. *Russell Vale East terrestrial ecological monitoring program annual report 2015*, Report for Wollongong Coal Limited. Authors: Reed K & Dunne C, Biosis Pty Ltd, Wollongong, New South Wales. Project no. 20492.
- Biosis 2019a. *Russell Vale Colliery – Underground Expansion Project: Updated Ecological Impact Assessment*, Report for Umwelt. Authors: B. Klein & N. Garvey, Biosis Pty Ltd. 24737.
- Biosis 2019b. *Russell Vale East - Terrestrial ecological monitoring program: Annual report 2017*, Report for Wollongong Coal Limited. Authors: McCann, S, Stone, L, Cable, T. Biosis Pty Ltd, Wollongong, New South Wales. Project no. 26657.
- Biosis 2020. *Russell Vale East Terrestrial Ecological Monitoring Program 2019*, Report for Wollongong Coal Limited. Author: Stone, L. Biosis Pty Ltd, Wollongong, New South Wales. Project no. 29636.
- BOM 2018. *Summary statistics Albion Park (Shellharbour Airport), Climate statistics for Australian locations, Bureau of Meteorology*, accessed 7 November 2018, http://www.bom.gov.au/climate/averages/tables/cw_068241.shtml.
- Cardno Ecology Lab 2009. *NRE No 1mine V Mains Area: Effects of Mine Subsidence on Aquatic Habitats and Biota*, Report prepared for ERM Australia Pty Ltd.
- Cardno Ecology Lab 2010. *Aquatic Ecology Monitoring for Gujarat No 1mine 2009-2010*, Report for Gujarat NRE Coking Coal Limited.

- Cardno Ecology Lab 2012a. *NRE No 1mine: Assessment of Subsidence Impacts on Aquatic Habitat and Biota*, Report for Gujarat NRE Coking Coal Limited. November 2012.
- Cardno Ecology Lab 2012b. *NRE No 1mine - Aquatic Ecology Monitoring Autumn 2012 Data Report*, Report for Gujarat NRE Coking Coal Limited.
- Cardno Ecology Lab 2012c. *NRE No 1mine: Aquatic Ecology Monitoring 2011-2012*, Report for Gujarat NRE Coking Coal Limited.
- DECC 2007. Submission of the strategic review of the impacts of underground mining in the Southern Coalfield, NSW Department of Environment and Climate Change.
- DoE 2013. Matters of National Environmental Significance, Significant Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999, accessed 19 May 2019, Australian Government Department of the Environment. Canberra, Australian Capital Territory.
- DoP 2008. Impacts of underground coal mining on natural features in the Southern Coalfield: Strategic review, State of NSW through the NSW Department of Planning.
- DoP 2009. The Metropolitan coal project review report, State of NSW through the NSW Planning and Assessment Commission.
- DoP 2010. The PAC review of the Bulli Seam Operations Project, State of NSW through the NSW Planning and Assessment Commission.
- DPIE 2010. Southeast NSW Native Vegetation and Mapping - SCIVL. VIS_ID 2230, State Government of NSW Department of Planning, Industry & Environment.
- DPIE 2016. Illawarra Plant Community Type Vegetation Map VIS_ID 4678, State Government of NSW Department of Planning, Industry & Environment.
- EcoLogical 2009. *Wonga East and Wonga West: Threatened fauna habitat assessment*, Report for ERM Australia.
- ERM 2013a. *NRE No. 1 Colliery Stage 2 Terrestrial Flora and Fauna Assessment*, Report to Gujarat NRE Coking Coal Ltd. ERM Australia Pty Ltd.
- ERM 2013b. *NRE No. 1 Colliery Project Application (09-0013) Environmental Assessment*, Report to Gujarat NRE Coking Coal Ltd. ERM Australia Pty Ltd.
- Hansen Bailey 2015. *Russell Vale Colliery Underground Expansion Project. Response to the Planning Assessment Commission Review Report – Part 2*, Report prepared by Hansen Bailey for Wollongong Coal.
- IAPUM 2020. *Advice Re: Russell Vale underground expansion project*, Report prepared by Independent Advisory Panel for Underground Mining.
- Mahony M, Knowles R, & Pattinson L 1997. Stuttering Barred Frog, *Mixophyes balbus*. In *Threatened Frogs of New South Wales: Habitats, Status and Conservation* pp 66-71. Ed H Ehmann.
- NPWS 2003. Native vegetation of the Woronora, O'Hares and Metropolitan catchments, New South Wales National Parks and Wildlife Service.
- OEH 2012. Risk assessment guidelines for groundwater dependent ecosystems: volume 1.

- PAC 2009. The Metropolitan coal project review report, State of NSW through the NSW Planning and Assessment Commission.
- PAC 2010. The PAC review of the Bulli Seam Operations Project, State of NSW through the NSW Planning and Assessment Commission.
- RBGDT 2020. *PlantNET - The Plant Information Network System of the Royal Botanic Gardens and Domain Trust (Version 2)*, New South Wales Office of Environment and Heritage, Sydney, NSW.
<http://plantnet.rbgsyd.nsw.gov.au>.
- SCT 2019. *Russell Vale Colliery: Subsidence Assessment for Proposed Workings in Wongawilli Seam at Russell Vale East*, SCT report number: UMW4609. SCT Operations Pty Ltd, Wollongong.
- SCT 2020a. IESC 2019-108: Quantitative Assessment of Risk of Pillar Failure in Russell Vale East Area.
- SCT 2020b. *Peer review of SCT reponse to IAPUM Advice*, Report prepared by BK Hebblewhite Consulting. Hebblewhite, B, Sydney, NSW.
- SCT Operations 2012. *Assessment of Mining Impacts on Cliffs and Steep Slopes for NRE No. 1 Colliery Underground Expansion Project (MP 09_0013)*, Report prepared for Gujarat NRE Coking Coal Ltd.
- Turak T, Johnstone G, & Waddell N 2004. New South Wales (NSW) AUSRIVAS Sampling and Processing Manual 2004., <http://AUSRIVAS.canberra.edu.au/man/NSW/>.
- WaterNSW & OEH 2015. Special Areas Strategic Plan of Management 2015, WaterNSW and Office of Environment and Heritage.
- WCL 2015a. Russell Vale Colliery. Russell Vale East – Longwalls 6 & 7 Biodiversity Management Plan Rev06, Wollongong Coal Ltd, Russell Vale.
- WCL 2015b. Russell Vale Colliery. Russell Vale East – Longwalls 6 & 7 Upland Swamp Management Plan Rev06, Wollongong Coal Ltd, Russell Vale.
- WCL 2018. Russell Vale Colliery Biodiversity Management Plan Rev017, Wollongong Coal Ltd, Russell Vale.

Appendices

Appendix 1 Existing swamp impacts

Table A.1 Summary of existing impacts on swamps – Balgownie and Bulli seam working

Table E.1.1 Summary of Existing Impacts on Swamps – Balgownie and Bulli Seam Working

Swamp	Bulli Seam Goaf Area	Potential for Standing Pillars Under Swamp	Located over Proposed First Workings	Max Predicted Vertical Subsidence – Bulli and Balgownie Seams (m)	Estimated Max Tensile Strain - (mm/m)
CCUS1	Area 6	No	Yes	2	10.5
CCUS2	Edge Area 7	No	Yes	1.1	5.8
CCUS3	Edge Area 3	No	No	1.1	5.5
CCUS4	N/A	No	No	0.9	4.7
CCUS5	Pt Area 2	No	Yes	0.6	3.3
CCUS6	Area 6	No	No	2.0	10.5
CCUS7	Nth of Mains	Yes	No	1.0	5.6
CCUS8	N/A	No	No	0.1	0.6
CCUS9	N/A	No	Yes*	0.1	0.5
CCUS10	Pt Area 10	No	Yes	0.6	3.2
CCUS11	Area 10	Yes	Yes	1.0	4.4
CCUS12	Part Area 10	Yes	Yes	0.5	2.1
CCUS13	Area 8	Yes	Yes	0.1	0.4
CCUS14	Area 14	Yes	Edge	1.2	6.5
CCUS15	N/A	No	Yes	0.2	0.9
CCUS16	N/A	N/A	No	0.5	2.5
CCUS17	N/A	No	Yes	0.1	0.5
CCUS18	N/A	No	Edge	0.1	0.5
CCUS19	N/A	No	No	0.1	0.5
CCUS20	Area 6	No	Yes	2.0	10.3
CCUS21	Area 6	No	No	2.0	10.7
CCUS22	Pt area 8	Yes	No	0.5	2.4
CCUS23	N/A	No	No	0.9	4.4
CCUS24	Edge Area 10	Yes	Yes	0.3	1.30
CRUS1	Pt Area 5	No	Part	0.5	2.5
	Edge Area 12	Yes	Yes		
CRUS2	Pt Area 12	Yes	Yes	0.6	4.3
CRUS3	Pt Area 13	Yes	Yes	0.6	3.1
CRUS6	Edge 9	Yes	Yes	0.1	0.40
CRUS7	Area 8	Yes	Yes	0.3	1.3
BCUS1	Nth of Mains	Yes	No	1	5.6
BCUS2	Nth of Mains	No	Yes*	0.5	2.6
BCUS3	Nth of Mains	No	Yes [#]	0.5	2.8
BCUS4	Area 10	Yes	Yes	0.6	3.1
BCUS5	Nth of Mains	Yes	No	0.5	2.7

Swamp	Bulli Seam Goaf Area	Potential for Standing Pillars Under Swamp	Located over Proposed First Workings	Max Predicted Vertical Subsidence – Bulli and Balgownie Seams (m)	Estimated Max Tensile Strain - (mm/m)
BCUS6	Nth of Mains	No	Yes [#]	0.1	0.5
BCUS7	Edge Area 8	No	Edge	0.1	0.5
BCUS8	Nth of Mains	No	Yes [#]	0.1	0.5
BCUS11	Area 10	Yes	Edge	0.5	2.2
BCUS14	Nth of Mains	No	Yes [#]	0.2	1.0

* Headings only

[#] Mains Headings Only

Appendix 2 Flora

Threatened flora species and ecological communities

The following table includes a list of the threatened flora species that have potential to occur within the study area. The list is based on database searches outlined in Section 4.1.

Notes to tables:

Conservation status – EPBC Act:

CR – Critically Endangered

EN – Endangered

VU – Vulnerable

Most recent record

species predicted to occur by the PMST (not recorded on other databases).

species predicted to occur based on natural distributional range and suitable habitat despite lack of records in the databases searched.

Table A.2 Threatened ecological communities recorded / predicted to occur within 10 kilometres of the study area

Scientific name	EPBC Act Status	Does the community occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community</i>	EN	No Restricted to coastal floodplains. Not recorded within study area.
<i>Coastal Upland Swamp in the Sydney Basin Bioregion</i>	EN	Yes Community occurs within the study area and is susceptible to subsidence.
<i>Illawarra and south coast lowland forest and woodland ecological community</i>	CE	No Not recorded within study area.
<i>Illawarra-Shoalhaven Subtropical Rainforest of the Sydney Basin Bioregion</i>	CE	No Not recorded within study area.
<i>Littoral Rainforest and Coastal Vine Thickets of Eastern Australia</i>	CE	No Restricted to within 2 km of the coast or adjacent to a large salt water body. Suitable habitat not present within study area.
<i>Shale Sandstone Transition Forest of the Sydney Basin Bioregion</i>	CE	No Occurs at ecotone between clay soils from the shale rock and earthy and sandy soils from sandstone, or where shale caps overlay sandstone. Suitable habitat not present within study area.
<i>Subtropical and Temperate Coastal Saltmarsh Vulnerable Community likely to occur within area</i>	VU	No Restricted to coastal areas under regular or intermittent tidal influence. Suitable habitat not present within study area.
<i>Turpentine-Ironbark Forest of the Sydney Basin Bioregion</i>	CE	No Restricted to Cumberland lowlands. Not recorded within study area.
<i>Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion</i>	EN	No Found on basalt and basalt-like substrates. Suitable habitat not present within the study area.

Table A.3 Threatened flora species recorded / predicted to occur within 10 kilometres of the study area

Scientific name	Common name	EPBC Act status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Acacia bynoeana</i>	Bynoe's Wattle	VU	2017	1	9,576	No Species commonly found in sandstone and gravel based soils, occasionally on rock platforms. Potential habitat is present. Not recorded within the study area. Species occurs in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Allocasuarina glareicola</i>		EN	#	-	-	No Grows on tertiary alluvial gravels, with yellow clayey subsoil and lateritic soil. Suitable habitat not present.
<i>Caladenia tessellata</i>	Thick Lip Spider Orchid	VU	#	-	-	No Perennial terrestrial orchid found in grassy Sclerophyll woodland on clay loam or sandy soils. Suitable habitat not present.
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	VU	#	-	-	No Not known from Woronora plateau.
<i>Cynanchum elegans</i>	White-flowered Wax Plant	EN	2017	11	1,939	No Known from ecotone between dry rainforest and grassy woodland communities on coastal plain. Suitable habitat not present.
<i>Genoplesium baueri</i>	Bauer's Midge Orchid	EN	#	-	-	No Grows in dry sclerophyll forest and moss gardens over sandstone. Potential habitat is present. Not recorded within the study area. Species occurs in a range of terrestrial environments with negligible risk of impact from subsidence.

Scientific name	Common name	EPBC Act status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	VU	#	-	-	No Occurs in sandy or light clay soils, usually over thin shales, in a wide range of vegetation types. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Haloragis exalata</i> subsp. <i>exalata</i>	Square Raspwort	VU	#	-	-	No Requires protected and shaded damp situations in riparian habitats. Outside known distribution.
<i>Leucopogon exolasius</i>	Woronora Beard-heath	VU	2019	8	8,419	No Occurs in a wide range of habitat types, including woodland, rocky hillsides and creeks. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Melaleuca biconvexa</i>	Biconvex Paperbark	VU	#	-	-	No Occurs in damp places, often near streams and rivers or low-lying areas on alluvial soils of low slopes or sheltered aspects. Suitable habitat not present.
<i>Melaleuca deanei</i>	Deane's Melaleuca	VU	#	-	-	No Occurs in heath communities on sand, and has been recorded from ridgetops, dry ridges and slopes. Strongly associated with sandy loam soils low in nutrient. Potential habitat is present. Not recorded within the study area. Species is not considered to be reliant on microhabitats that are at risk of impact due to subsidence

Scientific name	Common name	EPBC Act status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Persoonia acerosa</i>	Needle Geebung	VU	2007	1	6,082	No Grows in heath, scrubby low-woodland or dry sclerophyll forest. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Persoonia hirsuta</i>	Hairy Geebung	EN	2009#	6	1,689	No Occurs in dry sclerophyll forest and woodland with a shrubby understory. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Persoonia nutans</i>	Nodding Geebung	EN	#	-	-	No Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Pomaderris brunnea</i>	Brown Pomaderris	VU	1957	2	9,771	No Occurs in open forest often on sandstone, clay and alluvial soils of floodplains and creek lines. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Pterostylis gibbosa</i>	Illawarra Greenhood	EN	#	-	-	No Occurs on soils derived from Permian sedimentary rocks of the Berry formation at an altitude of 10 to 20m. Outside known altitudinal range.

Scientific name	Common name	EPBC Act status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Pterostylis saxicola</i>	Sydney Plains Greenhood	EN	#	-	-	No Grows in heathy forest, sclerophyll forest or woodland in shallow sandy soil over flat sheets of sandstone rock shelves or boulders at altitudes of 10 to 60m. Outside known altitudinal range.
<i>Pultenaea aristata</i>	Prickly Bush-pea	VU	2017#	130	Species is present within study area	Yes Occurs in open habitats, including upland swamps and adjacent woodland, where drainage is impeded. Previously located within study area. Fracturing of bedrock may result in changes in hydrology and result in impacts to the species.
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	VU	2014#	2	8,233	No Found in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Thelymitra kangaloonica</i>	Kangaloon Sun Orchid	CR	#	-	-	No Endemic to the Fitzroy Falls / Robertson / Kangaloon area occurring in swampy sedgeland. Outside known distribution. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
<i>Thesium australe</i>	Austral Toadflax	VU	#	-	-	No Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.

Appendix 3 Fauna

Threatened fauna species

The following table includes a list of the threatened fauna species that have potential to occur within the study area. The list is based on database searches outlined in Section 4.1.

Notes to tables:

Conservation status – EPBC Act:

CR – Critically Endangered

EN – Endangered

VU – Vulnerable

Most recent record

species predicted to occur by the PMST (not recorded on other databases).

species predicted to occur based on natural distributional range and suitable habitat despite lack of records in the databases searched.

Table A.4 Threatened fauna species recorded, or predicted to occur, within 10 kilometres of the study area

Scientific name	Common name	EPBC Act Status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Birds						
<i>Anthochaera phrygia</i>	Regent Honeyeater	CR	1995	1	2,994	No Potential foraging habitat present in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Botaurus poiciloptilus</i>	Australasian Bittern	EN	2001	3	2,119	No Found in terrestrial freshwater wetlands and, rarely, estuarine habitats. Suitable habitat not present.
<i>Calidris canutus</i>	Red Knot	EN	#	-	-	No Occurs in marine environment.
<i>Calidris ferruginea</i>	Curlew Sandpiper	CR	#	-	-	No Found in terrestrial freshwater wetlands and, estuarine habitats. Suitable habitat not present.
<i>Calidris tenuirostris</i>	Great Knot	CR	1999	1	4,970	No Occurs in marine environment.
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	EN	2018	55	Species is recorded within study area	No Potential habitat is present. Not recorded within the study area.
<i>Diomedea exulans</i>	Wandering Albatross	EN	2010	57	5,078	No Occurs in marine environment.
<i>Diomedea gibsoni</i>	Gibson's Albatross	VU	1979	1	9,488	No Occurs in marine environment.

Scientific name	Common name	EPBC Act Status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Grantiella picta</i>	Painted Honeyeater	VU	1991	1	7,662	No Potential foraging habitat in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Lathamus discolor</i>	Swift Parrot	CR	2018	19	1,660	No Potential foraging habitat in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Macronectes giganteus</i>	Southern Giant Petrel	EN	2009	12	4,987	No Occurs in marine environment.
<i>Macronectes halli</i>	Northern Giant-Petrel	VU	2009	2	9,003	No Occurs in marine environment.
<i>Neophema chrysogaster</i>	Orange-bellied Parrot	CR	#	-	-	No Potential foraging habitat in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Numenius madagascariensis</i>	Eastern Curlew	CR	#	-	-	No Found in terrestrial freshwater wetlands and estuarine habitats. Suitable habitat not present.
<i>Phoebastria fusca</i>	Sooty Albatross	VU	1975	1	4,400	No Occurs in marine environment.

Scientific name	Common name	EPBC Act Status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Polytelis anthopeplus monarchoides</i>	Regent Parrot (eastern subspecies)	VU	1990	1	3,447	No Potential foraging habitat in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Pterodroma leucoptera leucoptera</i>	Gould's Petrel	EN	1985	1	8,876	No Occurs in marine environment.
<i>Rostratula australis</i>	Australian Painted Snipe	EN	#	-	-	No Found in terrestrial freshwater wetlands and estuarine habitats. Suitable habitat not present.
<i>Thalassarche bulleri</i>	Buller's Albatross	VU	2009	2	5,981	No Occurs in marine environment.
<i>Thalassarche cauta</i>	Shy Albatross	VU	2013	4	7,697	No Occurs in marine environment.
<i>Thalassarche impavida</i>	Campbell Albatross	VU	1998	2	3,574	No Occurs in marine environment.
<i>Thalassarche melanophris</i>	Black-browed Albatross	VU	2013	11	4,507	No Occurs in marine environment.
<i>Thalassarche salvini</i>	Salvin's Albatross	VU	1960	1	5,078	No Occurs in marine environment.
<i>Thinornis rubricollis</i>	Hooded Plover	VU	2012	3	3,534	No Occurs in marine environment.

Scientific name	Common name	EPBC Act Status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Mammals						
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	VU	#	-	-	Yes Species may roost in caves and overhangs in study area. Potential habitat is present in the study area. Species not recorded. Subsidence may result in collapse of cliffs that provide potential roosting habitat for this species.
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	EN	2019	7	769	No Species habitat present in the study area. Potential habitat is present in the study area. Species not recorded. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Eubalaena australis</i>	Southern Right Whale	EN	1998	1	5,416	No Occurs in marine environment.
<i>Isoodon obesulus obesulus</i>	Southern Brown Bandicoot (eastern)	EN	2009	2	8,861	No Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Petauroides volans</i>	Greater Glider	VU	2017	60	37	No Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	VU	#	-	-	No Thought to be locally extinct in Southern Coalfield (DECC 2007).

Scientific name	Common name	EPBC Act Status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Phascolarctos cinereus</i>		VU	2018	33	807	No Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	VU	#	-	-	No Potential habitat is present in the study area. Species not recorded. Not reliant on sensitive environments susceptible to impact from subsidence.
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	VU	2019#	302	Species is recorded within study area	No Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Reptiles						
<i>Caretta caretta</i>	Loggerhead Turtle	EN	2010	1	4,432	No Occurs in marine environment.
<i>Chelonia mydas</i>	Green Turtle	VU	2009	4	3,940	No Occurs in marine environment.
<i>Eretmochelys imbricata</i>	Hawksbill Turtle	VU	2002	1	5,385	No Occurs in marine environment.
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	VU	2019	47	1,192	Yes Potential habitat is present in the study area. Subsidence may result in fracturing of rocky outcrops providing habitat for this species.

Scientific name	Common name	EPBC Act Status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Frogs						
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	VU	2016	47	Species is recorded within study area	Yes Known to inhabit ephemeral and intermittent streams in the locality. Subsidence can result in impacts to breeding habitat for this species through draining of pools.
<i>Litoria aurea</i>	Green and Golden Bell Frog	VU	2016	47	580	No Inhabits still, shallow water bodies. Restricted to several key known populations. No populations exist within the study area.
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog	VU	2018	488	1,270	Yes Known to inhabit ephemeral and intermittent streams in the locality. Potential habitat is present in the study area. Subsidence can result in impacts to breeding habitat for this species through draining of pools.
<i>Mixophyes balbus</i>	Stuttering Frog	VU	#	-	-	Yes Known to inhabit streams in the locality. Species rare in locality. Potential habitat is present in the study area. Subsidence can result in impacts to breeding habitat for this species through draining of pools.
Fish						
<i>Bidyanus bidyanus</i>	Silver Perch	CE	#	-	-	Yes Inhabits freshwater streams. Potential habitat is present. Species may have been recorded previously. Subsidence may result in impacts to aquatic environments.

Scientific name	Common name	EPBC Act Status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
<i>Epinephelus daemeli</i>	Black Rockcod	VU	#	-	-	No Occurs in marine environment.
<i>Maccullochella macquariensis</i>	Trout Cod	EN	#	-	-	Yes Inhabits freshwater streams. Potential habitat is present. Species may have been recorded previously. Subsidence may result in impacts to aquatic environments.
<i>Maccullochella peelii</i>	Murray Cod	VU	#	-	-	Yes Inhabits freshwater streams. Potential habitat is present. Species may have been recorded previously. Subsidence may result in impacts to aquatic environments.
<i>Macquaria australasica</i>	Macquarie Perch	EN	#	-	-	Yes Inhabits freshwater streams. Potential habitat is present. Species may have been recorded previously. Subsidence may result in impacts to aquatic environments.
<i>Prototroctes maraena</i>	Australian Grayling	VU	#	-	-	No Requires connectivity with marine environment.

Appendix 4 Field survey methodology

Flora surveys

Flora surveys have been undertaken by ERM (2013b) and Biosis (2012a, b, 2013a, 2014d). Flora surveys were undertaken between 2 and 6 February 2009, with additional surveys undertaken between 5 and 9 September 2011. The complete methodology is outlined in *NRE No. 1 Colliery Project Application (09-0013) Environmental Assessment* (ERM 2013b). These surveys included assessment of floristic composition at 16 sites using standardised 400 metres squared (20 metres x 20 metres) quadrats. Quadrat locations were randomly selected within vegetation communities and stratification units. All plants recorded within each quadrat were identified to species level. Random meander searches were undertaken in the areas surrounding each quadrat for between 10 and 15 minutes at each location to increase the likelihood of detecting threatened species.

ERM (2013b) undertook targeted surveys for threatened flora species including Prickly-bush Pea across three sites in the Wonga East Area, concentrated in upland swamps on 7 and 8 October 2009. These targeted surveys involved searches along straight line transects by two ecologists concentrated in upland swamps for a total of 7.6 person hours. These surveys were supplemented by further assessment (Biosis 2012) during the detailed mapping of upland swamps. Whilst the focus of these surveys was mapping of upland swamps, locations of threatened flora species were recorded whilst traversing the study area.

Coastal upland swamp mapping

Coastal upland swamp mapping has been previously undertaken by Biosis (2012). Light Detection and Ranging (LiDAR) data was obtained using Airborne Laser Scanning (ALS) from a fixed wing aircraft on 20 October 2009. Initial areas of 'Potential Wetland' were determined in an automated process using a series of Geographic Information System (GIS) analysis tools in ArcGIS, which were combined into a single ArcGIS Model Builder geoprocessing model. A Canopy Height Model (CHM) was developed by subtracting the values of the ground raster from the non-ground raster.

Boundaries of upland swamps were determined by looking for areas with a rate of change in the CHM of greater than 2 metres within 1 metre, and where the total vegetation height was less than 6 metres. Following the automated processing of LiDAR data into potential wetland polygons, manual 'cleaning' of the polygons was required to further filter out false positives. After comparison with the known swamp control dataset, it was decided that only polygons over 1,000 square metres should be kept in order to filter out further 'background noise'. Any obvious false positives, including areas such as clearings, roads and waterbodies, were manually removed from the dataset using aerial imagery interpretation. This process determined areas of 'Potential Wetlands'. The polygons were then loaded on GIS capable field computers for field staff to locate and ground-truth.

Following automated mapping of 'Potential Wetlands', these areas were ground-truthed to determine whether areas mapped were representative of upland swamps. A team of botanists experienced with the identification of upland swamps on the Woronora Plateau visited all 'Potential Wetlands'. Some areas mapped as 'Potential Wetland' consisted of rocky outcropping, mallee, dry heath vegetation or sparse canopy. These areas were excluded from further analysis. Areas of upland swamp were assessed in detail. Boundaries of all swamps were mapped accurately using a combination of LiDAR data, ground-truthing using a handheld GPS and aerial photo interpretation (API).

Vegetation sub-communities present within swamps were mapped using a combination of ground-truthing using a handheld GPS and API. Sub-communities were mapped according to community profiles contained within NPWS (2003) and included those communities considered part of the Coastal Upland Swamp EEC (TSSC 2014), including:

- MU42 Upland Swamps: Banksia Thicket
- MU43 Upland Swamps: Tea-tree Thicket
- MU44 Upland Swamps: Sedgeland Heath Complex:
 - MU44(a) Sedgeland
 - MU44(b) Restioid Heath
 - MU44(c) Cyperoid Heath.

Boundaries of upland swamps and of sub-communities within swamps were refined in collaboration with GIS staff using API.

Upland swamps were then grouped for naming and further analysis. Initially, areas of upland swamp vegetation connected by Fringing Eucalypt Woodland (MU45) or Mallee Heath (MU46), or upland swamp vegetation separated by rocky outcropping, were grouped and considered part of the one upland swamp complex. In areas where connectivity between proximate upland swamps was not obvious, slope and flow accumulation modelling were used to identify whether these swamps are independent or whether these swamps should be considered as the one upland swamp complex.

Upland swamps that were located in close geographic proximity and were part of the same flow pathway and / or located along terraced slopes were grouped together. Following an initial classification using this method, further refinement of swamp groupings was undertaken, as initial observations indicated that some swamps that would otherwise be considered part of the same swamp were, in fact, located along different flow pathways.

Swamps were then named based on the catchment they were positioned within, generally working from the upstream to downstream extent. Where a valley infill and headwater swamp were connected, this was considered to form one functional unit, and therefore considered part of the same upland swamp. However, due to potential differences in type and degree of impacts they have been considered separately where appropriate.

Upland swamp floristic monitoring

Additionally, Biosis has also undertaken ecological monitoring in Wonga East which consists of flora monitoring (commencing in 2011), at upland swamp CRUS1 and at quadrats located along Cataract River, Cataract Creek and Bellambi Creek. Following a review of the ecological monitoring programs in 2012, undertaken in conjunction with the Office of Environment and Heritage (now Department of Planning Industry and Environment (DPIE), monitoring along creeks was ceased and monitoring of an additional six upland swamps (CRUS2, CRUS3, CCUS1, CCUS2, CCUS3 and CCUS4) commenced. Since 2012 an additional four upland swamps (CCUS5, CCUS10, CCUS12 and BCUS4) were added to the monitoring program.

Monitoring of upland swamps is undertaken along three 15 metre transects within each swamp. The presence of all species within thirty 0.5 metre x 0.5 metre quadrats located along the 15 metre transect is recorded (Biosis 2017, 2019b, 2019a). These monitoring surveys have been conducted once in spring and once in autumn since 2012, summarised in Table A.5. Statistical analysis of flora total species richness (TSR) and species composition between control and impact swamps are used to determine whether there are significant differences between control and impact monitoring sites and at individual sites between years. Floristic data is analysed in partnership with The Analytical

Edge Statistical Consulting to best relate the data analysis with the assessment of Trigger Action Response Plans (TARPS) following mining, and focus on comparing sites based on accurate measures of subsidence impacts.

Table A.5 Upland swamp monitoring program sites

Site	Monitoring commenced
BCUS4 (Bellambi Creek Upland Swamp 4)	Spring 2013
BCUS11 (Bellambi Creek Upland Swamp 11)	Spring 2013
CCUS1 (Cataract Creek Upland Swamp 1)	Autumn 2012
CCUS2 (Cataract Creek Upland Swamp 2) - Photo-point Monitoring	Autumn 2012
CCUS3 (Cataract Creek Upland Swamp 3)	Autumn 2012
CCUS4 (Cataract Creek Upland Swamp 4)	Autumn 2012
CCUS5 (Cataract Creek Upland Swamp 5)	Autumn 2013
CCUS10 (Cataract Creek Upland Swamp 10)	Autumn 2013
CCUS12 (Cataract Creek Upland Swamp 12)	Spring 2013
CRUS1 (Cataract River Upland Swamp 1)	Autumn 2011
CRUS2 (Cataract River Upland Swamp 2) - Photo-point Monitoring	Spring 2012
CRUS3 (Cataract River Upland Swamp 3)	Autumn 2012

The location of the flora surveys is shown in Figure 5. The number of sites monitored in each year of the ecological monitoring program has changed over time, reflecting changes to the relevant mine plans and therefore areas potentially at risk of impact at the time of survey as well as post-mining monitoring requirements. Monitoring ceased at the completion of the 2017 ecological monitoring program. A total of 4.5 years of post-mining data had been collected for those sites that were at risk of impacts from Longwall 4 and Longwall 5, with Longwall 6 being mined during the 2015 monitoring period, three seasons (two and a half years) of post-mining data had been collected for those sites at risk of mining related impacts associated with that longwall. The most recent annual report was provided in 2019. This report evaluated the first year of the recommencement of the ecological monitoring in Russel Vale east (RVE) in the context of the previous years of data, and in response to the TARP trigger levels previously developed for longwall extraction that concluded in RVE in 2015. In order to establish pre-UEP baseline conditions and assess any ongoing levels of impacts following the completion of longwall mining.

Fauna surveys

Fauna surveys have been undertaken by ERM (2013a), Cardno Ecology Lab (2009, 2010, 2012a, 2012c, 2012b), EcoLogical (2009) and Biosis (2009, 2012, 2013, 2017, 2019b).

Fauna surveys undertaken as a part of the environmental impact assessment were undertaken in spring 2009 and summer of 2009/2010. The complete methodology is outlined in (ERM 2013a). These surveys include targeted surveys for threatened frogs, Broad-headed Snake, Microchiropteran bats, and threatened fish.

Fauna survey effort is shown in Figure 6 and a summary of the fauna survey methods are provided in the following sections.

Broad-headed Snake

Targeted surveys for the Broad-headed Snake have focused on identification of suitable habitat in the study area. Surveys have been undertaken by Biosis Research (2009), Biosis (2013a), EcoLogical (2009) and ERM (2013b).

Initial surveys were undertaken in March 2009 (Biosis, 2009). Ridgelines and rocky outcrops were traversed and searched to identify any high quality benched areas with exfoliating sheets of sandstone suitable for use as shelter habitat by the Broad-headed Snake (ERM 2013b). This included examination of ground litter, turning over logs and rocks and searching for prey species of the Broad-headed Snake (Biosis 2009). Follow up surveys were undertaken by EcoLogical (2009) in September and October 2009 using the same methodology.

Areas of habitat identified to be suitable for the species were monitored across two years as part of the ecological monitoring program. This monitoring included targeted searches within suitable habitat (e.g. rocky outcrops) at three 20 metre by 20 metre (400 metres squared) quadrats along each ridgeline (fauna ridgeline impact site) (Figure 6). These surveys consisted of active searching and rock turning at each site for 30 person-minutes. These surveys were undertaken once in autumn 2011 and once in autumn 2012 during periods when the Broad-headed Snake uses rocks and crevices as shelter sites. Monitoring of these sites ceased following a review of monitoring programs, due to the lack of detection of threatened species and lack of predicted impacts to monitored sites.

Threatened frogs

Initial surveys were undertaken by ERM (2013b). Call broadcasting for target frog species was undertaken within suitable habitats. Call broadcasting was undertaken during both daytime and nocturnal periods. A 10W amplifier was used to broadcast a call for three minutes followed by three minutes of listening. Nocturnal searches for frogs were also undertaken in habitat considered suitable for the target species. Habitat searches consisted of an initial five minute listening period followed by active searches of an area of at least 40 metres x 40 metres by searching ground litter, turning logs and rocks and examining low shrubs. Creeks were surveyed with an initial five minute listening period followed by two person hours of active spotlighting of 200 metres of each watercourse. Further survey of streams was undertaken by EcoLogical (2009), including searches for amphibian larvae, detection of calling individuals and searches beneath suitable cover.

Monitoring for Giant Burrowing Frog, Littlejohn's Tree Frog and Stuttering Frog have been undertaken in breeding and non-breeding habitat areas identified across the Proposed Action study area as part of annual ecological monitoring programs (Biosis 2013, Biosis 2017), described below.

Transect monitoring

The initial stages of the monitoring program focused on monitoring of three standardised transects per creek along Cataract River, Cataract Creek and Bellambi Creek. Following an initial five minute listening period, active searching of a standardised 50 metre transect was undertaken over a period of 30 minutes. The presence of all frogs located along each transect was recorded. These transects have been monitored twice each spring and autumn from 2011 to 2012.

Breeding habitat monitoring (transects)

Following a review of the ecological monitoring programs in 2012, undertaken in consultation with the then NSW Office of Environment and Heritage, monitoring of standardised transects along creeks was ceased. Due to a better understanding of potential impact mechanisms, the focus of monitoring changed to habitat for threatened frogs, particularly breeding habitat at risk of impact due to draining of breeding pools. In 2012, detailed mapping of potential breeding habitat for threatened

frogs in the study area was undertaken. An initial diurnal habitat assessment was completed across the study area. All areas of potential habitat were mapped and assessed for quality. Potential habitat identified by topography maps and aerials along streams was ground-truthed and all suitable breeding pools were marked using a GPS.

Locations of potential breeding habitat were identified by topographic maps and aerial imagery of the study area, focussed along streams and pools. These areas were ground-truthed by diurnal habitat assessment and all suitable breeding locations were mapped and incorporated into an ongoing monitoring program, based on transect sampling methodology. Following diurnal habitat assessments, locations considered to be suitable habitat of varying quality for the Stuttering Frog, Littlejohn's Tree Frog and Giant Burrowing Frog were then incorporated into the ongoing monitoring program through a transect sampling survey technique.

Transect surveys were undertaken by zoologists familiar with the target species (Giant Burrowing Frog, Littlejohn's Tree Frog and Stuttering Frog), and incorporated active Visual Encounter Survey (VES), spotlighting, and call detection techniques. Active nocturnal VES for adults, tadpoles and egg mass were completed in peak breeding times for each species to allow for a higher probability of detecting adult frogs. Spotlighting and call detection were undertaken along transects in areas assessed to contain suitable habitat for each of the species. Surveys were timed around seasonal movements of the target species, with monitoring undertaken in breeding season to detect calling males and the period of high activity in adult frogs, as well as following breeding season to target tadpoles and metamorphs. These monitoring surveys took place twice in autumn, twice in winter and twice in summer at six monitoring transects within suitable habitats between winter 2012 and summer 2015/2016. A summary is provided in Table A.6.

Table A.6 Targeted frog breeding habitat monitoring sites and survey commencement

Site	Survey type	Survey commenced
BCUS2 (1) (Bellambi Creek Upland Swamp 2 - Tributary)	Visual encounter survey, spotlighting and call detection	Summer 2013/14
BCUS2 (2) (Bellambi Creek Upland Swamp 2 (2) - Tributary)	Visual encounter survey, spotlighting and call detection	Summer 2013/14
CCUS4 (Cataract Creek Upland Swamp 4 - Tributary)	Visual encounter survey, spotlighting and call detection	Winter 2012
CRUS1 (1) (Cataract River Upland Swamp 1 - Tributary 1)	Visual encounter survey, spotlighting and call detection	Winter 2012
CRUS1 (2) (Cataract River Upland Swamp 1 - Tributary 2)	Visual encounter survey, spotlighting and call detection	Winter 2012
CRUS2 (Cataract River Upland Swamp 2 - Tributary)	Visual encounter survey, spotlighting and call detection	Winter 2012

Non-breeding habitat monitoring (quadrats)

In addition to monitoring of breeding habitat, Biosis has undertaken monitoring of non-breeding habitat identified by Biosis Research (2009) and EcoLogical (2009). Quadrat surveys for threatened frogs in upland swamps were conducted within one to three 25 metre x 25 metre (625 metres squared) quadrats per swamp, centralised around a fixed point. Each point was surveyed twice per season. An initial listening period was followed by active searching (by zoologists familiar with the target species) of all natural features including rocks, vegetation and leaf litter within each quadrat for 25 person minutes. The length of the initial listening period varied depending on the target

species. Five minutes was allocated to those habitats suitable for Littlejohn's Tree Frog, whereas a 30 minute listening period was allocated for those sites containing habitat for the Giant Burrowing Frog, given the time it can take for the species to re-commence calling following disruption. The presence and abundance of threatened species within each 25 metre x 25 metre quadrat was recorded. Between fixed quadrat survey points, randomised transects were surveyed by walking a specific distance through a randomly chosen route. Allowing for detection of threatened and non-threatened species across habitat gradients of the study area.

These surveys were undertaken in 2012. The surveys occurred twice in autumn, twice in winter and twice in summer for Littlejohn's Tree Frog and Giant Burrowing Frog at CCUS4, CRUS1 and CRUS2. Twice in winter and twice in summer for Littlejohn's Tree Frog and Giant Burrowing Frog at CCUS3. Twice in summer for Giant Burrowing Frog at CCUS1, CCUS2 and CRUS3.

Large-eared Pied Bat

Surveys were undertaken for Large-eared Pied Bat using Anabat units. Anabat units were deployed at four locations between 23 and 27 May 2009. At each location Anabat units were deployed for two nights. Anabat units were positioned in and adjacent to flyways, including vehicle tracks, riparian environments, freshwater pools, cliffs, upland swamps and rainforest understorey.

Subsequent detailed habitat assessment has been undertaken by Biosis. This habitat assessment focused on identifying potential roosting habitat for microchiropteran bats along cliff lines in the study area. Cliff lines were mapped using LiDAR data and surveyed to identify potential roosting habitat. These cliff lines were then surveyed by zoologists from Biosis to identify overhangs or caves suitable for roosting by threatened bats species.

Two additional Anabat units were deployed, targeting suitable roosting habitat identified during the habitat assessment outlined above. Anabat units were deployed between 6 and 9 February 2015. Anabat units were positioned adjacent to identified potential roost sites to determine if sites were being used as roosts.

Four harp traps were also set up over six nights in late March 2015 in areas of suitable habitat, with total trapping effort of 24 trap nights.

Threatened fish

Macquarie Perch within the Cataract Reservoir Catchment has been identified as being subject to potential impacts associated with subsidence as a result of underground coal mining in the Southern Coalfields (DECC 2007). To assess the potential impacts to threatened fish species, arising from subsidence associated with longwall mining. Monitoring of Macquarie Perch within Cataract Creek has been the focus of these assessments as other threatened species occur infrequently (Silver Perch and Trout Cod) or are not considered part of an important population (Murray Cod).

Fish survey has been undertaken in Cataract Creek, the focus of monitoring under previous longwall extraction within the RVE area, by Biosis between 2013 and 2019. A Smith-Root LR-24 backpack electrofisher was utilised to collect fish within shallow water environments. The sampling consisted of actively electrofishing a reach of Cataract Creek of between 0.3 to 2 kilometres with one operator and one dip netter. The power-on time and output fishing parameters were adapted according to the prevalent environmental conditions and set to maximise the collection of Macquarie Perch. The fish catch data and survey effort (electrofishing seconds) for each survey are summarised in Appendix 5. This survey effort was complimented by the use of Fyke netting at the confluence of Cataract Creek and Cataract River and boat based electrofishing within the downstream section of Cataract Creel one two separate occasions. In-stream habitat assessments including a description of basic geomorphology and physical attributes (e.g. depth, substrate, flow, cover, habitat connectivity

including barriers to fish passage, refugia and spawning areas, aquatic and riparian vegetation etc.), existing sources of disturbance and in-situ water quality variables (pH, dissolved oxygen, temperature, electrical conductivity, turbidity) were recorded.

Cardno Ecology Lab also undertook backpack electrofishing surveys of Cataract Creek between 2008 and 2012. Four surveys for threatened fish species were undertaken during each summer survey during 2009-2010, 2010-2011 and 2012 using backpack electrofishing techniques. The surveys were completed between the confluence of Cataract Creek and the Cataract River, up to a rock bar present along Cataract Creek, the same downstream transect along Cataract Creek utilised by Biosis. Collectively, backpack electrofishing surveys of Cataract Creek have occurred over a period of six years.

Assessment against survey guidelines

An assessment of the field survey methodology and survey effort for candidate species against the relevant Commonwealth survey guidelines is provided in Table A.7. The relevant available survey guidelines include:

- Commonwealth *Survey Guidelines for Australia's Threatened Frogs* (Frog Guidelines) (Commonwealth of Australia 2010a).
- Commonwealth *Survey Guidelines for Australia's Threatened Bats* (Bat Guidelines) (Commonwealth of Australia 2010b).
- Commonwealth *Survey Guidelines for Australia's Threatened Reptiles* (Reptile Guidelines) (Commonwealth of Australia 2011a).
- Commonwealth *Survey Guidelines for Australia's Threatened Fish* (Fish Guidelines) (Commonwealth of Australia 2011b).

There are currently no Commonwealth survey guidelines available for coastal upland swamps, or for the Prickly-bush Pea.

Table A.7 Assessment of field survey effort against relevant Commonwealth Survey Guidelines

Parameter	Commonwealth Survey Guidelines	Surveys undertaken
Macquarie Perch and Silver Perch		
Timing of surveys	The recommended survey period for the Macquarie Perch is March to September. Surveys should not be conducted throughout the breeding season of October to mid-January.	Surveys for threatened fish species in Cataract Creek and the Cataract River have been undertaken between 2009 and 2019. Surveys undertaken between 2009 and 2012 were undertaken during the breeding season. These surveys were largely undertaken prior to the development of the Fish Guidelines and would be effective in detecting the species. Timing of surveys since 2012 have been according to the Fish Guidelines. Surveys are ongoing.
Methods	<p>The methods can be used individually, but it is often found that a combination of methods provides the best results.</p> <p>Efforts should focus on boat-based electrofishing conducted according to the Australian Code of Practice (NSW Fisheries 1997), fyke nets and snorkelling in clear streams for juveniles.</p>	Surveys have predominantly been backpack electrofishing, considered to be the most suitable method to the target reaches. However fyke netting and boat electrofishing methods have also been employed. Due to the shallow depths of the reaches of Cataract Creek and Cataract River being surveyed boat-based electrofishing has generally not been feasible. Methods used in targeted surveys have been according to the Fish Guidelines.
Effort	Regular sampling during and throughout the time of year when the taxa are known to most likely occur at the study area is desirable. Some locations may be occupied by target taxa/taxon in some years but not others, requiring sampling over many years (if feasible).	Surveys completed by Cardno Ecology Lab between 2009 and 2012 (12 survey days) were undertaken at Cataract Creek. Biosis has undertaken 15 days of survey for threatened fish species within Cataract Creek and 7 days of survey in the Cataract River, between 2013 and 2019. Survey effort has been well in excess of the Fish Guidelines.
Area to be covered	Random sampling or systematic sampling, spaced a suitable distance apart to ensure independence of sites.	Fished reaches have varied in length, being typically between 0.3 and 2 km in length. Area covered is consistent with the Fish Guidelines.

Parameter	Commonwealth Survey Guidelines	Surveys undertaken
Littlejohn's Tree Frog		
Timing of surveys	Under optimum weather conditions; that is, after heavy rainfall on windless night. At time of peak activity for the species. Seasonal: Active in autumn through winter months. Weather conditions: Within three days of heavy rainfall. Active in summer after heavy rainfall.	Surveys have been undertaken during a wide variety of weather conditions (including within 3 days of heavy rainfall). However, surveys are undertaken using a local reference site to determine calling behaviour. Surveys for Littlejohn's Tree Frog are undertaken during Autumn, Summer and Winter. Autumn and Winter surveys target active calling for adult males, whilst Summer surveys target tadpoles in breeding pools. Timing of surveys has been according to the Frog Guidelines.
Methods	Spotlight and call detection. Accompanied by habitat assessment by appropriately experienced personnel. Larvae are distinctive, often observed at surface, and can be collected by dip netting. Multiple sweeps in pools.	Habitat assessment was undertaken by Biosis in 2011 to document all breeding habitat within the study area. Targeted surveys of all breeding and non-breeding habitat is undertaken according to the methodology outlined above and includes spotlighting, Visual Encounter Surveys (VES), active searching and tadpole surveys in suitable pools. Methods used in targeted surveys have been according to the Frog Guidelines.
Effort	A minimum of four nights under ideal conditions, covering a range of stream structure.	Surveys of breeding habitat have been undertaken for 16 nights (CRUS1 Tributary 1), 16 nights (CRUS1 Tributary 2), 15 nights (CCUS4 Tributary), and 33 nights (CRUS2 Tributary). Surveys of non-breeding sites have been undertaken for 25 nights (CRUS1), 16 nights (CRUS2), 6 nights (CCUS3) and 16 nights (CCUS4). Survey effort at all sites has been well in excess of the Frog Guidelines.
Area to be covered	Stream transect of a minimum of 200 m. Isolated pools in headwaters of streams and occasionally on ridges. Also occurs in ponds in forested habitats. Local area study should include reference sites where feasible.	Transects (of 200 m) cover suitable breeding habitat and associated pools identified during the habitat assessment. Surveys of local reference sites are undertaken prior to surveys. Area covered has targeted breeding habitat, mapped during the habitat assessment, which is considered at risk of impact by the Action. A local reference site has been used.

Parameter	Commonwealth Survey Guidelines	Surveys undertaken
Giant Burrowing Frog		
Timing of surveys	Under optimum weather conditions; that is, wet conditions. At time of peak activity for the species; that is, rainfall in spring and autumn. Seasonal: September–March. Weather conditions: Within one week of heavy rainfall (September–March) (heavy rainfall is >50 mm in seven days)	Surveys have been undertaken during a wide variety of weather conditions. However, surveys are undertaken using a local reference site to determine calling behaviour. Surveys for the Giant Burrowing Frog are undertaken during Summer, targeting calling behaviour and tadpoles in breeding pools. Timing of surveys has been according to the Frog Guidelines.
Methods	Using spotlight surveys on foot and by road. Best results during and immediately after rainfall. Accompanied by habitat assessment by appropriately experienced personnel. Larvae are distinctive and can be collected by dip netting. Multiple sweeps in pools.	Habitat assessment was undertaken by Biosis in 2011 to document all breeding habitat within the study area. Targeted surveys of all breeding and non-breeding habitat is undertaken according to the methodology outlined above and includes spotlighting, VES, active searching and tadpole surveys in suitable pools. Methods used in targeted surveys have been according to the Frog Guidelines.
Effort	A minimum of four nights under ideal conditions.	Surveys of breeding habitat have been undertaken for 15 nights (CCUS4 Tributary), 16 nights (CRUS1 Tributary 1 and 2) and 33 nights (CRUS2 Tributary). Surveys of non-breeding sites have been undertaken for 25 nights (CRUS1), 16 nights (CRUS2), 9 nights (CRUS3), 4 nights (CCUS1), 4 nights (CCUS2), 6 nights (CCUS3) and 16 nights (CCUS4). Survey effort at all sites has been well in excess of the Frog Guidelines.
Area to be covered	In the study site, spotlight surveys on foot should cover several square kilometres of track in suitable habitat. In the local area, spotlight road transects should traverse up to 30 km in suitable habitat, repeated sections after a period of about one hour is suitable.	Transects cover all suitable breeding habitat and associated pools identified during the habitat assessment. Surveys of local reference sites are undertaken prior to surveys. Area covered has targeted breeding habitat, mapped during the habitat assessment that is considered at risk of impact by the Action. A local reference site has been used.
Stuttering Frog		
Timing of surveys	Under optimum weather conditions; that is, substrate and leaf litter wet. At time of peak activity for the species. Seasonal: September–March. Weather conditions: Not during heavy rainfall or stream flow. One week after heavy rainfall.	Surveys have been undertaken during a wide variety of weather conditions. Surveys for the Stuttering Frog are undertaken during Summer, targeting calling behaviour and tadpoles in breeding pools. Timing of surveys has been according to the Frog Guidelines.

Parameter	Commonwealth Survey Guidelines	Surveys undertaken
Methods	Call playback and spotlighting while walking transect along stream or creek. Most suitably in riparian rainforest and wet sclerophyll forest. Detection by larvae presence. Road transects are effective after heavy rain. Larvae are distinctive and can be collected by dip netting. Multiple sweeps in pools.	Habitat assessment was undertaken by Biosis in 2011 to document all breeding habitat within the study area. Targeted surveys of all suitable habitat is undertaken according to the methodology outlined above and includes call playback, spotlighting, VES, active searching and tadpole surveys in suitable pools. Methods used in targeted surveys have been according to the Frog Guidelines.
Effort	A minimum of two nights under ideal conditions. Should be repeated on at least four separate occasions in activity period.	Surveys of all suitable habitat have been undertaken for 12 nights (CC1) and 12 nights (CC2). Survey effort at all sites has been well in excess of the Frog Guidelines.
Area to be covered	Stream transect of a minimum of 200 m. Local area study should include reference sites where feasible.	Transects cover all suitable habitat and associated pools identified during the habitat assessment. The Stuttering Frog may be extinct in the local area and thus no reference site is available. Area covered has targeted breeding habitat, mapped during the habitat assessment that is considered at risk of impact by the Action. This is in excess of the Frog Guidelines. A local reference site is not available.
Broad-headed Snake		
Timing of surveys	During winter.	Surveys were not undertaken according to the Reptile Guidelines. Surveys were undertaken in Autumn, as this is identified by OEH and experts from the University of Sydney as the best time for survey.
Methods	Searching suitable sheltering sites (under rocks or in crevices) on westerly-facing sandstone cliffs by day during winter. Searching appropriate sheltering sites with torches to detect the presence of the species. Searching rock outcrops by day will only sample a subset of rocky sheltering sites; in particular deep crevices will not be thoroughly examined.	Habitat assessment. Active searching and rock turning. Active searching for prey species. Methods used in targeted surveys have been according to the Reptile Guidelines.
Effort	No guidance provided.	Three 20 m x 20 m (400m ²) quadrats surveyed for 30 person minutes each, twice per year. Two sites identified during the habitat assessment were surveyed. Surveys were undertaken in 2011 and 2012. No guidance on survey effort is provided in the Reptile Guidelines.

Parameter	Commonwealth Survey Guidelines	Surveys undertaken
Area to be covered	No guidance provided.	Three 20 m x 20 m (400m ²) quadrats per site. Two sites surveyed. No guidance on area to be covered is provided in the Reptile Guidelines.
Large-eared Pied Bat		
Timing of surveys	October through to March.	Initial surveys by ERM were conducted outside of the period outlined. These surveys were not undertaken according to the Bat Guidelines. Follow up surveys were undertaken by Biosis during this period. These follow up surveys are consistent with the Bat Guidelines.
Methods	Prior to the survey, determine the potential for rocky outcrops, caves and mines to occur in the area. Conduct ground-based surveys for caves and roosts. Passive acoustic detection of a range of potential roost habitats. The use of electronic bat detectors is the best means of non-invasive survey, and the most efficient in terms of data collection and area coverage.	Habitat assessments were undertaken of all cliffs identified using LiDAR data to determine whether potential roost sites were present within the study area. Passive acoustic detection was undertaken at two identified roosts above LW9 using Anabat bat detectors. These were the only two suitable roosts identified. Methods used in targeted surveys have been according to the Bat Guidelines.
Effort	Unattended bat detectors – 16 detector nights for a minimum of four nights. Attended bat detectors – 6 detector hours for a minimum of three nights. Harp traps and/or mistnets – 16 trap or net nights for a minimum of four nights.	Four sites were surveyed in 2009 for five nights each. Two sites were surveyed in 2015 for four nights each. Total survey effort is 28 detector nights across nine nights. Survey effort at all sites is in accordance with the Bat Guidelines; however some surveys were undertaken outside of the survey period identified in the Bat Guidelines.
Area to be covered	In the vicinity of mines, caves and rocky outcrop, and also in foraging sites such as vegetation corridors and flyways, sandstone gorges, over watercourses, isolated waterholes and in representative vegetation types	Potential impacts limited to cliffs. Foraging habitat is at negligible risk of impact. Therefore potential roost sites were targeted. Area covered is in accordance with the Bat Guidelines.

Appendix 5 Collated survey data

Coastal upland swamp monitoring floristic data

The coastal upland swamp monitoring floristic dataset has been provided as electronic excel file '34330.Russellvale.Flora.Annual.2019.20200305'.

Giant Burrowing Frog records from site CRUS2

The raw records of Giant Burrowing Frogs recorded during the breeding habitat monitoring program at site CRUS2 has been provided as electronic excel file '34330.GBF.CRUS2.Export.20201128'.

Threatened fish survey data

Fish catch data from threatened fish surveys in Cataract Creek and the Cataract River by Biosis between 2013 and 2019 are presented in Table and Table .

Table A.8 Collated fish data collected from Cataract Creek by Biosis between 2013 and 2019

Site	Date	Effort (seconds)	Native species							Exotic species	
			Silver Perch	Broad-finned Galaxias	Mountain Galaxias	Galaxias species	Murray Cod	Macquarie Perch	Eel-tailed Catfish	Goldfish	Eastern Gambusia
			<i>Bidyanus bidyanus</i>	<i>Galaxias brevipinnis</i>	<i>Galaxias olidus</i>	<i>Galaxias spp.</i>	<i>Maccullochella peelii</i>	<i>Macquaria australasica</i>	<i>Tandanus tandanus</i>	<i>Carassius auratus</i>	<i>Gambusia holbrooki</i>
Cataract Creek downstream	22/02/2013	1,545	0	0	9	0	0	0	0	0	0
Cataract Creek downstream	21/02/2013	1,145	0	0	0	0	7	4	0	1	3
Cataract Creek downstream	18/07/2013	Fyke nets*	0	0	0	0	1	0	0	8	0

Site	Date	Effort (seconds)	Native species							Exotic species	
			Silver Perch	Broad-finned Galaxias	Mountain Galaxias	Galaxias species	Murray Cod	Macquarie Perch	Eel-tailed Catfish	Goldfish	Eastern Gambusia
			<i>Bidyanus bidyanus</i>	<i>Galaxias brevipinnis</i>	<i>Galaxias olidus</i>	<i>Galaxias spp.</i>	<i>Maccullochella peelii</i>	<i>Macquaria australasica</i>	<i>Tandanus tandanus</i>	<i>Carassius auratus</i>	<i>Gambusia holbrooki</i>
Cataract Creek downstream	15/04/2013	1,289	0	0	7	0	8	10	0	0	4
Cataract Creek downstream	20/02/2013	1,005	0	0	1	0	1	0	0	0	1
Cataract Creek downstream	12/03/2014	1,412	0	0	2	0	24	18	0	45	118
Cataract Creek downstream	26/05/2014	745	0	0	16	0	0	0	0	0	0
Cataract Creek downstream	10/06/2014	1,599	0	5	2	0	28	12	0	0	200
Cataract Creek downstream	13/06/2014	1,006	0	0	5	0	16	3	0	0	0
Cataract Creek upstream	14/03/2014	948	0	5	2	0	9	2	0	0	0
Cataract Creek downstream	9/02/2015	1,300	0	60	34	0	7	3	0	50	>1000
Cataract Creek downstream	12/02/2015	360 (Boat)	4	0	0	0	15	39	0	0	0

Site	Date	Effort (seconds)	Native species							Exotic species	
			Silver Perch	Broad-finned Galaxias	Mountain Galaxias	Galaxias species	Murray Cod	Macquarie Perch	Eel-tailed Catfish	Goldfish	Eastern Gambusia
			<i>Bidyanus bidyanus</i>	<i>Galaxias brevipinnis</i>	<i>Galaxias olidus</i>	<i>Galaxias</i> spp.	<i>Maccullochella peelii</i>	<i>Macquaria australasica</i>	<i>Tandanus tandanus</i>	<i>Carassius auratus</i>	<i>Gambusia holbrooki</i>
Cataract Creek downstream	13/02/2015	1,236	0	12	0	0	3	0	0	54	>1000
Cataract Creek downstream	24/07/2019	2,407	5	12	17	0	2	0	1	2	50
Cataract Creek downstream	3/09/2019	2,637	0	28	3	8	1	0	0	1	300

*3 fyke nets set over 5 hours at the confluence of Cataract Creek and the Cataract River

Table A.9 Collated fish data collected from the Cataract River by Biosis between 2013 and 2019

Site	Date	Effort (seconds)	Native species							Exotic species	
			Silver Perch	Broad-finned Galaxias	Mountain Galaxias	-	Murray Cod	Macquarie Perch	Eel-tailed Catfish	Goldfish	Eastern Gambusia
			<i>Bidyanus bidyanus</i>	<i>Galaxias brevipinnis</i>	<i>Galaxias olidus</i>	<i>Galaxias</i> spp.	<i>Maccullochella peelii</i>	<i>Macquaria australasica</i>	<i>Tandanus tandanus</i>	<i>Carassius auratus</i>	<i>Gambusia holbrooki</i>
Cataract River upstream	22/03/2013	N/A	0	0	2	0	0	4	0	0	0
Cataract River downstream	12/03/2014	1,029	0	0	0	0	8	5	0	20	480
Cataract River upstream	14/03/2014	727	0	0	1	0	4	1	0	0	0
Cataract River downstream	10/02/2016	475 (boat)	9	0	0	0	20	84	0	0	0
Cataract River upstream	12/02/2016	780	1	5	0	0	1	1	0	0	0
Cataract River	24/07/2019	1,515	1	36	0	9	0	0	0	0	4
Cataract River	3/09/2019	1,756	0	35	0	21	1	1	0	0	0