Russell Vale Colliery Revised Underground Expansion Project

SURFACE OPERATIONS WATER MANAGEMENT PLAN

RVC EC PLN 019

Revision History

PROPERTY	VALUE
Approved by	Group Environmental & Approvals Manager
Document Owner	Richard Sheehan
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Revisions

VERSION	DATE REVIEWED	REVIEW TEAM (CONSULTATION)	NATURE OF THE AMENDMENT
0	15/06/2021	Dr Adam Wyatt (Engeny Water Management)	Original plan preparation
Draft 6	02/08/2021	Dr Adam Wyatt (Engeny Water Management) Robert Faddy-Vrouwe Warwick Lidbury	Update Project Description to be consistent with all other management plans and incorporate DPIE feedback dated 21 July 2021.
Draft 7	30/08/2021	Robert Faddy-Vrouwe Devendra Vyas Warwick Lidbury	Updated to incorporate DPIE feedback dated 13 August 2021.

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1 INTRODUCTION

1.1 Overview

This Surface Operations Water Management Plan (SOWMP) was initially prepared by Dr Adam Wyatt (B.E., PhD) of Engeny Water Management, on behalf of WCL, in fulfilment of **Condition B17** and in accordance with the relevant conditions of consent outlined in **Section 4**. Adam is suitably qualified and experienced for the preparation of water management plans in accordance with **Schedule 2, Condition B17(a)**. Adam has over 15 years' experience as a consultant engineer and researcher. He has a wide range of water engineering experience in the resources sector including detailed hydrological and hydraulic analysis; identification of surface water impacts and mitigation; detailed one and two dimensional flood modelling; flood impact assessments; water management plans; erosion and sediment control; watercourse stability; watercourse rehabilitation design and closure planning; water management infrastructure; and auditing. Adam also developed the following sub plans:

- Erosion Sediment Control Plan;
- Colliery Pit Top Surface Water Management Plan; and
- Salt Balance

The water balance for the Russell Vale Colliery was prepared by Chris Bonomini of Umwelt on behalf of WCL. Chris is a Principal Water Engineer and Certified Professional in Erosion and Sediment Control (CPESC #9621) with 25 years of industry experience. He has undertaken surface water assessments for a range of coal mine, quarry and industrial projects including the preparation of detailed water balance assessments for sites with complex surface water - groundwater interactions. Further, Chris has provided ongoing operational management and reporting support with respect to surface water and groundwater management that has included preparation of reporting water balances for licenced surface and groundwater extraction, water quality investigations, annual water management reports and preparation of erosion and sediment control plans.

In recent years Chris has been approved by the Secretary to prepare, update and review water management plans for a number of operations including the United Wambo Joint Venture, the Concrush Resource Recovery facility, Hitchcock Road Quarry (reviewed on behalf of DPIE), Cooma Road Quarry, Haerses Road Quarry, Old Northern Road Quarry and the Invincible Colliery. Chris has a thorough understanding of the Russell Vale Colliery water management system having prepared the RVE UEP Surface Water Impact Assessment and surface water components (including the water balance) of the RVE UEP Public Environmental Report.

The Groundwater Management Plan, in **Appendix D**, was prepared by Claire Stephenson of Umwelt, on behalf of WCL. Claire has over 14 years' experience in environmental consulting across Australia. Claire has extensive experience managing complex groundwater projects, with diversified skills and experience in mine groundwater management, water supply development, planning and approvals (i.e. annual reviews, operational studies and groundwater impact assessments), field investigation programs, numerical groundwater modelling and independent auditing (Exemplar Global certified lead auditor in EMS). Claire has additional expertise in groundwater modelling, groundwater monitoring network design and installation, field program design and implementation, stakeholder engagement, 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.

1.2 Project Background

Wollongong Coal Limited (WCL) operates the Russell Vale Colliery (formerly the NRE No.1 Colliery) in the Southern Coalfield of New South Wales (NSW). The mine is located at Russell Vale approximately 8 kilometres north of Wollongong and 70 kilometres south of Sydney, within the local government areas (LGAs) of Wollongong and Wollondilly in the Illawarra region of NSW (**Figure 1**). The Colliery which has been on 'care and maintenance' since 2015. WCL successfully sought Approval under the Environmental Planning and Assessment Act 1979 (EP&A Act) to expand the mining operations at the Colliery; this ongoing application is referred to as the Underground Expansion Project (UEP). The UEP has recently been approved under the NSW *Environment Planning and Assessment Act 1979* (EP&A Act) by the Independent Planning Commission (IPC).

Mining as has been undertaken at Russell Vale Colliery since the 1880s. Continuous mining has been a feature of the PAA since 1887 and surface facilities have operated at the Russell Vale site since this time. With the advent of more sophisticated mining methods in the 1960s, workings progressed further west of the Illawarra Escarpment. Subsequently, four ventilation shafts (Shaft Numbers 1, 2, 3 and 5) and a shaft to provide personnel and materials access to the workings (No. 4 Shaft) were sunk to the west of the escarpment.

Mining has occurred in three seams, the Bulli Seam, Balgownie Seam and the Wongawilli Seam. The Balgownie seam is located approximately 10 metres (m) below the Bulli Seam and the Wongawilli Seam is located approximately 20 m below the Balgownie Seam. All three seams outcrop along the Illawarra Escarpment and the seams are accessed by adits directly into the seams. There are two main mining areas within the Russell Vale Colliery lease area, which are referred to as Wonga East and Wonga West. In the Wonga East area, the Bulli Seam and Balgownie Seam have largely been fully extracted. The existing and proposed workings are contained within Consolidated Coal Lease 745 (CCL745) and Mining Lease 1575 (ML1575)

The original UEP application submitted by Gujarat NRE Coking Coal Ltd in 2009 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.

In order to address residual uncertainty regarding the impacts of longwall mining raised by the PAC Second Review Report, a revised mine design has been developed based on a non-caving first workings mining system. The revised mine plan has been designed to be long term stable with negligible risk of pillar failure to address potential subsidence-related mining impacts on groundwater, surface water and biodiversity within the Cataract Reservoir catchment. Changes to the Russell Vale Pit Top are also proposed to address concerns regarding potential amenity impacts to surrounding residential areas. This revised plan is referred to in this document as the Revised Preferred Project.

Key elements of the Revised Preferred Project are:

- Mining by means of first working mining techniques only, with the workings designed to be long term stable with minimal subsidence impacts. No longwall mining is proposed;

- Extraction of approximately 3.7 Mt of ROM coal over 5 years at a production rate that will not exceed 1 Mt of product coal per year;
- Construction and use of a coal processing plant to improve the quality of product coal;
- Redesign of the Pit Top layout to strategically relocate (select key) infrastructure to more shielded locations;
- Reduced hours of operation for surface facilities relative to the Preferred Project mine plan; and
- Additional noise mitigation works at the Russell Vale Pit Top including a new noise barrier, extension to the height of existing bunds and acoustic treatment of coal processing (select) infrastructure.

Mining will be undertaken using the first workings bord and pillar mining methodology, resulting in minimal subsidence and negligible impact on the surface features above the mining area. This mining method was chosen due to the proximity of the proposed mining area to the Cataract Reservoir, the sensitive environmental features above the mining area (such as coastal upland swamps), and the high level of community and stakeholder interest in the project.

1.3 Purpose and Scope

This SOWMP, and associated sub plans, has been prepared in compliance with ***Condition B17/ Schedule 2*** of the Project Approval (***MP09_0013***), and in consideration of the relevant regulatory and licencing requirements as identified in **Table 6**. The contents of this overarching SOWMP covers the general conditions of consent and general information, which is applicable to all sub plans, with the sub plans providing the specific detail on the relevant water management practices and process.

It is important to note that a separate Water Management Plan for the extraction area will be developed as part of the extraction plan for second workings under ***Condition C10(g)(iii)/ Schedule 2***. The Ground Water Management Plan in **Appendix D**, however, has been developed to cover the pit top area, first workings and second workings in the extraction area. This GWMP is common to both the Water Management Plan required under ***Condition B17*** (Pit top and first workings) and the Water Management Plan required under ***Condition C10(g)(iii)/ Schedule 2*** (Second workings).

The objectives of the RVC SOWMP are to provide a description of the Water Management System for RVC site, methods to monitor watercourse stability, surface and groundwater quantities and qualities, and outline performance criteria in order to identify potential impacts associated with the mining operations. This plan also provides appropriate mitigation measures and outlines the contingency and adaptive management process where necessary.

This plan relates to:

- The Russell Vale Pit Top Area and surface facilities as outlined in **Figure 5** to **Figure 8**;
- The surrounding watercourses within the vicinity of the Russell Vale Pit Top, being Bellambi Gully, including downstream water quality and flow to the mine boundary; and
- Groundwater resources impacted by Bord and Pillar first workings.

The Russell Vale Pit Top (**Figure 5**) includes several modifications to surface infrastructure as part of MP09_0013 (**Figure 6** to **Figure 8**)**,** as outlined in **Section 2**. This management plan covers water management of the following stages and control measures as outlined below:

- Stage 1 (Section 2.2 – Stage 1) – No generation of rejects and the water will be managed as outlined in the water management system described in **Section 5.1**;
- Stage 2 (Section 2.2 – Stage 2a) – No generation of rejects and the water will be managed as outlined in the water management system described in **Section 5.1**;

This SOWMP has been prepared on a staged basis, in accordance with **Condition A21**, consistent with the project description outlined in **Section 2.2**. 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 SOWMP will be updated as outlined in **Appendix G**.

1.4 Surface Facilities

1.4.1 RV Pit Top facilities

The RVC Pit Top and surface facilities (study area) is located on the lower slopes of the Illawarra Escarpment, adjacent to the suburbs of Russell Vale and Corrimal (**Figure 5**). The study area occupies an area of approximately 100 hectares at the eastern extent of the Colliery holdings and includes existing coal handling, processing, storage and transport facilities, a mine water management system, mine entry adits, workshops and administration buildings. The Colliery Pit Top is located at the base of the Illawarra Escarpment above the suburb of Russell Vale.

The site is accessed via a private driveway from the Princes Highway at a signalised intersection with Bellambi Lane. Coal has historically been hauled from Russell Vale Colliery to Port Kembla Coal Terminal (PKCT) by truck, via Bellambi Lane and Memorial Drive.

The Russell Vale Emplacement Area (RVEA) is located immediately north of the Colliery Pit Top and is largely located outside the Colliery Holding and not covered by this plan or a part of this project as it operates under a development consent issued by Wollongong City Council (WCC) on the 11 April 1990.

Works associated with the planned upgrade are all located within the existing disturbance footprint of the study area, and within the boundary and capacity of the approved Pit Top surface water management system described in detail in the RVC Surface Operations Water Management Plan.

1.4.2 Ventilation shaft sites

There are five shafts within the RVC UEP surface facilities area. Four are exclusively ventilation shafts (vent shaft sites 1-3, 5) and one a shaft for personnel, materials and ventilation (vent shaft 4), The Ventilation Shafts 1 to 5 and their sites are located within the WaterNSW Metropolitan Special Area. Each of the vent shaft sites is discussed below.

1.4.2.1 No.1 Shaft

No.1 Shaft is located on a surface lease approximately five kilometres northeast of the Russell Vale site. It is surrounded by native bushland within the WNSW Special Catchment Area and is accessed via one of the SCA owned fire trails leading off Mount Ousley Road. No.1 Shaft is an upcast ventilation shaft, which allows waste air to be removed from underground workings. The fan at No.1 Shaft has a capacity air flow rate of 90 cubic metres per second. It provides effective ventilation for selected sections of the mine and complements the other upcast No.5 Shaft located on the lease further to the west.

An NRE owned substation is located about 50m north of No.1 Shaft. At this location, the 33kV power supply from Russell Vale (now decommissioned) enters the switchyard to the transformer and the power is reduced to 6.6kV. This 6.6kV supply is then cabled to a transformer at No. 1 Shaft where the power was previously used to drive one of two 185kW motors. These motors are used to drive the fan with one of the motors available on standby.

This Vent shaft is not part of the current underground mining program as detailed in the UEP Extraction plan and the activities onsite consist of property and APZ maintenance only, requiring no specific water management systems, procedures, or monitoring.

1.4.2.2 No.2 Shaft

No.2 Shaft is located on a surface lease approximately 70m from the currently operating upcast No.1 Shaft. The site consists of an empty brick building and an old vent fan. Also in the area, located between the two shafts is the remains of a building, parts of a now disused belt driven air compressor and compressed air vessel. Parts of the shaft evase and fan are also present, along with a disused electrical switch yard and concrete block building.

No.2 Shaft is an old ventilation shaft, which has been, decommissioned. The shaft has not been used for ventilation purposes for over 40 years. This Vent shaft is not part of the current underground mining program as detailed in the UEP Extraction plan and the activities onsite consist of property and APZ maintenance only, requiring no specific water management systems, procedures, or monitoring.

1.4.2.3 No.3 Shaft

No.3 Shaft was for previous mining used as a downcast ventilation shaft providing clean air to the underground workings. It is surrounded by native bushland within the WNSW Metropolitan Special Area and is accessed via fire trails.

The site consists of a 33kV power supply corridor with some lines and poles and a concrete slab that previously was the base for a disused switch yard, and associated buildings. The actual shaft has a steel mesh sheet across the top of it and is surrounded by a chain wire fence and low vegetation regrowth. This Vent shaft is not part of the current underground mining program as detailed in the UEP Extraction plan and the activities onsite consist of property and APZ maintenance only, requiring no specific water management systems, procedures, or monitoring.

1.4.2.4 No.5 Shaft

No.5 Shaft is an upcast ventilation shaft allowing waste air to be removed from the underground workings as was a component of previous workings. The No.5 Shaft site includes a compressed air facility, and power and water delivery pipeline to underground.

The site is accessed via a fire trail leading from No.4 Shaft and is located on a part of CCL 745 that includes the surface land, approximately 11km north-west of the Russell Vale site. It is surrounded by native bushland within the WNSW Metropolitan Special Area.

This Vent shaft is not part of the current underground mining program as detailed in the UEP Extraction plan and the activities onsite consist of property and APZ maintenance only, requiring no specific water management systems, procedures, or monitoring.

1.4.2.5 No. 4 shaft

The Number 4 Shaft (No. 4 shaft) and associated facilities, located approximately 10km north-west of the Russell Vale site, is accessed by Fire Trail No.8 north of Picton Road. The No.4 shaft is surrounded by native bushland within the WaterNSW Metropolitan Special Area. No 4 Shaft site is a cleared site with rehabilitated areas predominantly grassed bordering naturally vegetated areas (**Figure 2**).

The No.4 Shaft has previously been used for moving men and materials between the underground workings and surface facilities. Site facilities include a winder, offices, bathhouse, stores, workshop, a car parking area, water management facility, sewage treatment plant, electrical sub-station and explosives magazine. No power is currently supplied by the decommissioned electrical substation, rather the site is powered by a solar array and Tesla Battery.

This Vent shaft is not part of the current underground mining program as detailed in the UEP Extraction plan and the activities onsite consist of property maintenance inclusive of the solar array and battery, the sewerage treatment ponds (no longer in use), and APZ maintenance only, requiring no specific water management systems, procedures, or monitoring.

Figure 1 Location of the Russell Vale Colliery, New South Wales

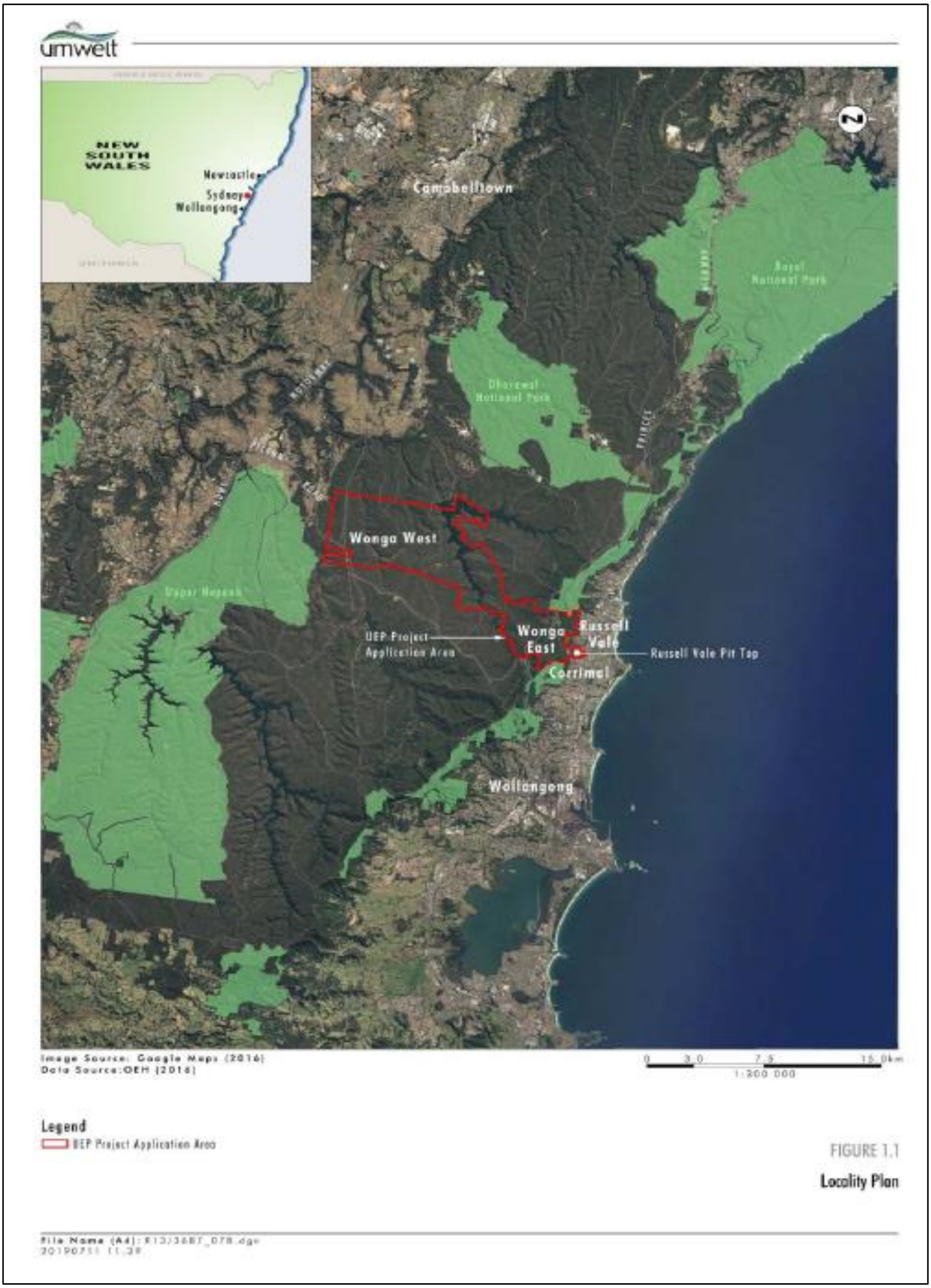
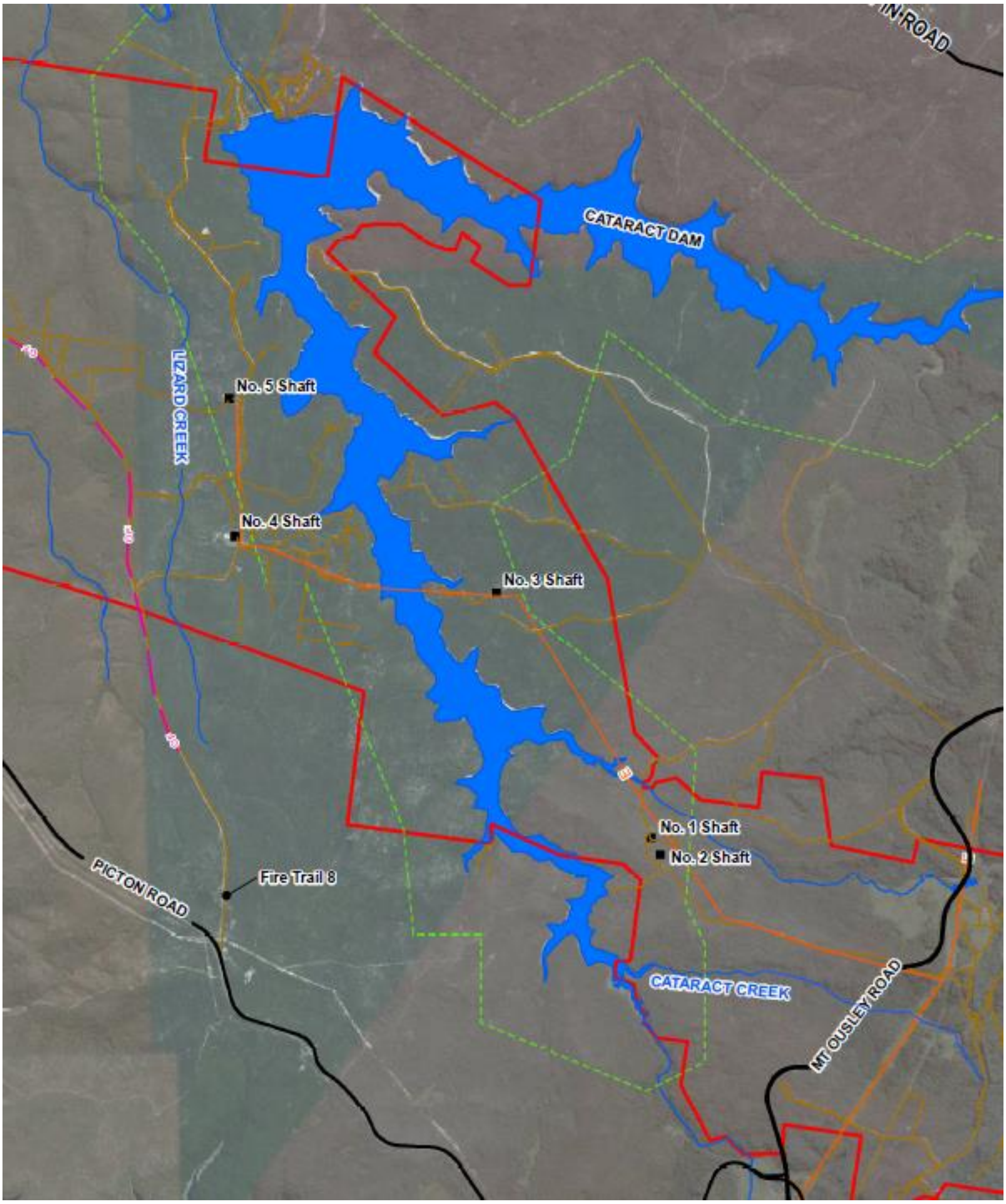


Figure 2 Russel Vale Colliery ventilation shaft study areas (Vent shaft 1,2,3)



1.5 Report Structure

The remainder of this SoBMP is structured as follows:

Chapter	Content
Section 1	Provides the background, purpose and structure of this Management Plan, outlines the conditions of consent, document scope, as well as consultation requirements and outcomes.
Section 2	Outlines the statutory requirements applicable to the BMP.
Section 3	Outlines the consultation and details where this consultation has been addressed in this plan
Section 4	Details the required statutory conditions from the Consent, the RPPR, and legislation.
Section 5	Outlines the baseline data and impact assessments undertaken which support this BMP.
Section 6	Describes the potential impacts of the proposal
Section 7	Details the performance measures and indicators that will be used to assess the UEP.
Section 8	Describes the monitoring program and its associated reporting
Section 9	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 10	Describes the protocols for the handling of incidents, complaints and non-conformances.
Section 11	Details how the BMP will be implemented, managed, reviewed and updated.
Section 12	Audit and Review
Section 13	Record Keeping and Document Control
Section 14	Plan References
Section 15	Plan Glossary of terms and abbreviations
Appendix A	Records of Agency consultation
Appendix B	Erosion and Sediment control Plan
Appendix C	Pit Top Surface Water Management Plan
Appendix D	Groundwater Plan

Appendix E	Site Water Balance
Appendix F	Salt Balance
Appendix G	Staging of the Water Management Plan

1.6 Environmental Management System Overview

WCL has a formalised environmental management system (EMS) for the Colliery (Wollongong Coal 2021a). The EMS provides a framework to ensure that activities at the Colliery are undertaken in an environmentally responsible manner, and are in general accordance with the following:

- NSW State Development consent MP09_0013;
- EPBC Approval (2020/8702)[1];
- ISO14001 Environmental Management Standard; and
- legislative and other requirements such as the site EPL.

The structure of the EMS is summarised in **Figure 4.** The EMS is implemented, managed, and updated as required, most recently in accordance with the Russell Vale Underground Expansion Project major project approval MP09_0013 ('the consent').

This SOWMP also forms part of RVC's Environmental Management System and should be read in conjunction with the RVC Environmental Management Strategy. All incidents reported at RVC, including water-related incidents, are managed in accordance with the RVC Pollution Incident Response Management Plan (PIRMP) (***RVC EC PLN 022***).

1.6.1 Water Management Plan Structure

This SOWMP is part of a set of documents that have been developed to manage surface and groundwater impacts for Russell Vale Colliery (refer to **Figure 3**). The contents of this overarching SOWMP covers the general conditions of consent and general information, which is applicable to all sub plans, with the sub plans providing the specific detail on the relevant water management practices and process. This SOWMP should also be read in conjunction with the Salt Balance, Site Water Balance and following discrete sub-plans, which are appended to this plan:

- Erosion and Sediment Control Plan (ESCP).
- Pit Top Surface Water Management Plan (SWMP).
- Groundwater Management Plan (GWMP).

[1] Noted as being in draft form at the completion of this management plan.

Figure 3 Water Management Plan Structure

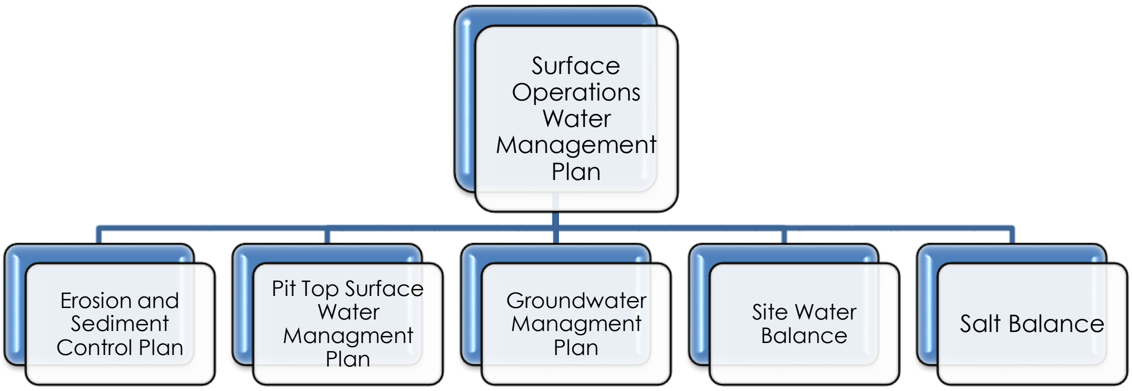
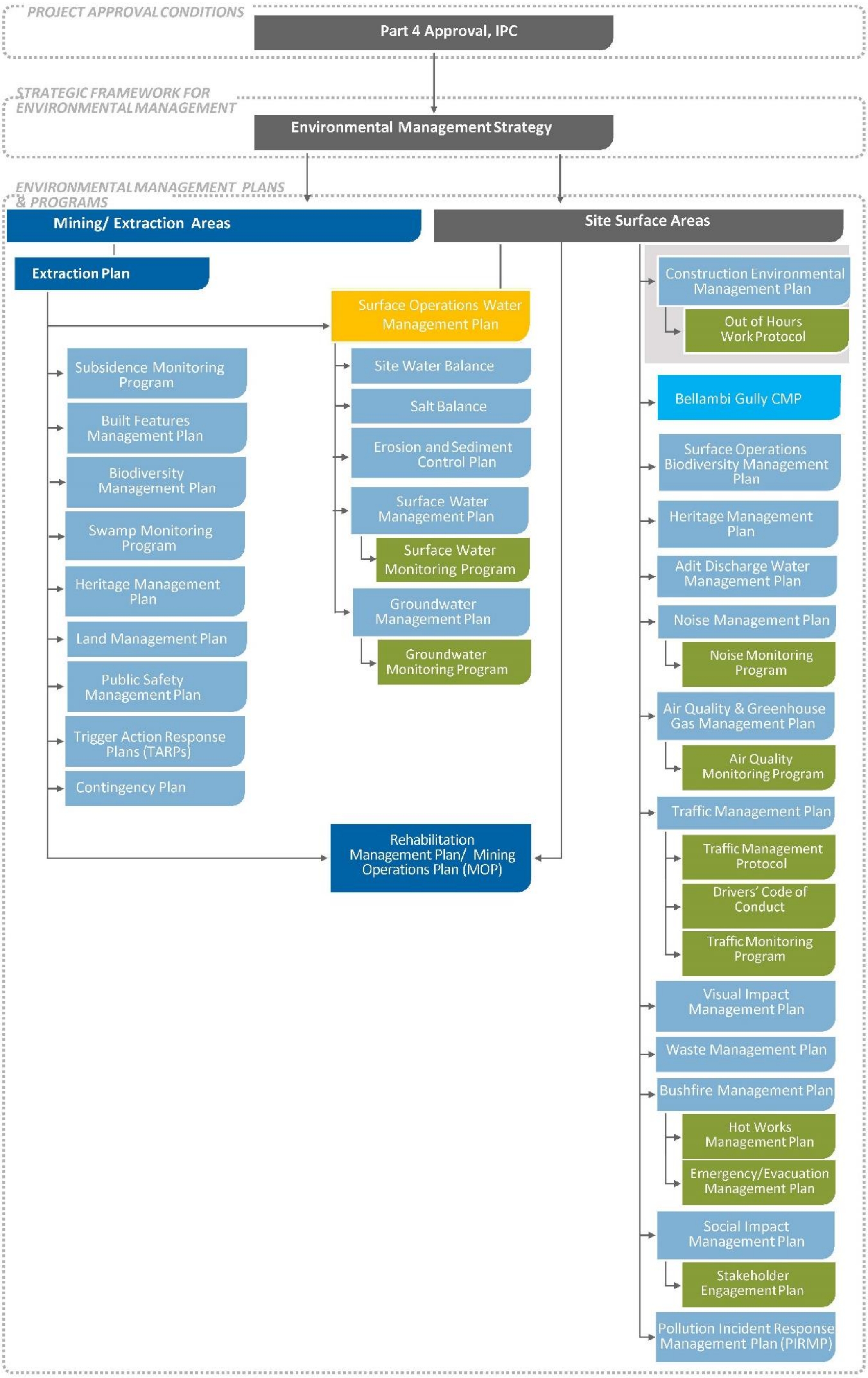


Figure 4 Environmental Management Framework (from EMS)



2 PROJECT DESCRIPTION

2.1 Project Overview – Surface Infrastructure

The project involves a revised mine plan that has been designed to have negligible subsidence to address potential subsidence-related mining impacts on groundwater, surface water and biodiversity within the Cataract Reservoir catchment.

The project also involves changes to the Russell Vale Pit Top (the Pit Top), which includes key project components (i.e. surface infrastructure) requiring construction.

The current and proposed surface infrastructure are presented in **Figure 5** and **Figure 6** to **Figure 8** respectively.

The key elements of the project are:

- mining by bord and pillar mining techniques only with the workings designed to be long-term stable with minimal subsidence impacts.
- extraction of approximately 3.7 million tonnes of Run-of-Mine (ROM) coal at a reduced production rate of up to 1 million tonnes of product coal per year (equivalent to approximately 1.2 million tonnes of ROM coal per year).
- redesign of the Pit Top layout to relocate infrastructure to more shielded locations to reduce amenity impacts.
- operation of surface facilities and product transport, typically limited to daytime hours (7.00am to 6.00pm Mondays to Friday, 8.00am to 6.00pm Saturday, no Sundays and Public Holidays), with provision for occasional operation until 10.00pm Monday to Friday to cater for unexpected port closures or interruptions.
- reduced product trucking rates relative to the previous UEP mine plan with a maximum of 17 trucks permitted per hour.
- 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 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.

2.2 Project Staging

The project will be implemented in stages as per below with the scope of this Plan covering all stages:

- **Stage 1**

Installation of environmental monitoring controls and mitigation measures, truck access roads, construction of new noise walls, noise bunds and new primary sizer.

Commencement of mining operations ramping up to approximately 0.5 Mtpa with crushed coal transferred to ROM stockpile and coal loading via front-end loader to trucks to be transported to PKCT.

Evaluation of the feasibility of a coal processing plant (CPP) to be installed as part of the new Stage 2 surface infrastructure.

Key elements included in Stage 1 Works include (See **Figure 6**):

- Development and mining by bord and pillar mining
- Up to 500,000 tonnes of product coal per year
- Installation of new primary sizer inline
- Front end loading ROM coal onto trucks
- ROM Stockpile 30,000 tonnes
- Construction of surface infrastructure works, including construction of new noise walls, noise bunds, truck access roads, and commissioning the design and construction of the truck loading bin and associated conveyers.

A copy of the Stage 1 surface infrastructure is provided in **Figure 6**.

- **Stage 2**

Finalise the construction and commissioning of new surface infrastructure, comprising truck loading bins and associated conveyors.

The coal will be transferred from the ROM stockpile through a series of conveyors to the truck loading bin to be loaded onto the trucks for transportation to PKCT or transferred to a new stockpile area for temporary stockpiling.

Coal from temporary stockpile will be loaded onto trucks by front-end loader for transportation to PKCT (Stage 2A – see **Figure 7**).

If the outcome of the evaluation in Stage 1 is to construct a CPP, the coal from the ROM stockpile will transferred by a series of conveyors to the CPP (Stage 2B – see **Figure 8**).

The product from the CPP will transferred to the truck loading bin to be loaded onto the trucks for transportation to PKCT or transferred to a new stockpile area for temporary stockpiling.

Coal from temporary stockpile will be loaded onto trucks by front-end loader for transportation to PKCT. The rejects conveyor will transfer the rejects from the CPP to the rejects stockpile (Stage 2B).

Commencement of full mining operations ramping up to 1.2 Mtpa to align when the new coal handling facilities and associated infrastructure is fully operational.

Key elements included in Stage 2 Works include:

- Mining by bord and pillar mining
- Up to 1 Million tonnes of product coal per year
- Up to 1.2 Million tonnes ROM coal per year
- Loading product coal onto trucks via bins
- Construction of new CPP
- Construction new surge bin
- ROM Stockpile 30,000 tonnes
- Product Stockpile 14,000 tonnes
- Emergency Stockpile
- Rejects stockpile 1,500 tonnes

- Waste rock from CPP used in rehabilitation
- Waste Rock from CPP emplaced underground

2.2.1 Coal Handling and Processing

The proposed coal handling facilities and surface infrastructure upgrades proposed as part of the Revised Preferred Project will be undertaken in accordance with the UEP Project Consent under the NSW EP&A Act to improve the quality of ROM coal in order to meet market demands and to minimise impacts on the environment and local community.

Works associated with the planned upgrade are all located within the existing disturbance footprint of the study area. The planned upgrades to the existing surface infrastructure within the study area (**Figure 5**) are shown on **Figure 6** to **Figure 8**.

2.2.2 Reject Material Handling

Following commissioning of a suitable CPP, if the company determines that it is financially viable to install the CPP as outlined in **Section 1.3**, it is anticipated that approximately 0.2 Mtpa of reject material will be produced at full production. Reject material consisting of rock material from the CPP will be transferred via the rejects conveyor to the reject stockpile (see **Figure 8**).

Beneficial reuse would be dependent on further application and or approval, whilst Underground emplacement would only be carried out if testing determines the material to be suitable – see RVC Waste Management Plan.

Reject material that after suitable testing meets the specifications (see Waste Management Plan *RVC ENV PLN 033*) are hauled back to the mine portal via the internal haul road (see **Figure 5**) for emplacement underground.

2.2.3 Coal Stockpiling

Three main coal stockpiles will operate within the Pit Top operational area, these being the main ROM stockpile (30,000 tonne (t) capacity), product stockpile (14,000 t capacity) and proposed temporary rejects stockpile (1,500 t capacity).

2.3 Bellambi Gully Creek

The RPPR describes proposed Bellambi Gully Creek realignment works as being a part of a modification to the previous project consent MP10_0046, i.e., MOD 4. The Modification was subsequently withdrawn, and the project was included in the UEP major project application. Subsequent to the issue of the RPPR in July 2019, and the UEP Additional Information Response Report in June 2020, on 23 July 2020 WCL was issued with an enforcement order by DPIE in relation to the replacement of the underground section of Bellambi Gully pipe. Generally the order requires WCL to engage a suitably qualified independent licensed engineer to develop detailed plans for the replacement of the underground pipe section of Bellambi Gully Creek with a suitably designed and engineered open channel, generally in accordance with the design parameters outlined in *Cardno 2020 Phase 1 and 2 Bellambi Gully Flood Assessment Proposed Stormwater Diversion Drain*.

As a result of and in compliance with this order the detailed design for Bellambi Gully Diversion and associated site water management system improvements was completed in late 2020 with works commencing onsite post approval of the Construction Management Plan (CMP) by DPIE in

April 2021. The construction works associated with the construction of the new diversion channel and associated site water management system improvements are reasonably expected to be completed by November 2021 are addressed in the Bellambi Gully Creek Diversion CMP. The operation of this new channel once completed in accordance with the DPIE order will be detailed in a specific maintenance plan inclusive of an implementation plan which would be included as appropriate in the RV Surface Operations Water Management Plan. This is shown in the context of the site EMS in **Figure 4**.

2.4 Rehabilitation

WCL intends to continue use of the site post the 5-year term of this MP09_0013 Consent. As a result, decommissioning and closure of the Russell Vale Colliery Pit Top facilities are not proposed following the completion of the UEP project.

Rather, if required pending the completion of the 5-year term of the current approval if there are delays to expected future planning assessment process such that mining operations are required to cease the site would be maintained in care and maintenance capacity until such time as a planning consent for mining operations is obtained. If consent for continuing use of the site is at the times not anticipated to be forthcoming, WCL will prepare and implement a detailed mine closure and rehabilitation plan in consultation with the Resources Regulator and other relevant government agencies and stakeholders.

For this project term of 5 years from the date of commencement of mining operations, the existing rehabilitation and mine closure strategy outlined in the current Russell Vale Colliery Rehabilitation Management Plan or its equivalent Mine Operations Plan, and generally in accordance with the Rehabilitation Objectives detailed in Table 5 of the Development Consent.

WCL will continue to progressively rehabilitate and decommission non-critical infrastructure as they are phased out of operations or become non-critical to potential future land use options at the Colliery. This will be further detailed in the Rehabilitation Management Plan or combined with the Mining Operations Plan as detailed in the RVC EMS (see **Figure 4**) and in accordance with **Condition B44.**

2.5 Environmental Duty of Care

WCL will 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 the consent.

Figure 5 Existing Russell Vale Colliery Pit Top.

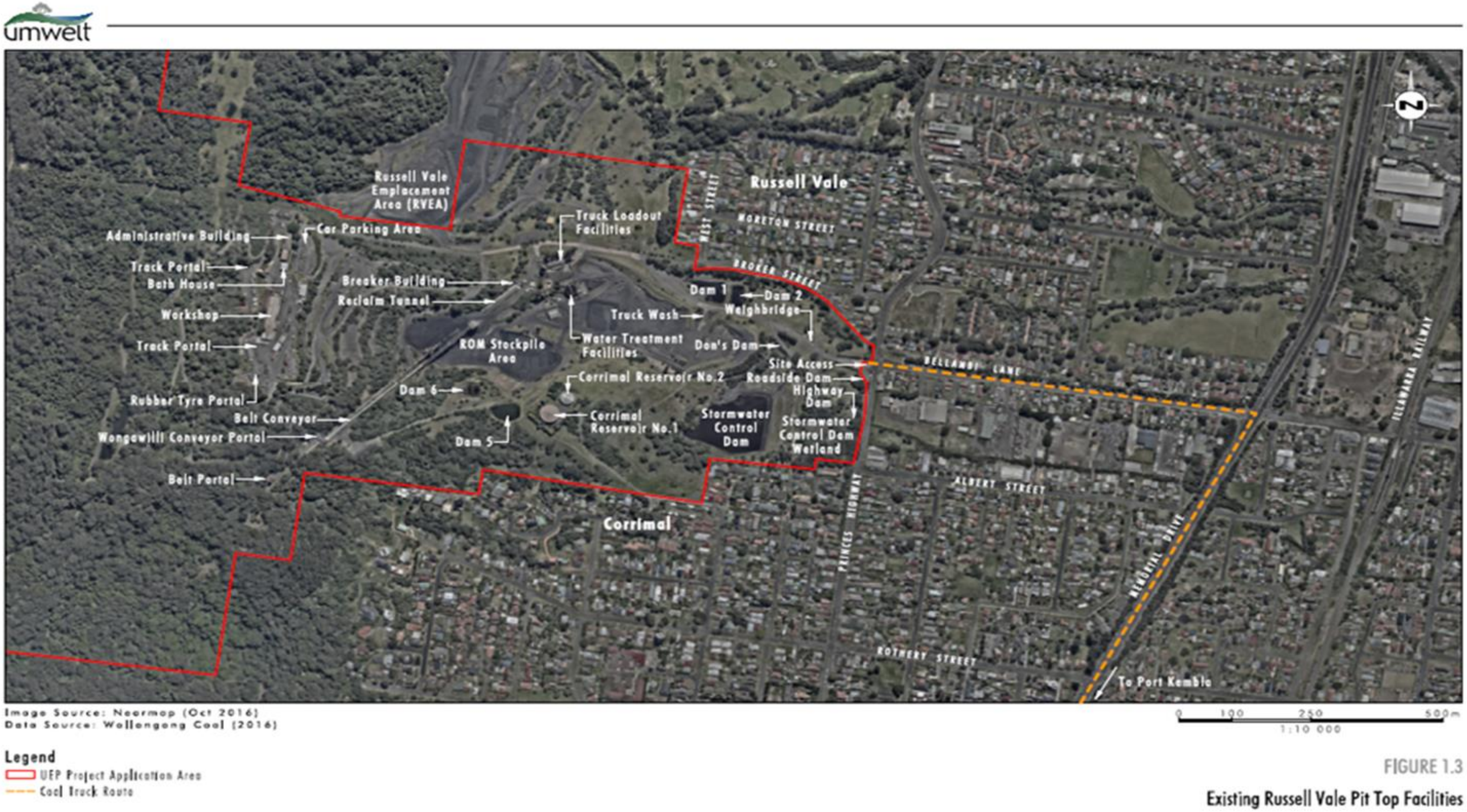


Figure 6 Proposed Stage 1 without surface infrastructure.

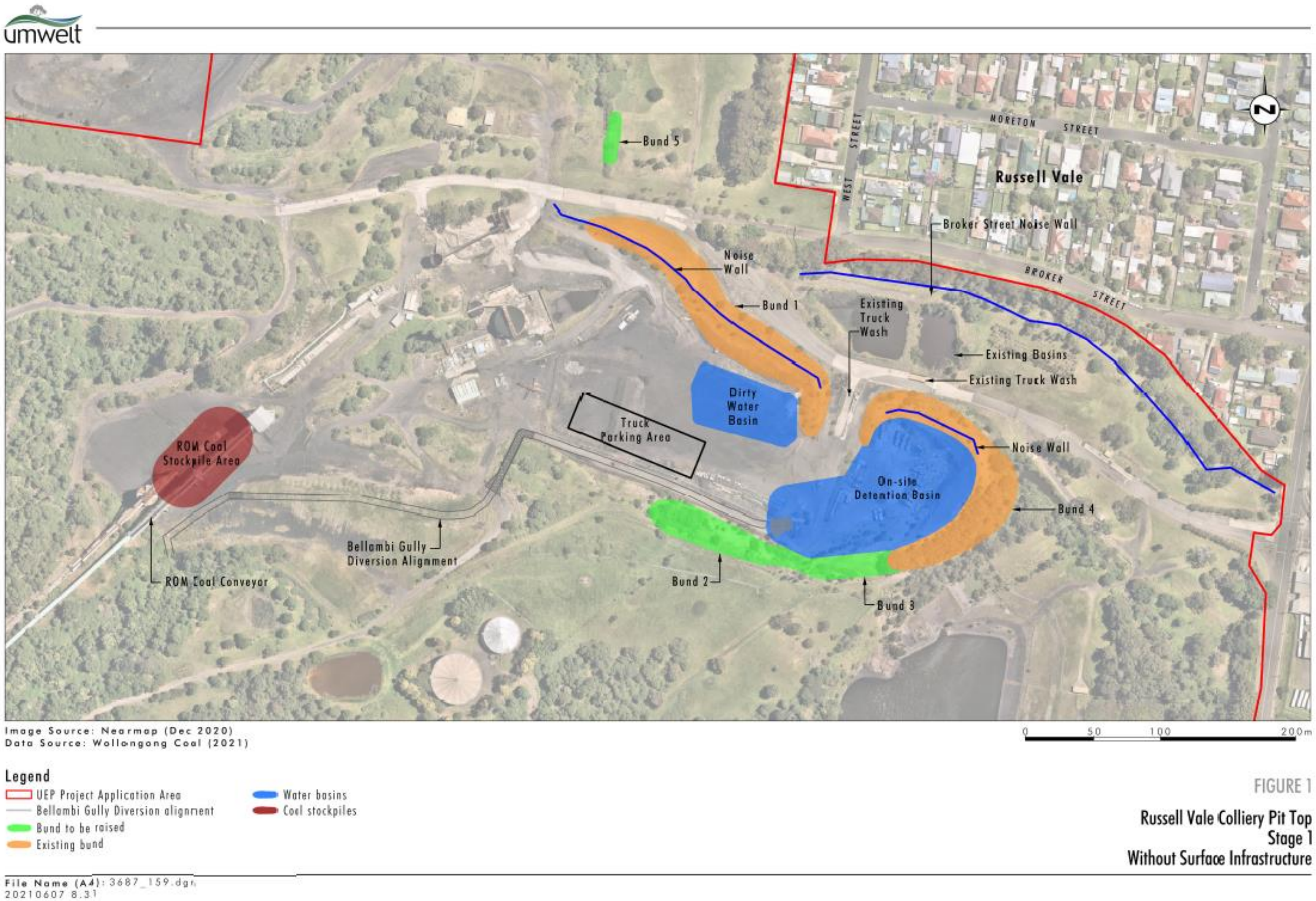


Figure 7 Proposed Stage 2A surface infrastructure components without coal processing plant.

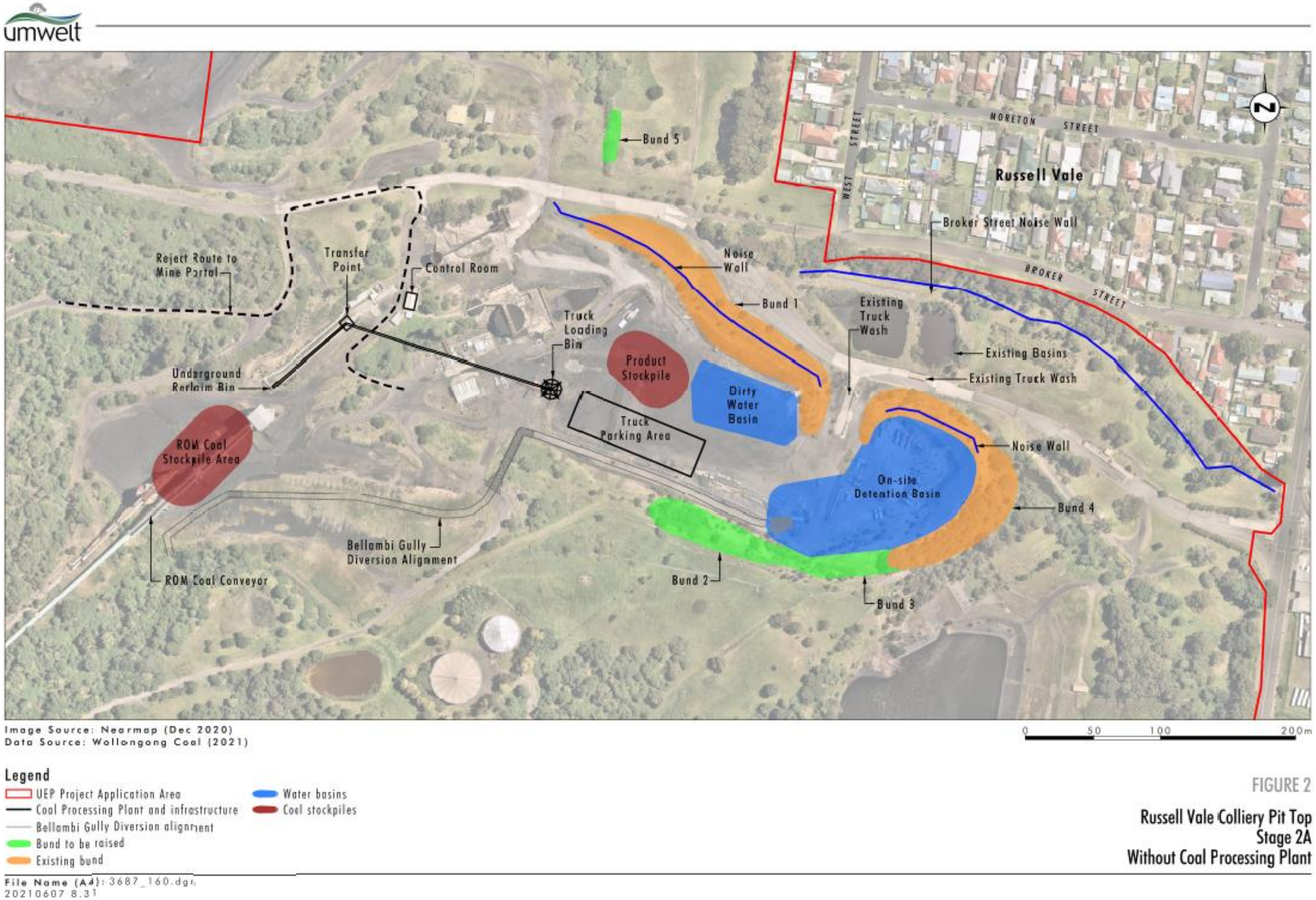
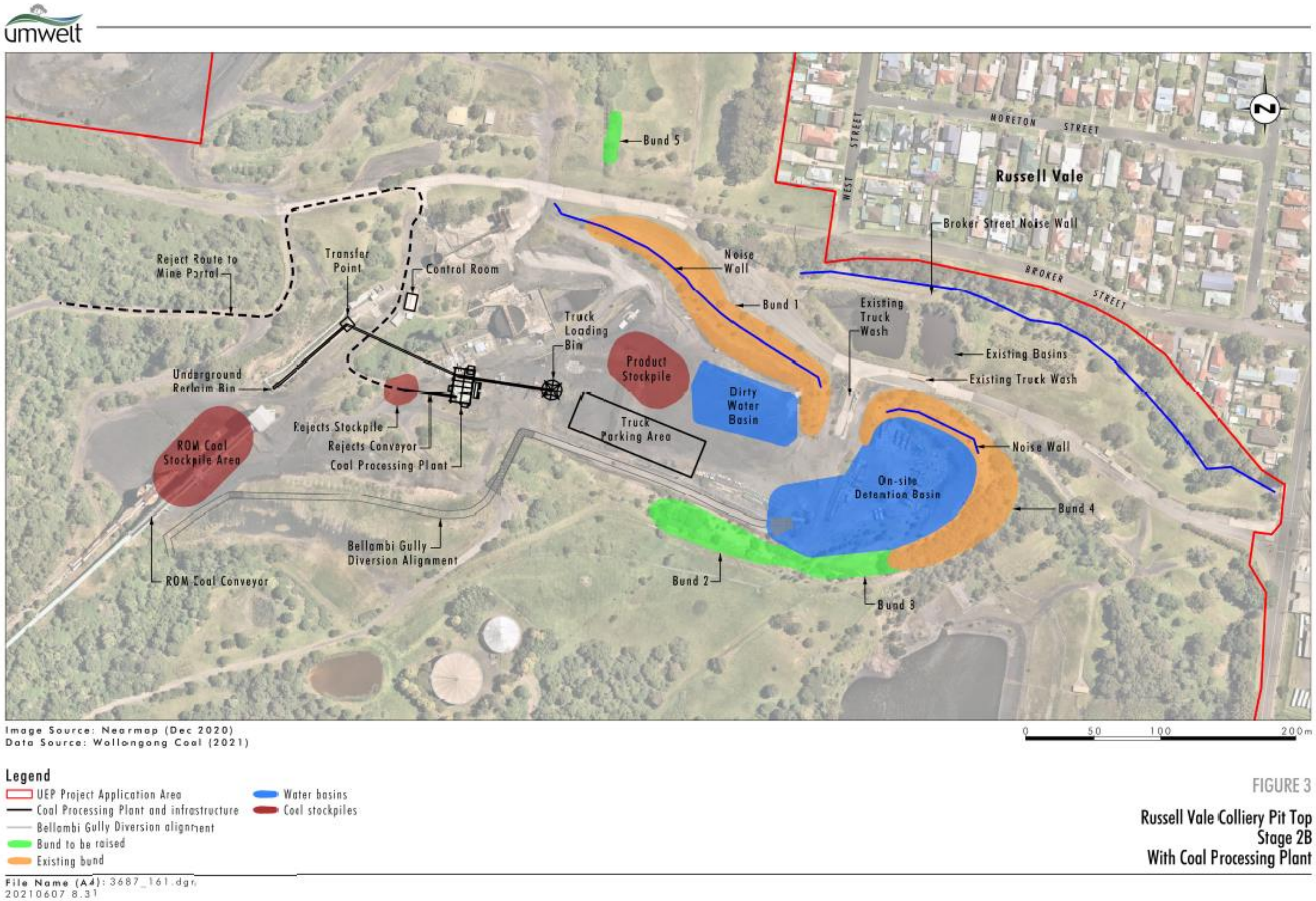


Figure 8 Proposed Stage 2B surface infrastructure components with coal processing plant.



3 CONSULTATION

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 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 SOWMP included:

- The Department of Planning, Industry and Environment (DPIE).
- WaterNSW.
- NSW Department of Planning, Industry & Environment – Water Group (DPIE Water).
- Wollongong City Council (WCC).
- NSW Natural Resource Area Regulator.
- NSW EPA

3.2 Consultation during the Preparation of the Management Plan

This SOWMP, including its sub-plans, has been prepared in consultation with the following state and local agencies as required by **Condition A20** and **Schedule 2, Conditions B17(b)**:

- NSW Department of Planning, Industry & Environment – Planning Group
- NSW Department of Planning, Industry & Environment – Water Group (DPIE Water)
- Wollongong City Council (WCC)
- NSW Environment Protection Authority (EPA).
- Water NSW.

Details of the consultation are provided in **Table 1** below and **Appendix A**.

Table 1 Results of Agency Consultation.

Agency	Feedback	Where addressed in Management Plan
NSW Department of Planning, Industry & Environment – Planning Group	▪ Various comments on the Water Management Plan received from DPIE on 22 July 2021.	See **Appendix A** for details. Updates included through this plan.
NSW Department of Planning, Industry &	▪ Deferred to NRAR	DPIE Water referred WCL to consult with NRAR as the appropriate agency.

Agency	Feedback	Where addressed in Management Plan
Environment – Water Group (DPIE Water)		
Wollongong City Council (WCC)	▪ Works within riparian area ▪ [Coal] stockpiles constructed at least 2 metres from hazard areas ▪ Clean water diversion ▪ Progressive rehabilitation	Minimal works proposed. Extent of riparian area considered to be minimal and generally no longer within the project area. Design includes separation measures (e.g., berms) where required. Dirty water management system in place to manage runoff from operational areas, separate from the clean water management system. Intent of the Bellambi Gully project is to separate the clean water from dirty water. Progressive rehabilitation is to be undertaken, as per the rehabilitation plan, to allow for the progressive release of catchment areas.
NSW Environment Protection Authority (EPA)	▪ A separate TARP was [previously] developed specifically for detection of highly turbid discharges from the premises using the continuous on-line monitors at LDP 11 and 12	Additional TARP for turbidity added to the Surface Water Management Plan (**Appendix C**)
Water NSW.	▪ The [pit top area is] outside the Sydney Drinking Water Catchment and Special Areas. WaterNSW therefore have no specific comments on this plan.	-
Additional consultation above approval requirements		
NRAR	*WCL was referred to consult with NRAR by DPIE Water. NRAR Comments:* Prior to approval: ▪ Correct the consultation section and the referenced consultation appendix. ▪ The mine pump groundwater extraction exceeds trigger criteria	Consultation Corrected, See **Appendix A** Agreed, groundwater pumping TARPs and trigger criteria are

Agency	Feedback	Where addressed in Management Plan
	must not be contingent upon the occurrence of subsidence. Not required prior to approval: ▪ Install all additional proposed monitoring sites (swamp and groundwater) at least two year's prior to site undermining to enable collection of data for the required minimum period. ▪ Monitor only swamps not undermined to represent baseline conditions in the Swamp Management Plan. Undermined but minimally impacted swamps must continue to be monitored and used as comparative indicators.	independent of subsidence measurements (see **Table 17** & TARPs in **Appendix D**), however, the response to any TARP triggers is informed by subsidence measurements and any other relevant information available at the time. These two comments relates to the monitoring under the Extraction Plan under Condition C10. As such it is not relevant to this plan and will be addressed in the Water Management Plan being developed under Condition C10(g) (iii)
DAWE	▪ Draft EPBC Approval Conditions: The approval holder must provide the Department (DAWE) with the final version of the plan within 10 business days of their approval by the NSW Planning Secretary.	Agreed, Approved Water MP to be provided to DAWE within 10 Business days of being approved by the NSW Planning Secretary.

4 STATUTORY REQUIREMENTS

4.1 Overview

A number of approvals, licences and consents apply to the project, with associated conditions and requirements. The following sections summarise those that are most relevant in relation to this Management Plan.

WCL will conduct all approved activities consistent with the approval and any other legislation that is applicable (**Condition A2**), in order to minimise environmental harm (**Condition A1**).

With regard to Biodiversity and Surface operations WCL will ensure that all plant and equipment used at the site is maintained in a proper and efficient condition; and operated in a proper and efficient manner in accordance with **Condition A27**.

In accordance with **Condition B5** WCL will ensure implementation of this Management Plan as is required prior to the commencement of mining operations, once approved by the Secretary.

4.1.1 Erosion and Sediment Control

Erosion and sediment control will be implemented and undertaken in accordance with the RVC Erosion and Sediment Control Plan (ESCP) (**Appendix B**). The ESCP, prepared to address the requirements of **Schedule 2, Condition B17(f)(iii)**, applies to all activities undertaken by RVC that have the potential to result in the triggering of erosion processes and the export of sediment-laden water into the downstream environment. The ESCP has be developed in accordance with the guidance series; *Managing Urban Stormwater: Soils and Construction - Volume 2E: Mines and Quarries (DECC 2008),* and all ERSED controls are to be designed, installed and maintained in accordance with these guidelines and the ESCP.

The objectives of the ESCP are to:

- Comply with the regulatory requirements set out in the Russell Vale Revised Underground Expansion Project (UEP) Development Consent Conditions and Environment Protection Licence (EPL) 12040.
- Identify activities that could cause erosion and generate sediment or affect flooding.
- Describes measures to minimise soil erosion and the potential for the transport of sediment to downstream waters, and to manage flood risk.
- Describe the location, function and capacity of ESC structures and flood management works.
- Provide that ESC structures are appropriately maintained.
- Provide methods to assess compliance with conditions of development consents, environmental protection licences and legislation relating to surface waters.
- Meet the requirements of the Blue Book (Managing Urban Stormwater: Soils and Construction Volumes 1 and Volume 2E); and
- Provide employees and contractors with a clear and concise description of their responsibilities in relation to erosion and sediment control (ESC) during the operation of the mine.

4.1.2 Pit Top Surface Water Management Plan

This Pit Top Surface Water Management Plan (SWMP) (**Appendix C**) has been prepared as part of a suite of water management plans to satisfy ***Condition B17/ Schedule 2*** and the relevant sections of ***Condition C10/Schedule 2*** of the Project Approval (MP09_0013) with consideration of the regulatory and licencing requirements.

The objectives of the SWMP are to:

- provide methods to monitor potential impacts to surface quantities and qualities.
- identify potential impacts associated with the mining operations on surface water resources; and
- provide appropriate mitigation measures and responses where necessary.

4.1.3 Groundwater Management Plan

This Groundwater Management Plan (GWMP) (**Appendix D**) relates to the groundwater systems potentially impacted by the approved operations. This Plan was prepared as a part of the SOWMP as required by ***Condition B17/ Schedule 2*** and the relevant sections of ***Condition C10/Schedule 2*** of the Project Approval (MP09_0013) with consideration of the regulatory and licencing requirements.

4.2 State UEP Approval Conditions

Condition B17 of the Development Consent outlines the requirements for the Water Management Plan. **Table 2** indicates where each component of the condition is addressed within this Plan.

Table 2 Project Approval Conditions

PROJECT APPROVAL CONDITION	WHERE ADDRESSED IN THIS PLAN
Condition A1 – Obligation to Minimize 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."*	**Section 4.1**
Condition A2 – Terms of the Consent *The development may only be carried out:* (a) *in compliance with the conditions of this consent;* (b) *in accordance with all written directions of the Planning Secretary; and* (c) *Generally, in accordance with the RPPR and the Development Layout.*	**Section 4**
***Condition A20* – Evidence of Consultation**	

PROJECT APPROVAL CONDITION	WHERE ADDRESSED IN THIS PLAN
Where conditions of this consent require consultation with an identified party, the Applicant must: *(a) consult with the relevant party prior to submitting the subject document; and* *(b) provide details of the consultation undertaken including:* **i.** *the outcome of that consultation, matters resolved and unresolved; and* **ii.** *details of any disagreement remaining between the party consulted and the Applicant and how the Applicant has addressed the matters not resolved.*	**Section 3** and **Appendix A**
Condition A21 – Staging, Combining, and Updating strategies, plans, or programs. With the approval of the Planning Secretary, the Applicant may: a) 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); b) combine any strategy, plan or program required by this consent (if a clear relationship is demonstrated between the strategies, plans or programs that are proposed to be combined); and c) update any strategy, plan or program required by this consent (to ensure the strategies, plans and programs required under this approval are updated on a regular basis and incorporate additional measures or amendments to improve the environmental performance of the development).	**Section 1.3** and **2.2**
Condition A27 Operation of Plan and Equipment. The Applicant must ensure that all plant and equipment used at the site is:" (a) maintained in a proper and efficient condition; and (b) operated in a proper and efficient manner.	**Section 10.1**
Condition A28 – Compliance The Applicant must ensure that all of its employees, contractors (and their sub-contractors) are made aware of, and are instructed to comply with, the conditions of this consent relevant to activities they carry out in respect of the development."	**Section 11.3**
Schedule 2, Condition B12 – Water Licences The Applicant must obtain all necessary water licences for the development, including during rehabilitation and following mine closure,	**Section 5.3** and **Table 8**

PROJECT APPROVAL CONDITION	WHERE ADDRESSED IN THIS PLAN
under the *Water Act 1912* and/or the *Water Management Act 2000* prior to the take of water occurring.	
Schedule 2, Condition B13 – Water Supply The Applicant must ensure that it has sufficient water for all stages of the development, and if necessary, adjust the scale of the development to match its available water supply.	**Section 6.1.1** and **Appendix E**
Schedule 2, Condition B14 – Water Supply The Applicant must report on water extracted from the site each year (direct and indirect) in the Annual Review, including water taken under each water licence.	**Section 6.1.1, Section 12.4** and **Appendix D** (GWMP)
Schedule 2, Condition B15 – Water Discharges The Applicant must ensure that all surface discharges from the site comply with: (c) discharge limits (both volume and quality) set for the development in any EPL; or (d) relevant provisions of the POEO Act.	**Section 5.1.5**
Schedule 2, Condition B16 – Water Performance Measures The Applicant must ensure that the development does not cause any exceedance of the performance measures in Table 4, to the satisfaction of the Planning Secretary.	**Section 7**
Schedule 2, Condition B17 – Water Management Plan The Applicant must prepare a Water Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:	
(a) be prepared by a suitably qualified and experienced person/s;	**Section 1.1**
(b) be prepared in consultation with WCC, DPIE Water, WaterNSW and the EPA;	**Section 3**
(c) be approved by the Secretary prior to the commencement of mining operations under this consent;	**Section 4.1**
(d) describe the measures to be implemented to ensure that the Applicant complies with the water management performance measures;	**Section 7** and **8** **Section 4 of Appendix C** (SWMP) **Section 8** of **Appendix D** (GWMP)
(e) build on existing monitoring programs, where practicable;	**Section 4** of **Appendix C** (SWMP) and **Section 7** of **Appendix D** (GWMP)
(f) include a: (i) **Site Water Balance** that includes details of:	

PROJECT APPROVAL CONDITION	WHERE ADDRESSED IN THIS PLAN
• predicted annual inflows to and outflows from the site. • sources and security of water supply for the life of the development (including authorised entitlements, licences and harvestable rights). • water storage capacity. • water use and management on the site, including any water transfers or sharing with other industries. • licensed discharge points and limits; and • reporting procedures, including the annual preparation of an updated site water balance;	**Section 6.1** and **Appendix E**
(ii) **Salt Balance** that includes details of: • sources of saline material on the site. • saline material and saline water management on the site. • measures to minimise discharge of saline water from the site; and • reporting procedures, including the annual preparation of an updated salt balance;	**Section 6.2** and **Appendix F**

(iii) **Erosion and Sediment Control Plan** that:
• is consistent with the requirements of Managing Urban Stormwater: Soils and Construction - Volume 1: Blue Book (Landcom, 2004) and Volume 2E: Mines and Quarries (DECC, 2008).
• identifies activities that could cause soil erosion, generate sediment or affect flooding.
  • includes a program to review the adequacy of flood protection works, and ensure they comply with the relevant performance measures.
  • describes measures to minimise soil erosion and the potential for the transport of sediment to downstream waters and manage flood risk.
  • describes the location, function, and capacity of erosion and sediment control structures and flood management structures; and
  • describes what measures would be implemented to maintain (and if necessary, decommission) the structures over time;
	Section 4.1.1 and ESCP (**Appendix B**)

(iv) **Surface Water Management Plan** that:
• Is consistent with the Guidelines for Controlled Activities on Waterfront Land (NRAR, 2018).
• Includes detailed baseline data on surface water flows and quality of watercourses and/or water bodies potentially impacted by the development, including:
  - stream and riparian vegetation health.
  - channel stability (geomorphology); and
  - water supply for another surface water users.
• Includes a detailed description of the surface water management system.
	Section 4.1.2 (description), **Section 8.1** (monitoring) and **Appendix C** (SWMP)

PROJECT APPROVAL CONDITION	WHERE ADDRESSED IN THIS PLAN
• Includes detailed plans, design objectives and performance criteria for water management infrastructure, including: - Any approved creek diversions or restoration works associated with the development, including details of the Bellambi Creek Diversion Works that were required under the Russell Vale Preliminary Works Project (MP10_0046). - Water run-off diversions and catch drains. - Water storages and sediment dams; and - Reinstated drainage networks on rehabilitated areas of the site. • Includes detailed performance criteria, including trigger levels for identifying and investigating any potentially adverse impacts (or trends) associated with the development, for: - Downstream surface water flows and quality. - Channel stability. - Downstream flooding impacts. - Stream and riparian vegetation heath. - Water supply for other water users; and - Post-mining water pollution from rehabilitated areas of the site. • Includes a program to monitor and evaluate: - Compliance with the relevant performance measures listed in Table 3 and the performance criteria in this plan - Controlled and uncontrolled discharges and seepage/leachate from the site. - Surface water inflows, outflows, and storage volumes, to inform the Site Water Balance; and - The effectiveness of the surface water management system and the measures in the Erosion and Sediment Control Plan; • includes reporting procedures for the results of the monitoring program, including notifying other water users of any elevated results; and includes a trigger action response plan to respond to any exceedances of the performance measures or performance criteria, and repair, mitigate and/or offset any adverse surface water impacts of the development;	
and (v) Groundwater Management Plan that includes: • Detailed baseline data of groundwater levels, yield, and quality for groundwater resources potentially impacted by the development. • A detailed description of the groundwater management system.	**Section 4.1.3** (description), **Section 8.2** (monitoring), and **Appendix D** (GWMP)

PROJECT APPROVAL CONDITION	WHERE ADDRESSED IN THIS PLAN
• Groundwater performance criteria, including trigger levels for identifying and investigating any potentially adverse groundwater impacts associated with the development, on: - regional and local aquifers (alluvial and hardrock); and - groundwater supply for other water users such as licensed privately-owned groundwater bores. • A program to monitor and evaluate: - 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, including from any final void. - 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. - The effectiveness of the groundwater management system. • Reporting procedures for the results of the monitoring program, including notifying other water users of any elevated results. • A 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; and • A 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; and	
(vi) A protocol to report on the measures, monitoring results and performance criteria identified above, in the Annual Review referred to in condition F11.	**Section 12.3** (monitoring results) and **Section 12.4** (annual reporting)
Schedule 2, Condition B44 – Rehabilitation Objectives The Applicant must rehabilitate the site in accordance with the conditions imposed on the mining lease(s) associated with the development under the *Mining Act 1992*. This rehabilitation must be generally consistent with the proposed rehabilitation strategy described in the RPPR and comply with the objectives in Table 5	**Section 10.2**

PROJECT APPROVAL CONDITION	WHERE ADDRESSED IN THIS PLAN
Schedule 2, Condition E1 **Notification of Exceedances** As soon as practicable, and no longer than 7 days after obtaining monitoring results showing: (a) an exceedance of any relevant criteria in PART B of this consent, the Applicant must notify affected landowners in writing of the exceedance, and provide regular monitoring results to these landowners until the development is again complying with the relevant criteria; and an exceedance of any relevant air quality criteria in PART B of this consent, the Applicant must also provide to any affected landowners and tenants a copy of the fact sheet entitled "Mine Dust and You" (NSW Health 2017).	**Section 12.6**
Schedule 2, Condition E2 **Independent Review** If an owner of privately-owned land considers the development to be exceeding the relevant criteria in PART B or PART C of this consent, then he/she may ask the Secretary in writing for an independent review of the impacts of the development on his/her land.	**Section 12.6**
Schedule 2, Condition E3 **Independent Review** If the Planning Secretary is not satisfied that an independent review is warranted, the Planning Secretary will notify the landowner in writing of that decision, and the reasons for that decision, within 28 days of the request for a review.	**Section 12.6**
Schedule 2, Condition E4 **Independent Review** If the Planning Secretary is satisfied that an independent review is warranted, within 3 months, or other timeframe agreed by the Planning Secretary and the landowner, of the Planning Secretary's decision, the Applicant must: (a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Planning Secretary, to: (i) consult with the landowner to determine their concerns; (ii) conduct monitoring to determine whether the development is complying with the relevant criteria in Part B and Part C; and (iii) if the development is not complying with the relevant criterion, identify measures that could be implemented to ensure compliance with the relevant criterion; and give the Planning Secretary and landowner a copy of the independent review.	**Section 12.6**

PROJECT APPROVAL CONDITION	WHERE ADDRESSED IN THIS PLAN
Schedule 2, Condition E5 **Independent Review** The Applicant must then comply with any written requests made by the Planning Secretary to implement any findings of the review and in accordance with any timeframes specified.	**Section 12.6**

4.3 Management Plan Conditions

Table 3 identifies where the specific management plan commitment from Part F of the Project Approval is addressed in this plan.

Table 3 Management Plan Commitments

Development consent	Plan Section
Condition F4 – Adaptive Management *The Applicant must assess and manage development-related risks to ensure that there are no exceedances of the criteria and/or performance measures in this consent. Any exceedance of these 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, the Applicant must, at the earliest opportunity:* *(a) take all reasonable and feasible steps to ensure that the exceedance ceases and does not reoccur;* *(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;* *to the satisfaction of the Secretary.*	**Section 9.7**
Condition F5 – Management Plan Requirements *Management plans required under this consent must be prepared in accordance with relevant guidelines, and include:* *(a) a summary of relevant background or baseline data;* *(b) details of:* *(i) the relevant statutory requirements (including any relevant consent, license or lease conditions);*	**(a) Section 2** of **Appendix C** and **Section 5** of **Appendix D** **(b)(i) Section 4**

Development consent	Plan Section
(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;* *(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;* *(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);* *(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;* *(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.* *(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.* ***Note**: The Planning Secretary may waive some of these requirements if they are unnecessary or unwarranted for particular management plans.*	**(b)(ii) Section 7** **(b)(iii) Section 5 of Appendix C & Section 8.4 of Appendix D** **(c) Section 4.5** **(d) Section 8** **(e)(i) Section 8** **(e)(ii) Section 6 of Appendix C & Section 8.3 of Appendix D** **(f) Section 9.5 & 9.7** **(g) Section 12.4** **(h)(i) Section 9** **(h)(ii) Section 9.6** **(h)(iii) Section 9** **(i) Section 13.2** **(i) Section 12.5**
Condition F6 – Management Plan Requirements *The Applicant must ensure that management plans prepared for the development are consistent with the conditions of this consent and any EPL issued for the site.*	**Section 4.4**
Condition F7– Revision of Strategies, Plans and Programs *Within three months of:* *(a) the submission of an incident report under condition F9;* *(b) the submission of an Annual Review under condition F11;* *(c) the submission of an Independent Environmental Audit under condition F13;*	**Section 12.5**

Development consent	Plan Section
or ***(d)*** *the approval of any modification of the conditions of this consent (unless the conditions require otherwise);* ***(e)*** *the suitability of existing strategies, plans and programs required under this consent must be reviewed by the Applicant.*	
Condition F8– Revision of Strategies, Plans and Programs *If necessary, to either improve the environmental performance of the development, cater for a modification or comply with a direction, the strategies, plans and programs required under this consent must be revised, to the satisfaction of the Planning Secretary. Where revisions are required, the revised document must be submitted to the Planning Secretary for approval within 6 weeks of the review.* ***Note****: This is to ensure strategies, plans and programs are updated on a regular basis and to incorporate any recommended measures to improve the environmental performance of the development.*	**Section 12.5**
Condition F9– Incident Notification *The Applicant must immediately notify the Department and any other relevant agencies immediately after it becomes aware of an incident. The notification must identify the development (including the development application number and name) and set out the location and nature of the incident.*	**Section 9.2**
Condition F10 – Non-Compliance Notification *Within seven days of becoming aware of a non-compliance, the Applicant must notify the Department 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.* ***Note****: A non-compliance which has been notified as an incident does not need to also be notified as a non-compliance.*	**Section 9.3**
Condition F11 – Annual Review *By the end of March each year after the commencement of the development under this consent, or other timeframe agreed by the Planning Secretary, a report must be submitted to the Department reviewing the environmental performance of the development, to the satisfaction of the Planning Secretary. This review must:* *(a) describe the development (including any rehabilitation) that was carried out in the previous calendar year and the development that is proposed to be carried out over the current calendar year;* *(b) 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:*	**Section 12.4**

Development consent	Plan Section
(i) relevant statutory requirements, limits or performance measures/criteria; *(ii) requirements of any plan or program required under this consent;* *(iii) monitoring results of previous years; and* *(iv) relevant predictions in the document/s listed in condition A2(c);* *(c) Identify any non-compliance or incident which occurred in the previous calendar year, and describe what actions were (or are being) taken to rectify the non-compliance and avoid reoccurrence;* *(d) evaluate and report on:* *(i) the effectiveness of the noise and air quality management systems; and* *(ii) compliance with the performance measures, criteria and operating conditions of this consent;* *(e) identify any trends in the monitoring data over the life of the development;* *(f) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and* *(g) describe what measures will be implemented over the next calendar year to improve the environmental performance of the development.*	
Condition F12 – Annual Review *Copies of the Annual Review must be submitted to WCC, WSC, and made available to the CCC and any interested person upon request.*	**Section 12.4**
Condition F13 – Independent Environmental Audit *Within one year of commencement of development under this consent, and every three years after, unless the Planning Secretary directs otherwise, the Applicant must commission and pay the full cost of an Independent Environmental Audit of the development. The audit must:* *(a) be prepared in accordance with the Independent Audit Post Approval Requirements (Department 2020 or as updated);* *(b) be led and conducted by a suitably qualified, experienced and independent by a suitably qualified, experienced and independent auditor whose appointment has been endorsed by the Planning Secretary;* *(c) 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;* *(d) be carried out in consultation with the relevant agencies and the CCC;* *(e) assess the environmental performance of the development and whether it is complying with the relevant requirements in this consent, water licenses and*	**Section 12.1**

Development consent	Plan Section
mining leases for the development (including any assessment, strategy, plan or program required under these approvals); *(f) review the adequacy of any approved strategy, plan or program required under the abovementioned approvals and this consent;* *(g) recommend appropriate measures or actions to improve the environmental performance of the development and any assessment, strategy, plan or program required under the abovementioned approvals and this consent; and* *(h) be conducted and reported to the satisfaction of the Planning Secretary.*	
Condition F14 – Independent Environmental Audit *Within three months of commencing an Independent Environmental Audit, or other timeframe agreed by the Planning Secretary, the Applicant must submit a copy of the audit report to the Planning Secretary, and any other NSW agency that requests it, together with its response to any recommendations contained in the audit report, and a timetable for the implementation of the recommendations.* *The recommendations must be implemented to the satisfaction of the Planning Secretary.*	**Section 12.1**
Condition F15– Monitoring and Environmental Audits *Any condition of this consent that requires the carrying out of monitoring or an environmental audit, whether directly or by way of a plan, strategy or program, is taken to be a condition requiring monitoring or an environmental audit under Division 9.4 of Part 9 of the EP&A Act. This includes conditions in respect of incident notification, reporting and response, non-compliance notification, compliance report and independent audit.* *For the purposes of this condition, as set out in the EP&A Act, "monitoring" is monitoring of the development to provide data on compliance with the consent or on the environmental impact of the development, and an "environmental audit" is a periodic or particular documented evaluation of the development to provide information on compliance with the consent or the environmental management or impact of the development.*	**Section 12.1** (auditing) and **Section 12.3** (monitoring results)
Condition F17– Access to Information *Before the commencement of construction until the completion of all rehabilitation required under this consent, the Applicant must:* *(a) make the following information and documents (as they are obtained, approved or as otherwise stipulated within the conditions of this consent) publicly available on its website:* *(i) the documents referred to in condition A2(c) of this consent;* *(ii) all current statutory approvals for the development;* *(iii) all approved strategies, plans and programs required under the*	**Section 13.1**

Development consent	Plan Section
conditions of this consent;	
(iv) *the proposed staging plans for the development if the construction, operation or decommissioning of the development is to be staged;*	
(v) *minutes of CCC meetings;*	
(vi) *regular reporting on the environmental performance of the development in accordance with the reporting requirements in any plans or programs approved under the conditions of this consent;*	
(vii) *a comprehensive summary of the monitoring results of the development, reported in accordance with the specifications in any conditions of this consent, or any approved plans and programs;*	
(viii) *a summary of the current phase and progress of the development;*	
(ix) *contact details to enquire about the development or to make a complaint;*	
(x) *a complaints register, updated monthly;*	
(xi) *the Annual Reviews of the development;*	
(xii) *audit reports prepared as part of any Independent Environmental Audit of the development and the Applicant's response to the recommendations in any audit report;*	
(xiii) *any other matter required by the Planning Secretary; and*	
(b) *keep such information up to date, to the satisfaction of the Planning Secretary.*	

4.4 Environment Protection Licence

Table 4 lists the Environment Protection Licence (EPL) conditions relevant to the SOWMP and indicates where each condition is addressed within this Plan.

Table 4 – Relevant EPL Conditions

EPL Condition	Plan Section
Operating Conditions	
Condition O1.1 – Activities must be carried out in a competent manner *Licensed activities must be carried out in a competent manner. This includes:* *a) the processing, handling, movement and storage of materials and substances used to carry out the activity; and* *b) the treatment, storage, processing, reprocessing, transport and disposal of waste generated by the activity.*	**Section 5.1.1**

EPL Condition	Plan Section
Condition O2.1 – Maintenance of plant and equipment *All plant and equipment installed at the premises or used in connection with the licensed activity:* *a) must be maintained in a proper and efficient condition; and* *b) must be operated in a proper and efficient manner.*	**Section 5.1.1 and 10.1**
Monitoring and Recording Conditions	
Condition M5.1 – Recording of pollution complaints The licensee must keep a legible record of all complaints made to the licensee or any employee or agent of the licensee in relation to pollution arising from any activity to which this license applies.	**Section 9.6**
Condition M5.2 – Recording of pollution complaints *The record must include details of the following:* *a) the date and time of the complaint;* *b) the method by which the complaint was made;* *c) any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;* *d) the nature of the complaint;* *e) the action taken by the licensee in relation to the complaint, including any follow-up contact with the complainant; and* *f) if no action was taken by the licensee, the reasons why no action was taken.*	**Section 9.6 and 13.4**
Condition M5.3 – Recording of pollution complaints *The record of a complaint must be kept for at least 4 years after the complaint was made.*	**Section 9.6 and 13.4**
Condition M5.4 – Recording of pollution complaints *The record must be produced to any authorized officer of the EPA who asks to see them.*	**Section 9.6 and 13.4**
M6.1 - Telephone complaints line *The licensee must operate during its operating hours a telephone complaints line for the purpose of receiving any complaints from members of the public in relation to activities conducted at the premises or by the vehicle or mobile plant, unless otherwise specified in the license.*	**Section 9.6**

EPL Condition	Plan Section
M6.2 - Telephone complaints line *The licensee must notify the public of the complaints line telephone number and the fact that it is a complaints line so that the impacted community knows how to make a complain.*	**Section 9.6**
M8.1 - Other monitoring and recording conditions *Availability of equipment for continuous monitoring required by this license.* *All continuous monitoring equipment must be operated and maintained with the aim of achieving 100% availability in each license year. Where a monitoring device does not achieve 95% availability, the licensee must report reasons and corrective actions to the EPA in the Annual Return.*	**Section 10.1 and 12.4**
Reporting Conditions	
R1.1 - Annual return documents *The licensee must complete and supply to the EPA an Annual Return in the approved form comprising:* *1. a Statement of Compliance.* *2. a Monitoring and Complaints Summary;* *3. a Statement of Compliance - Licence Conditions;* *4. a Statement of Compliance - Load based Fee;* *5. a Statement of Compliance - Requirement to Prepare Pollution Incident Response Management Plan;* *6. a Statement of Compliance - Requirement to Publish Pollution Monitoring Data; and* *7. a Statement of Compliance - Environmental Management Systems and Practices.* *At the end of each reporting period, the EPA will provide to the licensee a copy of the form that must be completed and returned to the EPA.*	**Section 12.4**
R1.2 - Annual return documents *An Annual Return must be prepared in respect of each reporting period, except as provided below.*	**Section 12.4**
R1.4 - Annual return documents	**Section 12.4**

EPL Condition	Plan Section
Where this licence is surrendered by the licensee or revoked by the EPA or Minister, the licensee must prepare an Annual Return in respect of the period commencing on the first day of the reporting period and ending on: a) *in relation to the surrender of a licence - the date when notice in writing of approval of the surrender is given; or* b) *in relation to the revocation of the licence - the date from which notice revoking the licence operates.*	
R1.5 - Annual return documents *The Annual Return for the reporting period must be supplied to the EPA via eConnect EPA or by registered post not later than 60 days after the end of each reporting period or in the case of a transferring licence not later than 60 days after the date the transfer was granted (the 'due date').*	**Section 12.4**
R1.6 - Annual return documents *The licensee must retain a copy of the Annual Return supplied to the EPA for a period of at least 4 years after the Annual Return was due to be supplied to the EPA.*	**Section 12.4**
R2.1 Notification of environmental harm *Notifications must be made by telephoning the Environment Line service on 131 555.*	**Section 9.2**
R2.2 Notification of environmental harm *The licensee must provide written details of the notification to the EPA within 7 days of the date on which the incident occurred.* *Note: The licensee or its employees must notify all relevant authorities of incidents causing or threatening material harm to the environment immediately after the person becomes aware of the incident in accordance with the requirements of Part 5.7 of the Act.*	**Section 9.2**
Incident Management ***R3.1 – Written report*** *Where an authorised officer of the EPA suspects on reasonable grounds that:* **a)** *where this licence applies to premises, an event has occurred at the premises; or* **b)** *where this licence applies to vehicles or mobile plant, an event has occurred in connection with the carrying out of the activities authorised by this licence, and the event has caused, is causing or is likely to cause material harm to the environment (whether the harm occurs on or off premises to which the licence applies), the authorised officer may request a written report of the event.*	**Section 1.6** and **Section 9.2**
R3.2 – Written report *The licensee must make all reasonable inquiries in relation to the event and supply the report to the EPA within such time as may be specified in the request.*	**Section 9.2**

EPL Condition	Plan Section
R3.3 – Written report *The request may require a report which includes any or all of the following information:* a) *the cause, time and duration of the event;* b) *the type, volume and concentration of every pollutant discharged as a result of the event;* c) *the name, address and business hours telephone number of employees or agents of the licensee, or a specified class of them, who witnessed the event;* d) *the name, address and business hours telephone number of every other person (of whom the licensee is aware) who witnessed the event, unless the licensee has been unable to obtain that information after making reasonable effort;* e) *action taken by the licensee in relation to the event, including any follow-up contact with any complainants;* f) *details of any measure taken or proposed to be taken to prevent or mitigate against a recurrence of such an event; and* *any other relevant matters.*	**Section 9.2**
R3.4 – Written report *The EPA may make a written request for further details in relation to any of the above matters if it is not satisfied with the report provided by the licensee. The licensee must provide such further details to the EPA within the time specified in the request.*	**Section 9.2**

4.5 Project Statements of Commitment

Table 5 identifies where the specific project statement of commitment as taken from the RPPR are addressed in this plan.

Table 5 Project Statement of Commitment

Statement of Commitment	Timing	Where addressed in this plan
WCL will implement pre-treatment of dirty water using flocculant block at the inlet to Dam 1 to aid settling of solids prior to overflowing into Dam 2.	Ongoing as required	**Section 3.2** in **Appendix C**
Ongoing real time turbidity monitoring of LDP 2 discharge, Bellambi Gully Creek upstream and Bellambi Gully Creek downstream to allow rapid response to deviations above water quality trigger values.	Ongoing	**Section 8.1**
WCL will implement the upgrades to the existing Water Management System as proposed in the Bellambi Gully Flood Assessment (Engeny, 2018), Response to Submissions for Modification 4 (Umwelt, 2018), Further Response to Submissions for Modification 4 (Umwelt, 2019) and additional information	In accordance with timing requirements outlined in the DPIE	MOD 4 was withdrawn due to constructability issues.

provided to DPIE on 14 November 2019, in accordance with the timing requirements established under MOD4.	Development Control Order dated 23 July 2020	The upgrades to the Water Management System are now being completed under the DPIE Development Control Order dated 23 July 2020 for Bellambi Gully Open Channel Clean Water Diversion Works. See **Section 5.1.2** for a current description of the works.
Detailed plans of the revised Water Management System will be prepared by a suitably qualified civil engineer in consultation with Wollongong City Council and provided to the consent authority for approval prior to commencement of works.	Prior to the commencement of construction	Detailed Engineering design plans dated 18/12/2020 "*2020.12.18 - ROC 20240 Rev 2 - Bel Gully Detailed Eng Plans*" submitted to the secretary for approval on the 6 Jan 2021. Plans were approved by the secretary on the 25 Feb 2021 and construction works commenced shortly thereafter.
WCL will maintain the existing Bellambi Gully Diversion Pipeline as the method to divert upslope runoff from the Bellambi Gully catchment through the site to the downstream creek.	Ongoing	**Section 5.1.2**
WCL will undertake a Pipeline Condition Assessment and develop a Pipeline Integrity Management Strategy, as detailed in Appendix 5 of the Further Response to Submissions for Modification 4 (Umwelt, 2019).	N/A	With MOD 4 being withdrawn this commitment is no longer relevant. The pipeline will be made redundant at the completion of construction of the Bellambi Gully Open Channel Clean Water Diversion in accordance with the DPIE

		Development Control Order dated 23 July 2020. This is in contrast to the MOD 4 design which continued to utilise the pipeline.
WCL will manage the proposed ROM stockpile height to not exceed 7m above the Bellambi Gully Diversion Pipeline.	Ongoing	**Section 5.1.2**
WCL will implement dedicated crossings for heavy vehicles driving over the Bellambi Gully Diversion Pipeline with offset areas of 5 m from the centreline of the pipe either side.	Prior to the commencement of construction	**Section 5.1.2**
A maintenance schedule will be prepared and implemented for the new on-site stormwater system.	Within 3 months of approval and ongoing	**Section 12.5**
New and existing flood structures and controls will be included on regular maintenance schedules.	Ongoing	**Section 12.5** This is related to the flood structures which are a part of the Bellambi Gully Open Channel Clean Water Diversion Works, and will be included in the maintenance and implementation plan as outlined above.
WCL will implement the management, monitoring and contingency measures described in Section 7.0 of the Response to Submissions for Modification 4 (Umwelt, 2018) and Section 4.2 of the Further Response to Submissions for Modification 4 (Umwelt, 2019).	Following the approval of MOD 4 and ongoing	MOD 4 was withdrawn due to constructability issues. The upgrades to the Water Management System are now being completed under the DPIE Development Control Order dated 23 July 2020 for Bellambi Gully Open Channel Clean Water Diversion Works. See **Section 5.1.2** for a current

		description of the works.
WCL will update the Surface Facilities Water Management Plan, including and / or taking account of: • Conditions and commitments set out in the Modification 4 approval. • Water Balance. • Erosion and Sedimentation Control Plan. • Baseline data on water quality. • Monitoring program details. Trigger levels for the investigation of any potentially adverse impacts.	Within 3 months of approval	MOD 4 was withdrawn due to constructability issues. See comments above. **Appendix E** – Site Water Balance **Appendix B** - Erosion and Sedimentation Control Plan **Section 2** in **Appendix C** **Section 4** in **Appendix C**
The Water Management Plan will include a Monitoring, Management and Maintenance Plan for the proposed flood levee and existing SWCD. This will include an effective monitoring, management and maintenance program designed to ensure the ongoing and safe operation of the flood levee and SWCD in the event of a significant flood.	Within 3 months of approval	Flood Levee proposed under MOD 4 is no longer being constructed as MOD 4 was withdrawn due to constructability issues. See comments above. See **Section 5.1.2** for a current description of the works.
WCL will continue to consult with WaterNSW to put in place a mutually agreeable Master Agreement to cover the conditions of the Mining Leases related to mining within the water catchment.	*Within 2 years of approval*	**Section 1.4**
Hazardous materials, including diesel fuel, water treatment chemicals and hydraulic fluid emulsions will be stored in appropriately sized bunds. All hydrocarbon storage and handling will be undertaken in accordance with *AS1940-2017: The storage and handling of flammable and combustible liquids*.	Ongoing	**Section 5.1.4**
Once the mine moves into production, subject to approval, the reject material will be further tested for Acid Base Account parameters on a 6-monthly basis.	*Ongoing on a 6 monthly basis*	**Section 1.3, 2.2** and **Appendix G**

4.6 Relevant Legislation and Guidelines

WCL will conduct approved mining operations consistent with the Revised UEP Development Consent conditions, EPL 12040 and any other legislation that is applicable including:

- Work Health and Safety (Mines and Petroleum Sites) Act 2013.
- Health and Safety (Mines and Petroleum Sites) Regulation 2014.
- Contaminated Land Management Act 1997.
- Dam Safety Act 2015, and Regs 2019.
- 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 NSW Act 2014.
- Biodiversity Conservation Act 2016.
- Water Act 1912.
- Water Management Act 2000 & Guidelines for Controlled Activities on Waterfront Land (NRAR, 2018).

4.7 Licences and Leases

In addition to the requirements of the Project Approval, all activities at or in association with the WCL RVC will be undertaken in accordance with the licences, permits and leases which have been issued or are pending as outlined in **Table 6.**

Table 6 Licences, Permits and Leases

LICENCE/APPROVAL	DOCUMENT NO.	ISSUE DATE	EXPIRY DATE
Environmental Protection Licence	12040	Current	-
EPA Approval for Storm Water Control Dam	90/6041 (280.021C/21)	10 Aug 1992	-
Water Access Licence	WAL 36488 WAL 43561	20 Feb 2017 15 Dec 2020	28 Jan 2028 -

5 BACKGROUND

5.1 Water Management System

5.1.1 Surface Water

The RVC Pit Top water management system has a total catchment area of about 43 ha and includes the separate management systems for clean and dirty water. The interactions between the clean and dirty water systems are summarised in **Figure 9**. This water management system is suitably designed to manage water for all stages of the projects operations (as detailed in

Section 2) with the water management and control measures being in place for all stages of the project development.

The purpose of the sites water management system is to mitigate impacts and minimise risks to the receiving environment and any downstream water users in accordance with **Condition B16**. To ensure this is achieved, WCL will carry out all licenced activates in a competent manner in accordance with EPL condition O1. This includes the processing, handling, movement and storage of materials and substances used to carry out the activity; and the treatment, storage, processing, reprocessing, transport and disposal of waste generated by the activity. The water management system will be operated and managed in a proper and efficient manner to ensure the water management performance criteria in **Table 12** are achieved. This includes complying with EPL condition O2.1 which states that:

> *All plant and equipment installed at the premises or used in connection with the licensed activity:*
>
> *a) must be maintained in a proper and efficient condition; and*
>
> *b) must be operated in a proper and efficient manner.*

The maintenance of the surface water management system is managed under the sites Work Order System and includes:

- The condition and effectiveness of drains and drainage lines around site are routinely inspected on a monthly basis, and following heavy rainfall;
- Trash racks, sumps and culverts around site are routinely inspected for damage, sedimentation and debris on a monthly basis, and following heavy rainfall;
- Dams and Ponds around site are routinely inspected for erosion, sediment level, slumping or any signs of potential failure, and other safety aspects on a monthly basis, and following heavy rainfall;
- Mechanical and electrical inspections and maintenance on pumping and water management equipment in accordance with OEM guidelines.

Based on these routine inspections, any rectification works that are identified become corrective actions, in the action register, or corrective work orders (if the issue cannot be resolved during the routine inspections. Trash racks, sumps, culverts, dams and ponds are desilted when sediment levels reach 30% to ensure sufficient function and capacity during rainfall events.

5.1.2 Clean Water

The clean water management system shown in **Figure 10** and **Figure 11** principally consists of a series of clan water diversions and an Onsite Detention Basin (OSD), for flood mitigation downstream. Diversions are designed to intercept runoff from clean catchment areas prior to it flowing into operational or disturbed areas. This system minimises the volume of water removed from the surrounding environment, and reduces the volume of water that entering the dirty water system (and therefore requiring treatment) during rainfall events. These diversions direct the intercepted clean water through or around the site and into the downstream environment, maintaining clean and dirty water separation.

The clean water management system at RVC is currently being upgraded with the Bellambi Gully Open Channel Clean Water Diversion (BG CWD), in accordance with the DPIE Order dated 23 July 2020. These works include the construction of an engineered open channel for improved clean and dirty water separation through site, and a clean water OSD for flood mitigation downstream, designed to capture and convey the 100-year ARI flood event (**Figure 11**). These upgrades to the clean water system have been designed to improved flood mitigation, and will improve and help maintain baseline channel stability both onsite and downstream.

The construction of the BG CWD is managed under ***RVC EC PLN 019*** *Bellambi Gully Creek Diversion Construction Management Plan*, which is published to the WCL website, and includes the detailed design for the works. A maintenance plan for the BG CWD is required under Term 2i of the DPIE Order dated 23 July 2020, and is to be developed within 1 month of completion of the Bellambi Gully Clean Water Diversion construction works. This water MP will be updated to include the relevant information as outlined in **Section 12.5.** During construction of the Open Channel Clean Water Diversion, and until construction works are complete and the existing Clean Water Diversion Pipeline is made redundant; the following mitigation measures will be implemented to protect the quality of the clean water within the diversion pipeline. This is in line with the Statement of commitments detailed in **Table 5**:

- WCL will implement dedicated crossings for heavy vehicles driving over the Bellambi Gully Diversion Pipeline with offset areas of 5 m from the centreline of the pipe either side.
- WCL must and will continue to maintain the existing Bellambi Gully Diversion Pipeline as the method to divert upslope runoff from the Bellambi Gully catchment through the site to the downstream creek.
- WCL will manage the proposed ROM stockpile height, above the Bellambi Gully Diversion Pipeline, to not exceed 7m to mitigate against any further impacts to the pipeline.

The clean water that flows through or around site, via the clean water diversions, is not utilised or extracted by the mine, and as such no surface water access licences for the pit top area are required under **Condition B12**.

Existing Clean Water Diversions within the vicinity of the RVC Pit Top Area include:

- A Diversion Channel - conveys stormwater (from the natural Bellambi Gully watercourse) around the coal handling area into a Clean Water Detention Basin.
- Diversions to intercept and convey clean water runoff from the northwestern upslope catchment and direct flows to the north around the Pit Top WMS.

Existing Clean Water Dams within the vicinity of the RVC Pit Top Area include:

- Clean Water Detention Basin – serves as a retarding basin to reduce the peak flow within the downstream reaches of Bellambi Gully.
- Dam 6 – A remnant dam that is no longer used.

A summary of clean water dams is included in **Table 7**.

5.1.3 Dirty Water

The mines dirty water management system is shown in the site water management schematic presented in **Figure 9**, and the dirty water catchments outlined in **Figure 10**. Dirty water typically consists of surface runoff generated within disturbed areas the site. Dirty water runoff is intercepted and managed by a series of dirty water drains, pipelines, and dams to allow for treatment and reuse on site. A summary of existing dirty water dams is included in **Table 7**.

The dirty water management system at RVC is currently being upgraded, in conjunction with the BG CWD works detailed above, and in accordance with the DPIE Order dated 23 July 2020. These works include the construction of a new engineered dirty water detention basin for improved clean and dirty water separation through site, and designed to capture and convey the 100-year ARI flood event for flood mitigation downstream (**Figure 11**). The construction of the BG CWD is managed under ***RVC EC PLN 019*** *Bellambi Gully Creek Diversion Construction Management Plan*, which is published to the WCL website, and includes the detailed design for the works. A maintenance plan for the BG CWD is required under Term 2i of the DPIE Order dated 23 July 2020, and is to be developed within 1 month of completion of the Bellambi Gully Clean Water Diversion construction works. This water MP will be updated to include the relevant information as outlined in **Section 12.5.**

The existing water treatment facility, 'the thickener tank' is used for treatment of dirty stormwater prior to reuse or discharge from site. Dirty stormwater generated on site enters Dam 1, for primary treatment through sedimentation, and then flows into the SWCD where it is stored before it is pumped to the thickener tank. Stormwater from the lower section of the access road, and vegetated area's near the Princes highway, flows to the highway dam where it is then automatically pumped into the SWCD. The highway dam is maintained at its lower limits, to provide for maximum capacity during rainfall events, and is automatically pumped to the SWCD when the dam level begins to increase. This system prevents overtopping of the highway dam and unlicensed discharge into Bellambi Gully. The SWCD has the function of providing suitable capacity for dirty water which is generated during rainfall events and captured in the sites dirty water system. Greater detail of the location of dirty water catchments is shown in **Figure 10**.

In accordance with **Condition B16** WCL continually investigates measures to reduce clean and potable water usage at the mine and maximise the use of recycled water wherever possible. This includes investigating options to maximise water reuse on site. Recycled water is generated when water enters the sites dirty water system during rain events, or when discharged from underground workings, and is treated in the sites water treatment facility. The water is treated to meet EPL discharge requirements, however recycled water is pumped to the Pit Top dam for storage and reuse post treatment instead of being discharged.

Measures that are currently in place to reuse recycled water on site include:

- Use of recycled water for mining operations underground;
- Use of recycled water for firefighting purposed and in the hydrant system;
- Use of recycled water for truck washing;
- Use of recycled water in stockpile sprays and roadside sprays for dust suppression
- Use of recycled water in the water cart to control dust in exposed areas of site (i.e. stockpiles areas, haul roads and other disturbed areas); and
- Optimising the processes by which dust suppression is conducted through automated weather and wind monitoring to control water use on site.

Use of recycled water in this manner ensure the mine minimises the use of make-up water from external sources. In addition to the measure already in place, WCL will continue to investigate opportunities to improve water management and water efficiency in accordance **Condition B16** whenever possible.

Table 7 Water Storages

DESCRIPTION	CAPACITY (ML)	FUNCTION	MANAGEMENT
Dirty water system			
Dam 1	7	Flow through sedimentation basin. Excess water draining from the truck wash, wheel wash, stockpile areas, and pumped transfers from the underground mining area.	Discharges under gravity to the Stormwater Control Dam. Management of sediment levels in the dam to less than 30% of the dam volume.
Dam 5	< 10	Redundant dam draining to SWCD.	Nil
Pit Top Dam	8	Provides storage capacity of recycled treated mine water for used in the pit top and underground water reticulation system for day to day mining operations. Dam does not to act as a catchment dam	Capacity maintained to allow for prescribed use. The dam water level is maintained to its full level by pumping from the Storm Water Control Dam.
Fire Dam	2	Provides firefighting water to the pit top and underground hydrants. Dam does not to act as a catchment dam	Capacity maintained to allow for the prescribed use. The dam water level is maintained to its full level by pumping from the Storm Water Control Dam.
Highway Dam	0.3	Capture water runoff from the lower section of the access road and vegetated area's near the Princes highway. Captured water is automatically pumped back to the SWCD.	The water level of the dam is maintained at its minimum level, by the pump which is automatically activated by a float switch to pump the water into the storm water control dam. The pump and spillway is inspected and maintained monthly under the WO System to ensure they are functioning correctly.

DESCRIPTION	CAPACITY (ML)	FUNCTION	MANAGEMENT
Stormwater control dam	62	Pumped transfers from the Highway Dam Runoff from about 7.5 ha of mostly undisturbed catchment (including Dam 5).	Registered with Dam Safety NSW (DS NSW). Maintenance of the spillway area Monitor seepage (see LDP 3) Monitor spillway overflow (LDP 9)
Seepage Sump (LDP 3)	0.001	Collection of the Stormwater Control Dam wall seepage.	Management of sediment levels in the sump to less than 30% of the sump volume.
Dry Detention Basin (OSD)	2.1	Stockpile and coal handling area. Maintenance and laydown areas.	Discharges under gravity to Dam 1. An emergency overflow pipe allows for discharges to the Clean Water Detention Basin to occur during extreme storm events.
Clean Water System			
Clean Water Detention Basin (under Construction)	Approximately 26 (under construction)	Serves to reduce the magnitude of the peak discharge entering Bellambi Gully from the clean water diversion during larger storm events.	Dry detention basin, that includes a low-flow path that connects to the existing Bellambi Gully pipeline via a stormwater pit. An emergency overflow weir is located at the north-eastern corner that directs flows during extreme storm events into the existing channel system.
BG Clean water Channel (under construction)	n/a	Convey flows from LDP 2 and BG upstream inclusive of 1:100 yr flood event.	Ongoing maintenance of debris control structures
Dam 6	n/a	Redundant dam draining to Dam 5.	Nil.

5.1.4 Chemical and Hydrocarbon Storage

All Hazardous materials, chemical and hydrocarbon products (including diesel fuel, water treatment chemicals and hydraulic fluid emulsions) will be stored in appropriately sized bunds (or approved alternative) which comply with the relevant Australian Standards and industry guidelines, to provide emergency spill containment. All hydrocarbon storage and handling will be undertaken in accordance with AS1940 - 2017: *The storage and handling of flammable and combustible liquids*. The capacity of the emergency spill containment will be at least equivalent to the 125% of the volume of the largest storage tank within the bunded area. These bunded areas will not be used to store water. All runoff generated within the bunded areas is collected within a sump or pumped out and disposed of to a licenced waste facility. Similarly, workshop areas drain towards a sump for management on site.

Figure 9 Approved Water Management System Schematic (from Appendix F).

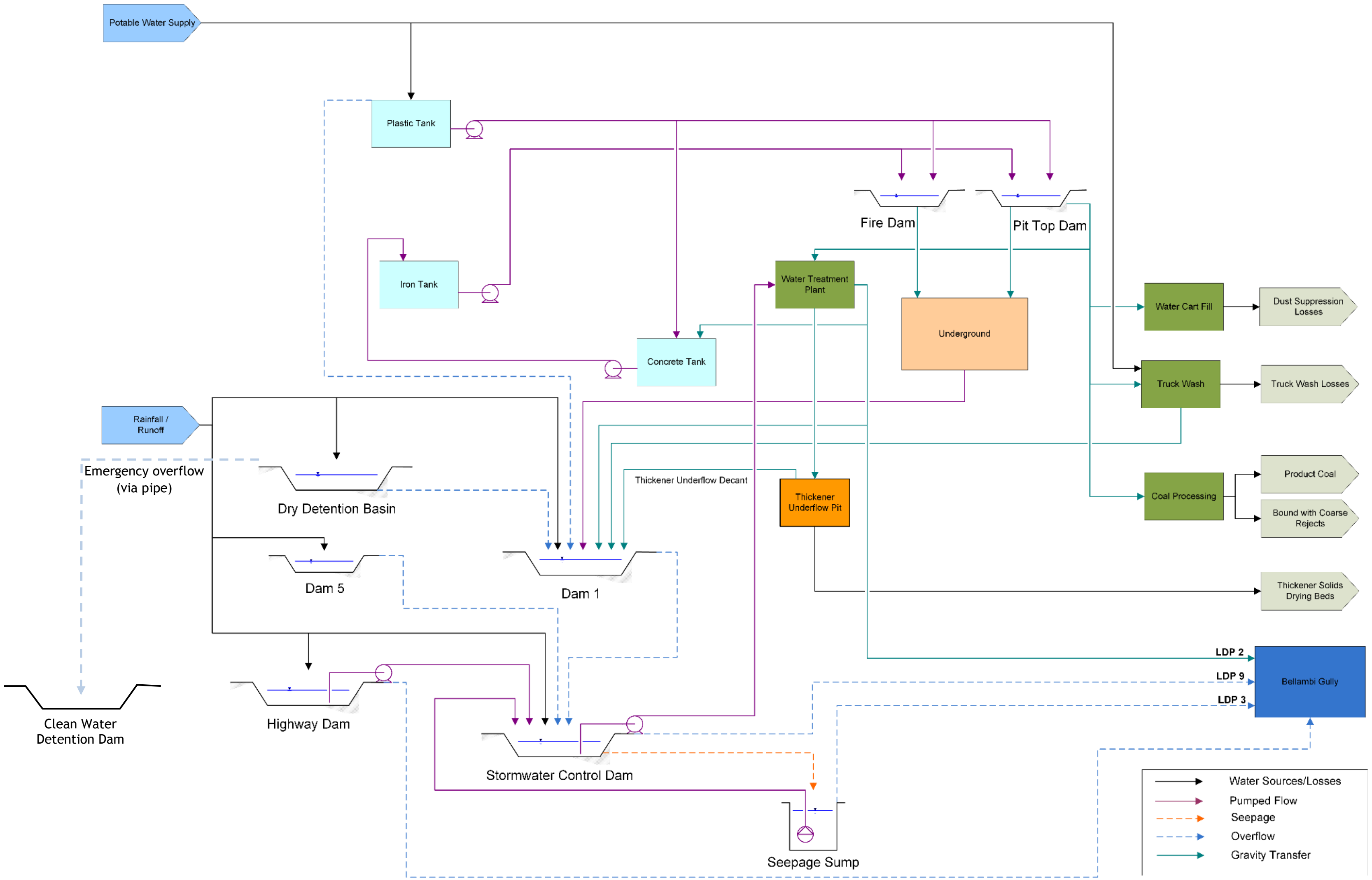


Figure 10 Approved Water Management System

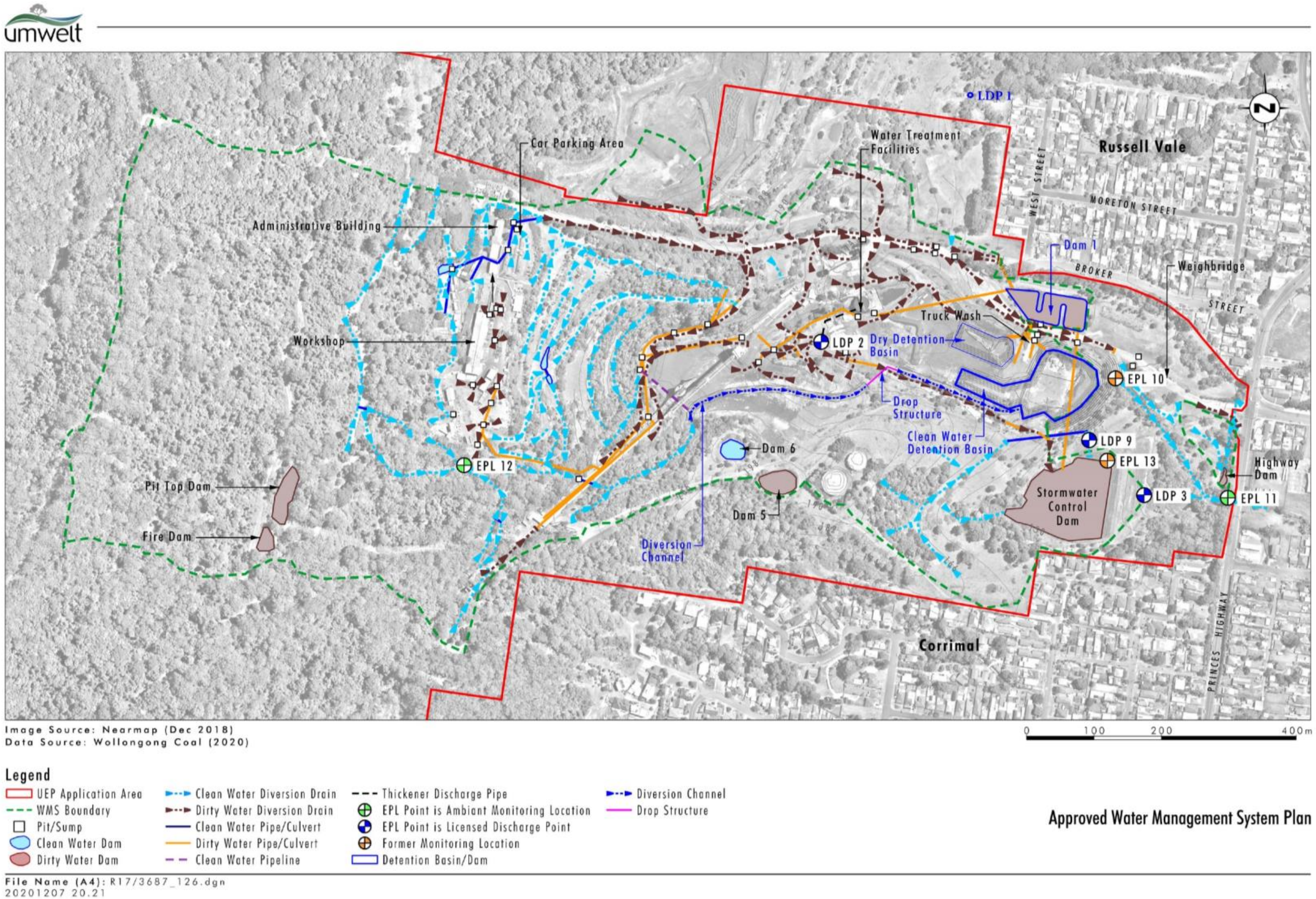
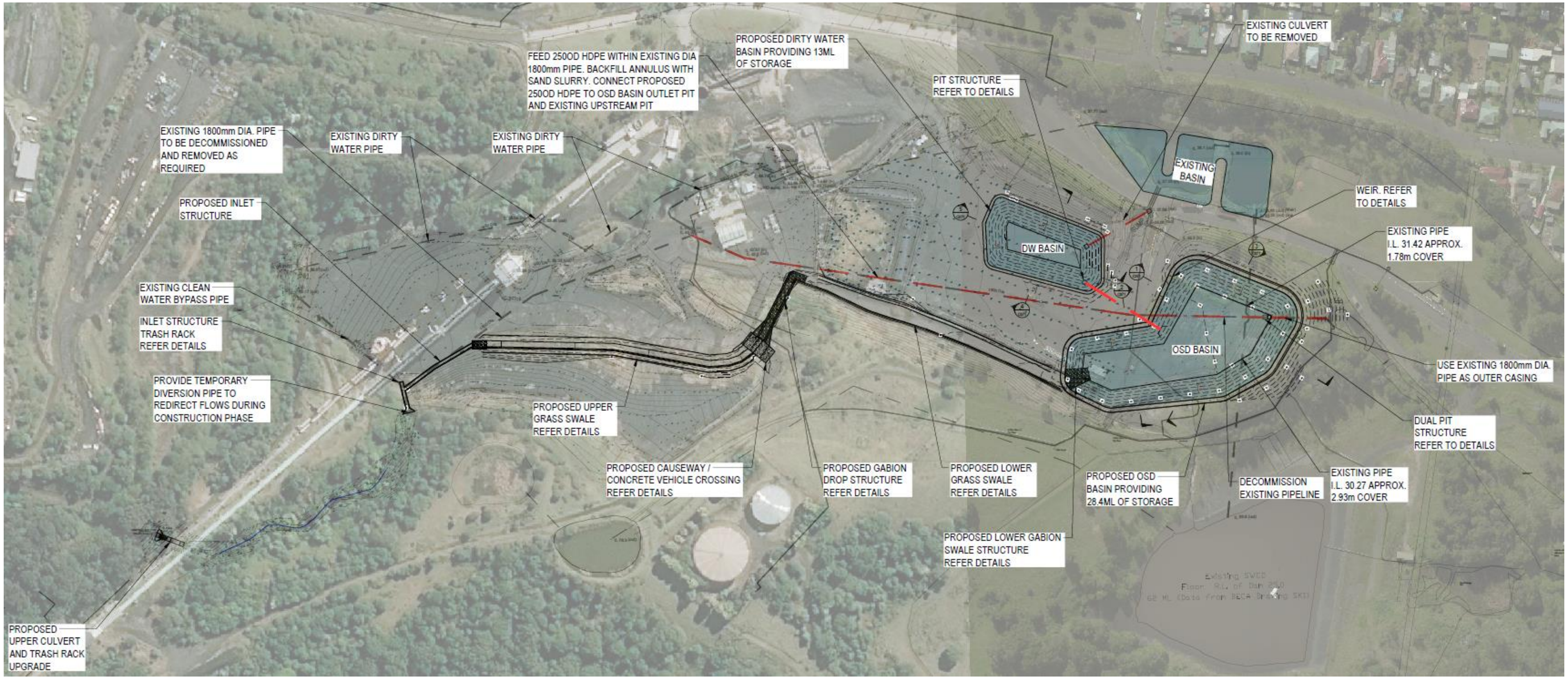


Figure 11 Bellambi Gully Open Channel Clean Water Diversion Design



5.1.5 Licensed Discharge Points

EPL 12040 permits discharges from the Pit Top area to occur at four Licensed Discharge Points (LDPs: refer to **Figure 10**):

- LDP 1 (EPA identification no. 1).
- LDP 2 (EPA identification no. 2).
- LDP 3 (EPA identification no. 3).
- LDP 9 (EPA identification no. 9).

Treated water discharged from the RVC Pit Top WMS is currently undertaken in accordance with EPL12040, which defines four licenced discharge points (LDPs 1, 2, 3 and 9). The applicable discharge limits at these locations are summarised in **Section 8.1**.

LDP1 is located at the concrete weir on the energy dissipater in Rath's Gully, and receives clean water diverted from the forested area upslope of the Pit Top area. There are no volume and concentration limits that apply to LDP1.

Water from the Water Treatment Plan (WTP) is discharged at LDP2 at a target maximum rate of 2,450 kL/day to ensuring that the EPL discharge limit (i.e. 2,500 kL/day) is not exceeded.

Discharges from LDP3 occur as seepage through the permeable dam wall of the SWCD, which during normal operations is collected in a sump and returned (via pump) to the SWCD. During large rainfall events, excess water from SWCD may discharge to Bellambi Gully via the SWCD spillway (LDP9).

It should be noted that reuse of process and mine water within the mining operation is the preferred and primary destination for water collected in the SWCD to minimise use of potable water onsite, and that discharge via LDP2 to Bellambi Gully is considered a secondary option.

5.2 Extraction area

The principal water management measures within the extraction area include:

- Dewatering of the underground mining area.
- Groundwater and watercourse monitoring points (Section **1**).

The volume of transferred from the underground mining areas to the surface WMS is estimated using a combination of:

- Groundwater modelling to estimate the regional groundwater flows and responses in relation to the underground mine workings.
- A simplified water balance model.

5.3 Water Access Licences

In accordance with **Schedule 2, Condition B12** of the project approval, WCL currently holds two Water Access Licences, allowing for a total extraction of 615 ML (units) per annum (**Table 8**). The water allocation in these two licences is sufficient for full operations at RVC under the development consent, as detailed in the site water balance in **Table 10**, and is in compliance with **Schedule 2, Condition B12**.

Table 8 Water Access Licences

LICENCE NUMBER	WATER SHARING PLAN	WATER SOURCE	SHARE
WAL 36488	Greater Metropolitan Region Groundwater Sources 2011	Sydney Basin Nepean Groundwater Source	515 units
WAL 43561			100 units
		Total	615 units

6 WATER AND SALT BALANCE

6.1 Water Balance

A site water balance was developed for the RVC Revised UEP as part of the Draft Public Environment Report (PER) (Umwelt, 2020) (refer to Appendix M of the Draft PER). The site water balance was modelled as an integrated system to include both the surface water and underground systems. The water balance was modelled for full operation of the site, including stage 2a as described in **Section 2.2**, and as such is relevant and suitable for all stages of the operation. The water management system at Russell Vale Colliery has been designed to cope with the operational demands across all project stages of the project, which includes water make, usage and treatment of surplus water. This is facilitated by the storage capacity of the Stormwater Control Dam, which stores surplus water from the site, and the licenced discharge of any surplus water via LDP 2 of up to 2.5ML/day. This is compared to the expected daily inflows from underground dewatering and rainfall of roughly 1.1ML/day. Details of the Water Balance Model are included in **Appendix E.**

The site water balance, developed to address the requirements of **Schedule 2, Condition B17(f),** will be recalculated on an annual basis and reported in the Annual Review.

6.1.1 Water Balance Modelling Results

Annual gross water balance model results for the 10th percentile, 50th percentile and 90th percentile rainfall scenarios are presented in **Table 9**. The predicted annual inflows and outflows from the site for the 50th percentile gross water balance year are presented in **Table 10.**

The water balance results indicate that the UEP will have a surplus gross water balance (i.e. will discharge treated excess water into the downstream environment from LDP 2), and modelled total groundwater make (288 ML/year: **Table 10**) is less than the total licensed groundwater extractions (615 ML/year: **Table 8**). This indicates that the site is likely to be able to adequately meet operational water demands with little to no import of water from off-site sources. As such WCL will ensure that there is sufficient water for all stages of the development and that the scale of the development will be adjusted to match its available water supply, in the unlikely event that supply is not sufficient to meet operational demand, (in accordance with **Schedule 2, Condition B13**).

Table 9 Annual Gross Water Balance Results

STATISTIC	ANNUAL EXCESS (DISCHARGES) (ML)
10th %ile	155
50th %ile	165
90th %ile	309

Table 10 50th Percentile Year Net Water Balance Results

PARAMETER	FLOW RATE (ML/YEAR)
INFLOWS	
Rainfall on dams and runoff	112

PARAMETER	FLOW RATE (ML/YEAR)
Underground dewatering (groundwater make)	288
Potable Water Import to Supplement Operational Demands	0
ROM coal moisture	29
Total Inflows	**429**
OUTFLOWS *(discharges and losses)*	
Evaporation	27
ROM Coal	83
Water Cart Dust Suppression	142
Truck Wash	11
LDP 2 (from WTP)	165
LDP 3 (SWCD seepage)	0
LDP 9 (SWCD spillway)	0
Spills from Highway Dam	0
Total Outflows	***429***
Change in Site Water Inventory	0
NET WATER BALANCE	0

6.2 Salt Balance

A site salt balance has been developed for the RVC Pit Top WMS as an extension of the site water balance, developed in response to the requirements of **Schedule 2, Condition B17(b)(ii)**. The salt balance model allows for the prediction of salt load and salinity of water which is exported from the RVC site. The salt balance was modelled for full operation of the site, including stage 2a as described in **Section 2.2**, and as such is relevant and suitable for all stages of the operation. Details of the salt balance are included in **Appendix E.**

Salt transfers were simulated within the site water balance in parallel with the water transfers. The site salt balance provides the expected salt loads (from inflows) and salt concentrations associated with each water transfer within the site water balance model.

The site salt balance will be reviewed on an annual basis and reported in the Annual Review.

The modelling of the predicted annual salt balance indicates a close to neutral balance (-2% of predicted salt inflows). Note, this error is considered reasonable for the predicted annual site balance. Average annual predicted salt imports and exports are presented in **Table 11**.

Table 11 Predicted Annual Salt Balance

PARAMETER	SALT MASS FLUX (KG/YEAR)
INFLOWS	
Rainfall on dams and runoff	401

PARAMETER	SALT MASS FLUX (KG/YEAR)
Groundwater	627
Potable Water Import to Supplement Operational Demands	136
ROM coal moisture	65
Total Inflows	**1229**
OUTFLOWS	
ROM Coal	1225
Licensed Discharges	30
NET BALANCE	-26 (-2% of inflows)

7 PERFORMANCE CRITERIA

The performance of this Surface Facilities Water Management Plan will ultimately be measured by compliance with the relevant water quality standards at monitoring locations (LDP1-3; and 9-13).

To provide confidence in meeting the water quality requirements in the EPL, the following additional performance measures will be implemented:

- Performance of the existing thickener tank will be measured during regular Environmental Inspections and confirming licence criteria are met;
- Measure sediment levels in Dams 1, and 2 as well as the SWCD. Target less than 20% dam volume sediments in the dams; and
- Measure compliance with the ESCP regarding frequency of inspections and maintenance.

A summary of the water management performance measures, prepared to address the requirements of **Schedule 2, Condition B16, and Schedule 2, Condition B17(d),** is included in **Table 12**.

Table 12 Water Management Performance Measures

FEATURE	PERFORMANCE MEASURE	WHERE ADDRESSED IN THIS PLAN
Water Management - General	• Maintain separation between clean, dirty (i.e., sediment-laden and mine water management systems • Minimise the use of clean and potable water on the site • Maximise water recycling, reuse and sharing opportunities • Minimise the use of make-up water from external sources • Design, install, operate and maintain water management systems in a proper and efficient manner • Minimise risks to the receiving environment and downstream water users	**Section 5.1** **Section 5.1.3 and 6.1** **Section 5.1.3 and 6.1** **Section 5.1.3 and 6.1** **Section 5.1** **Section 5.1** and **Appendix E**
Erosion and Sediment Control Works	• Design, install and maintain erosion and sediment controls in accordance with the guidance series Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom 2004) and 2E Mines and Quarries (DECC 2008) • Design, install and maintain any new infrastructure within 40 metres of watercourses in accordance with the guidance series for Controlled Activities in Waterfront Land (DPI Water 2012) • Design, install and maintained any creek crossings in accordance with the Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (DPI 2013) and Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries 2003)	**Section 4.1.1** and **Section 4.1** of **Appendix B** (ESCP) **Section 4.3.1** of **Appendix B** **Section 4.2.2** of **Appendix B**
Clean water diversions and	• Design, install and maintain the clean water system to capture and convey the 100-year ARI flood event	**Section 5.1.2**

FEATURE	PERFORMANCE MEASURE	WHERE ADDRESSED IN THIS PLAN
storage infrastructure	• Maximise, as far as reasonable, the diversion of clean water around disturbed areas on site	
Flood protections works	• Design, install and maintain flood levees to protect mining areas from a 100-year ARI flood event and to ensure no increased flood impacts on roads or privately-owned land	**Section 5.1.2**
Mine water storages	• Design, install and maintain mine water storage infrastructure to prevent unlicensed or in controlled discharge of mine water • New storages designed to contain the 100 year ARI storm event and minimise permeability	**Section 5.1.3**
Chemical and hydrocarbon storage	• Chemical and hydrocarbon products to be stored in bunded areas in accordance with the relevant Australian Standards	**Section 5.1.4**
Aquatic and riparian ecosystems, including affected sections of Bellambi Creek	• Maintain or improve baseline channel stability • Develop site-specific in-stream water quality objectives in accordance with ANZECC 2000 and Using the ANZECC Guidelines and Water Quality Objectives in NSW procedures (DECC 2006), or its latest version	**Section 5.1.2** and **Section 4.1, 4.4** & **4.5** of **Appendix C**

8 MONITORING

Surface and groundwater monitoring is undertaken under three categories:

- Visual inspection of watercourses and swamps.
- Surface water quality and flows at EPL monitoring points.
- Groundwater levels and quality throughout the underground mining area.

8.1 Surface Water Monitoring

EPL11 is a continuous ambient water monitoring site located within Bellambi Gully on the western side of the Princes Highway road culvert used to monitor the final water quality leaving site.

EPL12 is a continuous ambient water monitoring site located within Bellambi Gully upstream of the pit top area, which monitors upstream water quality prior to it entering site.

LDP2 discharge is monitored continuously for flow rate (discharge quantity) and turbidity, through the SCADA system. The continuous automated monitoring of LDP2 regulates discharge automatically (via predetermined logic built into the SCADA system) such that when the pre-set discharge volume and quality limits are reached, the discharge valve is automatically closed by SCADA and the water is recirculated through the water management system. This monitoring and control logic ensure water discharged via LDP 2 cannot exceed water quality or volume limits.

The ongoing real time turbidity monitoring of LDP 2 discharge, Bellambi Gully Upstream (LDP12) and Bellambi Gully Downstream (LDP11) allows for rapid response to deviations above water quality trigger values. The EPL12040 requires water discharged from LDPs to comply with the water quality limits and monitoring requirements tabulated in **Table 13**.

Table 13 Environmental Protection Licence Monitoring Locations

POINT	DESCRIPTION	FREQUENCY	MONITORING REQUIREMENTS	LIMIT CONDITIONS
1 (LDP1)	*Licensed Discharge Point:* Underground drainage from coal stockpile and forested area in Rath's Gully	Monthly during discharge	pH Total Suspended Solids Turbidity Electrical Conductivity	- N/A - N/A - N/A - N/A
2 (LDP2)*	*Licensed Discharge Point:* Treated water outlet from the thickener tank discharging into the Bellambi Gully diversion channel	Monthly during discharge	pH Total Suspended Solids Turbidity Electrical Conductivity	6.5 – 9.2 50 mg/L - N/A - N/A
		Continuous	Volume Turbidity**	2,500 kL/day* 60 NTU**

POINT	DESCRIPTION	FREQUENCY	MONITORING REQUIREMENTS	LIMIT CONDITIONS
3 (LDP3)	*Licensed Discharge Point:* Seepage through the SWCD wall into Bellambi Gully	-	-	- N/A
9 (LDP9)	*Licensed Discharge Point:* The SWCD gabion spillway discharging to Bellambi Gully	-	-	- N/A
11 (EPL11)	*Ambient Monitoring Point:* Bellambi Gully ambient water quality west of Princes Highway	Continuous	Turbidity Electrical Conductivity Volume	- N/A - N/A - N/A
12 (EPL12)	*Ambient Monitoring Point:* Bellambi Gully upstream ambient water quality	Continuous	Turbidity Electrical Conductivity Volume	- N/A - N/A - N/A

**Note*: *EPL Condition L3.2 states that: The volume of wastes discharged from Point 2 on any day must not exceed 2500kL under dry weather conditions, but may exceed this volume under wet weather conditions provided all practical measures are taken to minimise additional pollution caused by the wet weather*
Note: *For compliance with the above condition, 'Dry Weather Conditions' means less than ten millimetres of rain falling within a 24 hour period and is measured at a point on the premises; and 'Wet Weather Conditions' means anything other than Dry Weather Conditions.*
Note: *For 72 hours following wet weather conditions, water may be discharged in excess of 2500kL/day from Point 2, in order to allow the dam level to be quickly reduced to a safe level, provided all practical measures are taken to minimise additional pollution caused by the wet weather*
***Note**: Continuous turbidity monitoring of LDP2 is a process control measure for the SCADA system, implemented by WCL to ensure EPL discharge limits are complied with, it is not an EPL requirement or limit.*

Table 14 Proposed additional monitoring points – Bellambi Gully

POINT	DESCRIPTION	FREQUENCY	MONITORING REQUIREMENTS
Reference Site 1 **Reference Site 2**	Reference adjacent to Bellambi Gully to provide an estimate of the typical water quality generated by the site, without the influence of the pit top area.	Monthly during discharge & during significant rainfall events	pH Total Suspended Solids Turbidity Electrical Conductivity
BG 1			pH

POINT	DESCRIPTION	FREQUENCY	MONITORING REQUIREMENTS
BG 2	Monitoring point to identify potential water quality impacts downstream of the pit top area, within the receiving (urbanised) environment.	Monthly during discharge & during significant rainfall events	Total Suspended Solids Turbidity Electrical Conductivity

8.1.1 Surface Water Trigger Values

Surface water quality trigger values have been derived for the site, using observed water quality data (where sufficient data is available).

Table 15 Surface Water Impact Criteria

AREA	TRIGGER LEVEL	TRIGGER CRITERIA
EPL 11	**pH** Level 2 - 20th/80th percentile of baseline data Level 3 - 5th/95th percentile of baseline data	One exceedance of the 20th/80th percentile levels.
	EC & TSS Level 2 – 80th percentile of baseline swamp data Level 3 – 95th percentile of baseline data	One exceedance of the 80th percentile level.
	Turbidity Level 2 – Readings between 100 – 300 NTU (as agreed with EPA) Level 3 – Readings above 300 NTU (as agreed with EPA)	One exceedance above Trigger Levels
LDP2	**pH** Level 2 - 20th/80th percentile of baseline data Level 3 – EPL Limit	One exceedance above Trigger Levels

AREA	TRIGGER LEVEL	TRIGGER CRITERIA
	EC Level 2 - 80th percentile of baseline data Level 3 – 95th percentile of baseline data	One exceedance above Trigger Levels
	TSS Level 2 - 80th percentile of baseline data Level 3 – EPL Limit	One exceedance above Trigger Levels

8.1.2 Background Surface Water Quality

A summary of the surface water quality monitoring results is included **Table 16.**

Table 16 Observed Surface Water Quality

POLLUTANT	UNITS	EPL11 (DOWNSTREAM)		EPL12 (UPSTREAM)	
		MEDIAN	RANGE	MEDIAN	RANGE
pH	-	8.37	7.69 to 9.1	7.8	6.74 to 8.4
EC	µS/cm	736	471 to 2030	345	236 to 743
TSS	mg/L	49.5	6 to 4030	41.5	10 to 142
Turbidity	NTU	60.6	10.3 to 2120	40.8	2 to 163
Total Hardness	mg/L	52	27 to 103	74	49 to 218
Total Alkalinity	mg/L	294.5	214 to 799	147.5	53 to 264
TKN	mg/L	0.9	0.4 to 2.2	0.65	0.14 to 1.2
TP	mg/L	0.22	0.05 to 0.51	0.13	0.02 to 0.28
Aluminium	mg/L	0.16	0 to 1.22	0.11	0.07 to 0.16
Barium	mg/L	0.113	0.048 to 0.176	0.077	0.071 to 0.12
Boron	mg/L	0.06	0.06 to 0.07	0.06	0.06 to 0.06
Copper	mg/L	0.005	0.002 to 0.013	0.003	0.001 to 0.007
Iron	mg/L	0.17	0.07 to 0.31	0.19	0.1 to 0.21
Lithium	mg/L	0.06	0 to 0.24	0	0 to 0.01

POLLUTANT	UNITS	EPL11 (DOWNSTREAM)		EPL12 (UPSTREAM)	
		MEDIAN	RANGE	MEDIAN	RANGE
Manganese	mg/L	0.008	0.001 to 0.069	0.01	0.005 to 0.088
Nickel	mg/L	0.003	0.001 to 0.006	0.002	0.001 to 0.006
Strontium	mg/L	0.22	0.11 to 0.27	0.16	0.12 to 0.21
Zinc	mg/L	0.016	0.006 to 0.054	0.007	0.007 to 0.007

8.2 Groundwater Monitoring

Monitoring is undertaken for groundwater levels and quality in accordance with the RVC Groundwater Management Plan (GWMP).

Monitoring results will be reported in the Annual Review and made available on the WCL website. Refer to the GWMP for further detail.

8.2.1 Groundwater Trigger Values

Groundwater quality trigger values have been derived for the site, using observed water quality data (where sufficient data is available).

Table 17 Groundwater Impact Criteria

AREA	TRIGGER LEVEL	TRIGGER CRITERIA
Swamps	pH - 5th and 95th percentile of baseline swamp data (all RVE swamps)	Two consecutive readings outside the trigger levels
	EC – 95th percentile of combined baseline swamp data (all RVE swamps)	Two consecutive readings outside the trigger level
	SWL – 95th percentile of site-specific baseline depth to groundwater, calculated with dry readings excluded ***New sites: maximum 0.5 m change in depth to groundwater over 12-month period for swamps with water present.***	Two consecutive readings outside the trigger level, for periods with monthly rainfall exceeding 20 mm.
Hawkesbury Sandstone	pH - 5th and 95th percentile of baseline data (all RVE OSPs)	Two consecutive readings outside the trigger level
	EC – 95th percentile of combined baseline data (all RVE OSPs)	Two consecutive readings outside the trigger level
	WL – 95th percentile of site-specific baseline water levels ***New sites: initial trigger based on maximum 2 m groundwater level decline over 12-month period.***	Two consecutive readings outside the trigger level
Bulgo Sandstone	pH – 5th and 95th percentile of baseline data after 12 months of data collection.	Two consecutive readings outside the trigger level

AREA	TRIGGER LEVEL	TRIGGER CRITERIA
	New sites: initial trigger based on Hawkesbury Sandstone trigger.	
	EC – 95th percentile of baseline data after 12 months of data collection. ***New sites: initial trigger based on Hawkesbury Sandstone trigger.***	Two consecutive readings outside the trigger level
	WL – 95th 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.***	Two consecutive readings outside the trigger level
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.	Trigger level based on detection of a significant change in vertical head gradient, as indicated from the predicted head gradient and current observation data.
Permian coal measures - Mine Inflow Volumes	Mine pump volumes within predicted mine inflow range.	Mine pump volume exceeds predictions, where an increase in flow rate of >1ML/day (above predictions) for 7 successive days from active mining areas.
Permian coal measures - Mine Inflows	pH – minimum and maximum of site baseline mine inflow data	Readings outside the trigger level
	EC –maximum of site baseline mine inflow data	Readings outside the trigger level
	Sulfate - maximum of site baseline mine inflow data	Readings outside the trigger level
	Dissolved Al - maximum of site baseline mine inflow data	Readings outside the trigger level
	Dissolved As - maximum of site baseline mine inflow data	Readings outside the trigger level
	Dissolved Mo - maximum of site baseline mine inflow data	Readings outside the trigger level
	Dissolved Sb - maximum of site baseline mine inflow data	Readings outside the trigger level

8.2.2 Background Groundwater Quality

A summary of the ground water quality monitoring results for the Hawkesbury Sandstone and mine inflows (from the Permian Coal measures) across the UEP are included Table 18.

Table 18 Observed Groundwater Quality

POLLUTANT	UNITS	HAWKESBURY SANDSTONES		MINE INFLOW	
		MEDIAN	RANGE	MEDIAN	RANGE
EC	µS/cm	135	45 - 685	3,400	2,360 – 5,790
pH	-	5.0	2.7 - 8.2	8.8	7.7 – 9.4
Bicarbonate	mg/L	2.0	1 - 1540	1,554	1,210 – 2,700
Sulfate	mg/L	22.0	2 - 404	31	1 - 204
Aluminium	mg/L	0.290	0.010 - 2.000	0.03	0.01 – 0.12
Arsenic	mg/L	0.001	0.001 - 0.097	0.018	0.002 – 0.269
Copper	mg/L	0.005	0.001 - 0.095	0.010	0.001 – 0.107
Nickel	mg/L	0.004	0.001 - 0.099	0.003	0.001 – 0.039

9 INCIDENTS AND NON COMPLIANCE

9.1 Handling incidents and non-compliance

The Development Consent defines:

• an **'incident'** to be "an occurrence or a set of circumstances that causes or threatens to cause material harm and which may or nor cause a non-compliance".

• '**Non-compliance** as "an occurrence, set of circumstances or development that is a breach of this consent".

In accordance with Condition F1(d)(iv), any incidents, exceedance or non-compliance will be managed through established WCL procedures as detailed in the EMS (Wollongong Coal 2021a).

9.2 Incident Reporting

The DC MP09_0013 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 and 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.

In accordance with **Condition R2.1** of the site EPL, WCL must provide notification of environmental harm by telephoning the Environment Line services on 131 555.

In accordance with **Condition R2.2** of the site EPL, WCL must provide written details of the complaint to the EPA within 7 days of the date on which the incident occurred.

In accordance with **Condition R2.2** of the site EPL, WCL or its employees must notify all relevant authorities of incidents causing or threatening material harm to the environment immediately after the person becomes aware of the incident in accordance with the requirements of Part 5.7 of the Act.

In accordance with **Condition M5.3** of the site EPL the record of a pollution complaint must be kept for at least 4 years after the complaint was made and must be produced to any authorised officer of the EPA who asks to see it.

9.3 Non-Conformance Protocol

As required by **Condition F10**, WCL will notify DPIE of any non-compliance within seven days of becoming aware of it in accordance with established protocol developed as a component of the Environmental Management System (EMS).

The notification will set out the condition of the consent that the project is non-compliant with, why it does not comply, the reasons for the non-compliance (if known), and what actions have been, or will be, undertaken to address the non-compliance.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with WCL Russell Vale Colliery, and will be promoted through direct consultation and direction of the mines' Operations Manager. A Compliance Register will be established to monitor compliance against development consent criteria, mining leases and licenses.

The notification will set out the condition of the consent that the project is noncompliant with, why it does not comply, the reasons for the non-compliance (if known), and what actions have been, or will be, undertaken to address the non-compliance.

In addition, as required by **Condition E1** WCL is required to notify:

As soon as practicable, and no longer than 7 days after obtaining monitoring results showing:

- *an exceedance of any relevant criteria in Part B of this consent, the Applicant must notify affected landowners in writing of the exceedance, and provide regular monitoring results to these landowners until the development is again complying with the relevant criteria*.

No affected landowners or downstream users have been identified in relation to the development.

9.4 Inspections and compliance

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with WCL Russell Vale Colliery, and will be promoted via direct consultation and through the direction of the Operations Manager.

Regular targeted inspections and/or internal audits will be undertaken as required by suitably qualified personnel under the direction of the E&C Manager, to identify any remediation/rectification work required, and areas of actual or potential non-compliance.

A Compliance Register will be established to monitor compliance against Development Consent criteria, mining leases etc. Non-compliances identified through the Compliance Register are to be reported, with corrective actions implemented.

A review of WCL's compliance with all conditions of the Development Consent, mining leases and all other approvals and licences will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on WCL's website.

9.5 Contingency Plan

Condition F5(f) requires WCL to establish a contingency plan to manage any unpredicted impacts and their consequences, and to ensure that ongoing impacts reduce to levels below relevant performance measures or criteria as quickly as possible. The following section details the process that WCL will implement to ensure compliance with **Condition F5(f)**.

In the event that observed parameters or impacts exceed, or are considered likely to exceed, the performance measures detailed in **Section 7** of this Plan, WCL will implement the following Contingency Plan:

- The observation will be reported to WCL's Group Environmental Manager as soon as possible, or within 24 hours;
- The observation will be recorded;

- WCL will report any exceedance of the performance measure to the DPIE and any other relevant stakeholders as soon as practicable after WCL becomes aware of the exceedance;
- WCL will assess the exceedances referred to in the TARPs of this document 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 impact(s), in consultation with specialists and/or relevant agencies if necessary;
- WCL will identify any 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 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 the Management Plan.

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

9.6 Complaint Management

Complaints will be managed through established WCL procedures as detailed in the EMS. As required by ***Condition F17*** of the Project Approval and EPL Condition M5, WCL will establish a protocol for managing and reporting any complaints relating to water quality.

Complaints will be managed through established WCL procedures, as detailed in the EMS. The Colliery will ensure the telephone number and email address in which environmental and pollution complaints can be made is easily accessible to the community, via both signage at the operation and advertised by the Wollongong Coal website, in accordance with ***Condition F17*** and ***EPL Conditions 5.1, 5.2, 5.3, 5.4, M6.1*** and ***M6.2.***

The Environmental Manager is responsible for ensuring that the currency and effectiveness of the telephone service is maintained. Notifications of complaints received are to be provided as quickly as practicable to Environmental Manager, or delegate.

The complaints register will include the following details:

- Date and time of the complaint.
- The method by which the complaint was made.
- Any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect.
- The nature of the complaint.
- The action taken by the licensee in relation to the complaint, including any follow-up contact with the complainant.
- If no action was taken by the licensee, the reasons why no action was taken.

Continuous real-time water monitoring data at LDP 11 & LDP 12 will be used to assist with validating and responding to water management related complaints, where possible. Complaint records will be managed and maintained as outlined in **Section 13.4.**

In accordance with **Condition F17(a)(x**) of the Consent, a Complaints Register will be made publicly available on the website and updated on a monthly basis. A summary of complaints received and actions taken will be presented to the CCC as part of the operational performance review. A summary of complaints received and actions taken will also be included in the Annual Review and the Annual Return. The record of a complaint will be kept for a minimum four-year period after the complaint was made.

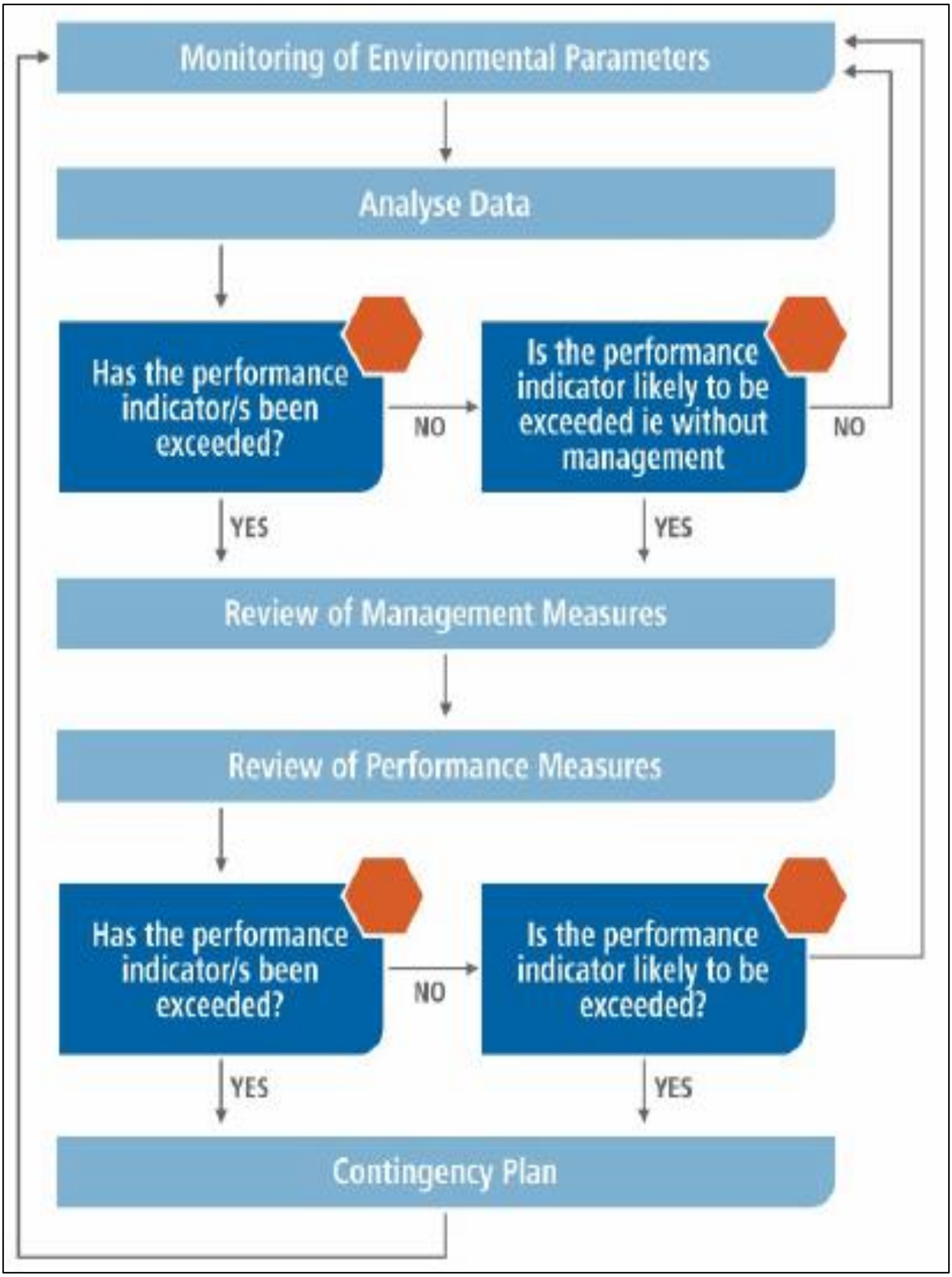
9.7 Adaptive management/ TARP

In accordance with **Condition F4,** where exceedances of criteria or performance measures has occurred, WCL will at the earliest opportunity:

- Take all reasonable and feasible steps to ensure that the exceedance ceases and does not re-occur (i.e. TARPs, contingency planning);
- 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 the remediation options and any preferred remediation measures or other course of action; and
- Implement remediation measures as directed by the Planning Secretary.

Trigger Action Response Plans (TARPs) for surface water and groundwater monitoring are detailed in the SWMP and GWMP respectively. The TARP outlines what actions will be undertaken in the case where exceedances of the required performance criteria occur.

Figure 12 Environmental Management Process



10 MITIGATION AND MANAGEMENT STRATEGIES

10.1 Equipment and Maintenance

As required by **Condition O2.1** of the EPL and Project Approval **Condition A27**, all water management infrastructure, plant and equipment installed at the premises (including pumps, pipelines, dams, and monitoring equipment) is to be maintained and operated in a proper and efficient manner/condition. This includes servicing and repairing as required, to maintain a suitable condition and ensure operation in a proper and efficient manner.

In accordance with EPL condition M8, all continuous monitoring equipment required by the licence must be operated and maintained with the aim of achieving 100% availability in each licence year. Where a monitoring device does not achieve 95% availability, WCL must report reasons and corrective actions to the EPA in the Annual Return and to the DPIE in the Annual Review. To minimise the occurrence of downtime for continuous monitors, WCL environmental staff and technical expert consultants routinely maintain and calibrate continuous monitors in accordance with OEM guidelines and procedures.

10.2 Site Rehabilitation

A summary of the site rehabilitation objectives, prepared in to address the requirements of **Schedule 2, Condition B44**, are included in **Table 19**.

Table 19 Rehabilitation Objectives

FEATURE	PERFORMANCE MEASURE	WHERE ADDRESSED IN THIS PLAN
All areas of the site affected by the development	• Safe, stable and non-polluting • Fit for the intended post-mining land use/s • Establish final landform and post-mining land use/s as soon as practicable after cessation of mining operations • Minimise post-mining environmental impacts	**Section 3** (Bellambi Gully clean water diversion)

Areas proposed for native ecosystem re-establishment	• Establish/restore self-sustaining native ecosystems
	• Establish local plant community types
	• Establish:
	  ◦ Riparian habitat within any diverted and/or re-established creek
	  ◦ Lines and retained water features.
	  ◦ Habitat, feed and foraging resources for threatened fauna species; and
	  ◦ Vegetation connectivity and wildlife corridors, as far as is reasonable and feasible
		Section 3 (Bellambi Gully clean water diversion)

Other areas affected by the development	• Restore ecosystem function, including maintaining or establishing self-sustaining ecosystems comprised of local native plant species for the intended post mining land use(s)	-

FEATURE	PERFORMANCE MEASURE	WHERE ADDRESSED IN THIS PLAN
Final landforms	• Stable and sustainable for the intended post-mining land use/s • Consistent with surrounding topography to minimise visual impacts • Incorporate relief patterns and design principles consistent with natural drainage that mimic natural topography and mitigate erosion to the greatest extent practicable	-
Surface infrastructure sites	• Decommissioned and, subject to Historic Heritage Management • Plan, removed, unless further approval is obtained for their retention and post-mining use. • Revegetated with suitable local native plant species to a landform consistent with the surrounding environment and the intended post mining land use(s)	-
Portals and vent shafts	• Decommissioned and made safe and stable • Retain habitat for threatened species (e.g., bats), where practicable	-
Watercourses subject to mine water discharges and/or subsidence impacts or environmental consequences that are greater than negligible	• Hydraulically and geomorphologically stable • Aquatic ecology and riparian vegetation that is the same or better than prior to grant of this consent	**Section 3**

Built features damaged by mining operations	• Repair to pre-mining condition or equivalent unless the:
	    • Owner agrees otherwise; or
	    • Damage is fully restored, repaired or compensated for under the Coal Mine Subsidence Compensation Act 2017
		-

Water quality	• Water retained on site is fit for the intended post-mining land use(s) • Water management is consistent with any regional catchment management strategy	-
Community	• No additional risk to public safety than prior to grant of this consent • Minimise adverse socio-economic effects associated with mine closure	**Section 3** (Bellambi Gully clean water diversion, including clean water detention basin)

10.3 Bellambi Gully

Under the UEP approval MP09_0013, WCL is required to implement diversion works on Bellambi Gully to manage pollution risks associated with flooding of the creek. The pollution risks have historically stemmed from the capacity of the diversion pipe being less than the 1% AEP storm event flows. A flood analysis and concept design for these works was undertaken by Cardno (2020). The works included analysis and design of an open channel to divert clean floodwaters from the operation areas, a detention basin to attenuate flood volumes and peak velocities leaving the site and design of a new dry sediment basin to improve stormwater quality and aid in floodwater detention to minimise flooding downstream of the site. Subsequently a detailed design was prepared during early 2021 based on the concept design works.

11 PLAN ADMINISTRATION

11.1 Roles and Responsibilities

Environment and community management is regarded as part of the responsibilities of all Russell Vale Colliery personnel. Roles and responsibilities are described in WCL's Management Operating System.

11.2 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 Management Plan.

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

11.3 Training

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 Environment Manager to ensure that these requirements are communicated to WCL Management. All training and inductions conducted are to be undertaken as per the ***WCL Training procedures*** and approval **Condition A28**.

11.3.1 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 requirement – Management.

Level 2 – Operational level training – Project Managers, Supervisors, Surface Personnel.

Level 3 – Basic environmental awareness – Underground staff.

Targeted water quality awareness training such as targeted toolbox talks 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 water quality 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 a water quality incident (e.g., stockpile contractors).

11.3.2 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 of works on site. This 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:

- Mandatory HSECQ Rules, Environment Policy and EMS requirements.
- General environmental duty of care;
- Relevant details of this Management Plan, including purpose and objectives;
- Key environmental matters of relevance i.e. aspects and impacts relevant to site biodiversity values;
- Specific requirements and responsibilities with regard to implementation of mitigation measures; 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.

12 AUDIT AND REVIEW

12.1 Auditing

In accordance with **Condition F13**, an Independent Environmental Audit will be undertaken by a suitably qualified auditor and include experts in any field specified by the Secretary. The timeframe and scope of the audit are defined in Section 5.2 of the EMS. In accordance with **Condition F14** WCL will submit a copy of the audit report to the Planning Secretary, and any other NSW agency that requests it, within three months of commencing the Independent Environmental Audit. WCL will submit a copy of the report together with a response to any recommendations contained in the audit report, along with a timetable for the implementation of the recommendations, and implement the recommendations to the satisfaction of the Planning Secretary.

It is further noted that any condition of this consent that requires the carrying out of monitoring or an environmental audit, whether directly or by way of a plan, strategy or program, it is taken to be monitoring or an environmental audit under Division 9.4 of Part 9 of the EP&A Act. This further includes conditions in respect of incident notification, reporting and response, non-compliance notification, compliance report and independent audit.

12.2 Model Review

Models used to inform the SOWMP (and sub-plans), notably the groundwater model and water balance model, will be reviewed and where required updated as part of the plan review process.

The SOWMP will be reviewed and revised in accordance with the schedule provided in Environmental Management Strategy or because of:

- Any regulatory or statutory requirements.
- Any significant change to water management practices.
- Construction of additional surface water storages.
- Development of new open cut or underground mining areas.
- Continual exceedances of any surface or groundwater trigger values.
- Any incident that requires reporting as discussed in Section 5.1.

12.3 Review of Monitoring Results

Monitoring results reviewed and reported on an annual basis and included in the Annual Review and made available on the WCL website. Refer to the SWMP for further detail.

12.4 Annual Review

In accordance with ***Condition F11 / Schedule 2*** of the Project Approval, an Annual Review of the environmental performance of the Project is prepared by the end of March each year, and covers the reporting period being the previous calendar year (or other timeframes as approved by the secretary).

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 received for the Project over the past year, including a comparison of these results against:
  - compliance with the performance measures, criteria, limits, relevant statutory requirements and operating conditions of this consent;
  - the requirements of any plan or program required under the Development Consent;
  - the monitoring results of previous years, identifying any trends in the monitoring data over the life of the Project; and
  - the relevant predictions in the EA (or PRRP).

- Identify any non-compliance or incident which occurred during the reporting period, and what actions were (or are being) taken to rectify the non-compliance and avoid recurrence.
- Identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies;
- Summarise the estimated volume of intercepted surface water and groundwater extraction, as well as discharges to the surrounding environment.
- Evaluate and report on the effectiveness of the water management systems; and
- Describe what measures will be implemented over the next calendar year to improve the environmental performance of the Project.
- Report on any continuous monitoring equipment required by the EPL, where the monitoring device does not achieve 95% availability in each licence year, in accordance with EPL condition M8. This will include reasons for not achieving greater than 95% availability and corrective actions.

A copy of the Annual Review will be submitted to the DPIE, RR, Water NSW, WCC, WSC and made available to the CCC and any interested person upon request, in accordance with **Condition F12**. Based on the environmental performance of operations, as evaluated in the Annual Review, WCL will investigate and implement ways to improve on the environmental performance of the development over the next year in accordance with **Condition F5(g)**.

12.5 Plan Revision

In accordance with **Condition F7**, this SOWMP will be reviewed within three months of:

- the submission of an incident report under **Condition F9**;
- the submission of an annual review under **Condition F11**;
- the submission of an independent environmental audit under **Condition F13**; or
- the approval of any modification of the conditions of the development consent (unless the conditions require otherwise).

The suitability of existing strategies, plans and programs required under the development consent will be reviewed by WCL.

In accordance with **Condition F8**, if necessary to either improve the environmental performance of the project, cater for a modification or comply with a direction, the strategies, plans and programs required under the Development Consent will be revised, to the satisfaction of the Planning Secretary. Where revisions are required, the revised document will be submitted to the Planning Secretary for approval within 6 weeks of the review.

In addition, the SOWMP will be reviewed and revised as a result of:

- Any change in a relevant regulatory or statutory requirements;
- Any significant change to water management practices at site;
- Construction of additional surface water storages on site;
- Continual exceedances of any surface or groundwater trigger values;
- Any incident that requires reporting as discussed in **Section 5.1**.

This plan will also be reviewed and updated following the completion of the Bellambi Gully Clean Water Diversion construction works, and the subsequent development of the specific maintenance plan required under Term 2i of the DPIE Order dated 23 July 2020. This will include the incorporation of a detailed maintenance plan/schedule, including an implementation plan with specific actions and timeframes, for the new clean water diversion and storage infrastructure, in line with the statement of commitments in **Table 5**.

12.6 Independent review

Conditions E2 to **E5** defines the procedure for an independent review, where a landowner considers the development to be exceeding the criteria in Part B and Part C of the consent**.**

Where the Planning Secretary is satisfied that an independent review of the impacts of the development is warranted in response to a request from a landowner, WCL will do the following within 3 months of the Planning Secretary's decision, or within another agreed timeframe:

- commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Planning Secretary, to:
    - consult with the landowner to determine their concerns;
    - conduct monitoring to determine whether the development is complying with the criteria; and
    - if the development is not complying with the criteria, identify measures that could be implemented to ensure compliance; and
- give the Planning Secretary and landowner a copy of the independent review.

WCL will then comply with any written requests made by the Planning Secretary to implement any findings of the review and in accordance with any timeframes specified.

13 RECORDS AND DOCUMENT CONTROL

13.1 Access to Information

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

Before the commencement of construction, and until the completion of all rehabilitation required under this consent, WCL will ensure the information and documents as stipulated in **Condition F17** and in the EMS, are made publicly available on its website (as they are obtained, approved or as otherwise stipulated within the conditions of the consent). This includes:

- The documents as listed in condition A2(c) of the consent;
- All current statutory approvals required for the development;
- All approved strategies, plans, programs required under the conditions of the consent, including this Water MP and sub-plans;
- The proposed staging plans for the development if the construction, operation or decommissioning of the development is to be staged;
- Minutes of CCC meetings;
- Regular reporting on the environmental performance of the development in accordance with the reporting requirements in any plans or programs approved under the conditions of this consent;
- A comprehensive summary of the monitoring results of the development, reported in accordance with the specifications in any conditions of this consent, or any approved plans and programs;
- A summary of the current phase and progress of the development;
- Contact details to enquire about the development or to make a complaint.
- A complaints register, updated monthly;
- The Annual Reviews of the development;
- Audit reports prepared as part of any Independent Environmental Audit of the development and the Applicant's response to the recommendations in any audit report; and
- Any other matter required by the Planning Secretary.

This information must be kept up to date to the satisfaction of the planning secretary. All documents described in this plan 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 EMS documentation.

13.2 Public sources of Information

To assist the public and other stakeholders understand the environmental impacts from the development, 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**, is outlined in **Section 13.1** of this plan. This information will be reviewed and updated as required on a regular basis to ensure it is up to date and available.

13.3 Document Control

All documents, environmental records and management plans, including this plan, relevant to the EMS are to be managed in accordance with the ***WCL SYS PRO 001*** Document and Data Control procedure. All EMS documents will be stored so that they are readily retrievable and suitably protected from deterioration or loss. Document review and archiving will be managed in accordance with the ***WCL SYS PRO 001*** Document and Data Control procedure.

The revision status of this plan is indicated in the title section of each copy, and revisions to any documents listed within this Plan will not necessarily constitute a revision of this document.

Controlled copies of this plan are addressed as below:

- 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;
- On the WCL website; and
- Within the WCL document register.

Any revisions undertaken of this plan, and sub plans, will be the responsibility of WCL and any notifications 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 Mine Site as described above.

13.4 Record Keeping

Environmental records are to be managed in accordance with the ***WCL SYS PRO 001*** Document and Data Control procedure. All records relating to 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.

In accordance with EPL condition M1, all monitoring records will be kept in a legible form for at least 4 years after the monitoring or event to which they relate took place, and will be produced for any authorised officer of the EPA who asks to see them. The results of any monitoring required to be conducted under the EPL licence, or a load calculation protocol, must be recorded and retained as set out below. Environmental monitoring records will contain:

- The date(s) on which the sample was taken;
- The time(s) at which the sample was collected;
- The point at which the sample was taken; and
- The name of the person who collected the sample.

Types of records to which this applies includes, but is not limited to:

- Monitoring, inspection and compliance reports/records;
- Correspondence with public authorities;
- Pollution complaints;
- 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 records and record keeping practices are subject to ongoing review and continual improvement. This includes during changes to scheduled activities, and legislative or licensing requirements. A master copy of each EMS records including all appendices and supporting information is to be held in the office of the E&C Department.

14 REFERENCES

ANZECC (2000). Australian and New Zealand Guidelines For Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand.

Cardno (2020), Flood Analysis and Concept Design, Bellambi Creek Diversion. Prepared for Wollongong Coal Ltd.

Umwelt, 2020, *Draft Public Environment Report: Russell Vale Colliery Revised Underground Expansion Project (EPBC 2020/8702)*, December 2020.

15 GLOSSARY AND ABBREVIATIONS

Abbreviations

ABREVIATION	DEFINITION
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment Conservation Council
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
BoM	Bureau of Meteorology
CHPP	Coal Handling and Preparation Plant
DAWE	Department of Agriculture, Water and the Environment
DECC	Former NSW Department of Environment and Climate Change (now NSW Office of Environment and Heritage)
DGV	Default Guideline Value
DO	Dissolved Oxygen
DPIE	NSW Department of Planning, Infrastructure and Environment
DSC	Dam Safety Committee
EA	Environmental Assessment
EC	Electrical Conductivity
EMS	Environmental Management Strategy
E&A Manager	Group Environment and Approvals Manager
EPA	Environment Protection Authority
EPBC Act	Environment Protection and Biodiversity Act 1999
EPL	Environment Protection Licence
GWMP	Groundwater Management Plan
ha	Hectares
LDP	Licenced Discharge Point
LGA	Local Government Area
LW	Longwall
ML	Megalitres
MNES	Matters of National Environmental Significance
MOD	Modification
MP	Management Plan
Mt	Million tonnes
NRAR	Natural Resources Access Regulator

ABREVIATION	DEFINITION
NSW	New South Wales
ORP	Oxidation and Reduction Potential
PAC	Planning Assessment Commission
PPR	Preferred Project Report
ROM	Run-of-mine
RPPR	Revised Preferred Project Report
SMP	Subsidence Management Plan
SOWMP	Surface Operations Water Management Plan
TARP	Trigger Action Response Plan
TDS	Total Dissolved Solids
TSC Act	Threatened Species Conservation Act 1995
TSS	Total Suspended Solids
UEP	Underground Expansion Project
WCC	Wollongong City Council
WCL	Wollongong Coal Limited
WMS	Water Management System
WO	Work Order
WTP	Water Treatment Plant

Terms

Terms	
Annual Review	The review as required by condition F11 of the approval.
Construction	The construction works for the project as described in the RPPR. Construction work does not include surveys, acquisitions, fencing, investigative drilling or excavation, minor clearing, minor access roads, minor adjustments to services/utilities, works which allow isolation of the site so that access for construction can be provided (including service relocations) and establishing temporary facilities for construction (including for example an office and amenities compounds, temporary water and communications, construction compounds, materials storage compounds, maintenance workshops, testing laboratory or material stockpile areas).
CCC	The Russell Vale Community consultative committee
Conditions of this consent	Conditions contained in Schedule 2

Terms	
Construction	The construction works for the project as described in the RPPR. Construction work does not include surveys, acquisitions, fencing, investigative drilling or excavation, minor clearing, minor access roads, minor adjustments to services/utilities, works which allow isolation of the site so that access for construction can be provided (including service relocations) and establishing temporary facilities for construction (including for example an office and amenities compounds, temporary water and communications, construction compounds, materials storage compounds, maintenance workshops, testing laboratory or material stockpile areas).
Day	7.00am - 6.00pm
dB(A)	A-weighted decibel
Department	Department of Planning, Industry & Environment
Early Morning Shoulder	5.00am - 7.00am
Evening	6.00pm – 10.00pm
First Workings	Development of main headings, gate roads, related cut throughs and other workings for mine access and ventilation.
Feasible	Means what is feasible and practical in the circumstances
Incident	A set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval and which may or may not be a non-conformance. See "Unintended Event" – the Russell Vale Colliery Logistics Manager and the Group Environmental Manager are responsible for determining if a report of an "unintended event" represents an "incident" as defined.
Material Harm	Material harm 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 and practicable measures to prevent, mitigate or make good harm to the environment). This definition excludes "harm" that is authorised under either this approval or any other statutory approval'.
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

Terms	
	emplacement of vegetation, topsoil, overburden and reject material. Mining operations include both phase-in and full operations.
Mine closure	Decommissioning and final rehabilitation of the site following the cessation of mining activities.
Mitigation	Activities associated with reducing the impacts of the development
Negligible	Small or unimportant, not worth considering.
Night	The period from 10pm to 5am on Monday to Saturday, and 10 pm to 8 am on Sundays and Public Holidays.
Noise Sensitive areas	Areas where mining operations are being carried out that have the potential to lead to increased noise at privately owned residences, such as elevated areas or areas near the boundary of the site.
Non-Compliance	An occurrence or set of circumstances or development that is a breach of the project consent.
Reasonable	Means applying judgement in arriving at a decision, taking into account mitigation benefits, cost of mitigation versus benefits provided, community views, and the nature and extent of potential improvements.
Secretary	The Secretary of the Department of Planning, Industry & Environment
Second Workings	The extraction of coal from board and pillar workings
Surface Facilities Site	Russell Vale Pit Top site, coal conveyor, truck load out facilities, ventilation shaft sites, and any other site subject to proposed surface disturbance (excluding subsidence impacts) associated with the development.

APPENDIX A. CONSULTATION

Planning, Industry & Environment

Richard Sheehan
Environment Manager
Wollongong Coal Limited
Princes Highway
Corrimal, NSW, 2158

22/07/2021

Dear Richard

Russell Vale Underground Expansion Project (MP 09_0013)
Water Management Plan - Request for Additional Information

I refer to the Water Management Plan (WMP) (file name *RVC SOWMP Rev 6 - Clean_MP09_0013-PA-29.pdf*) submitted to the Department as required under Condition B17, Schedule 2 of MP 09_0013 for Russell Vale Underground Expansion Project. After careful consideration, the Department is requesting that you provide additional information.

Detailed comments and required actions are included in the table attached and summary of key actions is provided below.

- Cross references to tables and sections and appendices need to be corrected throughout the document.
- Update Table 2, Table 3 and Table 4 in the main plan such that there is a section reference for each clause or dot point, to make the relevant sections easier to find.
- Address performance measures for aquatic and riparian ecosystems including affecting sections of Bellambi Creek (refer to Table 4 of the consent) in the WMP.
- Section 7 (Table 12) states no flood protection measures are proposed. However, the RPPR describes proposed improvements to the water management system to reduce flood impacts on downstream properties. Update the plan to address the performance measures for flood protection works.
- Much of the erosion and sediment control plan (ESCP) describes generic activities that may cause erosion and generic erosion and sediment control measures. The ESCP should be updated to be specific to the activities that will actually be undertaken during the project stages covered by the WMP, and associated controls including the location, function, capacity and maintenance of new erosion and sediment control infrastructure.
- Update the Surface Water Management Plan (Appendix C) to include baseline data on stream and riparian vegetation health, channel stability and groundwater users.
- Update the Surface Water Management Plan (Appendix C) to include detailed plans, design objectives and performance criteria for water management infrastructure, including any approved creek diversions.
- Update the Surface Water Management Plan (Appendix C) to include detailed performance criteria, including trigger levels, and performance indicators, for downstream surface water flows, channel stability, downstream flooding, stream and riparian vegetation health and post-mining water pollution from rehabilitated areas of the site. Some performance criteria for flooding and flows and geomorphology are provided in Table 7 of Appendix C however they are not sufficiently detailed. They do not include measurable indicators and do not allow actual performance to be determined.

- Update the surface water TARPs to include monitoring and management of all “features” in Table 4 of the consent.
- Update the surface water TARPs to include potential impacts associated with contaminants in mine inflows and rejects leachate that may enter the surface water management system via dewatering water.
- Update the surface water TARPs to describe the triggers and actions for current discharge management that are described in Section 3.4 of Appendix C.
- The Groundwater Management Plan in Appendix D is intended to address requirements of the Water management Plan as required by condition B17 and the Extraction Plan Water Management Plan (EP WMP) as required by condition C10g (iii). This Groundwater Management Plan has been assessed against condition B17 only. Reduce the scope and content of this plan to meet conditions of B17 only.
- Update the Groundwater Management Plan in Appendix D to describe baseline information for the Pit Top area, and management of groundwater impacts of the Pit Top area including water loss/seepage from water storages into the groundwater system.
- Update the plan to include performance criteria, indicators, monitoring and triggers for potential adverse impacts of pumped (dewatered) mine water on groundwater.
- Update the plan to include performance criteria, indicators, monitoring and triggers for potentially adverse impacts of underground rejects emplacement on groundwater.
- Update the Groundwater Management Plan TARPs to include triggers and actions relevant to potential impacts of the pit top area and surface infrastructure, pumped (dewatered) mine water, and rejects emplaced underground.
- Review and update the TARP for mine inflows to underground workings to include clear monitoring and analysis requirements. Review the level 1, 2 and 3 criteria that trigger actions such that action is triggered before the maximum baseline concentration is reached and the TARP is useful as an early warning system for preventing environmental impacts.

Please provide the information, or notify us that you will not provide the information by Friday 27 August 2021. If this timeframe is not achievable, please provide and commit to an alternative timeframe for providing this information .

If you have any questions, please contact Daniel Martin at daniel.martin@dpie.nsw.gov.au.

Yours sincerely

Stephen O'Donoghue
Director
Resource Assessments

Richard Sheehan

From: DPI Landuse Enquiries Mailbox <landuse.enquiries@dpi.nsw.gov.au> on behalf of DPI Landuse Enquiries Mailbox
Sent: Monday, 22 March 2021 8:36 AM
To: richard.sheehan@wcl.net.au
Subject: RE: Major Projects – Proponent Request for Advice - Russell Vale Underground Expansion - Water Management Plan (MP09_0013-PA-8) (Wollongong City)

Hi Richard,

I've closed this request in the major projects portal as it should be referred to the Natural Resources Access Regulator (NRAR).

Please raise a new task and assign to NRAR as they deal with post approval matters.

Regards,

Judy Court
Assistant Project Officer
Water Group|Department of Planning, Industry and Environment
T 9842 8126 | **E** judy.court@dpie.nsw.gov.au
4 Parramatta Square, 12 Darcy St, Parramatta
www.dpie.nsw.gov.au

Our Vision: Together, we create thriving environments, communities and economies

---

From: no-reply@majorprojects.planning.nsw.gov.au <no-reply@majorprojects.planning.nsw.gov.au>
Sent: Sunday, 21 March 2021 10:29 PM
To: DPI Landuse Enquiries Mailbox <landuse.enquiries@dpi.nsw.gov.au>
Subject: Major Projects – Proponent Request for Advice - Russell Vale Underground Expansion - Water Management Plan (MP09_0013-PA-8) (Wollongong City)

A proponent is requesting advice in relation to a post approval matter for the Russell Vale Underground Expansion.

Please sign in to your account to view the details of this request and to upload your advice.

If you have any enquiries about this request, you can contact Richard Sheehan at richard.sheehan@wcl.net.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

Subscribe to our newsletter

Contact: Natural Resources Access Regulator
Phone: 1800 633 362
Email: nrar.enquiries@nrar.nsw.gov.au

Our ref: DOC21/198889, V15/3875-5#18

28 July 2021

Richard Sheehan
PO Box 281
Fairy Meadow NSW 2519

Email: richard.sheehan@wcl.net.au

Dear Richard,

Re: Russell Vale Colliery Underground Expansion (MP09_0013)

Thank you for giving the Department of Planning, Industry and Environment – Water (DPIE-Water) the opportunity to review Russell Vale Colliery Underground Expansion (MP09_0013).

Department of Planning, Industry and Environment - Groundwater Management & Science Team (DPIE-Water) recommends the following:

Prior to approval

1. Correct the consultation section and the referenced consultation appendix.
2. The mine pump groundwater extraction exceeds trigger criteria must not be contingent upon the occurrence of subsidence.

Not required prior to approval

3. Install all additional proposed monitoring sites (swamp and groundwater) at least two-year's prior to site undermining to enable collection of data for the required minimum period.
4. Monitor only swamps not undermined to represent baseline conditions in the Swamp Management Plan. Undermined but minimally impacted swamps must continue to be monitored and used as comparative indicators.

Should you have any further queries in relation to this submission please do not hesitate to contact the Natural Resources Access Regulator's Service Support Team at nrar.servicedesk@dpie.nsw.gov.au.

Yours Sincerely

Jane Curran
A/Manager Licensing & Approvals
Water Regulatory Operations
Natural Resources Access Regulator

Adam Wyatt

From: Richard Sheehan <richard.sheehan@wcl.net.au>
Sent: Wednesday, 28 April 2021 9:55 PM
To: Adam Wyatt
Subject: Fwd: Re RussellVale water management plan
Attachments: ATT00001.htm; RV Colliery Bellambi Gully TARP.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

Adam

For discussion tomorrow - say around 1030.

Regards

Richard Sheehan
Wollongong Coal Environment and Approvals Manager

Begin forwarded message:

> **From:** Andrew Couldridge <Andrew.Couldridge@epa.nsw.gov.au>
> **Date:** 28 April 2021 at 7:11:45 pm AEST
> **To:** richard.sheehan@wcl.net.au
> **Cc:** Greg Newman <Greg.Newman@epa.nsw.gov.au>
> **Subject: FW: Re RussellVale water management plan**
>
> Dear Richard,
>
> Apologies for the lateness of our response.
>
> Please find the EPA's comments on the Water Management Plan at this link. The comments are made as annotations to the plan document for ease of reference. Many of the comments are minor and relate to clarification of points in the document.
>
> The plan provides a useful overview of water transport and treatment structures, monitoring requirements and contingency plans.
>
> I note that in the past that a separate TARP was developed specifically for detection of highly turbid discharges from the premises using the continuous on-line monitors at LDP 11 and 12. I have attached a copy of a 2018 version that Rob sent me following an incident where the community reported turbid water in Bellambi Gully. It would be useful for the NTU values (or any updated ones) to be included somewhere in the water management plan - perhaps the table on page 120.
>
> Please note that I could not upload our comments to DPIE's major project website because the entry appears to have disappeared. I also could not attach the plan document to this email due to its file size.
>
> Please let me know if you have any questions.
>
> Regards Andrew.

-----Original Message-----
From: Richard Sheehan <richard.sheehan@wcl.net.au>
Sent: Wednesday, 28 April 2021 4:55 PM
To: Richard Sheehan <richard.sheehan@wcl.net.au>; Andrew Couldridge <Andrew.Couldridge@epa.nsw.gov.au>
Subject: RE: Re RussellVale water management plan

Good afternoon Andrew,

Have you had the opportunity to complete this review? Apologies for the pattern of emails prompts we are working overtime here to prepare for a start up in May.

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
P Mob: 0404 972 746
M Email: Richard.sheehan@wcl.net.au

-----Original Message-----
From: Richard Sheehan <richard.sheehan@wcl.net.au>
Sent: Wednesday, 28 April 2021 7:33 AM
To: Andrew Couldridge <Andrew.Couldridge@epa.nsw.gov.au>
Subject: Re RussellVale water management plan

Good morning Andrew

Thanks for your time on the phone yesterday discussing the RussellVale Surface water management plan. As we approach May we are making our way towards recommencing site operations prior to mining. In support of this it would be greatly appreciated if you could pass on any comments on the water management plan today.

Thankyou in advance and apologies for any confusion that might have been created by closing off the consultation loop in the DPIE portal.

Regards

Richard Sheehan
Wollongong Coal Environment and Approvals Manager

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represent the views or policies of our company. Computer viruses can be transmitted via email. Our Group IT attempts to sweep e-mails and attachments for viruses, it does not guarantee that either are virus free. The recipient should check this email and any attachments for the presence of viruses. Jindal Steel & Power Ltd and associated business entities does not accept any liability for any damage sustained as a result of viruses.

This email is intended for the addressee(s) named and may contain confidential and/or privileged information.
If you are not the intended recipient, please notify the sender and then delete it immediately.
Any views expressed in this email are those of the individual sender except where the sender expressly and with authority states them to be the views of the Environment Protection Authority.

PLEASE CONSIDER THE ENVIRONMENT BEFORE PRINTING THIS EMAIL

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WOLLONGONG CITY COUNCIL

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013

Mr R Sheehan
Group Environmental Approvals Manager
Wollongong Coal Ltd
PO Box 281
FAIRY MEADOW NSW 2519

Our Ref:	Z21/58233
File:	MP-2009/13
Date:	22 Marach 2021

Dear Mr Sheehan

DRAFT RUSSELL VALE COLLIERY UNDERGROUND EXPANSION PROJECT WATER MANAGEMENT PLAN

Thank you for the opportunity to make comment on the Draft Russell Vale Colliery Underground Expansion Project Water Management Plan.

Council notes that the Water Management Plan (WMP) relates to the water management system and surrounding watercourses and groundwater resources within the vicinity of Russell Vale Colliery pit top. The scope of this plan is to detail the proposed water management system, monitoring, reporting and trigger-action-response-plans (TARPs) for downstream water quality and downstream stream flows.

Council acknowledges and generally supports the proposed management strategies contained in Section 3 of the plan. In this regard, the plan indicates that stockpiles within the pit top will be constructed on the contour at least two (2) metres from hazard areas, particularly areas of concentrated water flows or steep slopes. The stockpiles will be protected by installing upslope water diversion structures with run-off treated in a coarse sediment control trap before being stored in dams prior to treatment and re-use or discharge. Clean water runoff from undisturbed areas will be diverted through drains and banks into nearby watercourses. This may include the use of level spreaders prior to draining into rock armoured creek banks and additional planting of grass, small shrubs and riparian species to achieve the required bank stability. However, any such riparian works and planting regime will require separate approval from the NSW Natural Resource Access Regulator prior to commencement of such works.

The progressive rehabilitation of all disturbed areas within the pit top in accordance with the approved Mining Operations Plan is also supported.

Should you have any enquiries or wish to discuss this matter further, please contact Mr Ron Zwicker, Special Projects and Planning Support Manager on telephone (02) 4227 7111 or via email rzwicker@wollongong.nsw.gov.au

This letter is authorised by

Mark Riordan
Manager Development Assessment & Certification
Wollongong City Council
Telephone (02) 4227 7111

cc: Mr W Lidbury
Chief Executive Officer
Wollongong Coal Ltd
PO Box 281
FAIRY MEADOW NSW 2519

Richard Sheehan

From: no-reply@majorprojects.planning.nsw.gov.au
Sent: Wednesday, 14 April 2021 9:50 AM
To: richard.sheehan@wcl.net.au
Subject: Russell Vale Underground Expansion Water Management Plan - Response from WaterNSW

WaterNSW has responded to your request for advice in relation to the Russell Vale Underground Expansion Water Management Plan . The response is below and/or attached. Record of this consultation has been automatically saved to the portal.

When you are ready, login to your profile to submit the final document to the Department.

Public Authority Response
Good morning,

I refer to the Water Management Plan prepared to meet Condition B17 of the Russell Vale Expansion Project Development Consent. It is noted that this plan has been prepared to address water management matters during mining operations at the mine's pit top facilities and LDPs. These sites are all outside the Sydney Drinking Water Catchment and Special Areas. WaterNSW therefore have no specific comments on this plan.

WaterNSW is keenly interested in reviewing the Water Management Plan in relation to underground mining and required to be prepared as specified in Part C Special Environmental Conditions of the Consent. Conditions C1 and Table 6 Subsidence Impact Performance Measures for watercourses and storages, and Extraction Plan Condition C10 (III) Water Management Plan are particularly relevant with regards to impacts on surface and groundwater resources overlying the underground mining area. WaterNSW would appreciated the opportunity to review these documents when available.
Thank you
Jessie Evans
Mining Manager.

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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APPENDIX B. EROSION AND SEDIMENT CONTROL PLAN

Russell Vale Colliery

Underground Expansion Project

WATER MANAGEMENT PLAN

- Erosion and Sediment Control Plan

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1 INTRODUCTION

1.1 Project Background

Wollongong Coal Limited (WCL) operates the Russell Vale Colliery (RVC) 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.

Additional background information on the Russell Vale Colliery is included in Section 1 of the RVC Surface Operations Water Management Plan (SOWMP).

1.2 Scope

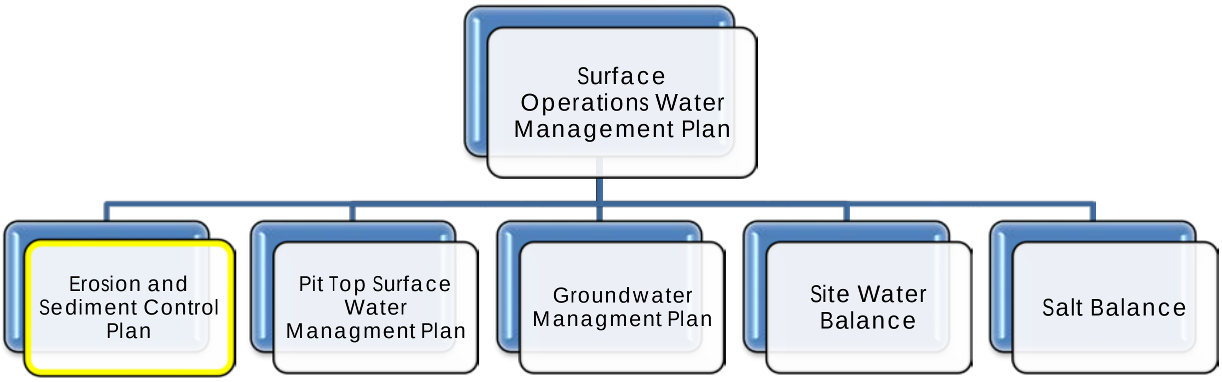
This Erosion and Sediment Control Plan (ESCP) has been developed to facilitate compliance with the relevant conditions of the Project Approval.

The key objectives of erosion and sediment control at RVC are to:

- satisfy regulatory requirements, including meeting performance criteria as detailed in the Consent;
- identify activities that could cause soil erosion, generate sediment, or affect flooding to identify relevant mitigation measures,
- detail a program to review the adequacy of flood protection works, and ensure they comply with the relevant performance measures
- minimise adverse effects on downstream waterways (including flooding and water quality impacts).

This ESCP is part of a set of documents that together form the Water Management Plan for Russell Vale Colliery (refer to **Figure 1**). 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 ESCP, as a sub plan of the overarching WMP, as outlined in Section 1.3 of ***RVC EC PLN 019***. This ESCP provides the specific detail on the relevant water management practices and process in compliance with the relevant consent conditions detailed in **Section 2**.

Figure 1 Water Management Plan Structure



1.3 Objective of ESCP

The objectives of the Erosion and Sediment Control Plan (ESCP) are to:

- comply with the regulatory requirements set out in the Russell Vale Revised Underground Expansion Project (UEP) Development Consent Conditions and Environment Protection Licence (EPL) 12040
- identify activities that could cause erosion and generate sediment or affect flooding;
- describes measures to minimise soil erosion and the potential for the transport of sediment to downstream waters, and to manage flood risk;
- describe the location, function and capacity of ESC structures and flood management works;
- provide that ESC structures are appropriately maintained;
- provide methods to assess compliance with conditions of development consents, environmental protection licences and legislation relating to surface waters; and
- meet the requirements of the Blue Book (Managing Urban Stormwater: Soils and Construction Volumes 1 and Volume 2E)
- provide employees and contractors with a clear and concise description of their responsibilities in relation to erosion and sediment control (ESC) during the operation of the mine.

2 STATUTORY REQUIREMENTS

2.1.1 Environmental Planning & Assessment Act 1979

Schedule 2 Condition B17 (f) (iii) of the Development Consent outlines the requirements for an Erosion and Sediment Control Plan (ESCP). ***Table 1-1*** indicates where each component of the condition is addressed within this Plan.

Table 1-1: UEP Consent Requirements for ESCP

Project Approval Condition	Plan Section
Schedule 2, Condition B16 – Performance measures - Erosion and Sediment Control	
• Design, install and maintain erosion and sediment controls in accordance with the guidance series Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom 2004) and 2E Mines and Quarries (DECC 2008)	**Section 4.1**
• Design, install and maintain any new infrastructure within 40 metres of watercourses in accordance with the guidance series for Controlled Activities in Waterfront Land (DPI Water 2012)	**Section 4.3.1**
• Design, install and maintained any creek crossings in accordance with the Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (DPI 2013) and Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries 2003)	**Section 4.2.2**
Schedule 2, Condition B17. (f) (iii) – Erosion and Sediment Control Plan	
(iii) **Erosion and Sediment Control Plan** that: • is consistent with the requirements of Managing Urban Stormwater: Soils and Construction - Volume 1: Blue Book (Landcom, 2004) and Volume 2E: Mines and Quarries (DECC, 2008);	This Plan
• identifies activities that could cause soil erosion, generate sediment or affect flooding;	**Section 3**
• includes a program to review the adequacy of flood protection works, and ensure they comply with the relevant performance measures listed in Table 4[1];	**Section 3.3**

Project Approval Condition	Plan Section
• describes measures to minimise soil erosion and the potential for the transport of sediment to downstream waters, and manage flood risk;	**Section 4**
• describes the location, function, and capacity of erosion and sediment control structures and flood management structures; and	**Section 4.1**
• describes what measures would be implemented to maintain (and if necessary decommission) the structures over time;	**Section 4.4 details the maintenance, monitoring,** **section 4.4.3 details the decommissioning of ESCP structures**

Note 1: refer to WMP

2.1.2 Protection of the Environment Operations Act 1997

Activities that do, or may, lead to pollution of waters in NSW are regulated by the NSW Environment Protection Authority (EPA) under the *Protection of the Environment Operations Act 1997* (POEO Act). Where discharge of waters is permitted it is strictly controlled by licence conditions such that discharges do not result in significant impacts on water resources.

RVC operates under the EPL 12040. In addition to the limits prescribed, Condition L1.1 of EPL 12040 requires compliance with Section 120 of the POEO Act, which prohibits pollution of waters. This will be achieved through the implementation of the management measures outlined in **Section 3**, minimising sediment generation and transportation to downstream waterways.

Uncontrolled discharge of sediment laden water from sediment basins is not considered an offence under s120 POEO Act if it occurs after receiving rain in excess of the design criteria detailed in the Blue Book within the specified timeframe.

3 PLANNING

3.1 Potential Sources of Erosion and Sediment

The mining operations and related activities that have the potential to cause erosion and/or generate sediment are:

- construction and or maintenance of water management structures (i.e. dams, diversion drains);
- changes to drainage lines and / or catchments;
- vehicle and equipment movements in operational areas;
- operational areas such as coal stockpile and coal handling equipment including mobile equipment;
- rehabilitation or preparation of disturbed areas including subsidence remediation works;
- disturbed areas not yet rehabilitated; and
- disturbed areas created by natural processes or by previous land uses.

These activities may result in greater mobilisation of sediments. For any earthworks or ground disturbance required as part of the UEP, the erosion risk will be reviewed and a task-specific ESCP developed, where required.

Bellambi Gully, where it crosses through the site is comprised of a natural creekline prior to a diversion pipeline under the operational area. Water quality is monitored before and after the pipeline in accordance with the site EPL.

The Bellambi Gully Creek pipeline has benefitted from rehabilitation work to seal up the pipe and prevent water ingress. (May 2018). NSW EPA (Reference) noted that water quality has improved accordingly.

3.2 Potential Erosion and Sedimentation Impacts

Erosion and sedimentation impacts include:

- increased runoff volumes and velocities from the removal of vegetation, land disturbance and the introduction of impervious surfaces on hardstand areas;
- increased potential for sedimentation to occur from increased erosion and runoff associated with stockpiling of material and the construction of surface facilities, access roads/tracks;
- potential for increased scouring during the construction of surface facilities adjacent to watercourses; and
- potential decline in water quality and degradation of local amenities through sediment transport to nearby watercourses.

3.3 Flooding

Erosion and sediment control measures are to be designed and installed in a manner that does not impact flooding. This is generally achieved by:

- Placement of all material stockpiles and associated controls (e.g. bunds, drains, and sediment dams) outside of potentially flood affected areas.
- Design and construction of diversions and bunds to discharge, as near as practical, away from adjacent infrastructure and neighbours.
- Installation of downslope controls (e.g. filter fences) away from drainage lines.

Proposed works that have the highest potential to result in flood impacts is the Bellambi Gully diversion. Under the UEP approval MP09_0013, WCL is required to implement diversion works on Bellambi Gully to manage pollution risks associated with flooding of the creek. A detailed design was prepared during early 2021 based on the concept design works (Cardno 2020). The approved design consists of a formalised overland flow path, which discharge into a gabion-basket reinforced drop structure and channel, before discharging into a detention dam (**Figure 2**).

Flood modelling of the concept design (Cardno 2020) indicates that the proposed diversion is expected to reduce flood levels downstream of the site, for the 100 year average recurrence interval (ARI) flood event (**Figure 2** Proposed Bellambi Gully Diversion Works

Figure 3).

Figure 2 Proposed Bellambi Gully Diversion Works

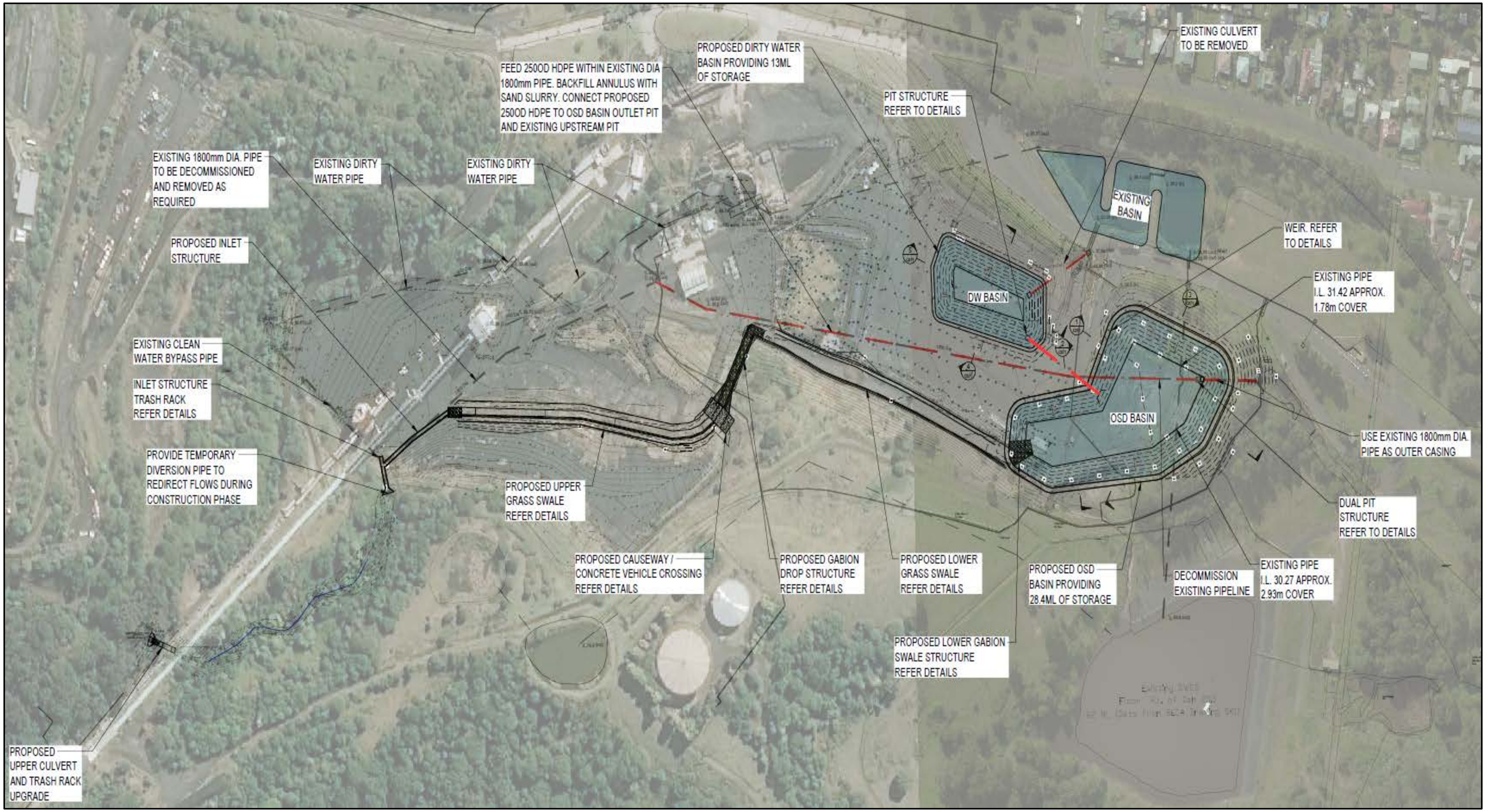
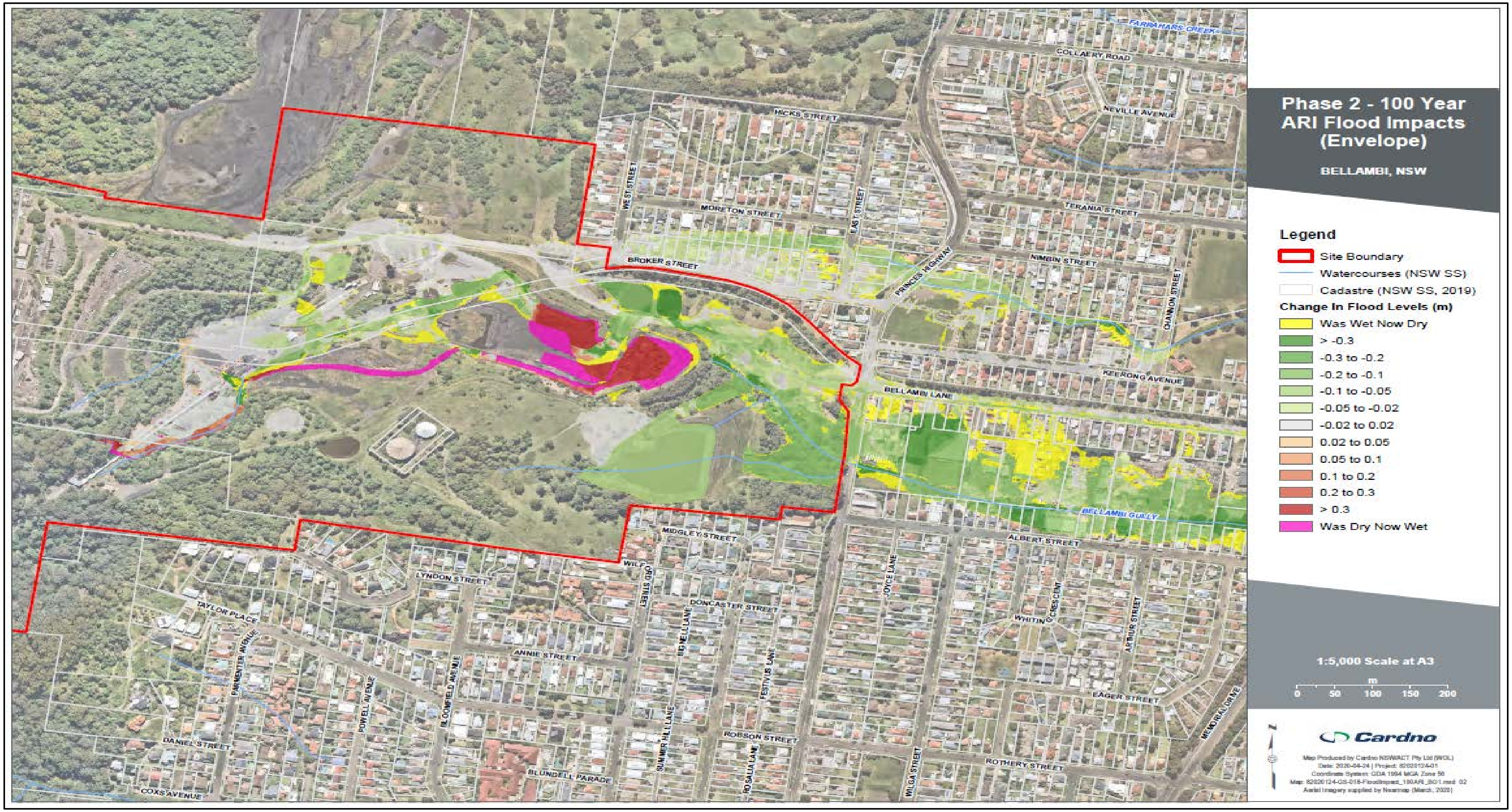


Figure 3 1% AEP Modelled Flood Extent and Impacts



4 MANAGEMENT STRATEGIES

RVC categorises water into three types to effectively manage water and to mitigate the potential for environmental harm. These are as follows:

- Clean Water
  - Runoff from areas undisturbed by mining activities, established rehabilitation or local water sources (creeks, rivers, or alluvial aquifers).
- Dirty Water
  - Runoff from coal stockpiles, workshop areas, vehicle wash-down bays and storage yards.
  - Runoff from area that are under rehabilitation, any new or additional clearing, general existing operational areas (hardstand, laydown areas, unsealed roads, or carparks).
- Mine Water
  - Dewatering of underground workings.

The volume of water managed by the RVC surface facilities WMS will be generally minimised by:

- using diversion drains to manage clean water runoff, to minimise the clean catchment runoff entering the WMS; and
- returning discharges from rehabilitated areas to the downstream environment, to minimise clean water capture.

The specific erosion and sediment control measures are managed on as needs on-going basis through:

- minimising the extent of disturbance consistent with operational requirements;
- avoiding and or otherwise minimising the extent of any additional clearing required only to that approved;
- establishment and/or maintenance of a vegetated cover on non-operational undisturbed areas;
- rehabilitation of disturbed areas when no longer required for operational purposes;
- redirection of runoff from clean water catchments;
- drainage design to enable the transfer of water at non-erosive velocities; and
- use of containment structures such as sedimentation dams or sumps.

4.1 Erosion and Sediment Controls

Erosion and sediment controls are installed where there is potential for erosion and transportation of sediments. Standard ESC techniques will be implemented at RVC in accordance with the requirements of *Managing Urban Stormwater: Soil and Construction Volume 1* (Landcom, 2004) and *Volume 2E: Mines and Quarries* (DECC, 2008) (the Blue Book).

The surface water management system at RVC is described in the SOWMP (RVC EC PLN 019).

4.2 Site Specific Strategies

4.2.1 Works within Watercourses

The construction of the Bellambi Gully diversion will require works within a watercourse where the diversion meets the existing channel. Within this area, specific controls will include:

- works within the 1:2 AEP flood level will include temporary surface protection measures such as grasses and gravels to minimise soil erosion during rainfall events; and
- planned works will be scheduled for forecasted dry weather periods.

4.2.2 Temporary Watercourse Crossings

Temporary waterway crossings may be required during the construction of the Bellambi Gully diversion. If required, these structures will be constructed in accordance with guidelines outlined in the Blue Book and Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013) and Why Do Fish Need To Cross The Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries, 2003).

The Bellambi Gully diversion also includes a permanent creek crossing, however, this is in the upper section of the Bellambi gully where there is only intermittent flow during rainfall, as that section of the creek is steep in gradient and runs dry shortly after rainfall ceases. Fish migration is not considered a relevant issue in this instance as fish migration would not occur under natural circumstances in that section of the gully.

4.2.3 Progressive Rehabilitation

Progress rehabilitation will be undertaken across the site, in accordance with the approved Mining Operations Plan (MOP) (Rehabilitation Management Plan as per ***Condition B43 / Schedule 2*** of MP09_0013) and the Rehabilitation Objectives described in **Condition B42**.

The establishment of stable vegetation cover is the key erosion and sediment control for these areas, however interim measures, such as filter fences (for small areas), and catch drains and sediment basins (for large areas) will be required until vegetation cover is established.

4.3 Erosion and Sediment Control Structures

4.3.1 Clean Water Diversion Drains and Banks

Diversion drains and banks are intended to divert clean runoff (generated within undisturbed or fully rehabilitated catchment areas) away from disturbed areas. This is intended to minimise the volume of dirty water to be managed on site.

Diversion drains are to be designed in accordance with the Blue Book (Landcom, 2004) to cater for a minimum 1:10 AEP storm event if only to be in place for less than 12 months, or a 1:20 AEP storm for greater than 12 months. The side batters are to have a maximum grade of 1V: 2H (vertical: horizontal) with typical dimensions as shown in **Figure 4** and **Figure 5**. The drains are to be located and designed with base widths to minimise peak velocities. Where peak design velocities exceed 1 m/s in clean water catchments and along the roadsides of permanent roads, rock bars will be placed along the invert of the drain every 100 metres to reduce the peak velocities.

Clean water runoff from undisturbed areas will be diverted around operational areas and dirty water catchments. If required, appropriate protection will be established to manage clean water diversions such as the use of level spreaders (refer to **Figure 5**) rock armouring, additional planting of grass, small shrubs and riparian species to enhance bank stability.

The Bellambi Gully Clean Water Diversion Works is the only new infrastructure being constructed within 40m of a watercourse and this has been engineered and designed in accordance with the terms of the DPIE Development Control Order dated 23 July 2020. There is no other new infrastructure proposed within 40m of waterways. See also section 5.1.2 of the SoWMP.

4.3.2 Dirty water diversion structures

Dirty stormwater consists of runoff from disturbed catchments and includes:

- Runoff from unsealed surfaces;
- Truck loading area;
- Run off from the ROM coal stockpile area; and
- First flush from the hardstand area in front of the portals.

The WMS is further described in the SOWMP.

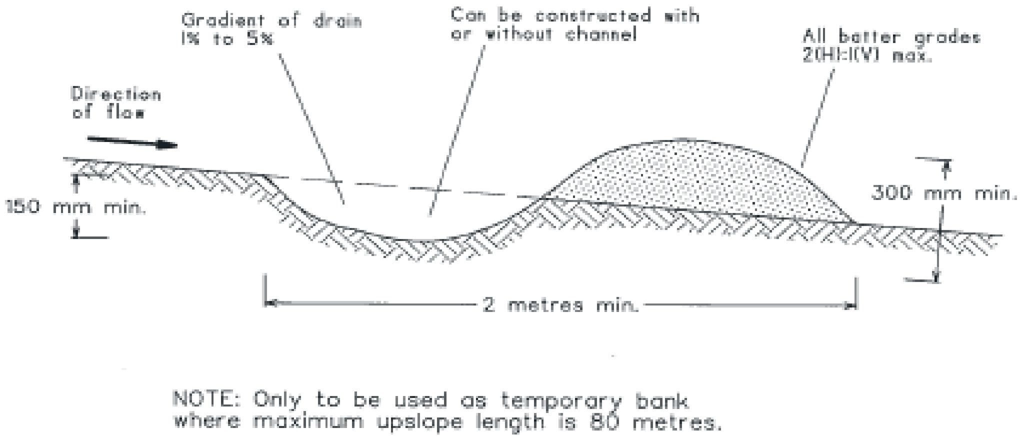
All dirty water diversion structures are to be designed in accordance with Blue Book (Landcom, 2004), specifically Table 6.1 of Volume 2E, to cater for a 1:20 AEP storm event. The typical specifications for dirty water diversion structures are shown this section, including side batters with a maximum grade of 1V:2H. The structures will be grass lined where practical and will be located and designed with base widths to minimise peak velocities.

Dirty water runoff from access roads will be directed to a piped storm water system, which will carry the dirty water down to the stockpile area and sediment basins.

4.3.3 Filter Fences

For small, temporary disturbance areas, filter fences, such as sediment fences (**Figure 6**) or straw bale filters (**Figure 7**), will be constructed immediately downslope of areas to be disturbed to minimise the potential for sediment to be transported into receiving catchments and waterways. Sediment fences will be designed and constructed in accordance with the Blue Book (Landcom, 2004) as show in the figures in this section.

Figure 4 Typical Diversion Drains/Banks (Low Flow) (Landcom, 2004)

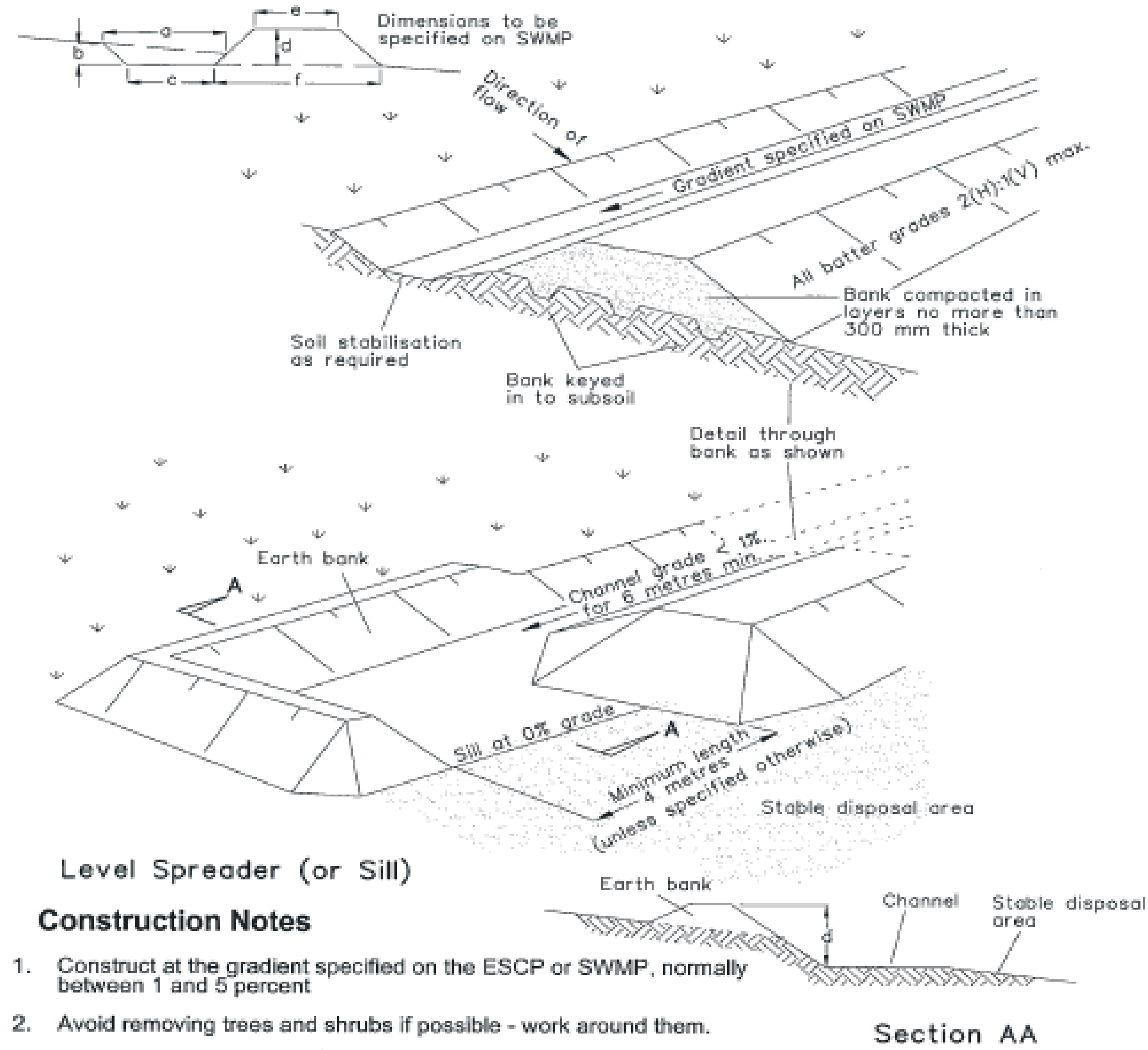


Construction Notes

1. Build with gradients between 1 percent and 5 percent.
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V shaped.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction.

EARTH BANK (LOW FLOW) **SD 5-5**

Figure 5 Typical Diversion Drains/Banks (High Flow) (Landcom, 2004)

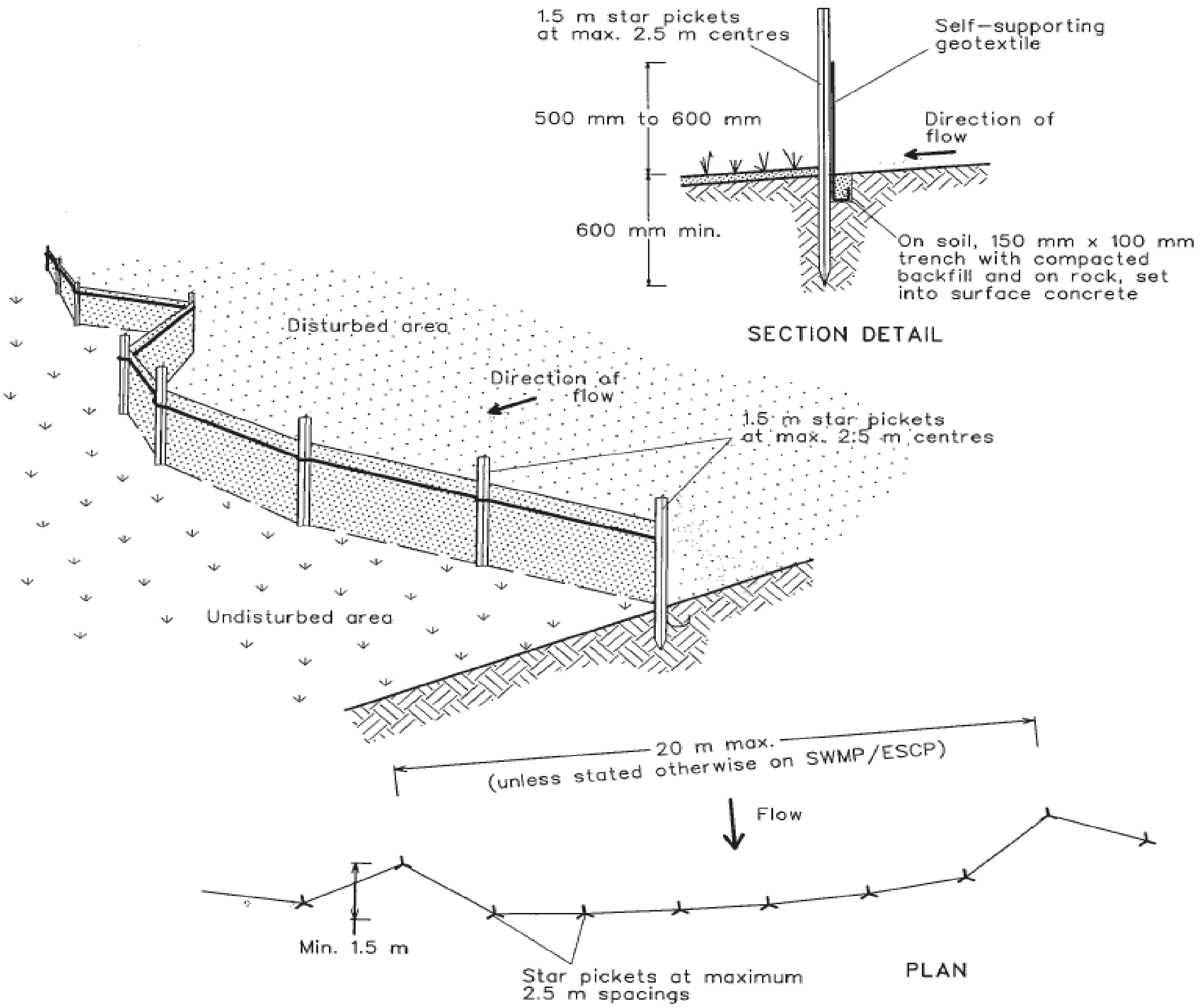


Construction Notes

1. Construct at the gradient specified on the ESCP or SWMP, normally between 1 and 5 percent
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V-shaped, at the dimensions shown on the SWMP.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction following Table 5.2 in Landcom (2004).
7. Where discharging to erodible lands, ensure they outlet through a properly constructed level spreader.
8. Construct the level spreader at the gradient specified on the ESCP or SWMP, normally less than 1 percent or level.
9. Where possible, ensure they discharge waters onto either stabilised or undisturbed disposal sites within the same subcatchment area from which the water originated. Approval might be required to discharge into other subcatchments.

EARTH BANK (HIGH FLOWS) **SD 5-6**

Figure 6 Typical sediment fence (Landcom 2004)

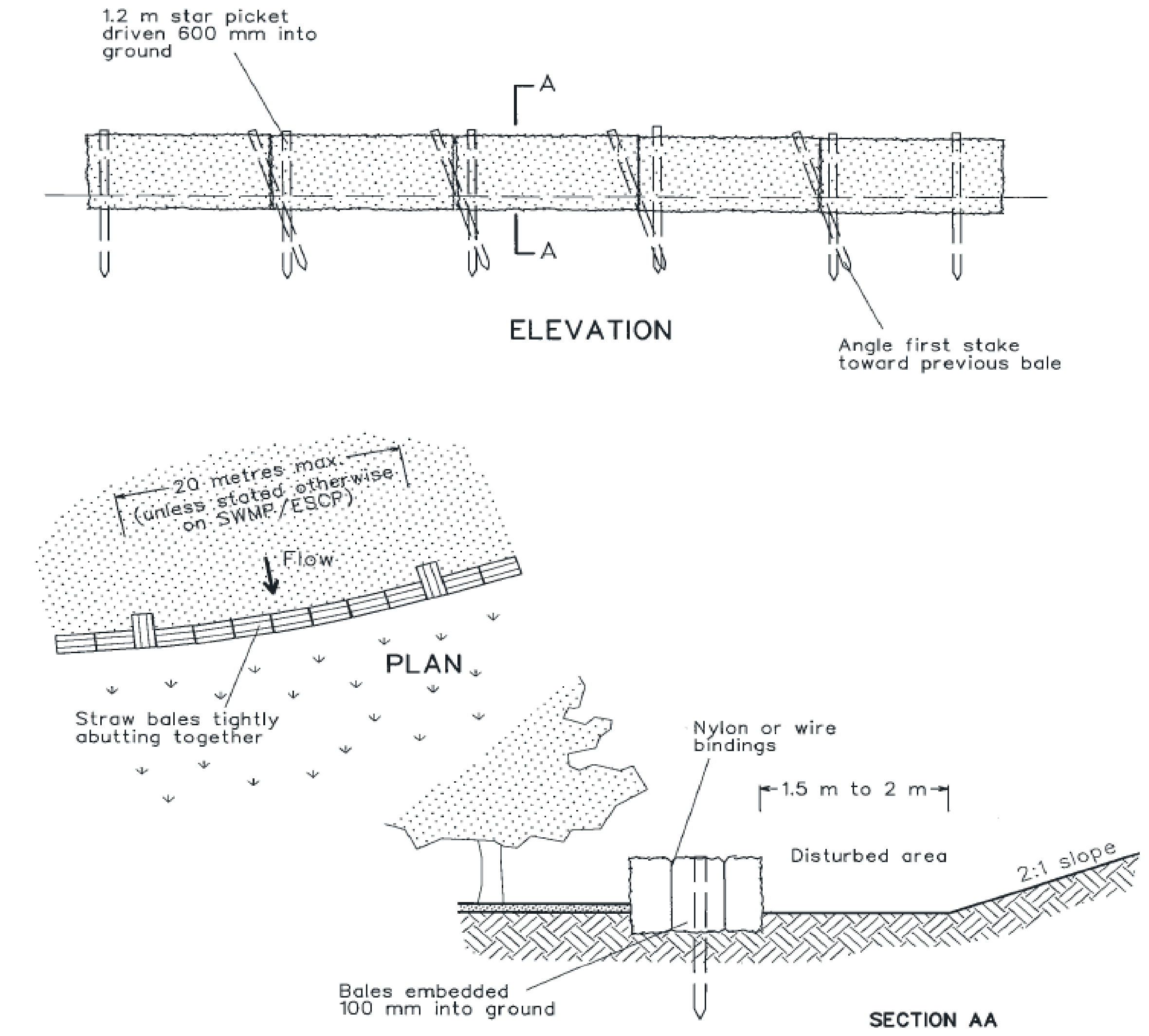


Construction Notes

1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year event.
2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5 metre long star pickets into ground at 2.5 metre intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.
5. Join sections of fabric at a support post with a 150-mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

SEDIMENT FENCE **SD 6-8**

Figure 7 Typical straw bale filter (Landcom 2004)



Construction Notes

1. Construct the straw bale filter as close as possible to being parallel to the contours of the site.
2. Place bales lengthwise in a row with ends tightly abutting. Use straw to fill any gaps between bales. Straws are to be placed parallel to ground.
3. Ensure that the maximum height of the filter is one bale.
4. Embed each bale in the ground 75 mm to 100 mm and anchor with two 1.2 metre star pickets or stakes. Angle the first star picket or stake in each bale towards the previously laid bale. Drive them 600 mm into the ground and, if possible, flush with the top of the bales. Where star pickets are used and they protrude above the bales, ensure they are fitted with safety caps.
5. Where a straw bale filter is constructed downslope from a disturbed batter, ensure the bales are placed 1 to 2 metres downslope from the toe.
6. Establish a maintenance program that ensures the integrity of the bales is retained - they could require replacement each two to four months.

STRAW BALE FILTER **SD 6-7**

4.3.4 Sediment Control Dams

Sediment dams will assist in improving water quality throughout the surface facilities site by capturing dirty runoff. There are currently three sediment control dams utilised. Dam 1 (see **Figure 8**: Current Site Overlay showing ESCP Dams

Figure 9:) is the primary dirty water dam and is located are in the north-eastern corner of the pit top area (**Figure 8**: Current Site Overlay showing ESCP Dams

Figure 9:). Dams are managed in in accordance with the requirements of the Blue Book Volume 2E.

The SWCD is an existing large 62ML dam located in the south-eastern corner (**Figure 8**: Current Site Overlay showing ESCP Dams

Figure 9:) of the pit top area. It is used to mitigate flows in major storm and as the primary storage area and final location of entrained sediments after pond 1 to settle. In addition to receiving discharges from Dam 1, the SWCD also receives pumped transfers from the Highway Dam and runoff from approximately 7.5 ha of existing upslope non-operational area catchment. Water is pumped from the SWCD, treated via the onsite treatment facilities to the required EPL parameters prior to discharge via LDP 2. This dam is to be maintained with enough spare capacity to minimise the chance of a major storm surcharging to Bellambi Gully.

The highway dam receives stormwater from the lower section of the access road, and vegetated areas adjacent to the Princes highway. It is maintained at its lower limits to provide for maximum capacity during rainfall events via an automatic float level operated pump that transfers water into the SWCD. This system prevents overtopping of the highway dam and unlicensed discharge into Bellambi Gully.

Dam 1 is an existing 7ML dam that functions as a flow through sediment basin under gravity to the SWCD (see **Figure 8**: Current Site Overlay showing ESCP Dams

Figure 9:). Dam 1 also receives excess water draining from the truck wash and pumped transfers from the underground mining operation (groundwater and excess process water pumped into the underground for operational purposes). In addition to receiving discharges from Dam 1, the SWCD also receives pumped transfers from the Highway Dam and runoff from approximately 7.5 ha of mostly undisturbed upslope catchment. SWCD is retards discharges from the site and provides a final location of entrained sediments to settle.

If required, new dams will be designed using the Revised Universal Soil Loss Equation (RUSLE) as described in Blue Book (Landcom, 2004). Sizing calculations typically assume Type D or F soils and are sized to contain the 5 day, 95th percentile rainfall depth. Typical details are shown in **Figure 10**.

Dams will include depth indication boards to allow for quick identification of water and sediment depths. These boards will include markers for the maximum permissible sediment depth (typically one-third of the total capacity of the dam) and a maximum operational water level (typically just above the maximum sediment storage level).

Sediment dams are to be dewatered within five days following a rainfall event. Uncontrolled discharges (overflows) from sediment dams are permissible only if a storm event exceeds the design standard of a sediment dam.

The new dirty water dry detention basin to be installed as a part of the Bellambi Gully diversion project is a new operational sediment control basin to contain runoff from the stockpile area with a 2.1 ML capacity. The dam flows under gravity via a pipeline to Pond 1 via the truck wheel wash sump. In the event of a large rainfall event an emergency overflow pipeline connects the DWB to the OSD to prevent flooding in the operational area.

The size, function, and operational management of these sediment dams is summarised in Table 4-1: ESCP Features - Sediment Control Dams.

Table 4-1: ESCP Features - Sediment Control Dams

DESCRIPTION	CAPACITY (ML)	FUNCTION	MANAGEMENT
Sediment Control Dams			
Dam 1	7	Flow through sediment basin. Excess water draining from the truck wash, wheel wash, stockpile areas, and pumped transfers from the underground mine.	Discharges under gravity to the Stormwater Control Dam. Management of sediment levels in the dam to less than 30% of the dam volume. Pre-treatment of dirty water using flocculant block at the inlet to Dam 1 to aid settling of solids prior to overflowing into Dam 2.
Highway Dam	0.3	Capture water runoff from the lower section of the access road and vegetated areas near the Princess Highway. Captured water is pumped back to the SWCD.	The water level of the dam is maintained at a low level, by the pump which is automatically activated from a float switch to pump the water into the storm water control dam. The pump and spillway is inspected and maintained monthly under the WO System to ensure they are functioning correctly.
Stormwater control dam	62	Pumped transfers from the Highway Dam Runoff from about 7.5 ha of mostly undisturbed catchment (including Dam 5).	Registered with Dam Safety NSW (DS NSW) and managed in accordance with Australian National Committee on Large Dams (ANCOLD) *Guidelines on Dam Safety Management*, 2003. Maintenance of the spillway area Monitor seepage (see LDP 3) Monitor spillway overflow (LDP 9)

DESCRIPTION	CAPACITY (ML)	FUNCTION	MANAGEMENT
Dry Detention Basin (DWB) (under construction as part of BG project)	2.1	Stockpile and coal handling area. Maintenance and laydown areas.	Discharges under gravity to Dam 1. An emergency overflow pipe allows for discharges to the Clean Water Detention Basin to occur during extreme storm events.

Figure 8: Current Site Overlay showing ESCP Dams

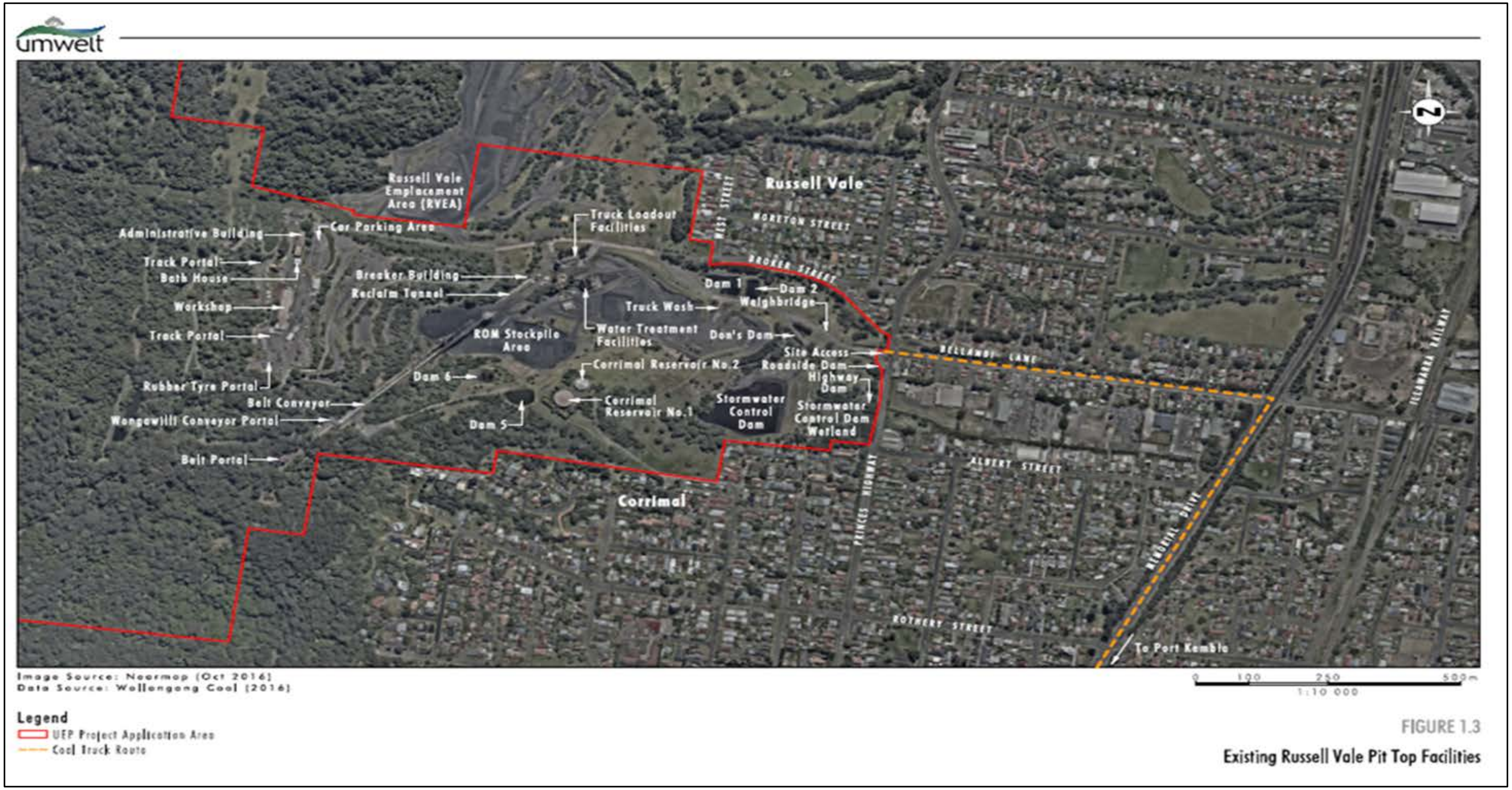
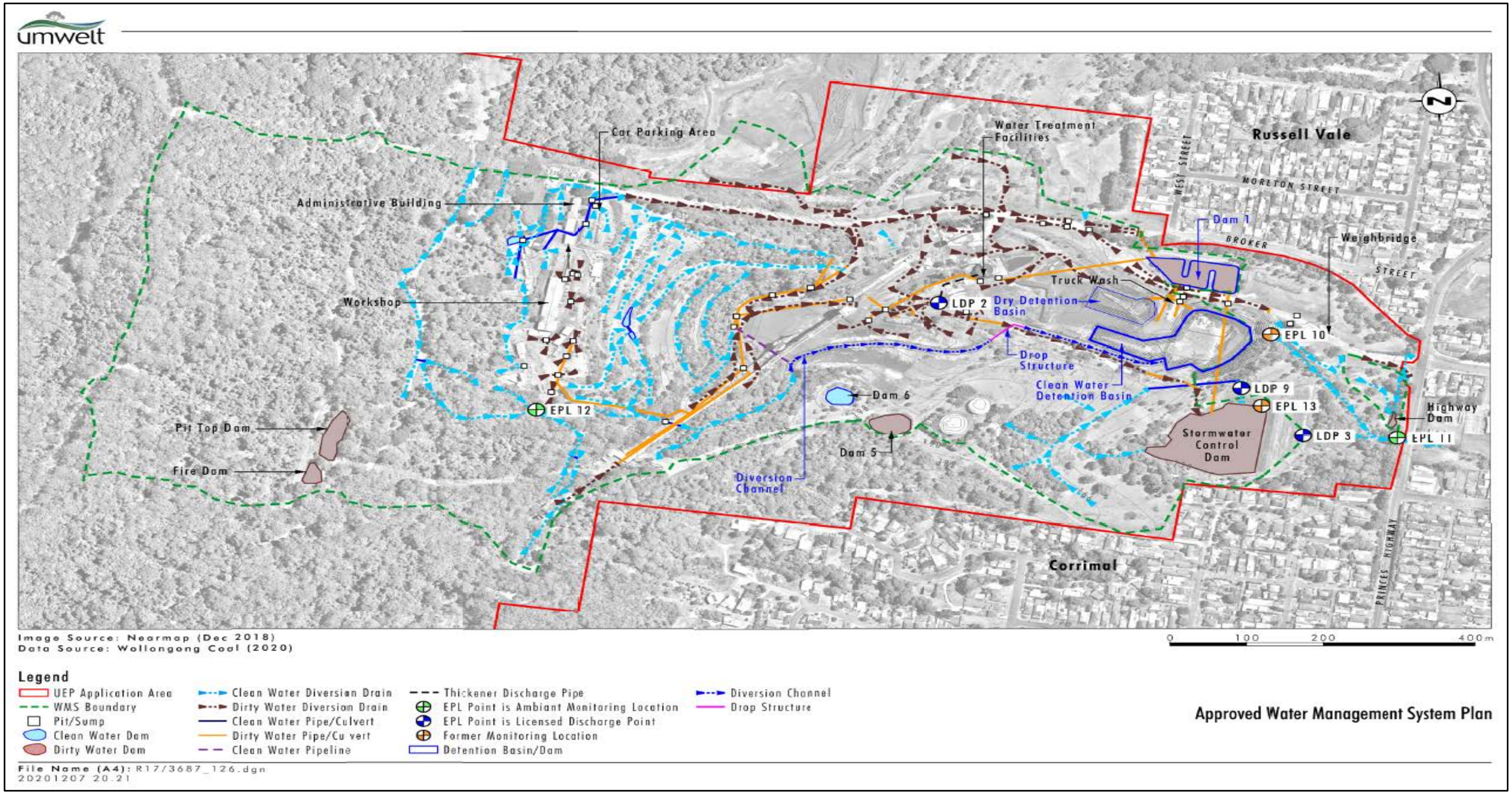


Figure 9: Approved Water Management System showing ESCP features



4.3.5 Temporary Erosion and Sediment Control

All temporary water diversion structures will be constructed as per Figure SD 5-6 of Section 5.4.4 of Managing Urban Stormwater – Soils and Construction Volume 1 (Landcom, 2004) (refer to figures in this section).

4.3.6 Specific Erosion and Sediment Control Plans

A review to determine the extent of erosion and sediment risk as per a permit to disturb is to be carried out prior to any proposed ground disturbance including construction works.

If required, an Erosion and Sediment Control Plan (ESCP) is to be prepared in accordance with Blue Book and this ESCP.

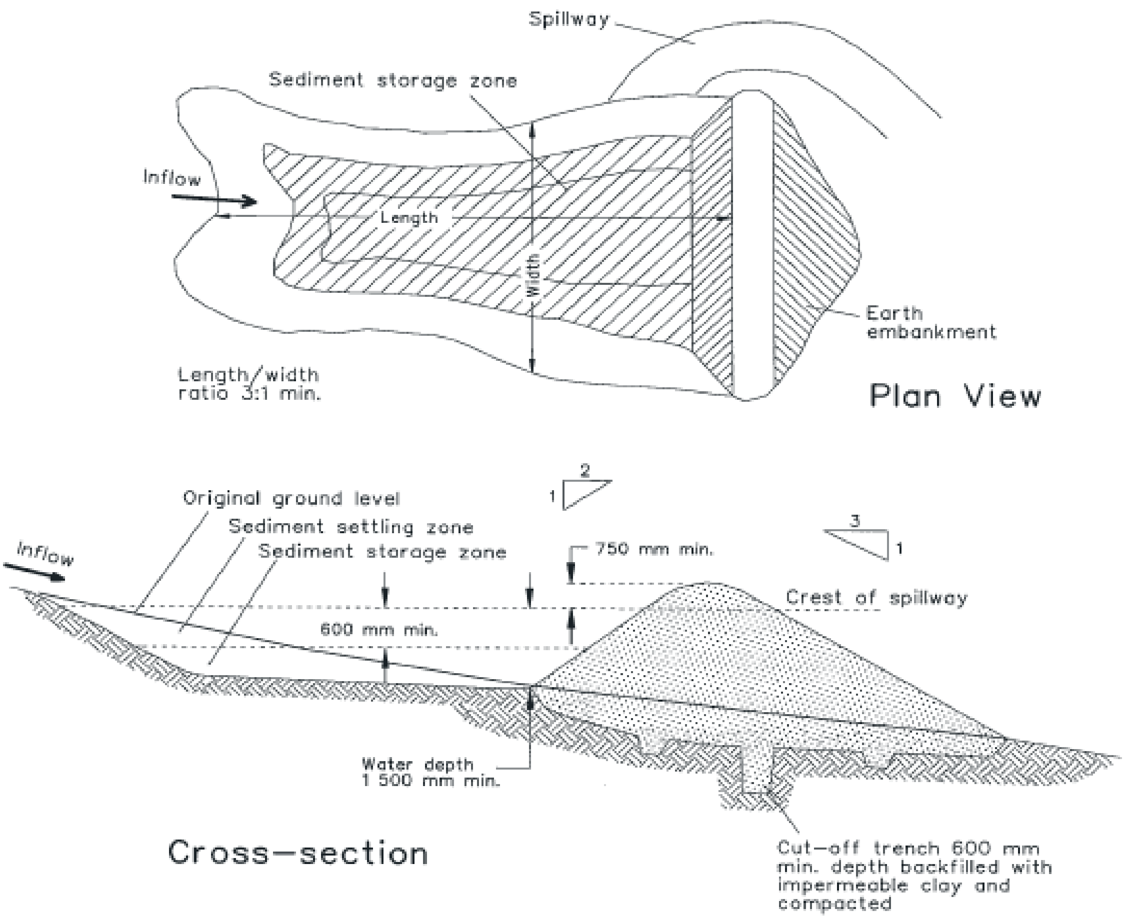
For small scale disturbances the ESCP is expected to include (at a minimum):

- A map of the construction site including the proposed areas of disturbance, no-go areas and environmentally sensitive areas.
- Access roads and haul roads.
- Drainage lines and flow direction.
- Stockpile areas.
- Location and type of permanent and temporary erosion and sediment control structures / measures including ponds and sumps.
- Relevant construction details and specifications of the proposed permanent and temporary erosion control structures / measures, and
- Rehabilitation requirements.

For medium to large scale disturbances the ESCP is expected to include (in addition to the above):

- Information on soil type and compaction requirements.
- Design calculations for sediment control features such as sediment control dams; and
- Staging and proposed time schedules (i.e. installation sequence) for construction of structures and implementation of erosion and sediment control measures through to rehabilitation stages.

Figure 10 Typical Sediment Dam (Landcom, 2004)



Construction Notes

1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Construct a cut-off trench 500 mm deep and 1,200 mm wide along the centreline of the embankment extending to a point on the gully wall level with the riser crest.
3. Maintain the trench free of water and recompact the materials with equipment as specified in the SWMP to 95 per cent Standard Proctor Density.
4. Select fill following the SWMP that is free of roots, wood, rock, large stone or foreign material.
5. Prepare the site under the embankment by ripping to at least 100 mm to help bond compacted fill to the existing substrate.
6. Spread the fill in 100 mm to 150 mm layers and compact it at optimum moisture content following the SWMP.
7. Construct the emergency spillway.
8. Rehabilitate the structure following the SWMP.

EARTH BASIN - WET

(APPLIES TO 'TYPE D' AND 'TYPE F' SOILS ONLY)

SD 6-4

4.4 Maintenance/Monitoring of Sediment and Erosion Control Structures

4.4.1 Inspections

The objective of monitoring of ESC structures is to:

- inspect ESC structures at a frequency appropriate with the level of risk associated with each of the respective structure.;
- check sediment and erosion control features, maintain sediment dams in a dewatered state prior to high rainfall events and dewater sediment dams within 5 days of a wet weather event.
- confirm that the program of erosion and sediment works is implemented and that the erosion and sediment control structures constructed at RVC are effective; and
- check that maintenance works are conducted as required.

Erosion and sediment control structures are routinely inspected monthly and after wet weather events greater than 10mm (in accordance with the Rainfall Monitoring Procedure), with maintenance works and repairs undertaken as required. Monitoring and inspections will include:

- Regular inspections of water level / capacity, silt build-up, structural integrity and effectiveness; and
- Revegetation progress of any disturbed areas.

4.4.2 Maintenance

Where inspections indicate accumulation of sediment in a dam (refer to **Section 4.4.1**) beyond 30% they will be restored to comply with the minimum levels.

Regular maintenance activities include:

- Sediment removal from drains and sediment ponds;
- Replacement of sediment control structures as required;
- Repairs of areas, which become unstable following periods of high flow ; and
- Checks on bund integrity and chemical storage to ensure compliance with the appropriate standards.

Any reported non-conformances or deteriorated control structures will be reported and captured in the WCL workflow process, assigned a work order and corrective action assessment will be taken as appropriate and implemented.

4.4.2.1 Drains and Banks

Signs of erosion along the length of drains and banks will be captured and remedial works undertaken as required. Where significant erosion is observed, a review of the cause would be carried out to determine the need for additional controls instream or upstream.

These additional controls may include:

- Upstream flow velocity controls and or diversions.
- Temporary bypasses.
- Establishment of vegetation cover.
- Use of temporary erosion and sediment control devices; and
- Scour protection..

4.4.2.2 Sediment Controls

Where visual inspection of sediment filters (**Section 4.4.1**) identify they are not functioning adequately, repairs will be undertaken.

4.4.2.3 Sediment Control Dams

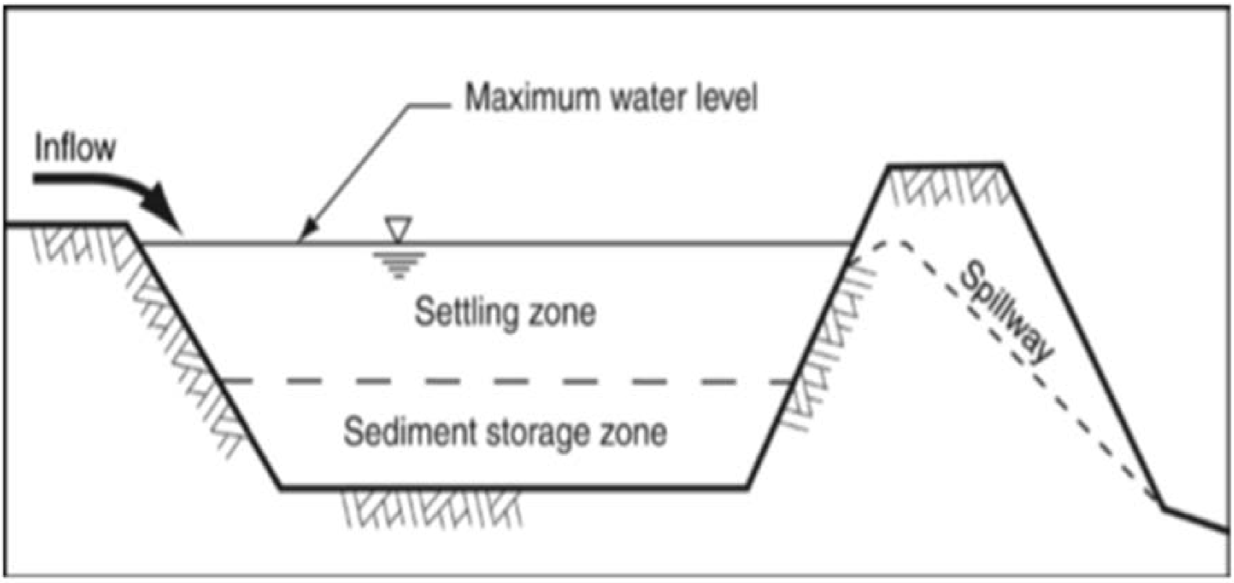
Sediment Control Dams are to be maintained as follows:

- Dewatering of Settling Zone (refer to **Figure 11**) within 5 days of a rainfall event by:
    - Transferring water to larger storages, and/or
    - Re-using water on site for dust suppression/irrigation where suitable, and/or
    - Discharge in accordance with the conditions of the EPL.
- De-silting of Sediment Zone (refer to **Figure 11**) once 30% reduction in storage capacity occurs.

The material removed from the sediment control dams will generally be disposed of in a way which will not pollute the environment. The Settling Zone volume is the volume of runoff predicted to report to the sediment control dam during the design storm event (5 day, 95th percentile rainfall event).

The Sediment Storage Zone volume if the volume of sediment predicted to report to the sediment control dam over a period of time (typically 2 to 12 months). For Type D and Type F soil materials, the Sediment Storage Zone is typically 50% of the defined Settling Zone.

Figure 11 Settling Zone and Sediment Storage Zone (IECA, 2018)



4.4.3 Decommissioning of sediment control structures / Dams

In the instance that there is a need to decommission any of the sediment control dams onsite such activities would be the subject of a specific risk review considering factors such as location of alternate structures, dewatering to support the development of a dam decommissioning strategy and appropriate controls.

Decommissioning of a declared dam would follow the appropriate Dam Safety NSW process including deregistering.

Erosion and sediment structures would not be decommissioned or removed until the landscape is long term stable, or a risk review indicates they are no longer required to manage the erosion and sediment control risk.

5 REPORTING AND REVIEW

5.1 Environmental Incidents

An environmental incident is defined as a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval.

Incidents will be managed through established WCL procedures in as detailed the Environmental Management Strategy (EMS).

WCL will notify the appropriate stakeholders of any incident in accordance with the requirements of the Project Approval.

5.2 Complaints Handling

Complaints will be managed through established WCL procedures as detailed in the EMS. As required by ***Schedule 2 Condition F9*** of the Project Approval 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 Review document.

5.3 Reporting

All internal and external reporting and the review of this document will be undertaken in accordance with the WMP (RVC-EP-PLN-019).

5.4 Review and Auditing

The ESCP will be reviewed and audited as part of the requirements for the review and audit of the parent WMP (RVC-EP-PLN-019).

6 PLAN ADMINISTRATION

6.1 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 ESCP are outlined in Table 5-1.

Table 5-1: Roles and Responsibilities

Responsibilities	Role
Operations Manager	• Approve the ESC Plan. • Provide adequate resources for the implementation of this Plan
Group Environment and Approvals Manager	• Implement the ESC Plan. • Provide that the Training and Communication, Monitoring and Review and Improvement requirements of this Plan are met. • Investigate and report all incidents involving the failure or damage to ESC or flooding structures. • Follow up on required inspection and maintenance of permanent ESC measures. • Investigate and report all incidents involving the failure or damage to ESC or flooding structures.
Site Logistics Manager	• Investigate and report all incidents involving the failure or damage to ESC or flooding structures. • Follow up on required inspection and maintenance of permanent ESC measures. • Investigate and report all incidents involving the failure or damage to ESC or flooding structures. • Engage contractors for maintenance and or repair works as required. • Manage routine maintenance of site facilities.
All contractors	• Undertake works in accordance with the objectives and principles of this Plan and GDP (where relevant). • Report all incidents involving the failure or damage to ESC or flooding structures.
All personnel	• Undertake works in accordance with the objectives and principles of this Plan and GDP (where relevant). • Report all incidents involving the failure or damage to ESC or flooding structures.

7 REFERENCES

Cardno (2020). *Flood Analysis and Concept Design – Bellambi Creek Diversion*

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Department of Primary Industries (2013). Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management.

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8 GLOSSARY OF TERMS AND ABBREVIATIONS

Abbreviations	
AEP	Annual Exceedance Probability
E&A Manager	Group Environment and Approvals Manager
EPA	Environment Protection Authority
EPL	Environment Protection Licence
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
GWMP	Groundwater Management Plan
LGA	Local Government Area
MOP	Mining Operations Plan
MP	Management Plan
NSW	New South Wales
ROM	Run-of-mine
RUSLE	Revised Universal Soil Loss Equation
SWCD	Stormwater Control Dam
SWMP	Surface Water Management Plan
TSS	Total Suspended Solids
UEP	Underground Expansion Project
WCL	Wollongong Coal Limited
WMP	Water Management Plan

Terms	
Incident	An event that results in breaches or exceeds the limits or performance measures/criteria in the Project Approval.
Mitigation	Activities associated with reducing the impacts of the project prior to or during those impacts occurring
Surface Facilities Site	Russell Vale Pit Top site, coal conveyor and truck load out facilities, ventilation shaft sites, and any other site subject to proposed surface disturbance (excluding subsidence impacts) associated with the development. See WMP (RVC-EP-PLN-019 for details)
Wet Weather Conditions	Underneath the current EPA licence this is considered a minimum of 10mm rainfall within a 24-hour period.

9 CONTROL AND REVISION HISTORY

PROPERTY	VALUE
Approved by	Group Environment and Approvals Manager
Document Owner	Richard Sheehan
Effective Date	26/08/2021

Revisions

VERSION	DATE REVIEWED	REVIEW TEAM (CONSULTATION)	NATURE OF THE AMENDMENT
Draft 1	13/03/2021	Adam Wyatt (Engeny) Richard Sheehan	Draft document for review
Draft 2	02/08/2021	Adam Wyatt (Engeny) Robert Faddy-Vrouwe	Final draft for approval following update to incorporate DPIE feedback dated 21 July 2021
Draft 3	26/08/2021	Adam Wyatt (Engeny) Richard Sheehan	Updated to incorporate DPIE feedback dated 13 August 2021.

APPENDIX C. PIT TOP SURFACE WATER MANAGEMENT PLAN

RUSSELL VALE REVISED PREFERRED UEP

Pit Top Surface Water Management Plan
- SURFACE WATER MANAGEMENT PLAN

RVC EC PLN 034

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7CONTROL AND REVISION HISTORY

Revision

PROPERTY	VALUE
Approved by	Group Environment & Approvals Manager
Document Owner	Richard Sheehan
Effective Date	30/08/2021

Revision History

VERSION	DATE REVIEWED	REVIEW TEAM (CONSULTATION)	NATURE OF THE AMENDMENT
Draft 0	03/05/2021	Dr Adam Wyatt (Engeny Water Management)	Original Plan Preparation
Draft 1	02/08/2021	Dr Adam Wyatt (Engeny Water Management) Robert Faddy-Vrouwe	Updated to incorporate DPIE feedback dated 21 July 2021
Draft 2	26/08/2021	Robert Faddy-Vrouwe Devendra Vyas Warwick Lidbury	Final draft for approval following update to incorporate DPIE feedback dated 13 August 2021.
Draft 3	30/08/2021	Robert Faddy-Vrouwe	Update formatting issue.

1. INTRODUCTION

1.1 Project Background

Wollongong Coal Limited (WCL) operates the Russell Vale Colliery (RVC) 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. Coal mining has occurred at this site, under a variety of different owners, since 1887 and contributes to the rich history of the Illawarra region.

Russell Vale Colliery operates under the current project approval Development Consent MP09_0013 (the 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.

Mining will be undertaken using the first workings bord and pillar mining methodology, resulting in minimal subsidence and negligible impact on the surface features above the mining area. This mining method was chosen due to the proximity of the proposed mining area to the Cataract Reservoir, the sensitive environmental features above the mining area (such as coastal upland swamps), and the high level of community and stakeholder interest in the project.

The Russell Vale Pit Top includes several modifications as part of MP09_0013 (**Figure 2**), including:

- Rejects and Product Stockpiles.
- Surge and Truck Loading Bins.
- Bunds; and
- Noise Walls.

Figure 1 Existing Russell Vale Colliery Pit Top

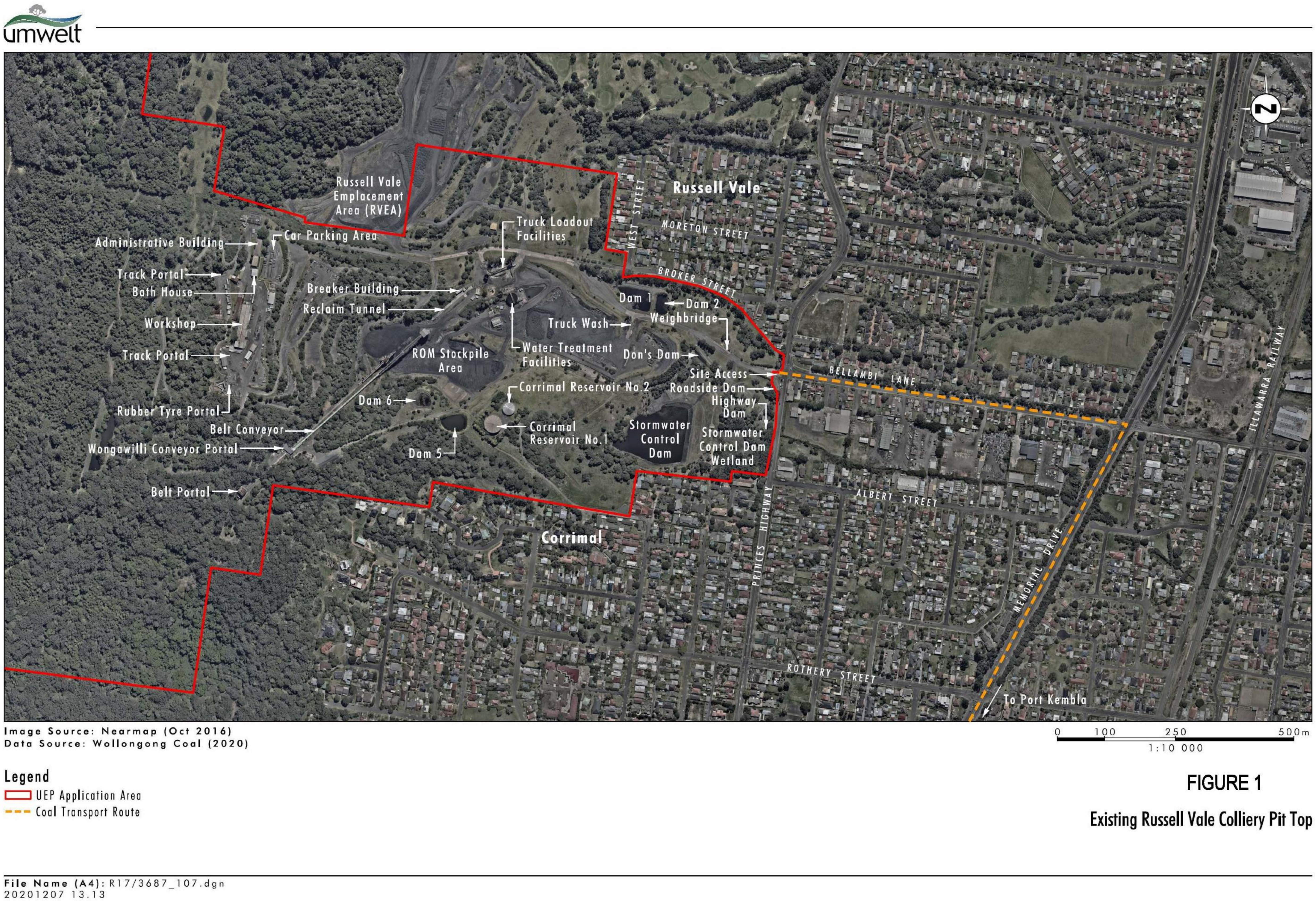
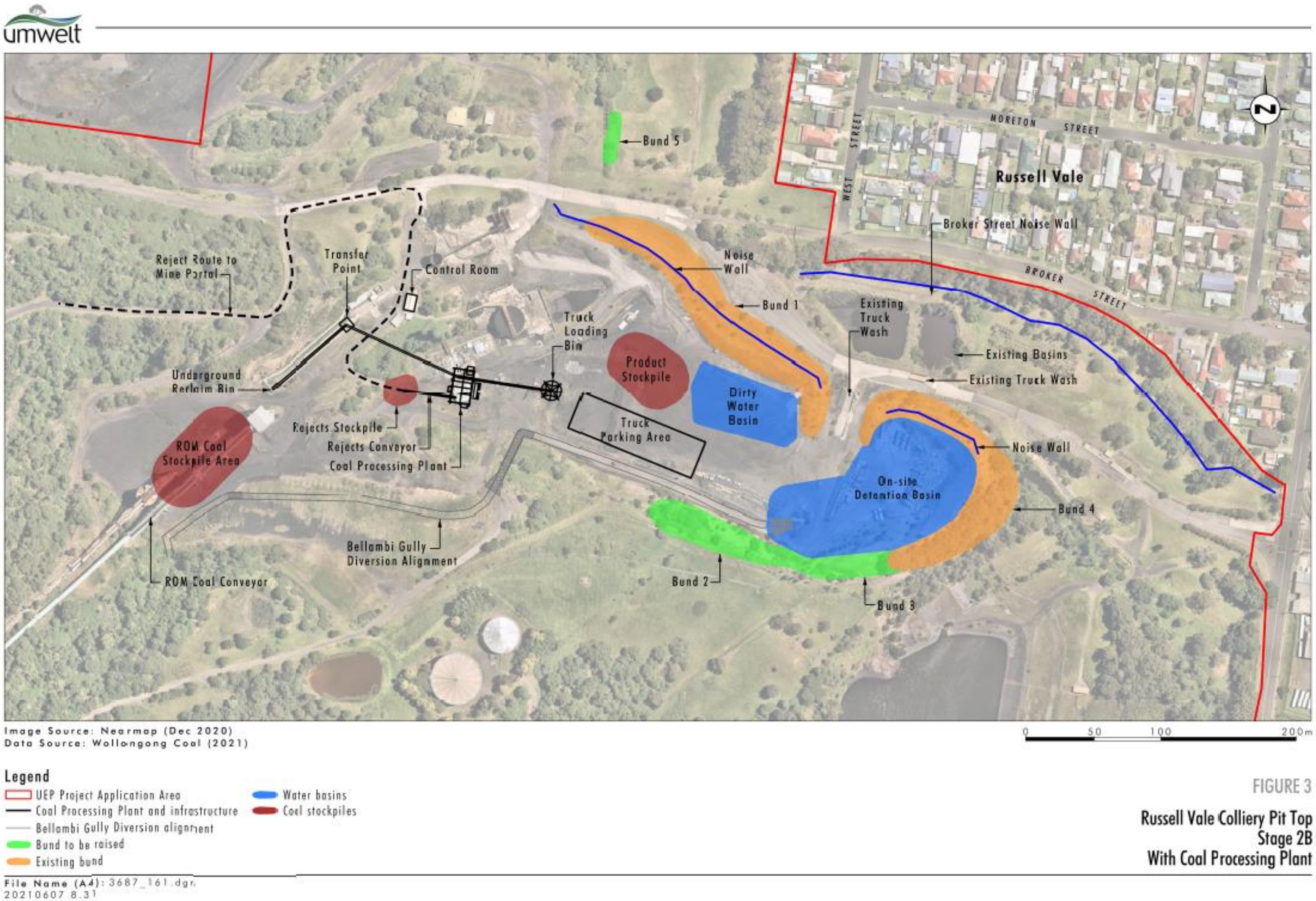


Figure 2 Russell Vale Colliery UEP Pit Top Upgrades (MP09_0013)



1.2 Objectives

This Pit Top Surface Water Management Plan (SWMP) has been prepared as part of a suite of water management plans (Section **1.3**) to satisfy ***Condition B17/ Schedule 2*** and the relevant sections of ***Condition C10/Schedule 2*** of the Project Approval (MP09_0013) with consideration of the regulatory and licencing requirements.

The Pit Top SWMP forms a sub-plan of the RVC Water Management Plan (WMP).

The objectives of the SWMP are to:

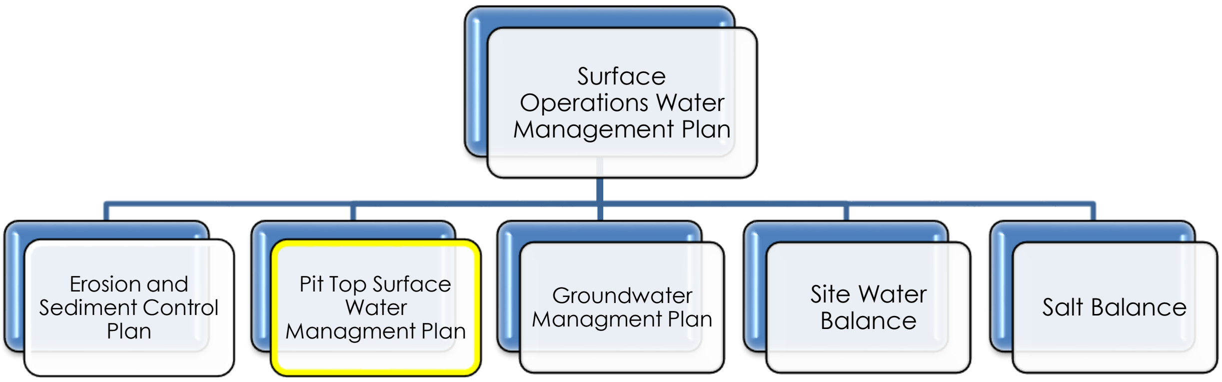
- provide methods to monitor potential impacts to surface quantities and qualities.
- identify potential impacts associated with the mining operations on surface water resources; and
- provide appropriate mitigation measures and responses where necessary.

1.3 Scope

This SWMP is part of a set of documents that have been developed to manage surface and groundwater impacts for Russell Vale Colliery (**Figure 3**). The SWMP is a sub-plan of the Surface Operations Water Management Plan (SOWMP). The SWMP should also be read in conjunction with the following plans:

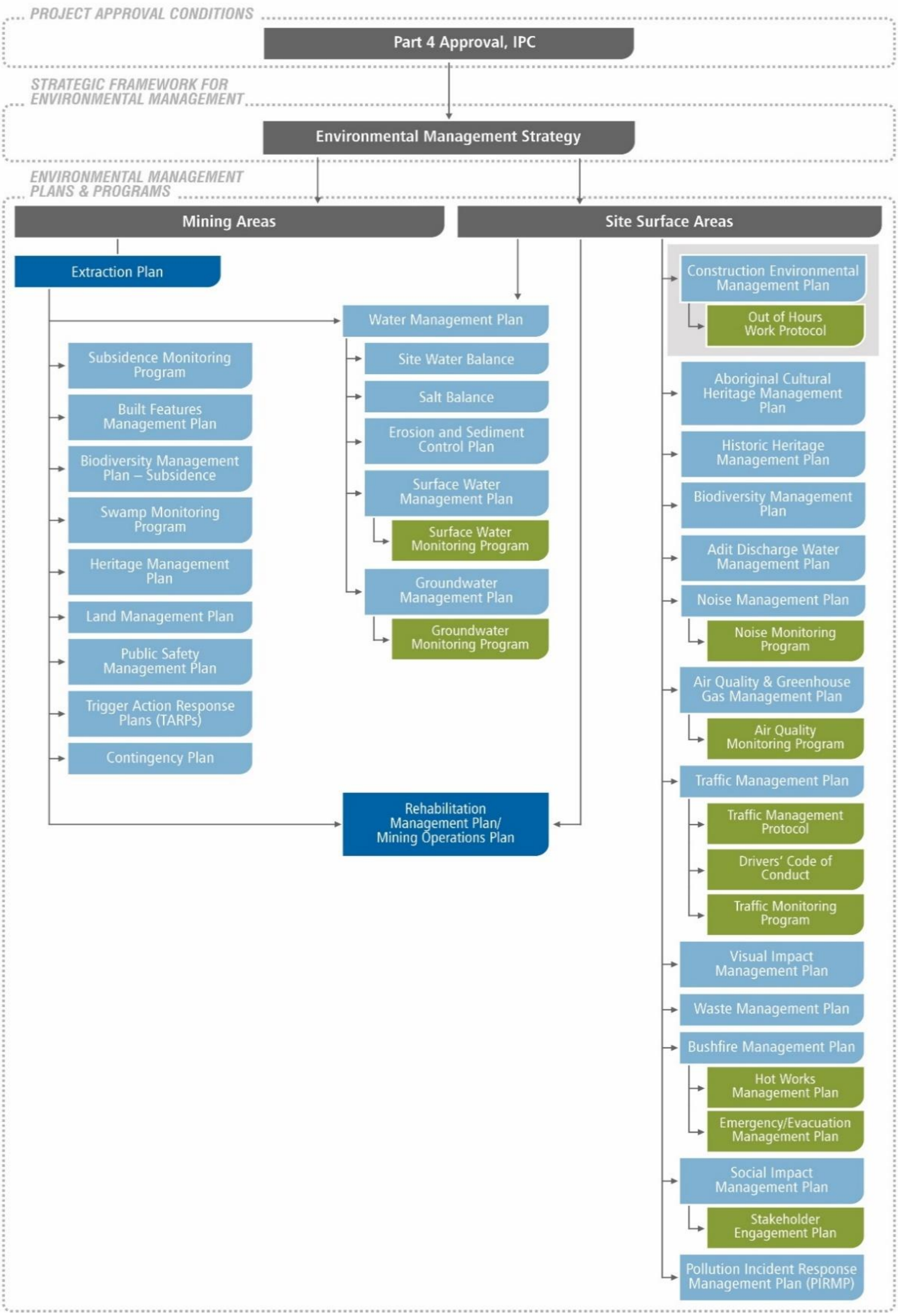
- Surface Operations Water Management Plan (SOWMP);
- UEP Surface Water Management Plan (also a sub-plan of the WMP);
- Erosion and Sediment Control Plan (ESCP) (also a sub-plan of the WMP);
- Groundwater Management Plan (GWMP) (also a sub-plan of the WMP);
- Upland Swamp Monitoring Plan (USMP); and
- Biodiversity Management Plan (BMP).

Figure 3 Water Management Plan Structure



This SWMP also forms part of RVC's Environmental Management System (EMS: **Figure 4**) and should be read in conjunction with the RVC Environmental Management Strategy. All incidents reported at RVC, including water-related incidents, are managed in accordance with the RVC Pollution Incident Response Management Plan (PIRMP) (RVC EC PLN 022).

Figure 4 Environmental Management Framework (from EMS)



1.4 Consultation

Details of the consultation undertaken during the development of this plan are included in the Water Management Plan ***RVC EC PLN 019***.

2. BASELINE DATA

2.1 Hydrology and Waterways

The Pit Top area is located within the catchment of Bellambi Gully (**Figure 7**), which meets the Pacific Ocean about 2 km east of the site. The catchment areas upslope (west) of the site are dominated by very steep rocky escarpments, which have a very flashy runoff response to storm events. Downstream of the site Bellambi Gully and its tributaries consist of more gentle slopes typical of coastal floodplains.

Large rainfall events within the upper catchment areas are driven by orographic rainfall, which is caused by warm, moist onshore coastal breezes being deflected upwards by the escarpment into the cooler upper atmospheric strata. The rapid cooling of the warm causes the moisture in the deflected sea breeze to coalesce into larger droplets, resulting in large rainfall events.

These large rainfall events result in significant runoff generated by the steep escarpment areas of the catchments, with significant flows entering Bellambi Gully (and other watercourses), that convey these flashy flows through the urbanised downstream environment.

2.2 Water Quality

A review of the baseline water quality data has been conducted for monitoring of site and receiving waters in accordance with Environment Protection Licence (EPL) 12040 at the monitoring locations indicated in **Figure 7** and **Table 2**, and monitoring undertaken for due diligence purposes is included in **Appendix A**. Surface water quality triggers have been derived for LDP 11 using the historical data sets and methods outlined in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018; ANZECC 2000). Water quality triggers for LDP 2 are based on baseline data 80th percentiles for the Level 2 trigger and EPL discharge limits for the Level 3 trigger. The surface water trigger levels and criteria are summarised in **Section 6.1**.

Table 1 Surface water quality monitoring locations

EPL POINT	CONTEXT	EASTING	NORTHING	DESCRIPTION
1 (LDP1)	Discharge point	306398	6196290	Discharge RVEA area and Clean Water Divert
2 (LDP2)	Discharge point	306202	6195925	WTP discharge
3 (LDP3)	Discharge point	306668	6195698	Seepage from SWCD
9 (LDP9)	Discharge point	306594	6195792	SWCD spillway
11 (LDP11)	Ambient water quality	306795	6195690	Bellambi Gully downstream
12 (LDP12)	Ambient water quality	305647	6195740	Bellambi Gully upstream

As part of the PER Umwelt (2020) undertook an analysis of the water quality data collected in 2020 (**Appendix A**). This analysis was extended to include previously collected data from 2016 to 2019. The results of this analysis for pH, EC, TSS and turbidity are summarised in **Table 2** to **Table 5**. Water quality monitoring results for laboratory testing of other analytes are included in **Table 6**.

Table 2 Surface water quality monitoring summary – pH

EPL POINT	DATE RANGE	# SAMPLES	5TH	20TH	80TH	95TH
2 (LDP 2)	Jan 2016 – Oct 2020	160	7.52	8.49	9.10	9.39
11 (LDP11)	Jun 2016 – May 2020	205	7.35	8.02	8.85	9.35
12 (LDP12)	Jun 2016 – May 2020	185	6.64	7.22	8.20	8.46

Table 3 Surface water quality monitoring summary – EC (μS/cm)

EPL POINT	DATE RANGE	# SAMPLES	5TH	20TH	80TH	95TH
2 (LDP 2)	Jun 2016 – Oct 2020	130	788	1148	2434	2910
11 (LDP11)	Jun 2016 – May 2020	206	648	931	2083	2651
12 (LDP12)	Jun 2016 – May 2020	186	304	436	683	787

Table 4 Surface water quality monitoring summary – TSS (mg/L)

EPL POINT	DATE RANGE	# SAMPLES	5TH	20TH	80TH	95TH
2 (LDP 2)	Jun 2016 – Oct 2020	57	6	8	26	34
11 (LDP11)	Jun 2016 – May 2020	99	6	8	30	111
12 (LDP12)	Jun 2016 – May 2020	73	6	8	52	115

Table 5 Surface water quality monitoring summary – Turbidity (NTU)

EPL POINT	DATE RANGE	# SAMPLES	5TH	20TH	80TH	95TH
2 (LDP 2)	Jun 2016 – Oct 2020	111	10	16	47	82
11 (LDP11)	Jun 2016 – May 2020	169	2	9	78	250
12 (LDP12)	Jun 2016 – May 2020	140	2	7	61	166

Table 6 Surface water quality monitoring summary – other analytes

POLLUTANT	UNITS	EPL11 (DOWNSTREAM)		EPL12 (UPSTREAM)	
		MEDIAN	RANGE	MEDIAN	RANGE
Total Hardness	mg/L	52	27 to 103	74	49 to 218
Total Alkalinity	mg/L	294.5	214 to 799	147.5	53 to 264
TKN	mg/L	0.9	0.4 to 2.2	0.65	0.14 to 1.2
TP	mg/L	0.22	0.05 to 0.51	0.13	0.02 to 0.28
Aluminium	mg/L	0.16	0 to 1.22	0.11	0.07 to 0.16
Barium	mg/L	0.113	0.048 to 0.176	0.077	0.071 to 0.12
Boron	mg/L	0.06	0.06 to 0.07	0.06	0.06 to 0.06
Copper	mg/L	0.005	0.002 to 0.013	0.003	0.001 to 0.007
Iron	mg/L	0.17	0.07 to 0.31	0.19	0.1 to 0.21
Lithium	mg/L	0.06	0 to 0.24	0	0 to 0.01
Manganese	mg/L	0.008	0.001 to 0.069	0.01	0.005 to 0.088
Nickel	mg/L	0.003	0.001 to 0.006	0.002	0.001 to 0.006
Strontium	mg/L	0.22	0.11 to 0.27	0.16	0.12 to 0.21
Zinc	mg/L	0.016	0.006 to 0.054	0.007	0.007 to 0.007

2.3 Surface Water Flows, Flooding and Water Supply for Other Water Users

Surface water flow monitoring of Bellambi Gully has been conducted at LDP 11 and LDP 12 since 2016. This data is captured by a Water Level sensor at both of these locations which is an indication of the flow of water at each location. The water flow at LDP 12 is seen to be sporadic, with flow occurring during rainfall events and the site becoming dry with no water flow shortly after rainfall ceases. LDP 11 is seen to have a constant base flow of water which is modulated Russell Vale Colliery's treated water discharge, via LDP 2. The historic data from LDP 11 & 12 is presented in **Figure 5** & **Figure 6** below.

The Bellambi Gully Clean Water Diversion (BGCWD) Open Channel Works, which are currently under construction, have been designed and engineered in accordance with the DPIE order to cope with a 1 in 100 year flood event and provide flooding mitigation to the downstream environment. The OSD at the end of the BGCWD is designed to capture the flood surge and moderate the flow of water downstream, thereby controlling surface water flows and flooding impacts. This protects the downstream environment from extreme flows and flooding, through the controlled release of water which is dictated by the aperture of the discharge outlet from the clean water OSD.

Following completion of the construction of the BGCWD Works, and as per Term 2i of the DPIE Order dated 23 July 2020, a specific maintenance plan is required to be developed following the completion of the Bellambi Gully Clean Water Diversion construction works. This plan will include an inspection and monitoring program of Bellambi Gully to monitor for flooding, water flow, channel stability and the riparian vegetation of Bellambi Gully. On completion of the construction works, and subsequent development of the maintenance plan, this Water Management Plan will be reviewed and updated to detail this monitoring program. The initial assessment of the parameters in the monitoring program will form the basis for establishing the baseline data. Subsequent monitoring of the parameters will be in reference to the newly established baseline data, which will also set the performance criteria to monitor against in the future.

Figure 5 LDP 11 Water Level & Flow Baseline Data

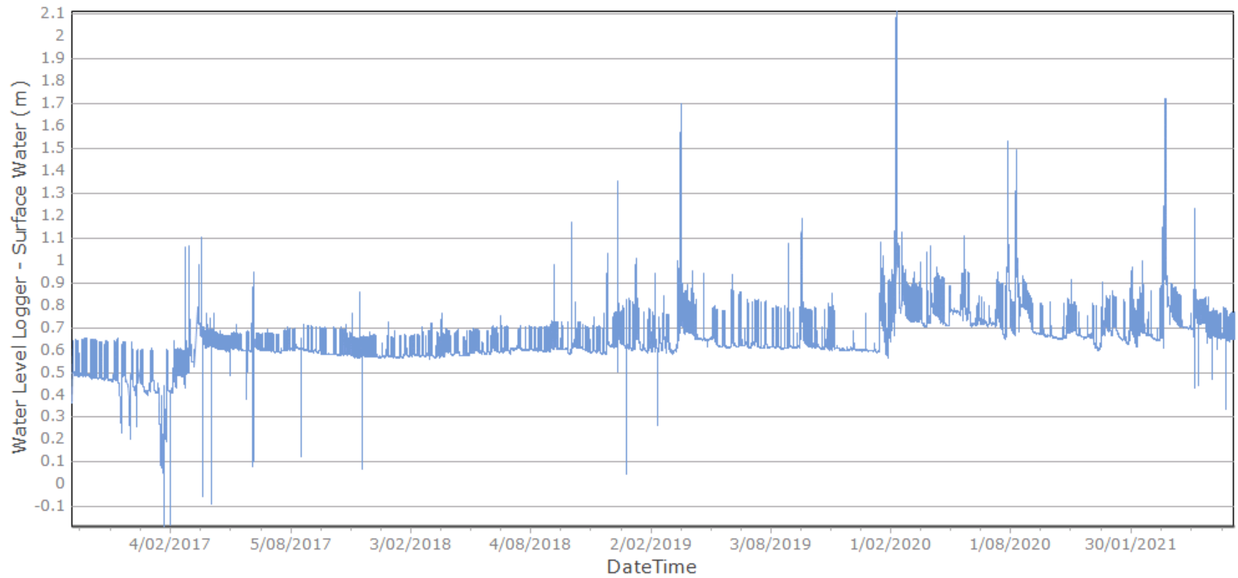
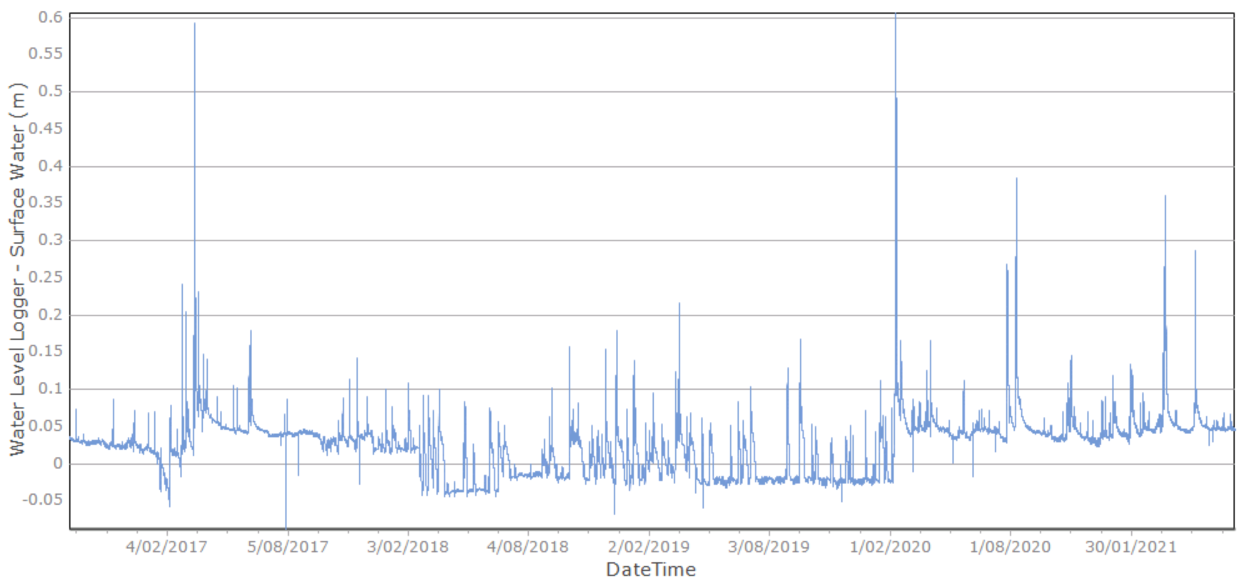


Figure 6 LDP 12 Water Level & Flow Baseline Data



No affected landowners or downstream water supply users have been identified in relation to the development; as such there will be no impacts to water supply for other surface water users and this has not been considered further in this plan.

2.4 Stream and Riparian Vegetation Health

Stream and riparian vegetation health monitoring has not occurred at Russell Vale Colliery under previous project approvals, and was not assessed under the RPPR, and as such no baseline data exists for this aspect. WCL has developed a monitoring program, as outlined in **Section 4.5** below, to begin monitoring stream health in the form of aquatic ecological monitoring, and this will be implemented within 6 months of the approval of this plan. WCL will also develop a riparian vegetation monitoring program and this will be implemented within 6 months of the approval of this plan. Following implementation of this monitoring program the baseline conditions of the stream and riparian vegetation health will be added to this plan.

Following completion of the construction of the BGCWD Works, and as per Term 2i of the DPIE Order dated 23 July 2020, a specific maintenance plan is required to be developed following the completion of the BGCWD construction works. This plan will include an inspection and monitoring program of Bellambi Gully to monitor for flooding, water flow, channel stability and the riparian vegetation of Bellambi Gully. On completion of the construction works, and subsequent development of the maintenance plan, this Water Management Plan will be reviewed and updated to detail this monitoring program. The initial assessment of the parameters in the monitoring program will form the basis for establishing the baseline data. Subsequent monitoring of the parameters will be in reference to the newly established baseline data, which will also set the performance criteria to monitor against in the future.

The riparian vegetation along the lower section of Bellambi Gully (below the BGCWD OSD) consists of a mix of remnant native vegetation and exotic weeds as described in Figure 15 of the ***RVC EC PLN 032*** Biodiversity Management Plan. This riparian vegetation has been mapped as Urban Native/Exotic with a weed density of 26-50%. Weed management, reduction, performance criteria and monitoring is discussed in detail in the ***RVC EC PLN 032*** Biodiversity Management Plan.

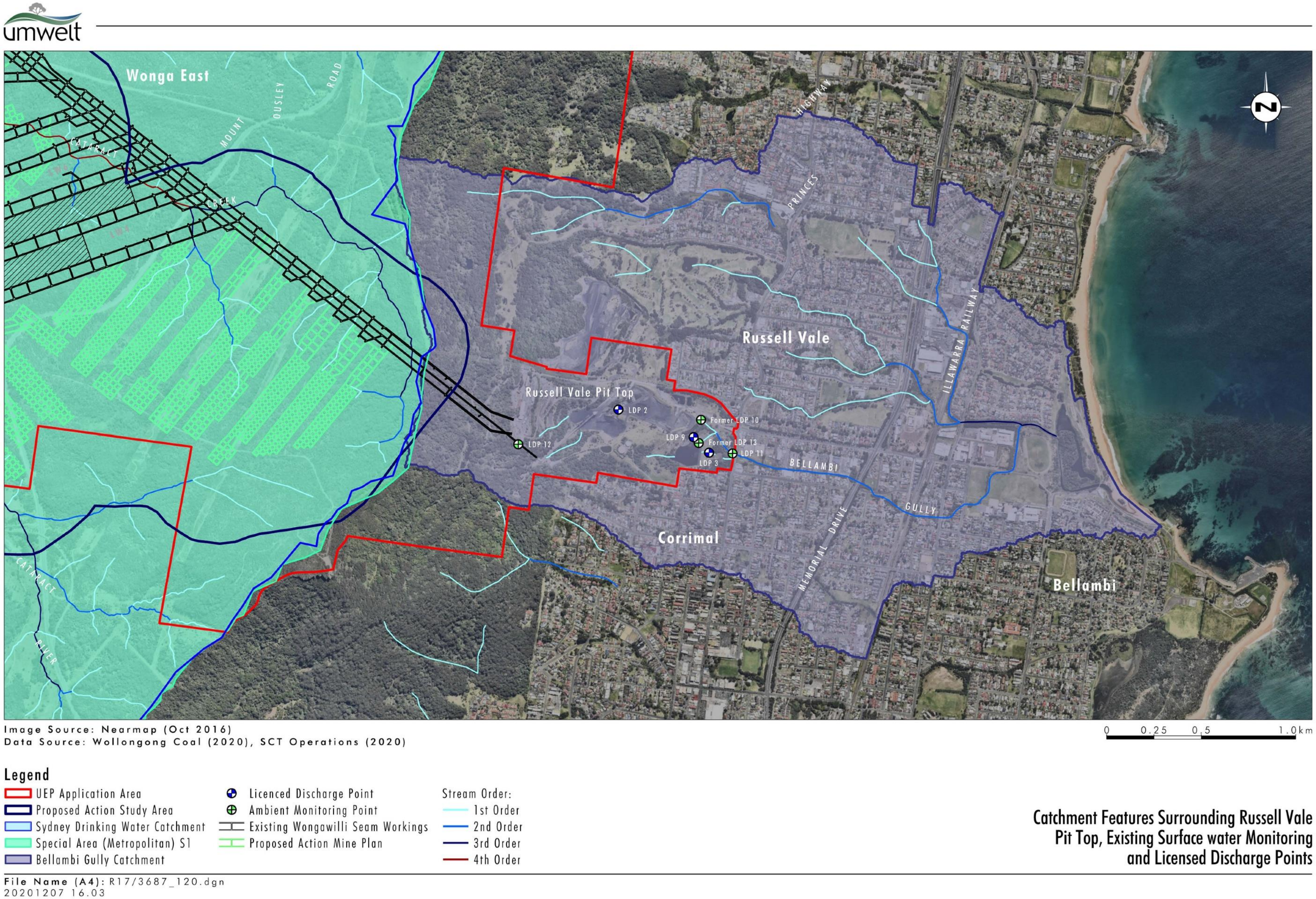
2.5 Channel Stability

Channel stability monitoring has not occurred at Russell Vale Colliery under previous project approvals, and was not assessed under the RPPR, and as such no baseline data exists for this aspect.

The Bellambi Gully Clean Water Diversion Works, as outlined in section 5.1 of the SOWMP, has been designed and engineered in accordance with the DPIE order to ensure that the channel remains stable. This engendered channel makes up the majority of Bellambi gully that runs through site, with only a small section, between the bottom of the clean water OSD and the site boundary, not been reconstructed. These works are designed to protect the downstream section of Bellambi Gully from extreme flows and souring by the controlled release of water from the Clean Water OSD Basin. This is due to the aperture of the discharge outlet from the clean water OSD moderating the release of water from the OSD to the downstream environment.

Further as per Term 2i of the DPIE Order dated 23 July 2020, a specific maintenance plan is required to be developed following the completion of the Bellambi Gully Clean Water Diversion construction works. This plan will include an inspection program of Bellambi Gully to monitor for channel stability of Bellambi Gully. On completion of the construction works, and subsequent development of the maintenance plan, this Water Management Plan will be reviewed and updated to detail this channel stability monitoring program (including a detailed baseline assessment and performance criteria). The newly constructed channel will set the baseline conditions for future monitoring.

Figure 7 Catchment Features Surrounding Russell Vale Pit Top, Existing Surface Water Monitoring and Licensed Discharge Points



3. SURFACE WATER MANAGEMENT SYSTEM

The existing approved RVC Pit Top Water Management System (WMS) catchment is approximately 43 ha in area and consists of the following sub catchments:

- Rehabilitated and undisturbed natural catchments.
- Disturbed catchments including the pit top area and coal handling infrastructure.
- Hardstand areas including the maintenance workshop area, administration offices, access roads and car parking.

The existing WMS allows for two categories of water:

- Clean water, comprising runoff from undisturbed and fully rehabilitated areas, and
- Dirty water, comprising runoff from any area disturbed by mining operations, runoff from areas where coal is stockpiled and handled, and groundwater extracted from the underground workings. Surplus water is treated (as required) and discharged under licence from the site.

The WMS was designed to maximise the separation of clean and dirty water. **Figure 8** and **Figure 9** present a plan and flow schematic of the existing WMS, respectively.

3.1 Clean Water System

Clean stormwater primarily consists of runoff from the naturally vegetated escarpment above site. Clean stormwater is also generated from some non-operational vegetated areas that sit within the pit top area. The clean water management system depicted in **Figure 8** principally consists of a series of clean water drains, diversions and dams.

Diversions are intended to intercept runoff from clean catchments areas prior to flowing into operational or disturbed areas, thereby minimising the volume of water removed from the surrounding environment. These diversions direct the intercepted clean water around the site and into the downstream environment.

Clean Water Diversions within the vicinity of the RVC Pit Top Area, shown in **Figure 8** and **Figure 10**, include:

- Bellambi Gully Diversion Channel - conveys stormwater (from the natural Bellambi Gully watercourse) around the coal handling area into a Clean Water Detention Basin.
- Diversions to intercept and convey clean water runoff from the north western upslope catchment is directed to the north around the Pit Top WMS.

Clean Water Dams within the vicinity of the RVC Pit Top Area, shown in **Figure 8** and **Figure 10**, include:

- Clean Water Detention Basin – serves as a retarding basin to reduce the peak flow within the downstream reaches of Bellambi Gully.
- Dam 6 – A remnant dam that is no longer used.

A summary of clean water dams are included in Table 8. The clean water system is described in further detail in section 5.1.2 of the SOWMP.

3.1.1 Bellambi Gully Diversion Works

WCL is constructing the clean water diversion channel system to the south around the stockpile area (**Figure 10**). Under the UEP approval MP09_0013, WCL is required to implement diversion works on Bellambi Gully to manage pollution risks associated with flooding of the creek. The pollution risks have historically stemmed from the capacity of the diversion pipe being less than the 1% AEP storm event flows. During major storm events, such as the 1% AEP storm event, clean water overtops the pipe entry and flows through the stockpile and coal handing areas prior to flowing into Bellambi Gully downstream of the site.

A flood analysis and concept design for these works was undertaken by Cardno (2020). The works included analysis and design of an open channel to divert clean floodwaters from the operation areas, a detention basin to attenuate flood volumes and peak velocities leaving the site and design of a new dry sediment basin to improve stormwater quality and aid in floodwater detention to minimise flooding downstream of the site. Subsequently a detailed design was prepared during early 2021 based on the concept design works.

The design criteria for the Bellambi Gully Diversion Channel are:

- produce a stable channel, which is unlikely to undergo significant geomorphic change over time;
- reduce the need for ongoing maintenance where possible; and
- ensure sufficient capacity to convey the estimated peak flow from the 1% AEP storm event.

The performance and completion criteria for the Bellambi Gully Creek Diversion are outlined in **Table 7**.

Table 7 Bellambi Gully Creek Diversion Performance Criteria

ASPECT	PERFORMANCE CRITERIA
Water quality	As per the water quality triggers for Bellambi Gully monitoring point LDP 11.
Flooding and flows	No increase in peak flood levels, flood extents, flood hazards, velocities for all events and durations downstream of the site for all flood events.
Geomorphology	Channel bank – no evidence of significant rill erosion, undercutting or slumping. Invert and outlet – no evidence of significant scour or erosion. In-stream structures – structure is stable. Vegetation – not evidence of significant weed growth or dead vegetation. Deposition of sediment and debris – no evidence of significant accumulation or degradation, or large blockages in channel.

The design of the diversion is intended to minimise flooding and erosive impacts to the downstream reaches of Bellambi Gully, thereby minimising impacts to the remaining riparian areas. It is noted that as the downstream area is highly urbanised, the downstream reaches of Bellambi Gully include a number of control structures such as concrete channels, bridges, and culverts, which serve to control existing and potential future erosion within the watercourse.

As the diversion is part of a major project approval, the proposed works are exempt from the requirements for controlled activities for waterfront lands.

The Bellambi Gully Open Channel Clean Water Diversion will be maintained in accordance with the maintenance plan, required under Term 2i of the DPIE Order dated 23 July 2020, that is to be developed within 1 months of completion of the construction works. This Water Management Plan will be updated to incorporate the maintenance requirements as outlined in **Section 12.5** of ***RVC EC PLN 019***.

3.2 Dirty Water System

Dirty stormwater consists of runoff from disturbed catchments and includes:

- Runoff from unsealed coal contaminated surfaces.
- Truck loading and coal processing area.
- Runoff from the ROM coal stockpile area; and
- First flush from the hardstand area in front of the portals.

The RVC Pit Top WMS includes six water management dams and a seepage sump, as shown on **Figure 9**.

Runoff from the stockpile and coal handling area, and maintenance and laydown areas, drains to a dry detention basin to settle coarse suspended solids prior to discharging under gravity to Dam 1. Dam 1 functions as a flow through sediment basin and discharges under gravity to the SWCD. Dam 1 also receives excess water draining from the truck wash and pumped transfers from the underground mining operation (groundwater and excess process water pumped into the underground for operational purposes). WCL will implement pre-treatment of dirty water using flocculant block at the inlet to Dam 1 to aid settling of solids prior to overflowing into Dam 2.

The SWCD also receives pumped transfers from the Highway Dam and runoff from approximately 7.5 ha of mostly undisturbed upslope catchment which also includes Dam 5. Dam 5 has minimal catchment, and no water is actively sourced from Dam 6 for operational demands.

All chemical and hydrocarbon storage tanks are located within bunded areas (or approved alternative) to provide emergency spill containment. The capacity of the emergency spill containment will be at least equivalent 125% of the largest storage tank within the bunded area (as per Australian Standard AS 1940). These bunded areas will not be used to store water.

A summary of dirty water dams is included in **Table 8.**

Table 8 Water Storages

DESCRIPTION	CAPACITY (ML)	FUNCTION	MANAGEMENT
Dirty water system			

DESCRIPTION	CAPACITY (ML)	FUNCTION	MANAGEMENT
Dam 1	7	Flow through sediment basin. Excess water draining from the truck wash, wheel wash, stockpile areas, and pumped transfers from the underground mine.	Discharges under gravity to the Stormwater Control Dam. Management of sediment levels in the dam to less than 30% of the dam volume.
Dam 5	< 10	Redundant dam draining to SWCD.	Nil.
Pit Top Dam	8	Provides storage capacity of recycled treated mine water for used in the pit top and underground water reticulation system for day to day mining operations. Dam does not to act as a catchment dam.	Capacity maintained to allow for the prescribed use. The dam water level is maintained to its full level by pumping from the Storm Water Control Dam.
Fire Dam	2	Provides firefighting water to the pit top and underground hydrants. Dam does not to act as a catchment dam.	Capacity maintained to allow for prescribed use. The dam water level is maintained to its full level by pumping from the Storm Water Control Dam.
Highway Dam	0.3	Capture water runoff from the lower section of the access road and vegetated area's near the Princes highway. Captured water is pumped back to the SWCD.	The water level of the dam is maintained at a low level, by the pump which is automatically activated from a float switch to pump the water into the storm water control dam. The pump and spillway is inspected and maintained monthly under the WO System to ensure they are functioning correctly.

DESCRIPTION	CAPACITY (ML)	FUNCTION	MANAGEMENT
Stormwater control dam	62	Pumped transfers from the Highway Dam Runoff from about 7.5 ha of mostly undisturbed catchment (including Dam 5).	Registered with Dam Safety NSW (DS NSW). Maintenance of the spillway area Monitor seepage (see LDP 3) Monitor spillway overflow (LDP 9)
Seepage Sump (LDP 3)	0.001	Collection of the Stormwater Control Dam wall seepage.	Management of sediment levels in the sump to less than 30% of the sump volume.
Dry Detention Basin (OSD)	2.1	Stockpile and coal handling area. Maintenance and laydown areas.	Discharges under gravity to Dam 1. An emergency overflow pipe allows for discharges to the Clean Water Detention Basin to occur during extreme storm events.
Clean Water System			
Clean Water Detention Basin	Approximately 26 (under construction)	Serves to reduce the magnitude of the peak discharge entering Bellambi Gully from the clean water diversion during larger storm events.	Dry detention basin, that includes a low-flow path that connects to the existing Bellambi Gully pipeline via a stormwater pit. An emergency overflow weir is located at the north-eastern corner that directs flows during extreme storm events into the existing channel system.
Dam 6	n/a	Redundant dam draining to Dam 5.	Nil.

Figure 8 Approved Water Management System Plan

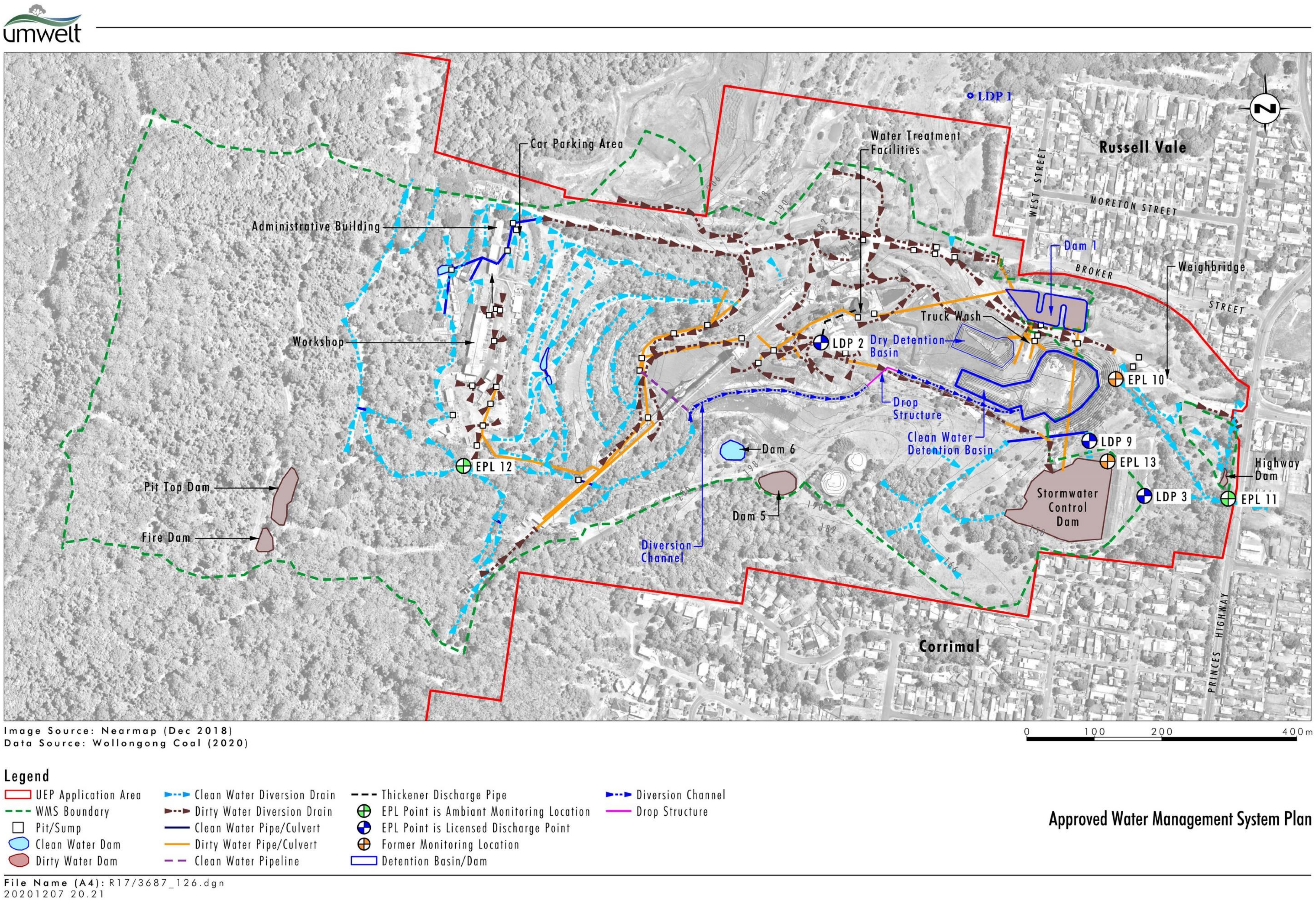


Figure 9 Approved Water Management System Schematic

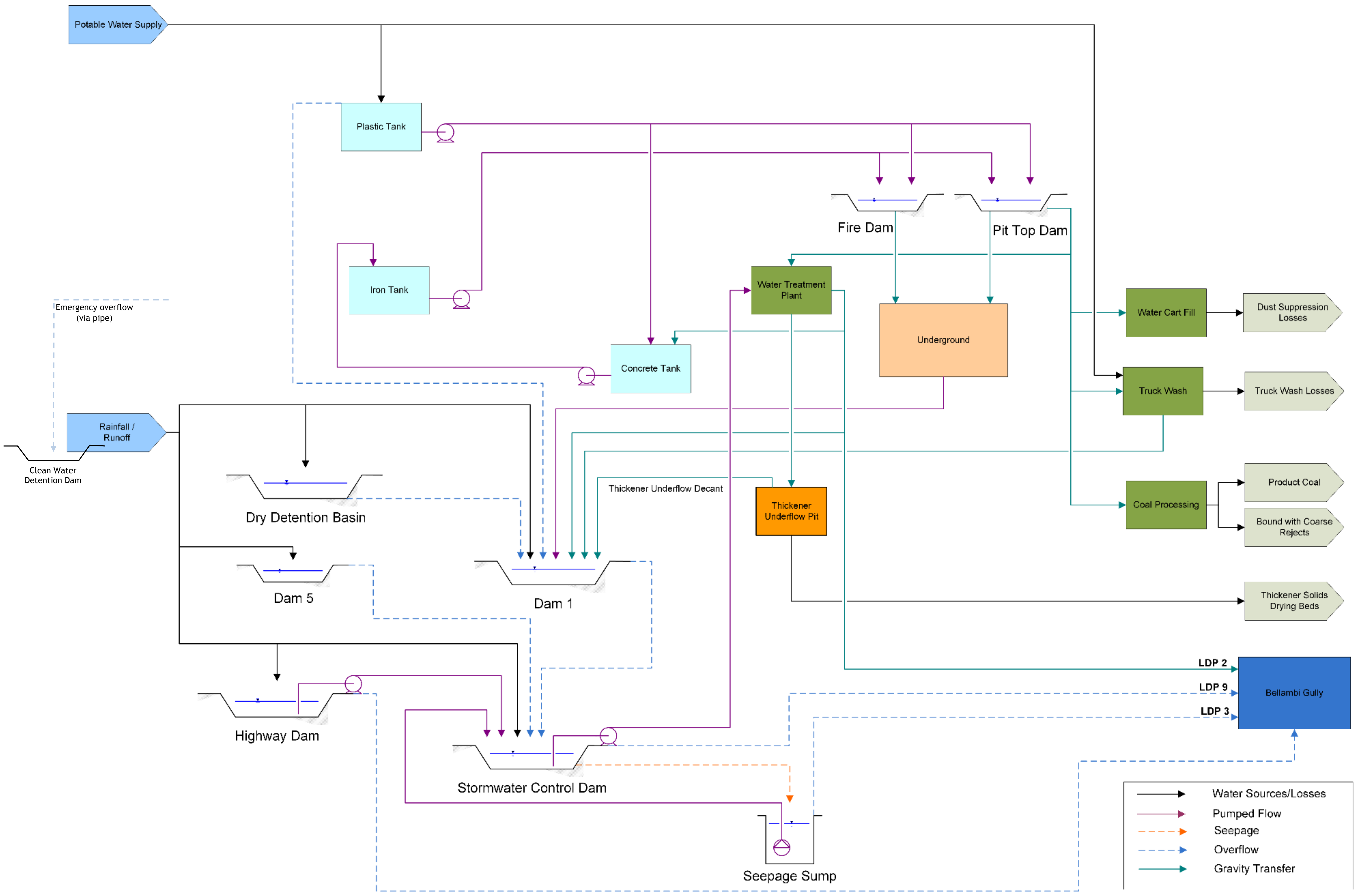
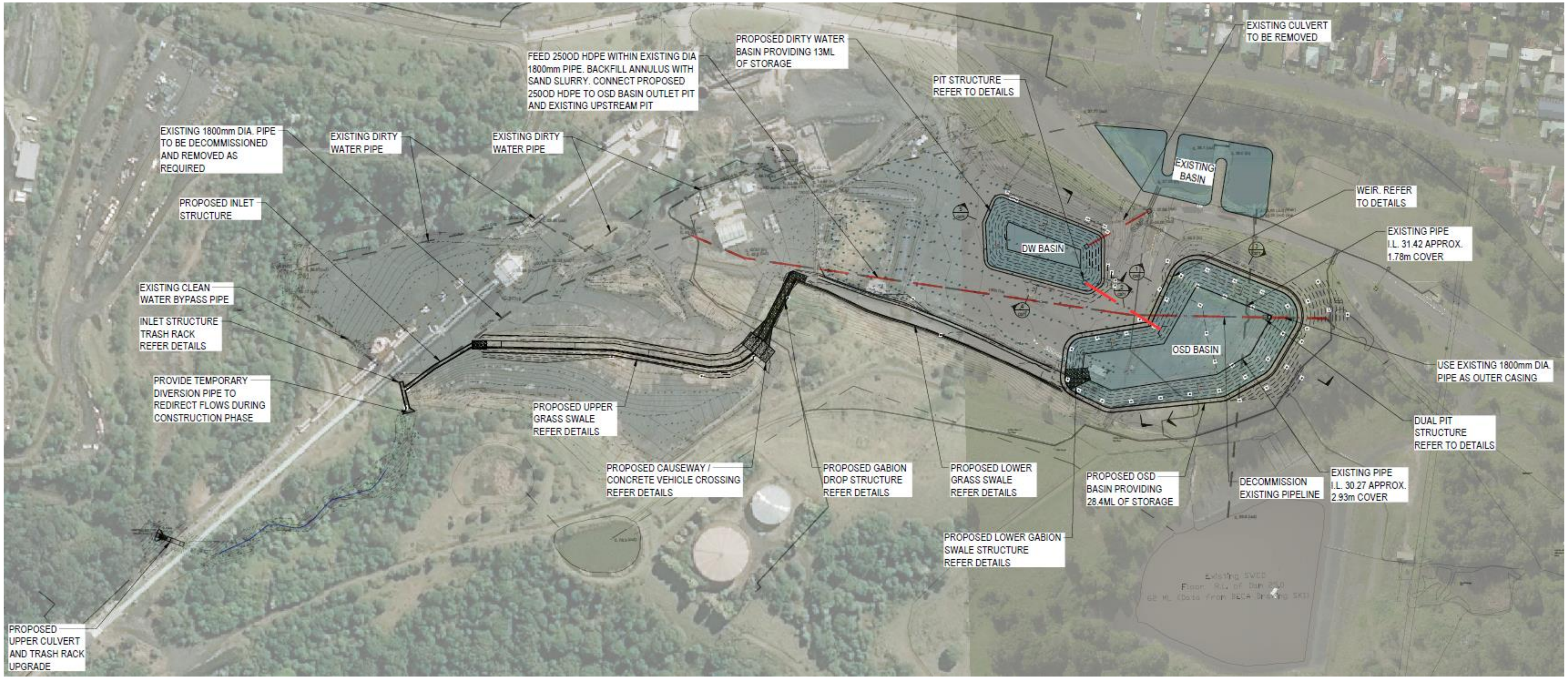


Figure 10 Proposed Bellambi Gully Diversion Works



3.3 Discharge System

Water from the SWCD is transferred to the Water Treatment Plant (WTP) (**Figure 9**), which incorporates a thickener tank to remove suspended solids (using a coagulant) prior to either reuse as process water or discharge to the Bellambi Gully via a licenced discharge point (**LDP 2,** see **Table 9** and **Figure 10).** The solids stream generated by the thickener tank is released into a small drying bed adjacent to the thickener tank, which is desilted as required. Seepage through the SWCD wall is collected in the Seepage Sump, along with runoff from the small Seepage Sump catchment and returned to the SWCD.

Wherever possible, the treated water is reused within the mining operations as a priority to minimise the import of water from other sources (such as the Sydney Water supply) and minimise the licensed discharges to Bellambi Gully.

Treated water discharged from the RVC Pit Top WMS is currently undertaken in accordance with EPL12040, which defines four licenced discharge points (LDPs 1, 2, 3 and 9) and two ambient water quality monitoring points (EPLs 11 and 12) for the RVC site (**Table 9**). The ambient monitoring points allow for a comparison of the downstream water quality (EPL 11) to the upstream (EPL 12) water quality, providing a means of estimating the surface water quality impacts associated with the discharges from the site.

Table 9 Environment Protection Licence Monitoring Locations

POINT	DESCRIPTION	MONITORING REQUIREMENTS	FREQUENCY	LIMIT CONDITIONS
1 (LDP1)	Licensed Discharge Point: Underground drainage from the emplacement area and forested area in Rath's Gully	pH Total Suspended Solids Turbidity Electrical Conductivity	Monthly during discharge	- N/A - N/A - N/A - N/A
2 (LDP2)*	Licensed Discharge Point: Treated water outlet discharging to Bellambi Gully	pH Total Suspended Solids Turbidity Electrical Conductivity	Monthly during discharge	6.5 – 9.2 50 mg/L - N/A - N/A
		Volume Turbidity**	Continuous	2,500 kL/day* 60 NTU**
3 (LDP3)	Licensed Discharge Point: Seepage through the SWCD wall into Bellambi Gully	-	-	- N/A

POINT	DESCRIPTION	MONITORING REQUIREMENTS	FREQUENCY	LIMIT CONDITIONS
9 (LDP9)	Licensed Discharge Point: The SWCD gabion spillway discharging to Bellambi Gully	-	-	- N/A
11 (EPL11)	Ambient Monitoring Point: Bellambi Gully ambient water quality west of Princes Highway	Turbidity Electrical Conductivity Volume	Continuous	- N/A - N/A - N/A
12 (EPL12)	Ambient Monitoring Point: Bellambi Gully upstream ambient water quality	Turbidity Electrical Conductivity Volume	Continuous	- N/A - N/A - N/A

Note: *EPL Condition L3.2 states that: The volume of wastes discharged from Point 2 on any day must not exceed 2500kL under dry weather conditions, but may exceed this volume under wet weather conditions provided all practical measures are taken to minimise additional pollution caused by the wet weather*
***Note:** For compliance with the above condition, 'Dry Weather Conditions' means less than ten millimetres of rain falling within a 24 hour period and is measured at a point on the premises; and 'Wet Weather Conditions' means anything other than Dry Weather Conditions.*
***Note:** For 72 hours following wet weather conditions, water may be discharged in excess of 2500kL/day from Point 2, in order to allow the dam level to be quickly reduced to a safe level, provided all practical measures are taken to minimise additional pollution caused by the wet weather*

Note: *Continuous turbidity monitoring of LDP2 is a process control measure for the SCADA system, implemented by WCL to ensure EPL discharge limits are complied with, it is not an EPL requirement or limit.*

Water from the WTP is discharged at LDP2. The site SCADA system is programmed to cease discharges when the total flow on any given day at LDP2 reaches 2,450 kL ensuring that the discharge volume limit (i.e. 2,500 kL/day) (**Table 9**) is not exceeded.

LDP2 discharge is monitored continuously for flow rate (discharge quantity) and turbidity, through the SCADA system. The continuous automated monitoring of LDP2 regulates discharge automatically (via predetermined logic built into the SCADA system) such that when the pre-set discharge volume and quality limits are reached, the discharge valve is automatically closed by SCADA and the water is recirculated through the water management system. This monitoring and control logic ensure water discharged via LDP 2 cannot exceed water quality or volume limits. If the turbidity in Bellambi Gully downstream of site exceeds 100 NTU, Wollongong Coal implement a Trigger Action Response Plan (**Section 6 TARP)** to investigate the cause of the elevated turbidity and respond accordingly to mitigate any potential contributions from colliery operations.

Water seepage through the SWCD wall (LDP3) is collected in a sump and returned to the SWCD by a submersible pump. However, discharges from LDP3 to Bellambi Gully may occur when the seepage rate combined with the seepage sump catchment runoff exceeds the capacity of the submersible pump. During periods of high rainfall, excess water draining to the SWCD may spill to Bellambi Gully via the SWCD spillway (LDP9). It is noted that RVC has been discharging treated water into Bellambi Gully for more than 30 years.

4. MONITORING PROGRAM

4.1 Surface Water Monitoring Program

4.1.1 Bellambi Gully

An additional monitoring location will be established on the Bellambi Gully Diversion, directly downstream of the dry detention basin. The Bellambi Gully monitoring locations, frequencies and parameters are summarised in **Table 10** and **Appendix B**.

Each monitoring location will be fitted with automated flow monitors. Once sufficient flow and depth data has been obtained, a rating curve will be developed for each location. Water quality monitoring at the Bellambi Gully monitoring sites will be undertaken. The proposed additional downstream monitoring sites, in **Table 10** below, will be established to assess and quantify downstream Bellambi Gully stream health and help inform suitable site specific water quality objectives (in accordance with ANZECC guidelines). In addition to this, aquatic ecological monitoring of Bellambi Gully Creek will be conducted as outlined in the Biodiversity Management Plan.

Table 10 Proposed additional monitoring points – Bellambi Gully

POINT	EASTING (MGA56)	NORTHING (MGA56)	JUSTIFICATION
Reference Site 1	TBC	TBC	Reference adjacent to Bellambi Gully to provide an estimate of the typical water quality generated by the site, without the influence of the pit top area.
Reference Site 2	TBC	TBC	
BG 1	TBC	TBC	Monitoring point to identify potential water quality impacts downstream of the pit top area, within the receiving (urbanised) environment.
BG 2	TBC	TBC	

The proposed monitoring sites in the table above have not yet been established, and will be installed prior to second workings, in conjunction with the aquatic ecological sites described in Section 4.5 below and the BMP. As described in the BMP, a minimum of two downstream sites and two reference sites will be established and this management plan will be updated with the sites specific location and descriptions once the sites have been selected and established. These sites will also assist in the monitoring for Post-mininig water pollution from rehabilitated areas of the site.

4.1.2 Licensed Discharge Points

Licenced discharge points (LDP 1, 2, 3, and 9) on the Russell Vale will be monitored in accordance with the EPL 12040, as described in **Table 11**.

Table 11 EPL Monitoring Frequency Requirements

POLLUTANT	UNITS	LDP1, 2
Electrical Conductivity	mg/L	Monthly during discharge
pH	pH units	Monthly during discharge

POLLUTANT	UNITS	LDP1, 2
Total Suspended Solids	mg/L	Monthly during discharge
Turbidity	NTU	Monthly during discharge

Any uncontrolled discharges from site, which are not from the LDP's mentioned above, would trigger the Pollution Incident Response Management Plan (PIRMP) required under the EPL. Monitoring of uncontrolled discharges from site would be conducted in accordance with the PIRMP.

4.1.3 Monitoring of surface water management system

A monitoring program to review and assess the effectiveness of the surface water management system, including the erosion and sediment control structures/measures contained in the ESC Plan, has been implemented at RVC site. This monitoring program includes routine monthly and weekly inspections and checks of the following items below, which make up the surface water management system:

- Dams;
- Sumps;
- Culverts;
- Drainage lines;
- Pumps,
- Pipelines,
- Flow meters,
- Valves, and
- Temporary erosion and sediment control structures, such as silt fences.
- Rainfall event based monitoring.

These routine inspections and checks are managed by the Work Order System and are conducted based on OEM guideline recommendations or industry best practice. Triggered event based rainfall monitoring (as described in **Section 4.1.4**) is also conducted to ensure the water management system, and erosion and sediment controls, are functioning effectively as designed during significant rainfall events.

Surface water inflows, outflows and storage volumes are monitored to inform the site water balance. Inflows into the surface water management system from rainfall runoff and underground mine water discharge, are monitored by the site weather station and the flow meter at B-Portal respectively. Treated recycled water entering the mines underground workings, used in the underground water reticulation system for mining, is measured via a flow meter at A/C portal, and is subtracted from the B-Portal reading to calculate net water make from underground. Outflows, or discharge of excess water off site, via LDP 2 is also continuously monitored via a flow meter at LDP 2. The water levels in the storage dams onsite are monitored with an automatic level sensors, and all the monitoring data is automatically recorded and logged by the SCADA system.

4.1.4 Water Quality

Water quality sampling will be undertaken at each monitoring site as required by the EPL. Additional event-based water quality sampling will occur at all LDPs and Bellambi Gully sites for the period specified with in the Rainfall Sampling Procedure (RVC EC PRO005), specifically:

- 10 to 50 mm of rain in 24 hours - 1 day of samples
- 50 to 100 mm of rain in 24 hours – 2 days of samples
- > 100 mm of rain in 24 hours – 3 days of samples or until the discharges via the spillway cease, whichever comes last.

Monitoring teams will visit main channel sites to observe and identify potential inputs from catchment runoff and all key water quality parameter variations during, and for an appropriate period, after mining.

Monitoring will be conducted for the following three parameter sets (**Table 12**)

Table 12 Analyte suites

ANALYSIS	UNITS
Field Analysis	Field analysis of pH, EC, TDS, ORP and temperature
Discrete	**Field analysis** plus: TDS, TSS, major ions (Na, K, Ca, Mg, Cl, SO4), F, HCO3, CaCO3, NO3, Total N, Total Alkalinity, filtered DOC and dissolved metals P, Cu, Pb, Zn, Ni, Fe, Mn, As, Li and Ba
Full Suite	**Discrete analysis** plus: Dissolved metals Al, B, Cd, Co, Hg, Se and Ag, and nutrients NO2 and Total Kjeldahl Nitrogen (TKN).

All samples will be collected in appropriately cleaned and prepared equipment, stored in appropriately cleaned and rinsed sample containers, then transported and analysed according to ANZECC 2000 standards, with 0.45µm filtering and nitric acid preservation to less than pH 2 for metals samples.

The monitoring data required by the EPL (**Table 1**), including the metals and nutrient analytes outlined above, will be recorded, reviewed, and reported within the Annual Report.

Seepage or leachate from site is addressed in section 8.2 – Groundwater Management System of the GWMP (***RVC EC PLN 006***).

4.2 Stream Flow and Pool Depths

Water level gauges at LDP 11 and LDP 12 will be used to monitor Bellambi Gully pool depth (see **Appendix B**) for the life of mine. Stream water levels are monitored at LDP 11 and LDP 12 using pressure transducers, set up to monitor stream water levels continuously (logged every 15 min) and reports the data via telemetry.

Monitoring will assess the inputs from catchment runoff and flow variations within the Project Areas before, during and after the extraction period, particularly for low flows.

The collected data will be reviewed monthly to identify potential long term changes in flows that may impact the downstream environment.

4.3 Adit Discharge Water Management Plan

The monitoring program defined in this SWMP details monitoring and mitigation measures designed to manage surface water both during mining as well as post mining.

The monitoring program defined in **Appendix B** will inform the basis of the Adit Discharge Water Monitoring Programs, including adit outflow treatment, once the project has finished, through the following:

- Monitoring of analytes, including a broad suite of metals and other contaminants, in addition to pH, EC, TSS and turbidity, and comparison of these results with ANZG (2018) guidelines for 95% species protection for aquatic ecosystems.
- Collating data on the total flow volumes and frequencies of high, median, and low flows. Changes to the flow regimes may have direct effects on native biota (e.g. potential breeding and nursery habitats of native fish) and the water quality of the receiving environments.
- Collating continuous and accurate stream gauging data in Bellambi Gully just upstream of the release point to enable accurate calculation of pollutant dilution and loads for discharge of adit water.
- Development of site-specific in-stream water quality objectives for physico-chemical parameters which have considered the ANZG Guidelines (2018) for aquatic ecosystem protection, as detailed in Huynh and Hobbs (2019) (refer to **Section 6.2**).
- Analysis of the potential long-term impacts of adit outflows by providing further information on expected changes in outflow quantity and quality, including whether groundwater discharged at the adit has interacted with rejects deposited within the mine workings (refer to the Groundwater Management Plan).

No explicit triggers for adit discharges are included, however such discharges typically include elevated salinity levels, which during low-flow periods would be identified at the existing downstream water quality monitoring locations.

4.4 Watercourse Channel Stability

A detailed visual inspection of downstream watercourses is to be undertaken prior to the resumption of mining. This inspection will include photographs of the existing condition of the downstream watercourses every 200m along the stream, to identify potential areas of erosion and scouring that should be incorporated into the monitoring program. Once established, photographic monitoring at these locations as identified during the establishment of baseline recordings will be undertaken quarterly or after significant rainfall events and reviewed quarterly to identify potential erosion and scouring. This monitoring program will be established as detailed in Section 2.5 above.

4.5 Aquatic and Riparian Ecosystem Monitoring of Bellambi Gully

Aquatic ecological monitoring of Bellambi Gully will be undertaken during operations to inform closure planning and address EPBC conditions. This is in regard to the development of appropriate downstream site specific ANZECC criteria and monitoring to determine compliance with the ANZECC. Aquatic ecology monitoring will also be required prior to post closure Adit discharge that is anticipated to occur around 2050. The summary below details the aquatic ecological monitoring for Bellambi Gully, as set out in the Biodiversity Management

Plan (***RVC EC PLN 032***), with the full details of the sites ecological monitoring program discussed in the Biodiversity Management Plan.

A riparian vegetation monitoring program for Bellambi Gully will be developed following completion of the Bellambi Gully Clean Water Diversion construction works, and included in the maintenance plan required following the completion of the construction works.

4.5.1 Operational Discharge Monitoring

Aquatic ecological monitoring will be undertaken at Bellambi Gully in order to identify any impacts to aquatic biota associated with the ongoing Adit discharge and discharge of treated water from Russell Vale Colliery included as part of the approved project in accordance with the EPBC Approval and Table 4 of the Consent. The aquatic ecological monitoring will enable the identification of any impacts to aquatic environments within Bellambi Gully and provide baseline data to inform relevant management measures to protect downstream aquatic biota or receiving waterbodies. This data will also assist in the development and application of site specific physico-chemical trigger values.

A minimum of two downstream aquatic ecological monitoring sites will be established along Bellambi Gully, with a minimum of two control sites also established to provide reference conditions. These control sites will be located such that any impacts associated with the Adit operational discharges can be differentiated from past and existing diffuse impacts to local waterbodies associated with residential, industrial and infrastructure development in the locality and provide a characterisation of the current pollution status of waterways. The results will provide a suitable basis for the interpretation of monitoring results from Bellambi Gully in the context of current waterway conditions and likely effect on aquatic ecosystems.

The impact and control sites will be established during an initial site assessment to be completed before second working commence. This will ensure the most appropriate and representative locations for monitoring are utilised.

The aquatic ecological monitoring at Bellambi Gully will be undertaken bi-annually in spring and autumn within freshwater environments during operational discharge. The aquatic ecological monitoring methods will include the collection of 'edge' macroinvertebrate samples according to the NSW AUSRIVAS protocols. The biological sampling will be augmented by the following supplementary methods to build a comprehensive understanding of aquatic conditions at each site:

- Visual aquatic habitat assessments (HABSCORE), following Barbour et al. (1999).
- Supplementary on-site water quality measurements for a basic suite of parameters including pH, dissolved oxygen, electrical conductivity, turbidity and alkalinity at a minimum.
- Photo point monitoring.
- Consideration of the results of discharge water and sediment monitoring undertaken by Wollongong Coal as relevant to the aquatic ecological monitoring program.

The collective data will be used to compare ecological condition between the impact and control monitoring sites. The multiple methods of analysis will be used to characterise the steam health condition and water quality status of each site and also enable the detection of any impacts to aquatic ecosystems within Bellambi Gully. These data will also provide an indication of any potential impacts to downstream receiving environments beyond Bellambi Gully.

These data will provide a longer term and more sensitive understanding of stream health conditions of Bellambi Gully and reference waterways than physicochemical water quality sampling alone. In addition, these data will also identify how any impacts associated with discharge may manifest within the aquatic environment. The data will provide a biological input into the development of site-specific water quality monitoring trigger values for operational discharges in order to inform ongoing monitoring works, impact assessments and management or mitigation measures.

4.5.2 Closure planning Adit discharge aquatic ecological monitoring

As closure is anticipated to occur around 2050, it is likely that specific aquatic ecological monitoring sampling methods will have progressed in that time. However, the framework of monitoring described above for operational monitoring provides a suitable basis to inform the closure planning monitoring approach. A review of monitoring methods included in this section and the suitability of control sites should be completed and updated as relevant prior to the monitoring commencing.

The aquatic ecological monitoring at Bellambi Gully will be undertaken bi-annually in spring and autumn within freshwater environments. Aquatic monitoring will be undertaken at least two years year prior to anticipated Adit discharge (informed through groundwater monitoring and modelling), and for at least two years following the commencement of any discharge of Adit water into Bellambi Gully (should discharge occur). The survey methods will include:

- Macroinvertebrate sampling according to the NSW AUSRIVAS protocols, along with benthic macroinvertebrate sample collection.
- Visual aquatic habitat assessments (HABSCORE), following Barbour et al. (1999).
- Supplementary on-site water quality measurements for a basic suite of parameters including pH, dissolved oxygen, electrical conductivity, turbidity and alkalinity at a minimum.
- Photo point monitoring.
- Analysis of the results of discharge water and sediment monitoring undertaken by Wollongong Coal as relevant to the aquatic ecological monitoring program.

The collective data will be used to compare ecological condition between the impact and control monitoring sites, as well as post-discharge monitoring data to pre-discharge monitoring data. Benthic macroinvertebrate samples analysed to ascertain the pollution sensitivity of the benthic macroinvertebrate community at each site and infer the pollution status of sediments.

These multiple lines of evidence will be used in partnership with the before-after-control-impact (BACI) approach to enable the detection of any impacts to aquatic ecosystems within Bellambi Gully and provide an indication of any potential impacts to downstream receiving environments. The data will provide biological input into the development of site-specific water quality monitoring trigger values for the Adit discharge in order to inform ongoing monitoring works, impact assessments and management or mitigation measures.

5. PERFORMANCE MEASURES

Performance measures are included in the Russell Vale UEP consent **Table 4 (Condition B16, Schedule 2)**. The relevant performance measures related to surface water management within the Pit Top area are presented in **Table 13.**

As detailed in the baseline section of this plan; following completion of the construction of the BGCWD Works, and as per Term 2i of the DPIE Order dated 23 July 2020, a specific maintenance plan is required to be developed following the completion of the Bellambi Gully Clean Water Diversion construction works. This plan will include an inspection and monitoring program of Bellambi Gully to monitor for flooding, water flow, channel stability and the riparian vegetation of Bellambi Gully. On completion of the construction works, and subsequent development of the maintenance plan, this Water Management Plan will be reviewed and updated to detail this monitoring program. The initial assessment of the parameters in the monitoring program will form the basis for establishing the baseline data. Subsequent monitoring of the parameters will be in reference to the newly established baseline data, which will also set the performance criteria for the following aspects:

- Downstream surface water flows;
- Channel Stability;
- Downstream flooding impacts;
- Stream and riparian vegetation health;

Post-mininig water pollution from rehabilitated areas of the site, will be included as a part of the maintenance plan (as detailed above) following completion of the construction of the BGCWD Works. At least one of the proposed monitoring sites will be installed at the intersection of Bellambi Gully and Albert Street Bridge near the Princes highway to assist in monitoring for Post-mininig water pollution from rehabilitated areas of the site, as outlined in **Section 4.1**. Relevant performance criteria are addressed in the TARPs (**Section 6** of this document).

Table 13 Water Management Performance Measures

FEATURE	PERFORMANCE MEASURE	PLAN SECTION
Water Management - General	▪ Maintain separation between clean, dirty (i.e., sediment-laden) and mine water management systems ▪ Minimise the use of clean and potable water on the site ▪ Maximise water recycling, reuse, and sharing opportunities ▪ Minimise the use of make-up water from external sources ▪ Design, install, operate, and maintain water management ▪ systems in a proper and efficient manner ▪ Minimise risks	Section 3
Erosion and sediment control works	▪ Design, install and maintain erosion and sediment controls in accordance with the guidance series Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom, 2004) and 2E Mines and Quarries (DECC, 2008) ▪ Design, install and maintain any new infrastructure within 40 metres of watercourses in accordance with the guidance series for Controlled Activities on Waterfront Land (DPI Water, 2012) ▪ Design, install and maintain any creek crossings in accordance with the Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013) and Why Do Fish Need To Cross The Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries, 2003)	This is covered in the ESCP
Clean water diversions and storage infrastructure	▪ Design, install and maintain the clean water system to capture and convey the 100-year ARI flood event ▪ Maximise, as far as reasonable, the diversion of clean water around disturbed areas on site	Section 4
Flood protection works	▪ Design, install and maintain flood levees to protect mining areas from a 100-year ARI flood event and to ensure no increased flooding impacts on roads or privately-owned land	Section 3.1.1

FEATURE	PERFORMANCE MEASURE	PLAN SECTION
Mine water storages	▪ Design, install and maintain flood levees to protect mining areas from a 100-year ARI flood event and to ensure no increased flooding impacts on roads or privately-owned land	Section 3
Chemical and hydrocarbon storage	▪ Chemical and hydrocarbon products to be stored in bunded areas in accordance with the relevant Australian Standards	Section 3.2
Aquatic and riparian ecosystems, including affected sections of Bellambi Creek	▪ Maintain or improve baseline channel stability ▪ Develop site-specific in-stream water quality objectives in accordance with ANZECC 2000 and Using the ANZECC Guidelines and Water Quality Objectives in NSW procedures (DECC 2006), or its latest version	Section 4, Section 6, **Appendix B**

6. TRIGGERS ACTION RESPONSE PLAN

The Trigger Action Response Plan (TARP) for surface water, as presented in **Appendix B** and has been designed 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 management and contingency actions.

6.1 Trigger Levels

Where a trigger is exceeded, the cause and effect will be investigated, and an action plan developed if it is determined that the cause is directly related to mining. The use of soft engineering works will be considered in consultation with the WaterNSW and other relevant regulatory agencies. Refined triggers will be proposed, where required, and reported in Annual Reviews.

6.2 Surface Water Quality

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018; ANZECC 2000) provide a framework for conserving ambient water quality in rivers, lakes, estuaries, and marine waters.

The ANZG (2018) Water Quality Guidelines and ANZECC (2000) Guidelines recommend that wherever possible, site-specific in-stream water quality data should be used to define objective for physico-chemical parameters which can adversely impact the aquatic ecosystem. The approach to develop site-specific water quality objectives (guideline values), in accordance with ANZECC (2000), requires a minimum of two years of monthly data at the reference site. Guideline values for pH are derived using the 95th, 80th, 20th and 5th percentile of the site-specific monitoring data, while the guideline values for EC and TSS are derived by calculating the 95th and 80th percentiles only. If suitable site-specific guideline values cannot be developed, the default guideline values (DGVs) defined by ANZG (2018) apply.

Surface water quality triggers have been derived for LDP 11 using the historical data sets in accordance with the methods outlined in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018; ANZECC 2000). LDP 11 trigger levels have been set for turbidity (NTU) and not TSS so as to allow for rapid/timely response to triggers, as turbidity is measured in real time, whereas TSS samples are sent to the laboratory for analysis. Turbidity trigger levels have been set as outlines in **Table 14** in consultation with, and as agreed by, the EPA. Water quality triggers for LDP 2 are based on baseline data 80th percentiles for the Level 2 trigger and EPL discharge limits for the Level 3 trigger.

The surface water trigger levels (estimated using to 20/80th percentile observed levels, based on methods presented in ANZG (2018)) and impact criteria are summarised in **Table 14** and detailed further in **Appendix B.**

Table 14 Surface Water Quality Trigger Levels

TRIGGER LEVEL	DESCRIPTION	LDP 11	LDP 2
Level 1 - Normal	Surface water quality metrics are within typical ranges. Operations continue as normal.	pH within the range of 8.0 to 8.9 range (20th/80th percentile) EC less than 2,083 µS/cm (80th percentile of baseline data) Turbidity less than 100 NTU	pH within the range of 8.5 to 9.1 (20th / 80th percentile) EC less than 2,434 µS/cm (80th percentile of baseline data) TSS less than 26 mg/L (80th percentile of baseline data)
Level 2 - Warning	Minor or persistent low-level exceedances indicate potential degradation of failure of a system. Internal investigation of potential causes and rectify if practical.	pH outside of the range of 8.0 to 8.9 range (20th/80th percentile) EC greater than 2,083 µS/cm (80th percentile of baseline data) Turbidity between 100 – 300 NTU	pH outside of the range of 8.5 to 9.1 (20th / 80th percentile) EC greater than 2,434 µS/cm (80th percentile of baseline data) TSS between 26-50 mg/L (80th percentile of baseline data and EPL limit)
Level 3 - Exceedance	Exceedance of pollutant limits, requiring reporting to agencies, clean up action, and post-incident investigation.	pH outside of 7.5 to 9.4 range (5th/95th percentile) EC greater than 2651 µS/cm (95th percentile of baseline data) Turbidity greater than 300 NTU	pH outside of 6.5 – 9.2 range (EPL limit) EC greater than 2,910 µS/cm (95th percentile of baseline data) TSS greater than 50 mg/L (EPL limit)

6.3 Response to TARP Criteria Exceedances

The TARP outlines what actions will be taken in the case where exceedances of the surface water or stream health assessment criteria occur.

Where trigger criteria are exceeded, WCL will inform DPIE and the NSW EPA discuss requirement, need and potential cost/benefit of a mitigation plan with stakeholders. Investigation into the cause of the trigger exceedance will be instigated within 1 week of trigger exceedance being noted.

An investigation will be undertaken into the potential cause by a suitably qualified person. DPIE and the NSW EPA will be informed of the investigation outcomes.

Site specific mitigation, or corrective management action (CMA) plans, may be required, and 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 (including potential review of trigger values);

- 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 actions to reduce the ongoing impacts, as well as outline the target rehabilitation criteria to allow for stakeholder consultation and adaptive management.

As the downstream environment is urbanised, no downstream water users (who are dependent on the flows for water supply) have been identified.

6.4 Contingency Plan

If the observed parameters or impacts exceed or are considered likely to exceed the performance measures detailed in the TARPS contained in **Appendix B**, WCL will implement the following Contingency Plan:

- The observation will be reported to WCL's Group Environment and Approvals Manager within 24 hours.
- The observation will be recorded.
- WCL will report any exceedance of the performance measure practicable to the Secretary of DPIE and other relevant stakeholders as soon as practicable after WCL becomes aware of the exceedance.
- WCL will assess the exceedances referred to in the relevant TARP of this document 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 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.
- 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.

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

Contingency options will be implemented if it is demonstrated the environmental, water or safety impacts are greater than predicted, with the management framework involving the following components:

- Identifying features/values of significance and impact prediction to determine the range of possible events and impacts;

- Risk assessment in terms of determining the probability and consequence of an event occurring;
- Defining triggers and trigger levels for features/values affected and/or the identified events/impacts;
- Defining and implementing environmental monitoring;
- Identifying responses/actions to be taken when different triggers and trigger levels are reached, including response measures and actions relating to avoidance, minimisation, mitigation and compensation and contingency plans and emergency responses;
- Identifying roles and responsibilities of various stakeholders; and
- Assessing measured and predicted impacts as mining progresses for features/values affected and implement responses/actions identified based on triggers and various pre-defined trigger levels being exceeded. Impacts need to be assessed based on the significance, extent, scale or longevity of impact and practical aspects of mitigation/rehabilitation.

With the provision of contingency measures, there is the potential to cause secondary impacts through the introduction of materials to the area or any disturbance associated with the activity.

Considerable care and relevant approvals will be obtained to ensure the protection of the environment as such works are executed.

7. REFERENCES

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NSW Department of Planning (2008). Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield - Strategic Review. NSW Department of Planning, Sydney.

NSW Planning Assessment Commission (2010). The PAC Review of the Bulli Seam Operations Project. NSW Planning Assessment Commission, Sydney.

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APPENDIX A – BASELINE WATER QUALITY MONITORING DATA REVIEW

umwelt
Environmental & Social Consultants

Inspired People
Dedicated Team
Quality Outcomes

Our Ref: 3687_SWM RVC Pit Top_20201215a_ltr

15 December 2020

Richard Sheehan
Wollongong Coal Limited

E| Richard.sheehan@wcl.net.au

Dear Richard

Re: Site and receiving water quality monitoring data review

Wollongong Coal has an extensive water quality monitoring program in place at the Russell Vale Colliery Pit Top that includes monitoring of site and receiving waters in accordance with Environment Protection Licence (EPL) 12040 and monitoring undertaken for due diligence purposes.

Summary water quality statistics and charts for the water sources presented below in **Table 1**. EPL monitoring locations are shown on **Figure 1**.

As discharges into Bellambi Gully from LDP 3 and LDP 9 are infrequent and only occur during high rainfall events when there is significant dilution from broader catchment runoff, the analysis of existing impacts is focussed on the impacts associated with the frequent discharges from LDP 2.

Table 1 Russell Vale Colliery Pit Top Water Quality Monitoring

Water Source	Reason for Monitoring	Parameters Assessed	Data Period
Bellambi Gully upstream (EPL monitoring location 12) and downstream (EPL monitoring location 12) of the Pit Top facilities	Historical EPL requirement	pH Electrical Conductivity Total Suspended Solids Turbidity	June 2016 – May 2020
	Due Diligence	pH Electrical Conductivity Total Suspended Solids Turbidity Hardness and Alkalinity Nutrients Biochemical Oxygen Demand Metals and Metalloids	January 2020 – October 2020
Thickener discharge water (Licensed Discharge Point 2)	EPL Requirement	pH Electrical Conductivity Total Suspended Solids Turbidity Oil and Grease	January 2016 – October 2020
Groundwater quality from eleven separate monitoring locations (statistics presented are for the combined data set from all monitoring locations)	Due Diligence	pH Electrical Conductivity Total Suspended Solids Turbidity Hardness and Alkalinity Nutrients Biochemical Oxygen Demand Metals and Metalloids	January 2020 – October 2020

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Figure 1 EPL 12040 Monitoring Locations

The groundwater monitoring data referred to in **Table 2** were obtained from analysis of water samples taken at various locations across the existing underground workings. The water samples analysed are representative of the groundwater currently dewatered to the Pit Top water management system that mixes with Pit Top surface water runoff prior to reuse or treatment and discharge to Bellambi Gully. At this stage, it is also considered that this groundwater monitoring data is generally representative of the groundwater that is predicted to eventually discharge from the escarpment adit following the completion of mining. As discharges are not anticipated until around 2057, further characterisation closer to the time of discharge will be required. Monitoring of groundwater in the underground workings following the completion of mining will, however, be used to better inform options for managing the anticipated escarpment adit discharge.

The following tables and charts are provided as an analysis of water quality monitoring data collected at the Russell Vale Colliery Pit Top:

- *Table 2* *LDP 2 Water Quality (January 2016 to October 2020)*
- *Table 3* *Upstream (EPL 12) Water Quality (January 2020 to October 2020)*
- *Table 4* *Downstream (EPL 11) Water Quality (January 2020 to October 2020)*
- *Table 5* *Groundwater Quality (January 2020 to October 2020)*
- *Chart 1* ***Bellambi Gully and LDP 2 pH*** which contains results for Bellambi Gully upstream (EPL 12), downstream (EPL 11) and LDP 2 discharges where results were recorded at each location on the same day.

- *Chart 2 Bellambi Gully and LDP 2 Electrical Conductivity* which contains results for Bellambi Gully upstream (EPL 12), downstream (EPL 11) and LDP 2 discharges where results were recorded at each location on the same day.

- *Chart 3* ***Bellambi Gully and LDP 2 Turbidity*** which contains results for Bellambi Gully upstream (EPL 12), downstream (EPL 11) and LDP 2 discharges where results were recorded at each location on the same day.

Review of results

Reference should be made to the following tables and charts with respect to the overview of water quality results presented below.

- Licensed discharges from the Pit Top facilities have an observable impact on the following water quality parameters:
    - Turbidity and TSS concentrations
    - pH levels
    - EC levels
    - Nutrients concentrations
    - Metal/Metalloid concentrations

- LDP 2 discharges are typically within EPL limits with only 1 of 57 TSS results (May 2016) and 22 of 162 pH results above the respective EPL limits of 50 mg/L and 9.2.

- Most dissolved metal/metalloid and nutrient concentrations recorded at detectable concentrations in groundwater were on average higher than those recorded upstream of the Pit Top facilities (EPL 12) with the exception of Aluminium, Iron and Manganese.

- Most dissolved metal/metalloid and nutrient concentrations recorded at detectable concentrations in groundwater were on average higher than those recorded downstream of the Pit Top facilities (EPL 11) with the exception of Boron and Manganese.

- pH, EC, TSS and turbidity levels recorded in groundwater and downstream of the Pit Top facilities (EPL 11) were on average higher than those recorded upstream of the Pit Top facilities (EPL 12).

- Concentrations of Aluminium (11 of 17 results), Copper (12 of 19 results), Vanadium (1 of 1 result) and Zinc (3 of 19 results) were recorded above the ANZG DGVs at the Bellambi Gully downstream monitoring location (EPL 11).

- All Total Nitrogen and NOx results in groundwater were above the respective ANZECC 2000 DGVs and 60 of 66 Total Phosphorus results were above the respective ANZECC 2000 DGVs

- Metals, pH, EC, turbidity and nutrient impacts on downstream water quality are considered to be primarily associated with the high fraction of groundwater in discharges from LDP 2.

- It is noted that the water quality of Bellambi Gully upstream of the Pit Top facilities at times exhibits:
    - Concentrations of aluminium (4 of 18 results) and copper (5 of 18 results) above the respective ANZG DGVs which could be associated with seepage of groundwater from the upslope escarpment face draining to Bellambi Gully.
    - TP concentrations (7 of 8 results) above the ANZECC 2000 DGV.

Turbidity values and TSS concentrations above the respective ANZECC 2000 DGV and EPL limits

Table 2 LDP 2 Water Quality (January 2016 to October 2020)

Parameter	Units	EPL Limit	# Results	Minimum	20th Percentile	50th Percentile	80th Percentile	Average	# >EPL Limit
pH	-	6.5 – 9.2	160	6.09	8.492	8.84	9.1	11.55	20
Electrical Conductivity	µS/cm	-	130	0	1148	1638	2434.4	3264	-
Total Suspended Solids (TSS)	mg/L	50	57	5	8.4	15	25.6	100	1
Turbidity	NTU	-	111	2.6	16	26.5	46.7	441	-

Table 3 Upstream (EPL 12) Water Quality (January 2020 to October 2020)

Parameter	Units	Limit of Reading (LOR)	Default Guideline Value (DGV)	# Results	# Results >LOR	Minimum	20th Percentile	50th Percentile	80th Percentile	Maximum	Average	# Results >DGV
Physical and Chemical Stressors and Other Parameters												
pH	-	0.01	6.5-8.5[1] (6.5-9.2)[2]	17	17	6.74	7.43	7.80	8.09	8.40	7.73	-
Electrical Conductivity (EC)	µS/cm	1	125-2200[1]	17	17	236	282.8	345	498	743	407	-
Total Suspended Solids (TSS)	mg/L	5	50[2]	18	16	10	16	41.5	68	142	51	15
Turbidity	NTU	0.1	6-50[1]	18	18	2	11.3	40.8	72.4	163.0	46.9	8
Hardness (as $CaCO_3$)	mg/L	1	-	10	10	49	63	74	170	218	105	-
Alkalinity (as $CaCO_3$)	mg/L	1	-	8	8	53	83	148	154	264	137	-
Total Nitrogen	mg/L	0.1	-	-	-	-	-	-	-	-	-	-
Total Kjeldahl Nitrogen	mg/L	0.1	-	8	8	0.14	0.34	0.65	1.02	1.2	0.7	-
NOx	mg/L	0.01	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (TP)	mg/L	0.01	0.025[1]	8	8	0.02	0.09	0.13	0.16	0.28	0.13	7

Parameter	Units	Limit of Reading (LOR)	Default Guideline Value (DGV)	# Results	# Results >LOR	Minimum	20th Percentile	50th Percentile	80th Percentile	Maximum	Average	# Results >DGV
Biochemical Oxygen Demand	mg/L	2	-	17	4	2	2	2	6	13	5	-
Dissolved Metals and Metalloids												
Aluminium	mg/L	0.01	0.055[3]	10	4	0.07	0.07	0.11	0.15	0.16	0.11	4
Antimony	mg/L	0.001	-	2	-	-	-	-	-	-	-	-
Arsenic	mg/L	0.001	0.013[4]	8	-	-	-	-	-	-	-	-
Barium	mg/L	0.001	-	10	4	0.071	0.075	0.077	0.094	0.120	0.086	-
Beryllium	mg/L	0.001	-	1	-	-	-	-	-	-	-	-
Boron	mg/L	0.05	0.37[3]	10	1	0.06	0.06	0.06	0.06	0.06	0.06	-
Cadmium	mg/L	0.0001	0.0002[3]	9	-	-	-	-	-	-	-	-
Chromium	mg/L	0.001	0.0033[5]	9	-	-	-	-	-	-	-	-
Cobalt	mg/L	0.001	0.0014[6]	1	-	-	-	-	-	-	-	-
Copper	mg/L	0.001	0.0014[3]	18	6	0.001	0.002	0.003	0.003	0.007	0.003	5
Iron	mg/L	0.05	-	10	4	0.10	0.15	0.19	0.20	0.21	0.17	-
Lead	mg/L	0.001	0.0034[3]	18	-	-	-	-	-	-	-	-
Lithium	mg/L	0.001	-	10	4	0.003	0.003	0.004	0.005	0.006	0.004	-
Manganese	mg/L	0.001	1.9[3]	10	4	0.005	0.007	0.010	0.042	0.088	0.028	-
Molybdenum	mg/L	0.001	0.034[6]	1	-	-	-	-	-	-	-	-
Nickel	mg/L	0.001	0.011[3]	18	7	0.001	0.001	0.002	0.002	0.006	0.002	-
Selenium	mg/L	0.01	0.011[3]	1	-	-	-	-	-	-	-	-
Silver	mg/L	0.001	0.00005[3]	9	-	-	-	-	-	-	-	-
Strontium	mg/L	0.001	-	10	2	0.118	0.136	0.163	0.189	0.207	0.163	-
Thallium	mg/L	0.001	0.00003[6]	2	-	-	-	-	-	-	-	-
Tin	mg/L	0.001	-	1	-	-	-	-	-	-	-	-
Titanium	mg/L	0.01	-	1	-	-	-	-	-	-	-	-
Vanadium	mg/L	0.01	0.006[6]	1	-	-	-	-	-	-	-	-
Zinc	mg/L	0.005	0.008[3]	18	1	0.007	0.007	0.007	0.007	0.007	0.007	-

Notes:

[1] Aquatic ecosystem protection for lowland rivers; [2] Environment Protection Licence 12040 limit condition; [3] 95% species protection level guideline value; [4] AsV as no speciation in results and more conservative than AsIII DGV of 0.024 mg/L; [5] Guideline value for Chromium III as potential sources of Chromium VI (e.g. crushed concrete) are considered unlikely at the UEP; [6] Species protection level unknown

Table 4 Downstream (EPL 11) Water Quality (January 2020 to October 2020)

Parameter	Units	Limit of Reading (LOR)	Default Guideline Value (DGV)	# Results	# Results >LOR	Minimum	20th Percentile	50th Percentile	80th Percentile	Maximum	Average	# Results >DGV
Physical and Chemical Stressors and Other Parameters												
pH	-	0.01	6.5-8.5[1] (6.5-9.2)[2]	18	18	7.69	8.00	8.37	8.94	9.10	8.41	6
Electrical Conductivity (EC)	µS/cm	1	125-2200[1]	18	18	471	567	736	1508	2030	1012	-
Total Suspended Solids (TSS)	mg/L	5	50[2]	19	18	6	20	49.5	224	4030	328	15
Turbidity	NTU	0.1	6-50[1]	19	19	10.3	34.6	60.6	174.8	2120.0	226.8	11
Hardness (as $CaCO_3$)	mg/L	1	-	11	11	27	49	52	72	103	58	-
Alkalinity (as $CaCO_3$)	mg/L	1	-	8	8	214	221	295	574	799	393	-
Total Nitrogen	mg/L	0.1	-	-	-	-	-	-	-	-	-	-
Total Kjeldahl Nitrogen	mg/L	0.1	-	8	8	0.4	0.4	0.9	1.7	2.2	1.1	-
NOx	mg/L	0.01	-	-	-	-	-	-	-	-	-	-
TP	mg/L	0.01	0.025[1]	8	8	0.05	0.12	0.22	0.31	0.51	0.23	8
Biochemical Oxygen Demand	mg/L	2	-	18	8	2	2	3	4	6	3	-
Dissolved Metals and Metalloids												
Aluminium	mg/L	0.01	0.055[3]	17	14	0.00	0.05	0.16	0.31	1.22	0.24	11
Antimony	mg/L	0.001	-	1	1	0.005	0.005	0.005	0.005	0.005	0.005	-
Arsenic	mg/L	0.001	0.013[4]	3	1	0.002	0.002	0.002	0.002	0.002	0.002	-
Barium	mg/L	0.001	-	11	11	0.048	0.079	0.113	0.130	0.176	0.109	-
Beryllium	mg/L	0.001	-	1	-	-	-	-	-	-	-	-
Boron	mg/L	0.05	0.37[3]	11	3	0.06	0.06	0.06	0.07	0.07	0.06	-
Cadmium	mg/L	0.0001	0.0002[3]	3	-	-	-	-	-	-	-	-

Parameter	Units	Limit of Reading (LOR)	Default Guideline Value (DGV)	# Results	# Results >LOR	Minimum	20th Percentile	50th Percentile	80th Percentile	Maximum	Average	# Results >DGV
Chromium	mg/L	0.001	0.0033[5]	3	-	-	-	-	-	-	-	-
Cobalt	mg/L	0.001	0.0014[6]	1	-	-	-	-	-	-	-	-
Copper	mg/L	0.001	0.0014[3]	19	12	0.002	0.003	0.005	0.005	0.013	0.005	12
Iron	mg/L	0.05	-	11	11	0.07	0.10	0.17	0.28	0.31	0.18	-
Lead	mg/L	0.001	0.0034[3]	19	1	0.001	0.001	0.001	0.001	0.001	0.001	-
Lithium	mg/L	0.001	-	17	17	0.001	0.004	0.063	0.163	0.244	0.083	-
Manganese	mg/L	0.001	1.9[3]	17	10	0.001	0.003	0.008	0.027	0.069	0.018	-
Molybdenum	mg/L	0.001	0.034[6]	1	1	0.020	0.020	0.020	0.020	0.020	0.020	-
Nickel	mg/L	0.001	0.011[3]	19	19	0.001	0.002	0.003	0.004	0.006	0.003	-
Selenium	mg/L	0.01	0.011[3]	1	-	-	-	-	-	-	-	-
Silver	mg/L	0.001	0.00005[3]	9	-	-	-	-	-	-	-	-
Strontium	mg/L	0.001	-	11	11	0.111	0.188	0.218	0.261	0.271	0.213	-
Thallium	mg/L	0.001	0.00003[6]	1	-	-	-	-	-	-	-	-
Tin	mg/L	0.001	-	1	-	-	-	-	-	-	-	-
Titanium	mg/L	0.01	-	1	-	-	-	-	-	-	-	-
Vanadium	mg/L	0.01	0.006[6]	1	1	0.01	0.01	0.01	0.01	0.01	0.01	1
Zinc	mg/L	0.005	0.008[3]	19	5	0.006	0.007	0.016	0.036	0.054	0.023	3

Notes:

[1] Aquatic ecosystem protection for lowland rivers; [2] Environment Protection Licence 12040 limit condition; [3] 95% species protection level guideline value; [4] AsV as no speciation in results and more conservative than AsIII DGV of 0.024 mg/L; [5] Guideline value for Chromium III as potential sources of Chromium VI (e.g. crushed concrete) are considered unlikely at the UEP; [6] Species protection level unknown

Table 5 Groundwater Quality (January 2020 to October 2020)

Parameter	Units	Limit of Reading (LOR)	Default Guideline Value (DGV)	# Results	# Results >LOR	Minimum	20th Percentile	50th Percentile	80th Percentile	Maximum	Average	# Results >DGV
Physical and Chemical Stressors and Other Parameters												
pH	-	0.01	6.5-8.5[1] (6.5-9.2)[2]	71	71	7.70	8.56	8.80	9.00	9.40	8.76	58
Electrical Conductivity (EC)	µS/cm	1	125-2200[1]	71	71	2360	3160	3390	3730	5790	3589	71
Total Suspended Solids (TSS)	mg/L	5	50[2]	71	57	5	10	24	142.8	1240	111	44
Turbidity	NTU	0.1	6-50[1]	71	71	0.2	1.7	16.2	211.0	12800.0	398.8	49
Hardness (as $CaCO_3$)	mg/L	1	-	71	71	2	9	18	35	74	22	-
Alkalinity (as $CaCO_3$)	mg/L	1	-	41	41	1210	1560	1700	1930	2700	1758	-
Total Nitrogen	mg/L	0.1	-	41	41	0.8	0.8	1.2	3.4	29.4	2.8	41
Total Kjeldahl Nitrogen	mg/L	0.1	-	71	68	0.1	0.2	0.4	1.7	29.3	1.4	-
NOx	mg/L	0.01	-	41	40	0.11	0.44	0.74	0.90	6.72	0.97	40
TP	mg/L	0.01	0.025[1]	71	66	0.01	0.04	0.08	0.34	1.24	0.21	60
Biochemical Oxygen Demand	mg/L	2	-	71	36	2	2	3	5	34	4	-
Dissolved Metals and Metalloids												
Aluminium	mg/L	0.01	0.055[3]	71	42	0.01	0.02	0.03	0.07	0.12	0.04	12
Antimony	mg/L	0.001	-	41	23	0.001	0.002	0.005	0.018	0.128	0.014	-
Arsenic	mg/L	0.001	0.013[4]	41	41	0.002	0.004	0.005	0.016	0.059	0.010	10
Barium	mg/L	0.001	-	71	71	0.043	0.243	0.490	0.571	1.120	0.445	-
Beryllium	mg/L	0.001	-	41	1	0.003	0.003	0.003	0.003	0.003	0.003	-
Boron	mg/L	0.05	0.37[3]	71	63	0.05	0.08	0.09	0.11	0.37	0.10	-
Cadmium	mg/L	0.0001	0.0002[3]	41	2	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	-

Parameter	Units	Limit of Reading (LOR)	Default Guideline Value (DGV)	# Results	# Results >LOR	Minimum	20th Percentile	50th Percentile	80th Percentile	Maximum	Average	# Results >DGV
Chromium	mg/L	0.001	0.0033[5]	41	4	0.001	0.001	0.001	0.001	0.002	0.001	-
Cobalt	mg/L	0.001	0.0014[6]	41	-	-	-	-	-	-	-	-
Copper	mg/L	0.001	0.0014[3]	71	51	0.001	0.002	0.004	0.015	0.107	0.012	49
Iron	mg/L	0.05	-	71	7	0.05	0.06	0.07	0.08	0.21	0.09	-
Lead	mg/L	0.001	0.0034[3]	71	4	0.001	0.002	0.004	0.005	0.006	0.004	2
Lithium	mg/L	0.001	-	40	40	0.224	0.368	0.476	0.525	0.959	0.490	-
Manganese	mg/L	0.001	1.9[3]	71	38	0.001	0.002	0.003	0.006	0.016	0.004	-
Molybdenum	mg/L	0.001	0.034[6]	41	41	0.006	0.034	0.054	0.069	0.090	0.052	32
Nickel	mg/L	0.001	0.011[3]	71	67	0.002	0.002	0.003	0.006	0.039	0.005	5
Selenium	mg/L	0.01	0.011[3]	41	1	0.01	0.01	0.01	0.01	0.01	0.01	-
Silver	mg/L	0.001	0.00005[3]	41	0	-	-	-	-	-	-	-
Strontium	mg/L	0.001	-	71	71	0.142	0.294	0.353	0.486	1.760	0.431	-
Thallium	mg/L	0.001	0.00003[6]	41	0	0.000	-	-	-	0.000	-	-
Tin	mg/L	0.001	-	41	1	0.001	0.001	0.001	0.001	0.001	0.001	-
Titanium	mg/L	0.01	-	41	0	0.00	-	-	-	0.00	-	-
Vanadium	mg/L	0.01	0.006[6]	41	10	0.01	0.01	0.02	0.05	0.10	0.03	10
Zinc	mg/L	0.005	0.008[3]	71	53	0.005	0.011	0.025	0.050	0.159	0.035	47

Notes:

[1] Aquatic ecosystem protection for lowland rivers; [2] Environment Protection Licence 12040 limit condition; [3] 95% species protection level guideline value; [4] AsV as no speciation in results and more conservative than AsIII DGV of 0.024 mg/L; [5] Guideline value for Chromium III as potential sources of Chromium VI (e.g. crushed concrete) are considered unlikely at the UEP; [6] Species protection level unknown

Chart 1 Bellambi Gully and LDP 2 pH

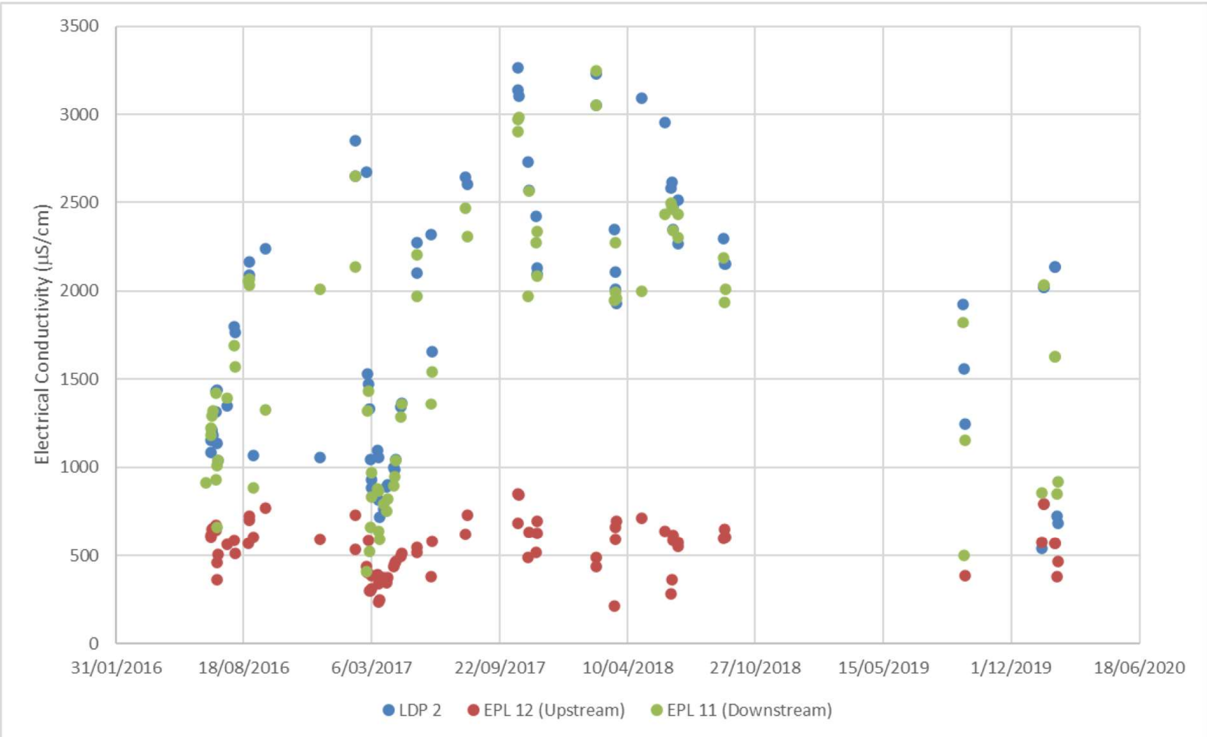

Chart 2 Bellambi Gully and LDP 2 Electrical Conductivity

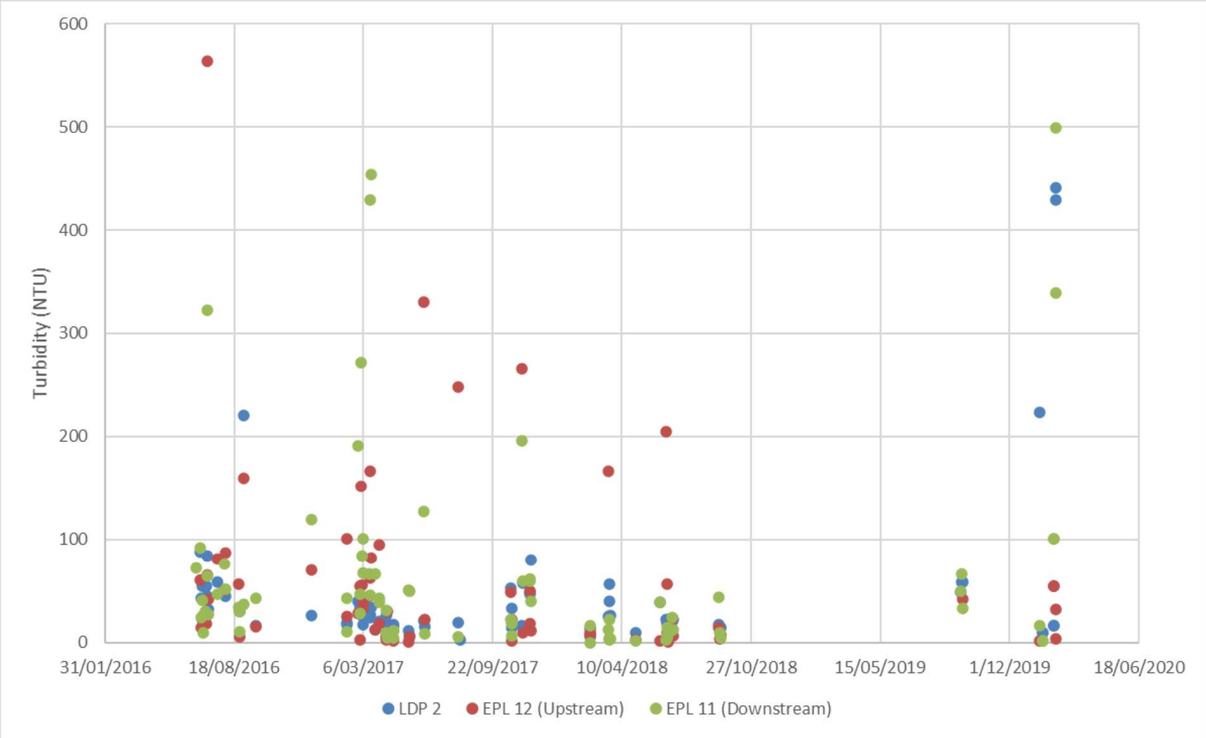

Chart 3 Bellambi Gully and LDP 2 Turbidity

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We trust this information meets with your current requirements. Please do not hesitate to contact the undersigned on 1300 793 267 should you require clarification or further information.

Yours sincerely

Chris Bonomini
Senior Process Engineer

LDP 2 - Field Measurement Data

Statistic	pH	ORP (mV)	DO (mg/L)	EC @ 25°C	TSS	Turbidity
# Results	160	103	103	130	57	111
Min	6.09	65.8	6.81	0	5	3
5th Percentile	7.52	93.4	8.84	788	6	10
20th Percentile	8.49	113.5	9.50	1148	8	16
50th Percentile	8.84	165.5	10.39	1638	15	27
80th Percentile	9.10	224.2	11.62	2434	26	47
95th Percentile	9.39	307.7	12.08	2910	34	82
Max	11.55	403.8	14.50	3264	100	441
Date	**pH**	**ORP (mV)**	**DO (mg/L)**	**EC (μS/cm)**	**TSS (mg/L)**	**Turbidity (NTU)**
29/01/2016	9.1				32	
25/02/2016	9				7	
31/03/2016	8.9				10	
27/04/2016	8.9				5	
24/05/2016	8.9				100	
20/06/2016	8.6				11	
27/06/2016	8.74	217.2	11.69	1081		87.7
28/06/2016	8.77	202.5	11.83	1150		42.4
30/06/2016	8.82	233.1	12.08	1208		54.7
1/07/2016	8.68	233.8	11.79	1182		26.3
5/07/2016	8.83	224.2	12.04	1314		55.1
6/07/2016	8.74	235.2	11.52	1430		54.7
7/07/2016	8.74	221.2	11.44	1440		83.8
8/07/2016	8.74	215.9	11.35	1137		44.7
9/07/2016	8.75	201.6	11.65	1040		32.5
23/07/2016	8.76	221.6	10.87	1349		58.1
26/07/2016	8.8				27	
3/08/2016	8.87	230.8	11.64	1799		48.4
4/08/2016	8.87	209.7	11.67	1767		44.9
25/08/2016	8.9				15	
26/08/2016	8.87	202.2	10.98	2092		30.4
27/08/2016	8.84	183.3	10.66	2166		31.3
2/09/2016	7.86	161.7	6.81	1067		220
21/09/2016	8.96	166.7	10.18	2238		16.8
28/09/2016	9				10	
21/10/2016	9.2				26	
23/11/2016	9				5	
15/12/2016	8.29			1057		26.3
20/12/2016	9.1				23	
27/01/2017	9.2				20	
8/02/2017	9.67	169	12.84	2853		19
9/02/2017	8.72	176.5	14.5	2650		17.4
20/02/2017	8.12	83.6	10.41	2585		15.9
21/02/2017	8.84	96.2	10.48	2640		39.6
22/02/2017	8.91	118.5	10.54	2684	10	13
26/02/2017	9.3	97.1	10.86	2675		39.5
28/02/2017	8.67	151.3	12.07	1528		41.2
1/03/2017	9.75	109.3	12.46	1471		34.5
3/03/2017	9.39	113.3	12.2	1332		31

4/03/2017	9.24	110.8	11.8	1046		26.5
5/03/2017	8.89	103.3	11.76	886		17
6/03/2017	9.25	110.9	12.08	927		26.7
15/03/2017	8.56	102.3	10.25	1094		25.4
16/03/2017	8.71	99.3	10.3	1053		23.8
17/03/2017	8.86	93.1	10.13	817		27
18/03/2017	8.79	124.6	10.42	718		34.2
25/03/2017	9.01	112	10.14	765		12.4
27/03/2017	8.6				8	
30/03/2017	8.35	129.8	10.22	891		20.1
31/03/2017	8.58	146.1	10.29	903		20.6
10/04/2017	8.22	128.9	10.6	1000		26
11/04/2017	8.72	152.1	10.25	988		5
12/04/2017	8.91	169.2	10.38	1041		17.5
21/04/2017	8.38	147.7	10.64	1340		16.3
22/04/2017	8.57	172.6	10.38	1365		16.9
27/04/2017	8.9				26	
11/05/2017	8.9				15	
15/05/2017	9.3	102.9	10.46	2274		11.9
16/05/2017	9.37	126.7	10.85	2105		6.5
7/06/2017	9.75	282.8	12.18	2319		20.9
9/06/2017	8.92	283.3	11.7	1655		15.4
27/06/2017	8.9				12	
31/07/2017	11.55	226.7	11.88	2643	6	19.1
2/08/2017	9.01	308.1	11.73	2608		2.6
31/08/2017	9.1				16	
12/09/2017	9.1				20	
11/10/2017	9.1				20	
20/10/2017	8.83	259.1	10.21	3264		52.7
21/10/2017	8.82	314	10.18	3140		14.5
22/10/2017	8.7	304.3	9.7	3102		33.3
6/11/2017	8.71	403.8	10.55	2730		16.1
7/11/2017	8.77	374	10.65	2569		57.4
15/11/2017	9				14	
18/11/2017	8.04	296.4	10.11	2423		47.2
19/11/2017	7.91	311.6	9.85	2130		48.4
20/11/2017	7.83	316.5	10.14	2096		79.9
2/12/2017	7.41			2522		30.2
2/12/2017	7.41	262.8	9.46	2522		30.2
3/12/2017	7.4			2577		27.9
3/12/2017	7.4	279.5	9.19	2577		27.9
21/12/2017	9.1				21	
4/01/2018	9.16				15	
5/02/2018	9.2				6	
20/02/2018	9.54	223.9	9.76	3230		5.1
21/02/2018	9.18	166.8	9.55	3055		13.2
6/03/2018	9				17	
21/03/2018	9.02	83.8	9.68	2351		25.4
22/03/2018	8.92	103.8	9.96	2106		56.3
23/03/2018	8.97	123.6	9.92	2008		40.3

24/03/2018	8.82	123.9	9.69	1931		25.9
11/04/2018	9				5	
2/05/2018	8.84	178.4	10.4	3093		9.3
10/05/2018	9.1				8	
8/06/2018	8.86	167.7	11.04	2956	14	39.2
18/06/2018	8.7	259.8	11.29	2581		22
19/06/2018	8.89	207.3	11.93	2618		19.9
20/06/2018	8.76	212.7	11.58	2480		18.4
21/06/2018	8.62	220.6	11.42	2346		22.5
28/06/2018	8.59	212.5	10.42	2514		19.9
29/06/2018	8.51	212.5	10.95	2269		22.1
30/06/2018						
1/07/2018						
26/07/2018	9.1				<5	
1/08/2018	7.2				8	
8/09/2018	8.99	161.8	10.48	2296		17.5
9/09/2018	9.06			2152		14.5
10/09/2018	9.06	145.3	10.66	2155	23	14.6
10/10/2018	9			0	15	
18/10/2018	8.67	241.8	9.61	1571		20.3
2/11/2018	6.09			0	13	
8/11/2018	8.66	169.1	9.61	1544		33.1
9/11/2018	7.54	224.2	10.44	2012		30.5
28/11/2018	7.53			2011		
14/12/2018	6.13	208.9	10.03	1600		36.7
15/12/2018	6.56	176	9.17	1282		72.7
9/01/2019	8.32	189.5	8.9	1244	21	
10/01/2019	8.34	163.2	8.77	1255		
11/01/2019	8.25	151.8	8.83	1218		
13/01/2019	8.06	165.5	9.07	1220		
30/01/2019	8.59			1757		30.4
19/02/2019	8.52	191.2	9.17	1619		
20/02/2019	8.53	160.2	9.37	1353		
21/02/2019	8.41	147.3	9.11	1241		
22/02/2019	8.55	148.2	8.28	2232	13	
19/03/2019	8.51			1621		41.8
20/03/2019	8.53			1356		28.4
21/03/2019	8.41				28	
30/03/2019	8.4	155.1	9.04	1391		
31/03/2019	8.57	133.6	10.06	1488		
1/04/2019	8.61	65.8	9.38	1537		
4/04/2019	8.4	145.9	9.61	1552		
5/04/2019	8.44	175	9.73	1537		
6/04/2019	8.35	110	9.78	1560		
7/04/2019	8.27	155.8	8.81	1572		
8/04/2019	8.46	159.1	9.16	1545	14	
9/05/2019	9.02			2057	15	10.5
14/06/2019	9.07			1900	32	28.2
9/07/2019	9.09			1689	15	10.5
23/08/2019	9			1996	7	11.9

29/08/2019	9.39	133	11.21	2082		14
6/09/2019	8.9			1661	34	36.7
17/09/2019	9.43	153.4	10.76	1925		48.7
18/09/2019	8.84	70.8	10.78	1558		58.5
19/09/2019	9.38	142.7	10.39	1246		58.9
20/09/2019	9.33	113.7	10.21	1203		33.3
4/10/2019	9.09			1248	35	17.2
4/11/2019	9.1			1803	8	16.2
6/12/2019	8.84			2756	29	23.6
17/01/2020	10.08	127.2	9.05	538		223
21/01/2020	9.6	70.8	8.74	2022	22	9.7
21/01/2020	9			2022	22	9.7
7/02/2020	9.31	146.5	9.17	2136	16	16
7/02/2020	9.1			2136	16	16
10/02/2020	8.9	102.2	9.35	722		429
11/02/2020	8.61	107.9	9.15	684		441
6/03/2020	8.5			998	15	17.4
7/04/2020	8.9			1225	30	49.5
19/05/2020	8.9			1754	11	14.9
13/07/2020	9			1863	6	26.5
4/08/2020	8.45			859	24	36.3
3/09/2020	8.89			1392	34	24.2
20/10/2020	9			1140	20	46.7

LDP 11 - Field Measurement Data

Statistic	pH	ORP (mV)	DO (mg/L)	EC (µS/cm)	TSS (mg/L)	Turbidity (NTU)
# Results	205	206.0	205.00	206	99	169
5th Percentile	7.35	83.8	6.28	648	6.00	2.24
20th Percentile	8.02	121.3	7.69	931	8	9.4
50th Percentile	8.58	160.1	9.26	1377	13	31
80th Percentile	8.85	232.0	10.38	2083	30	78
95th Percentile	9.35	304.9	11.18	2651	111	250
Date	**pH**	**ORP (mV)**	**DO (mg/L)**	**EC (µS/cm)**	**TSS (mg/L)**	**Turbidity (NTU)**
18/06/2016	9.09	212.6	10.56	761		97.2
19/06/2016	8.81	220.7	9.81	576		165
20/06/2016	8.48	265.9	10.2	913		72.7
21/06/2016	8.36	232	10.01	910		114
22/06/2016	8.58	205.6	10.45	1041		99.7
23/06/2016	8.61	237.6	10.6	1068		100
24/06/2016	8.63	263.1	10.81	1066		88.6
27/06/2016	8.71	205.4	11.42	1180		92.3
28/06/2016	8.74	135.6	11.66	1222		23.8
29/06/2016	8.43	332.5	11.2	1238		28.2
30/06/2016	8.71	250.2	11.52	1288		40.5
1/07/2016	8.72	232.5	11.59	1320		9.5
5/07/2016	8.78	213.3	11.32	1423		30.5
6/07/2016	8.6	284.3	10.56	931		27.5
7/07/2016	8.49	215.6	10.94	659		322
8/07/2016	8.61	217.4	10.57	1009		64.3
9/07/2016	8.61	189.1	10.89	1039		26.7
10/07/2016	8.13	196.4	10.7	933		84.8
11/07/2016	8.6	233.2	10.5	1164		21
20/07/2016	8.57	224.3	10.13	1030		82.9
21/07/2016	8.25	233.5	9.84	997		54.5
22/07/2016	8.24	208.1	10.05	1074		42.6
23/07/2016	8.69	234	10.57	1395		46.3
3/08/2016	8.86	222.3	11.3	1692	12	76.5
4/08/2016	8.81	227.6	11.15	1569	14	51.4
5/08/2016	8.51	292.3	11.2	982	16	93.6
6/08/2016	8.85	223	10.86	1556	8	31.3
7/08/2016	8.75	213.9	10.67	1585	8	54.5
25/08/2016	8.91	187		2054	12	34
26/08/2016	8.84	186	10.49	2033	12	30
27/08/2016	8.81	177.5	10.43	2065	5	10.1
2/09/2016	8.67	124	9.56	883	23	36.5
3/09/2016	8.28	199.6	9.59	877	8	66.4
4/09/2016	8.4	182.9	10.06	1216	32	4.1
19/09/2016	8.55	180.3	9.66	970	<5	4.4
20/09/2016	8.27	219.1	9.97	1156	6	0
21/09/2016	8.52	175.1	9.51	1324	56	43.2
13/11/2016	8.84	18.1	6.87	2189	10	
14/11/2016	8.83	-47	6.26	2266	6	
17/11/2016	8.85	-42.6	3.68	2275	138	
15/12/2016	9.08	67	7.18	2013	13	118.9
16/12/2016	8.04	21.7	7.57	957	73	158
17/12/2016					19	109.4
18/12/2016					20	77.3
7/02/2017	8.95	193.5	9.14	834	23	57.8
8/02/2017	8.91	191.3	11.05	2134	21	42.4

9/02/2017	9.46	192.2	12.65	2650	13	10
20/02/2017	9.35	112.6	9.49	2648	20	5.7
21/02/2017	9.13	116.9	9.27	2651	10	12
22/02/2017	9.2	138.1	9.94	2750	6	7.9
26/02/2017	7.9	124.1	9.77	408	62	191
27/02/2017	8.82	129.4	10.03	941	18	98.8
28/02/2017	9.23	151.8	11	1319	14	47
1/03/2017	9.78	134	11.19	1435	8	28.4
3/03/2017	8.73	154.8	10.48	524	128	271
4/03/2017	8.73	149.2	10.61	661	26	83.8
5/03/2017	8.61	146.7	10.37	833		101
6/03/2017	9.02	125	10.83	969	12	67.4
15/03/2017	8.82	111.8	9.37	877	25	66.5
16/03/2017	8.81	105.4	9.12	868	28	45.6
17/03/2017	8.57	135.8	9.36	638	111	429
18/03/2017	8.58	127.2	9.41	591	124	454
19/03/2017	8.41	125.6	9.37	584	172	590
20/03/2017	8.42	145.1	8.79	736	37	210
23/03/2017	8.21	148.7	8.86	739	40	218
24/03/2017	8.61	148.4	8.89	752	59	316
25/03/2017	8.57	120.1	9.21	789	6	66.8
30/03/2017	8.82	134.2	9.1	751	10	38.7
31/03/2017	8.55	135	9.44	821	16	42.8
1/04/2017	8.61	133.5	8.85	882	38	35.8
10/04/2017	8.54	130.9	9.75	897	21	31.2
11/04/2017	8.59	155.9	9.27	947	8	9.1
12/04/2017	8.93	148	9.77	1037	<5	4.4
21/04/2017	8.76	146.2	9.71	1284	14	11.7
22/04/2017	8.89	160.4	9.63	1357	9	4.2
15/05/2017	9.41	107.2	9.89	2204	10	51.11
16/05/2017	9.45	124.1	9.29	1972	5	49.91
17/05/2017	8.78	303.7	9.94	2055	<5	10.4
7/06/2017	9.84	275	11.03	1357	81	127
8/06/2017	8.67	288	10.75	1550	14	10
9/06/2017	8.79	264.7	10.88	1543	12	9
10/06/2017	7.62	277.8	10.29	532	76	157
11/06/2017	7.59	268.1	10.18	649	32	71.7
12/06/2017	7.92	320.2	10.19	851	7	27.2
31/07/2017	10.66	241.2	10.74	2467	10	5.9
1/08/2017	8.84	342.3	11.26	2635	12	1.4
2/08/2017	8.65	274.5	10.31	2306	<5	0
4/08/2017	8.81	165.4	9.35	1537	7	23.2
5/08/2017	8.85	194.4	9.1	2000	<5	1.5
6/08/2017	8.77	178.7	9.85	2119	<5	8.7
20/10/2017	8.72	283.5	9.28	2903	14	22.4
21/10/2017	8.68	344.9	9.48	2973	8	6.9
22/10/2017	8.69	273.2	9.56	2985	<5	18.5
27/10/2017	8.62	355.3	9.07	2623	10	18.1
28/10/2017	8.61	251.3	7.48	2445	10	44.5
29/10/2017	8.56	158.3	7.45	2480	6	17.6
6/11/2017	8.69	406	9.44	1969	115	196
7/11/2017	8.76	405.1	9.94	2566	19	59.2
8/11/2017	8.82	354	10	2494	24	37.3
18/11/2017	8.1	291.7	9.33	2274	35	61.1
19/11/2017	7.83	305	9.36	2338	28	59.6

20/11/2017	8.08	320.2	10.18	2083		40.3
2/12/2017	7.62	221	8.58	2083		111
3/12/2017	7.34	264.8	9.05	2282		9.7
4/12/2017	7.26	233.4	9.37	1815		18.4
31/12/2017	8.45	196.5	8.07	1315		55.1
1/01/2018	7.84	244.2	8.49	1818		43.4
2/01/2018	7.77	272.3	9.44	1794		27
20/02/2018	9.82	184	8.97	3246	18	16.2
21/02/2018	9.14	115.2	8.67	3050	6	0
22/02/2018	8.99	134.9	7.69	2871	5	0
25/02/2018	8.12	145.9	7.06	647	37	20.1
26/02/2018	8.54	180.8	7.61	1236	6	12.1
27/02/2018	8.32	155.4	8.02	1438	<5	19.7
21/03/2018	8.96	68.6	8.42	1950	12	12.5
22/03/2018	8.9	106.6	9.14	2274	20	22.2
23/03/2018	8.94	106.4	9.12	1995	8	2.8
24/03/2018	8.82	111.5	9.08	1960	12	3.8
30/04/2018	8.58	164.5	8.11	1909	<5	7.2
1/05/2018	8.61	143	7.32	2013	6	2.6
2/05/2018	8.45	149.3	7.19	1998	6	2
12/05/2018	8.8	175.7	9.11	2699	8	11.5
13/05/2018	8.8	102.1	9.82	3017	6	0
14/05/2018	8.93	131.3	8.95	3013	17	9.1
6/06/2018	8.72	179.6	8.28	1787	5	9.3
7/06/2018	8.55	177.3	8.64	1640	10	30.6
8/06/2018	8.76	141.9	10.08	2435	17	38.9
18/06/2018	8.91	238	10.81	2495	13	3.1
19/06/2018	8.89	210.4	10.86	2475	9	5
20/06/2018	8.83	199.7	10.75	2463	8	14.9
21/06/2018	8.66	207.2	10.22	2342	20	8.5
28/06/2018	8.59	212.7	10.27	2435	<5	24
29/06/2018	8.58	195.9	10.54	2303	11	12.3
30/06/2018	8.47	196.4	10.15	2097	6	6.9
1/07/2018	8.38	191.5	9.77	2033	<5	13.2
8/09/2018	9.03	120.1	9.59	2188	42	43.4
9/09/2018	9.01	112.6	8.19	1939	11	9.3
10/09/2018	9.1	149.4	9.83	2010	18	4.8
5/10/2018	7.48	148.7	8.13	600	25	50.6
6/10/2018	8.1	134.6	8.43	1034	18	35.7
7/10/2018	7.8	117.3	8.57	973	10	12.1
8/10/2018	7.72	117.1	7.65	945	<5	23.8
9/10/2018	8	116.1	7.38	1138		18.4
18/10/2018	8.72	222.1	8.87	1508		24.4
19/10/2018	8.05	149.8	6.94	1473		8.5
20/10/2018	8.03	106.9	7.61	1523		5.4
8/11/2018	8.63	129.6	8.74	1513		24.6
9/11/2018	8.5	140.1	8.05	1435		19.7
10/11/2018	9.87	315.4	9.04	1578		16.4
28/11/2018	7.32	220.1	8.96	989		79.6
29/11/2018	7.36	232	9.27	773		44.4
30/11/2018	6.97	225.1	8.69	1149		14.6
14/12/2018	6.56	179.3	9.11	1623		23.8
15/12/2018	6.6	175.6	8.92	1261		23.6
16/12/2018	6.57	202.2	7.5	1252		25.5
17/12/2018	6.69	180.6	7.52	1353		11.4

31/12/2018	6.62	231.8	7.5	1266		
1/01/2019	8.19	264.8	8.93	1421		
2/01/2019	8.41	304.4	11.05	1286		
9/01/2019	7.9	182.7	7.94	721		
10/01/2019	8.21	128.6	7.6	1281		
11/01/2019	8.23	131	8.22	1210		
12/01/2019	7.84	159.8	7.18	1016		68.1
13/01/2019	8.14	146.1	8.13	1250		
14/01/2019	7.91	168.9	7.33	1193		
28/01/2019	7.47	126.8	4.62	1146		
29/01/2019	7.75	81.3	4.92	1358		
30/01/2019	8.02	129.2	6.59	1649		
9/02/2019	7.53	125.7	5.3	1083		18.5
10/02/2019	7.59	93.1	5.45	1167		17
11/02/2019	7.45	69.5	5.88	1225		11.1
22/02/2019	8.54	105.6	7.91	2060		
23/02/2019	8.19	112.9	5.51	1897		
24/02/2019	7.9	121.3	6.15	1657		
15/03/2019	7.55	146	6.34	954		
16/03/2019	7.18	163	6.38	687		
17/03/2019	7.35	142	8.21	655		
18/03/2019	7.43	105.9	7.58	933		
19/03/2019	7.55	220.1	8.43	780		
20/03/2019	8.22	180.4	8.07	1244		
21/03/2019	8.25	150.3	8.01	1253		
22/03/2019	7.82	148	7.05	1349		
30/03/2019	8.47	141.9	8.25	1546		
31/03/2019	8.59	96.4	9.13	1511		
1/04/2019	8.61	67.4	9.26	1580		
4/04/2019	8.42	139.9	8.88	1584		
5/04/2019	8.46	141.8	8.97	1585		
5/04/2019	8.19	122.5	7.69	1240		
6/04/2019	8.39	98.1	8.84	1574		
7/04/2019	8.42	118.1	8.37	1569		
8/04/2019	8.45	127.5	8.52	1617		
23/04/2019	7.68	179.7	6.54	1471		
24/04/2019	7.94	150.4	5.32	1783		
25/04/2019	7.82	141.6	4.79	1798		
4/06/2019		116.6	7.42	1132		35.3
29/08/2019	9.25	134.8	9.95	1816		46.1
17/09/2019	9.34	155.6	9.63	1823		50.1
18/09/2019	8.71	91.4	9.52	497		66.4
19/09/2019	9.27	188.7	9.73	1150		32.8
17/01/2020	7.88	170.8	7.12	855		15.9
20/01/2020	9.25	149.9	6.66	2067		
21/01/2020	9.47	92.3	7.81	2033		1.5
7/02/2020	9.35	92.4	8.03	1628		101
9/02/2020	9.58	48.8	8.88	610		379
10/02/2020	8.14	117	7.97	849		339
11/02/2020	8.24	100.2	7.59	917		499
2/04/2020	8.31	121.8	8.42	811		42.7
1/05/2020	8.31	77.8	8.76	1346		

EPL 12 - Field Measurement Data

Statistic	pH	ORP (mV)	DO (mg/L)	EC (µS/cm)	TSS (mg/L)	Turbidity (NTU)
# Results	185	186	186	186	73	140
5th Percentile	6.64	94.0	6.42	304	5.60	2.10
20th Percentile	7.22	141.1	8.47	436	8	7.4
50th Percentile	7.71	200.5	9.73	596	17	20
80th Percentile	8.20	255.7	10.83	683	52	61
95th Percentile	8.46	330.7	11.52	787	115	166
Date	**pH**	**ORP (mV)**	**DO (mg/L)**	**EC (µS/cm)**	**TSS (mg/L)**	**Turbidity (NTU)**
27/06/2016	8.45	228.1	11.84	613		60.8
28/06/2016	8.34	157.9	11.97	605		14.9
29/06/2016	8.18	331.7	12.12	629		23.1
30/06/2016	8.38	232.6	11.97	649		21.9
1/07/2016	8.36	243.6	11.98	655		20
5/07/2016	8.4	235.4	11.48	641		27.1
6/07/2016	8.32	220.3	11.3	674		18.7
7/07/2016	7.9	256	11.18	363		564
8/07/2016	8.07	229.2	11.08	461		65.2
9/07/2016	8.06	217.6	11.47	508		42.2
10/07/2016	8.06	236.7	11.35	539		32.3
11/07/2016	8.08	254.2	10.87	554		16.4
20/07/2016	7.93	216.5	10.51	497		147
21/07/2016	8.17	251.8	10.51	609		19.4
22/07/2016	8.31	242	10.44	610		34.2
23/07/2016	8.21	234.6	10.81	565		81.5
3/08/2016	8.22	251.8	11.62	586	27	50.3
4/08/2016	7.74	241.7	11.55	513	30	87.3
5/08/2016	8.3	247.8	11.65	560	12	39.9
6/08/2016	8.2	238.8	11.51	584	<5	14.1
7/08/2016	8.2	231.6	11.33	609	<5	20.4
25/08/2016	7.6	250	10.87	566	14	56.4
26/08/2016	7.7	236.8	11.08	701	<5	
27/08/2016	8.25	230.6	11.5	722	<5	5.1
2/09/2016	7.97	198	10.3	604	94	160
3/09/2016	7.99	217.4	10.2	689	5	38.4
4/09/2016	8.05	191.5	10.78	729	<5	12.7
19/09/2016	8.03	180.3	9.94	618	<5	
20/09/2016	8.46	191	10.26	663	<5	
21/09/2016	7.76	201.1	10.12	768	<5	15.4
13/11/2016	8.36	34.8	8.51	743	<5	
14/11/2016	8.34	77.7	8.99	811	<5	
17/11/2016	8.27	72.6	8.77	775	5	
15/12/2016	8.34	91.2	9.32	590	24	70.6
16/12/2016	8.36	133.6	9.35	441	31	78
17/12/2016	8.22	101.9	8.84	621	6	15
18/12/2016					30	11.3
7/02/2017	8.97	172.2	10.83	1344	37	83.1
8/02/2017	8.08	160.3	10.97	532	58	101
9/02/2017	7.45	171.3	12.29	727	<5	24.9
26/02/2017	7.52	72.8	10.35	435	19	28.4
27/02/2017	7.73	96.8	10.53	572	6	25.2
28/02/2017	7.71	93.8	10.65	404	26	54.3
1/03/2017	7.92	136	10.62	587	100	2.2
3/03/2017	7	131	10.83	302	97	152
4/03/2017	7.55	118.5	10.77	301	17	55.9

5/03/2017	7.22	107.7	10.7	310	17	39.8
6/03/2017	7.75	165.8	10.3	385	<5	32.6
15/03/2017	7.97	100.1	9.66	389	18	45.1
16/03/2017	7.88	105.2	9.66	337	97	166
17/03/2017	7.96	162.9	9.87	235	31	62.1
18/03/2017	7.91	147.5	9.88	248	54	82.3
19/03/2017	7.81	107.7	9.81	261	38	59.4
20/03/2017	8	130.6	9.42	318	21	13.8
23/03/2017	7.38	120.4	9.67	343	14	23.3
24/03/2017	7.78	168.6	9.75	356	16	1.2
25/03/2017	7.51	114.1	9.86	375	<5	12.6
30/03/2017	7.16	127.1	9.58	345	61	94.7
31/03/2017	7.58	165.4	10	376	15	18.5
1/04/2017	8.3	141.1	10.31	406	<5	6.3
10/04/2017	7.15	113.1	10.47	436	<5	2.6
11/04/2017	8.5	159.9	10.34	454	<5	6.3
12/04/2017	8.46	195.7	10.44	467	<5	30.1
21/04/2017	7.36	161.4	10.1	495	14	11.3
22/04/2017	7.3	196.2	9.9	514	17	2.1
15/05/2017	8.45	118.8	9.98	515	11	0.9
16/05/2017	8.38	167.4	10.27	544	88	5.3
17/05/2017	8.22	324.6	10.59	682	8	13.1
7/06/2017	8.07	354.5	11.52	380	213	330
8/06/2017	7.91	300.2	11.06	542	22	20.3
9/06/2017	7.84	276.9	10.98	577	50	22.5
10/06/2017	7.38	287.8	11	453	72	55.3
11/06/2017	7.92	263.8	10.97	472	15	27.6
12/06/2017	7.56	301.4	11.07	512	10	36.1
31/07/2017	7.86	324.1	11.06	622	128	248
1/08/2017	7.91	328.9	11.29	694	8	8.2
2/08/2017	7.89	311.8	10.96	727	<5	
4/08/2017	8.16	203.7	11.09	644	15	35.2
5/08/2017	8.35	154.8	10.96	671	7	14.8
6/08/2017	8.31	170.5	10.79	641	<5	16.6
20/10/2017	6.53	264.9	9.59	683	16	48.6
21/10/2017	7.39	269.8	5.95	848	9	22.4
22/10/2017	7.51	241.6	6.19	843	46	2.1
27/10/2017	6.82	395.4	9.73	637	19	22
28/10/2017	7.58	379	6.94	830	20	7.1
29/10/2017	7.27	382.1	9.19	745	8	5
6/11/2017	7.13	382.2	10.33	487	148	266
7/11/2017	7.57	369.4	11.03	634	<5	9.3
8/11/2017	7.84	361	11.37	676	<5	0.6
18/11/2017	7.54	283.2	10.09	518	34	50.1
19/11/2017	6.94	284.5	8.09	625	13	18.5
20/11/2017	7.05	353.6	11.06	693	<5	11.9
2/12/2017	6.89	270.9	9.32	471		149
3/12/2017	7.05	267.4	9.81	668		46.9
4/12/2017	6.45	262.8	9.6	540		108
31/12/2017	8.14	223.8	9.18	541		47.6
20/02/2018	6.59	241.4	6.36	435	16	9.1
21/02/2018	7.12	215.6	5.39	490	5	7.4
22/02/2018	7.21	151.6	4.92	539	-	
25/02/2018	7.01	191.2	7.7	353	13	20
26/02/2018	7.29	253.8	8.82	532	5	17.6

27/02/2018	7.54	195.8	8.55	546	<5	4.9
21/03/2018	7.17	172.2	8.88	213	53	166
22/03/2018	7.52	182.4	9.18	592	10	3.4
23/03/2018	7.51	167	9.08	662	<5	
24/03/2018	7.81	172.5	9.88	693	<5	
30/04/2018	7.42	217.3	9.35	639	7	11
2/05/2018	7.32	223.5	7.63	712	10	2.3
12/05/2018	7.08	255.5	8.47	271	123	11.7
13/05/2018	7.07	265.3	6.5	341	10	
14/05/2018	7.07	251.2	7.05	423	6	
6/06/2018	7.5	170.7	9.73	662	9	18.7
7/06/2018	7.76	194.9	10.51	516	6	19.4
8/06/2018	7.64	196.9	9.13	635	<5	1.2
18/06/2018	7.21	226	10.35	280	109	205
19/06/2018	7.19	212.4	9.95	362	20	56.7
20/06/2018	7.36	261.2	10.33	614	<5	9.5
21/06/2018	8.2	214.5	9.46	583	<5	0.3
28/06/2018	7.37	217.9	9.99	573	6	22.1
29/06/2018	7.41	230.2	10.65	553	<5	6.9
30/06/2018	7.77	218.1	9.41	592	<5	
1/07/2018	7.67	220.7	8.85	619	42	8.8
8/09/2018	7.85	199.9	10.32	597	<5	14.3
9/09/2018	8.53	166.6	9.37	650	6	3.3
10/09/2018	8.41	145	8.93	605	10	7.4
5/10/2018	7.34	241.4	9.32	554		28.4
6/10/2018	8.26	207.3	10.21	664		0.3
7/10/2018	7.32	181.8	9.33	320		53.7
8/10/2018	7.53	165	9.32	625		11.7
9/10/2018	8.05	162.9	9.34	644		6.8
18/10/2018	7.68	303.1	8.97	647		6.2
19/10/2018	8.26	219.5	8.58	645		
20/10/2018	8.65	165.4	11.28	702		
8/11/2018	7.43	277.9	8.79	758		11.7
9/11/2018	7.62	258.8	6.99	820		
10/11/2018	7.09	331.3	7.3	913		2.3
28/11/2018	6.5	253.6	10.26	331		95.7
29/11/2018	6.58	309.9	9.94	613		12.8
30/11/2018	6.34	266.8	9.82	716		
14/12/2018	5.3	259.5	9.06	648		21.2
15/12/2018	6.03	215.2	9.08	662		16.5
16/12/2018	6.57	190.7	8.38	743		18.6
17/12/2018	6.49	241.4	8.93	744		
31/12/2018	6.98	203.5	8.88	773		2.4
9/01/2019	7.37	231.9	7.8	557		
10/01/2019	7.76	184.9	7.79	622		
11/01/2019	7.68	195	7.94	560		
12/01/2019	7.74	191.8	7.99	573		
13/01/2019	7.69	159.2	7.72	616		
14/01/2019	8.03	209.4	7.65	701		
29/01/2019	7.33	154	2.8	630		
9/02/2019	7.12	255.7	7.11	594		19
10/02/2019	7.24	166	4.33	688		14.2
11/02/2019	7.27	176.8	4.86	721		8.2
22/02/2019	6.83	232.6	7.91	702		
15/03/2019	7.01	209.4	8.12	625		

16/03/2019	7.31	206.7	8.5	598		
17/03/2019	7.58	196.1	8.93	419		
18/03/2019	7.87	122.8	8.04	619		
19/03/2019	7.16	234.4	8.37	620		
20/03/2019	7.34	192.2	8.71	535		
21/03/2019	7.63	163.5	8.22	567		
22/03/2019	7.43	178.2	7.97	665		
30/03/2019	7.14	187.6	8.12	647		
31/03/2019	8.13	178.3	9.4	680		
1/04/2019	8.09	111.6	8.13	782		
4/04/2019	6.85	274.9	8.81	394		
5/04/2019	7.14	215.9	8.51	701		
5/04/2019	7.39	190.4	8.39	623		
6/04/2019	7.68	119.4	8.65	647		
7/04/2019	8.2	171.6	9.75	661		
23/04/2019	7.98	181.3	8.58	799		
24/04/2019	7.68	201.9	9.2	812		
4/06/2019		102.3	9.81	589		79.5
29/08/2019	7.65	149.5	8.67	246		84.3
18/09/2019	8.6	53.7	10.33	357		156
17/09/2019	8.37	126.4	9.67	513		84.6
19/09/2019	8.58	107.3	10.17	383		42.2
17/01/2020	8.02	82.8	7.96	575		2
20/01/2020	7.66	314	4.49	543		
21/01/2020	8.66	71.1	6.39	789		
7/02/2020	8.07	140.4	8.38	570		54.5
9/02/2020	7.65	88.2	9.23	295		380
10/02/2020	7.45	115.1	8.97	382		31.6
11/02/2020	8.09	94.6	8.56	463		3.6
2/04/2020	8.47	132.4	9.45	613		11.2
1/05/2020	8.03	115.5	10.41	716		

APPENDIX B – SURFACE WATER MONITORING PROGRAM

MONITORING REQUIREMENT	MONITORING LOCATION	MONITORING FREQUENCY			PARAMETERS	PURPOSE
		PRIOR	DURING	POST		
Surface Water Monitoring	Proposed Reference Site 1 Proposed Reference Site 2 Proposed BG 1 Proposed BG 2	• Monthly during discharge • Triggered during significant rainfall events as outlined below: ○ 10 to 50 mm of rain in 24 hours - 1 day of samples ○ 50 to 100 mm of rain in 24 hours – 2 days of samples ○ > 100 mm of rain in 24 hours – 3 days of samples or until the discharges via the spillway cease, whichever comes last.			• Field Analysis • Discrete Field analysis • Full Suite analysis (see **Table 12**)	Assess the effectiveness of the surface water management system during rainfall evets
	LDP 1 and 2	• Monthly during discharge			In accordance with EPL 12040: • Monthly – pH, Total Suspended Solids (TSS), EC and Turbidity	Monitoring of discharge water quality in accordance with EPL.
	LDP 11 and 12	• Continuous (LDP 11-12)			In accordance with EPL 12040: • Continuous EC and Turbidity • Water Level & Pool Depth	Monitoring of discharge water quality in accordance with EPL.

MONITORING REQUIREMENT	MONITORING LOCATION	MONITORING FREQUENCY			PARAMETERS	PURPOSE
		PRIOR	DURING	POST		
Adit seepage monitoring and inspection – seepage rate and water quality	Mine workings	N/A		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 (3 monthly) – discrete analysis for an agreed period (minimum 1 year) after mining is completed	**Field Analysis** *pH, EC, DO, ORP and temperature* **Discrete** *Field analysis, plus 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*	Visualise and verify post closure seepage conditions.

APPENDIX C – TRIGGER ACTION RESPONSE PLAN

TARP - Surface Water – LDP11

Monitoring				Trigger			
Location	**Parameters**	**Timing / Frequency**	**Purpose**	**Level**	**Action/Reporting**	**Timing**	**Responsibility**
LDP11	pH EC TSS Turbidity	Monthly During discharges	To determine if mining operations are impacting surface water quality.	**Level 1** Normal Operations pH 8.0 to 8.9 EC < 2,083 µS/cm Turbidity < 100 NTU	1. Continue monitoring.		Russell Vale Colliery (Group Environment & Approvals Manager; Logistics Manager)
				Level 2 pH 1 sample outside of 8.0 to 8.9 range (20th / 80th percentiles) EC 1 sample greater than 2,083 µS/cm (80th percentile) Turbidity between 100 - 300 NTU	1. Compare readings at LDP 11 to the readings at LDP 12 to determine if there is a significant difference in water quality (indicating a potential contribution from site) 2. If a significant difference in water quality is identified at step 1, investigate potential cause of	1. Immediately (within 24 hours) 2. Immediately (within 24 hours)	Russell Vale Colliery (Group Environment & Approvals Manager; Environment Monitoring Manager; Control Room Officer)

Monitoring				Trigger			
Location	**Parameters**	**Timing / Frequency**	**Purpose**	**Level**	**Action/Reporting**	**Timing**	**Responsibility**
					exceedances via a site inspection. 3. Identify mitigation options 4. Review monitoring frequency and parameters 5. Report potential impact, and response, within six monthly reporting	1 month. Commence works within 2 months. 1 month.	
				Level 3 pH: 1 sample outside of 7.5 – 9.4 range (5th / 95th percentiles) EC:	1. Compare readings at LDP 11 to the readings at LDP 12 to determine if there is a significant difference in water quality (indicating a potential contribution from site)	1. Immediately (within 24 hours) 2. Immediately (within 24 hours)	Russell Vale Colliery (Group Environment & Approvals Manager; Environment)

Monitoring				**Trigger**			
Location	**Parameters**	**Timing / Frequency**	**Purpose**	**Level**	**Action/Reporting**	**Timing**	**Responsibility**
				1 sample greater than 2,651 µS/cm (95th percentile) Turbidity > 300 NTU	2. If a significant difference in water quality is identified at step 1, investigate potential cause of exceedances via a site inspection. 3. If the source poor water quality is identified to be originating from site Inform DPIE and NSW EPA 4. Inform DPIE and NSW EPA of investigation outcomes 5. Identify mitigation options 6. Review monitoring frequency and parameters	3. Immediately (within 24 hours) 4. 1 week 5. 1 month. Commence works within 2 months 6. 1 month.	

Monitoring				**Trigger**			
Location	**Parameters**	**Timing / Frequency**	**Purpose**	**Level**	**Action/Reporting**	**Timing**	**Responsibility**
					7. Report potential impact, and response, within six monthly reporting		

TARP - Surface Water – LDP2

Monitoring				**Trigger**			
Location	**Parameters**	**Timing / Frequency**	**Purpose**	**Level**	**Action/Reporting**	**Timing**	**Responsibility**
LDP2	pH EC TSS	Monthly During discharges	To determine if mining operations are impacting surface water quality.	**Level 1** Normal Operations pH 8.5 to 9.1 EC < 2,434 µS/cm TSS < 26mg/L	1. Continue monitoring.		Russell Vale Colliery (Group Environment & Approvals Manager; Logistics Manager)
				Level 2 pH 1 sample outside of 8.5 to 9.1 range (20th / 80th percentiles) EC 1 sample greater than 2,434 µS/cm (80th percentile) TSS 1 sample between 26-50 mg/L	1. Investigate potential cause of exceedances (e.g. climatic; systemic; failure) including comparison to EPL12 results (upstream) and proposed adjacent urbanised monitoring point (B2) and consideration of potential mine water contamination	1 month	Russell Vale Colliery (Group Environment & Approvals Manager; Environment Monitoring Manager; Control Room Officer)

Monitoring				Trigger			
Location	**Parameters**	**Timing / Frequency**	**Purpose**	**Level**	**Action/Reporting**	**Timing**	**Responsibility**
				(80th percentile and EPL limit)	2. Identify mitigation options 3. Review monitoring frequency and parameters 4. Report potential impact, and response, within six monthly reporting	1 month. Commence works within 2 months. 1 month.	
				Level 3 pH: 1 sample outside of 6.5 – 9.2 range (EPL limit) EC 1 sample greater than 2,910 µS/cm (95th percentile)	1. Cease discharge (if TSS trigger) 2. Inform DPIE and NSW EPA 3. Investigate and report on the cause of the trigger exceedances (e.g. climatic; systemic; failure) including comparison to EPL12 results (upstream) and proposed	1 week 1 week	Russell Vale Colliery (Group Environment & Approvals Manager; Environment)

Monitoring				**Trigger**			
Location	**Parameters**	**Timing / Frequency**	**Purpose**	**Level**	**Action/Reporting**	**Timing**	**Responsibility**
				TSS: 1 sample greater than 50 mg/L (EPL limit)	adjacent urbanised monitoring point (B2) and consideration of potential mine water contamination 4. Inform DPIE and NSW EPA of investigation outcomes 5. Identify mitigation options 6. Review monitoring frequency and parameters 7. Report potential impact, and response, within six monthly reporting	 1 month. Commence works within 2 months 1 month.	

APPENDIX D. GROUNDWATER MANAGEMENT PLAN

Russell Vale Colliery

Revised Underground Expansion Project

WATER MANAGEMENT PLAN

Groundwater Management Plan

RVC EC PLN 006

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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 Environmental and Social Consultants. 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).

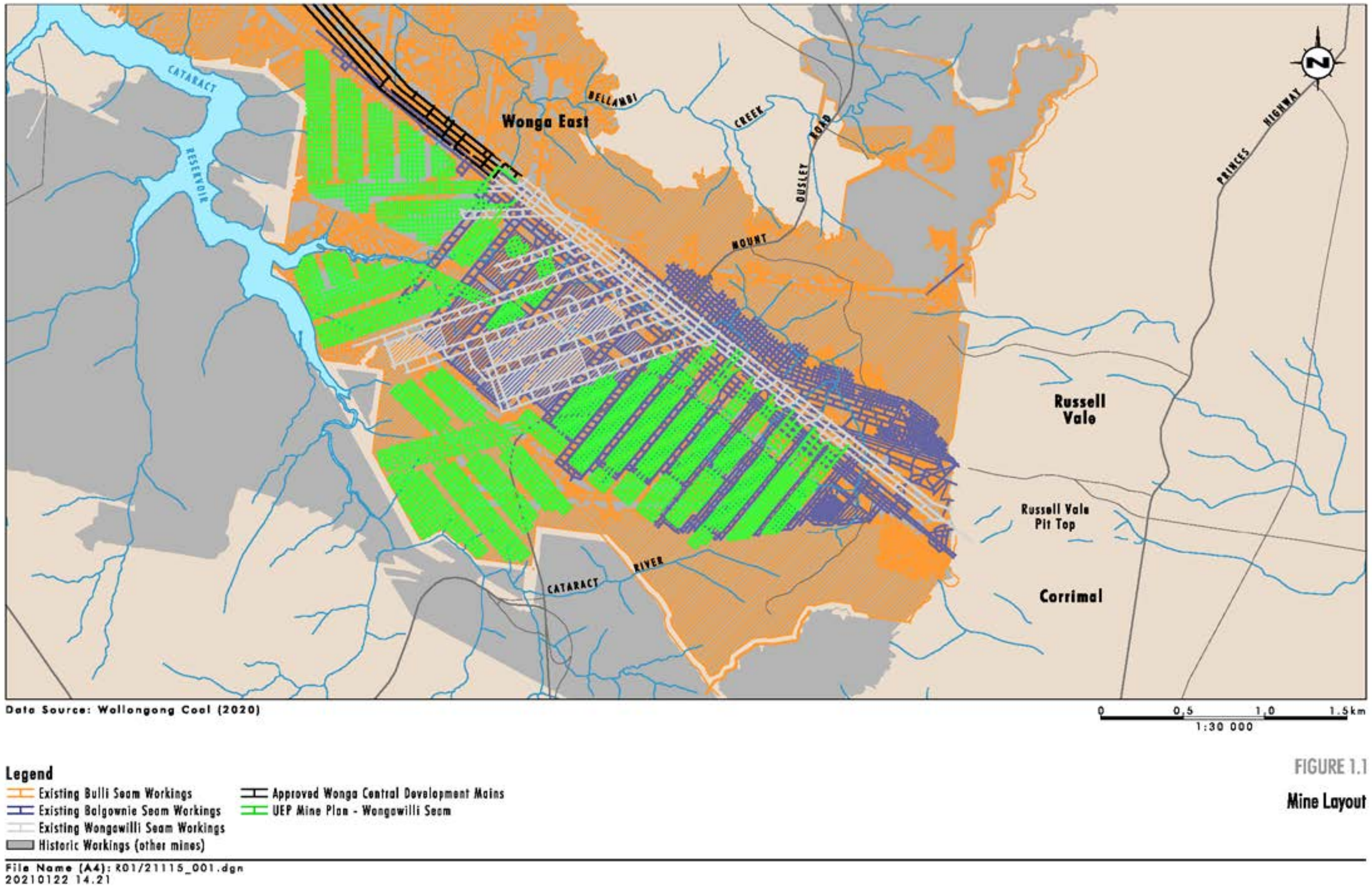
Consultation records are included in WMP Appendix A, with feedback received addressed in S1.3 of the WMP.

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.

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: • 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: • 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;	**Section 7** and **Appendix F**

Project Approval Condition	Where addressed in this Plan
• 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.	
Reporting procedures for the results of the monitoring program, including notifying other water users of any elevated results.	**Sections 7** and **9.3**
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 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: • detailed baseline data on: - 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.
• 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.
• a surface water monitoring program to monitor and report on: - stream flows and quality; - stream and riparian vegetation health; and - channel and bank stability;	Refer EP WMP for surface water.

Project Approval Condition	Where addressed in this Plan
• a groundwater monitoring program to monitor and report on: - 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**
• 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
• 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
• 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 Water Management Plan 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

Project Approval Condition	Timing	Where addressed in this Plan
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 Water Management Plan. 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 Water Management Plan and LW5 Water Management Plan will remain in place.	Ongoing, with regular review of the results, effectiveness and ongoing need for monitoring as set out in the Water Management Plan	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]);
- 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)

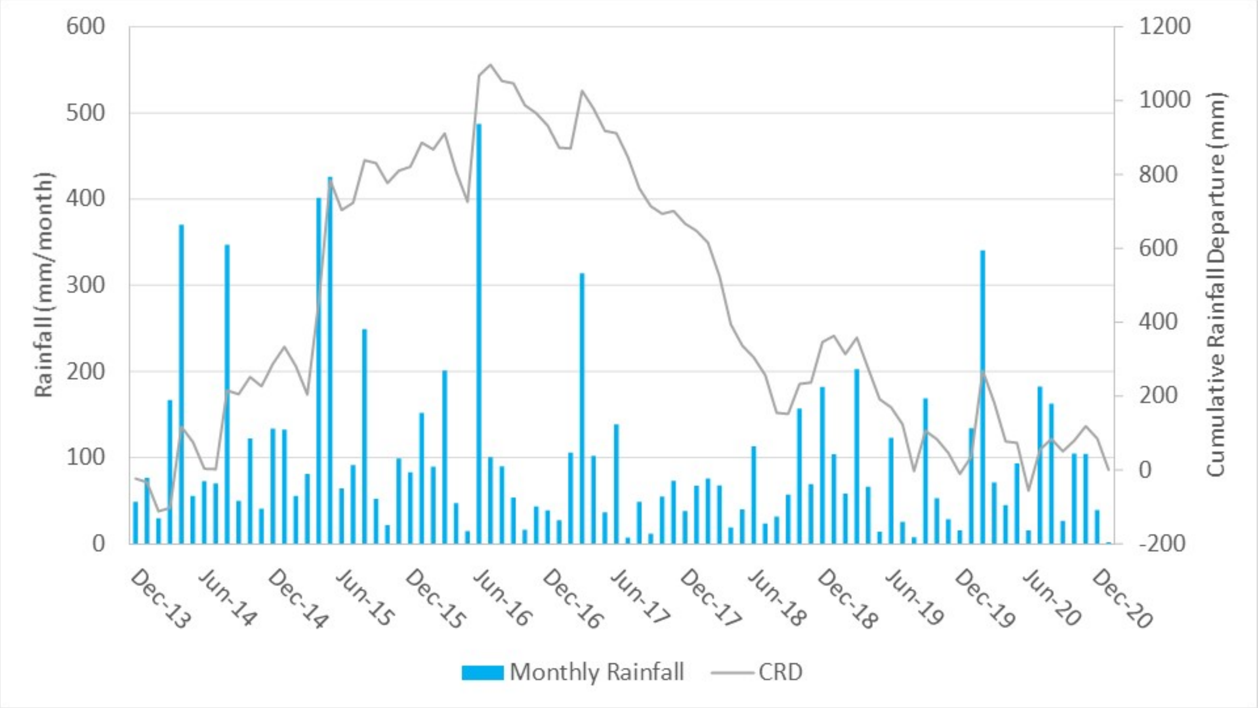
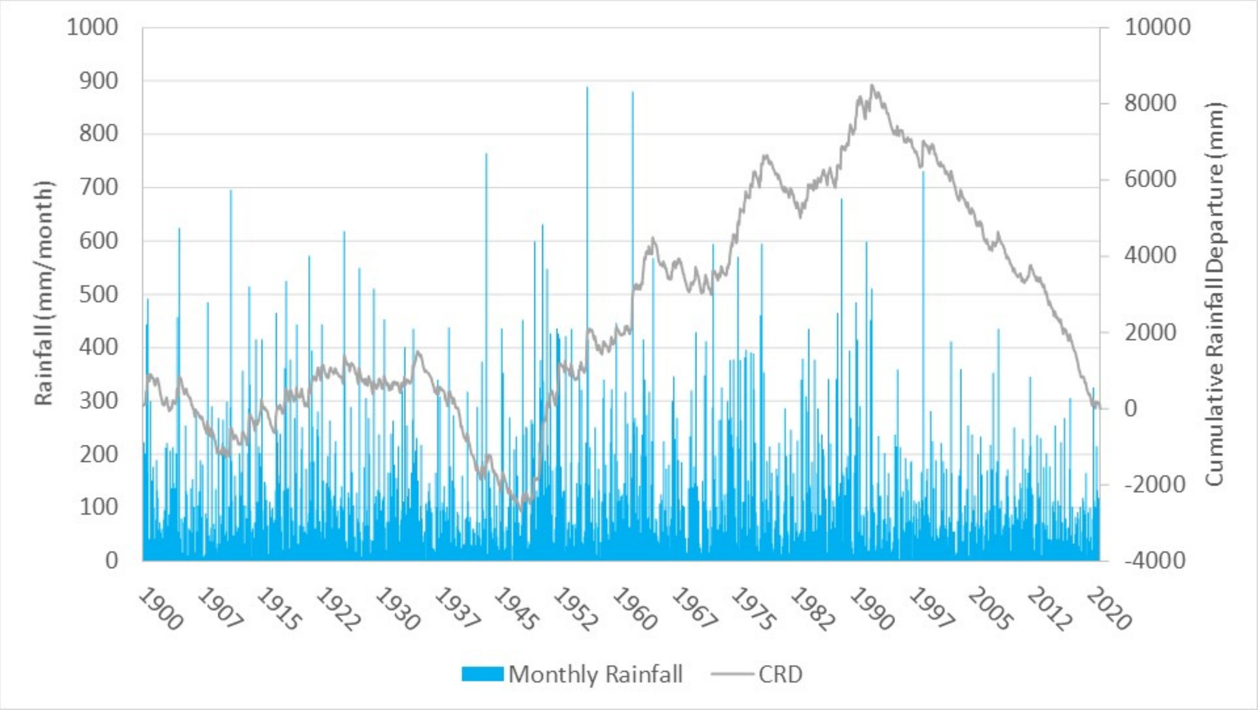


Figure 3-2 Cumulative Rainfall Departure (SILO)



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**.

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).

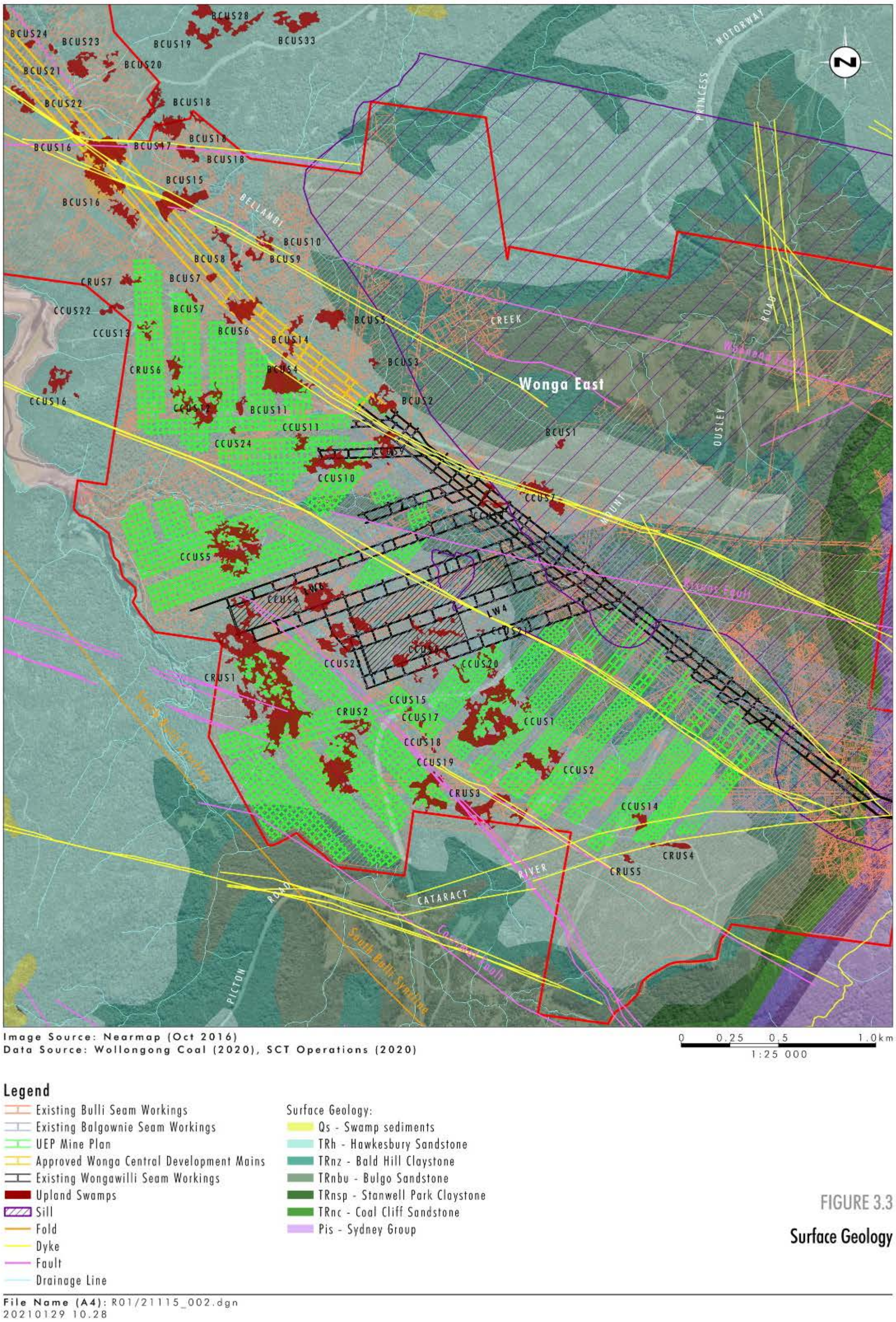
The north-west south-east trending Rixon's Pass Fault is shown at surface on the 1:100,000 geological map to be sub-parallel to Cataract Creek (refer **Figure 3-3**); however, no trace of it has been identified in the Bulli or Balgownie workings.

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

Age	Formation	Group	Lithology	Thickness in Project area
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



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:

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.

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).

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.

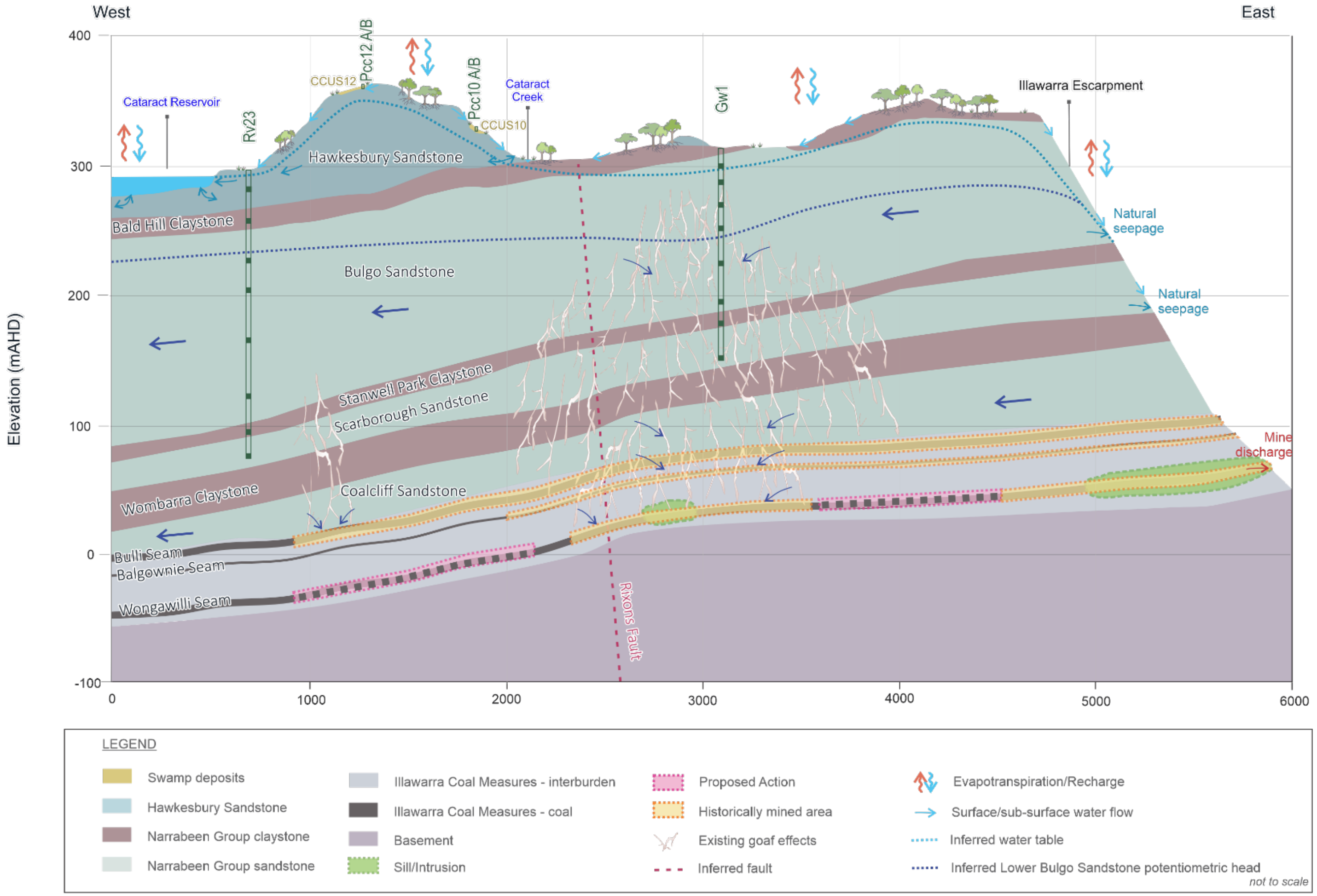
The main ecohydrological features relevant to RVE UEP include:

- 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 km^2. 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.

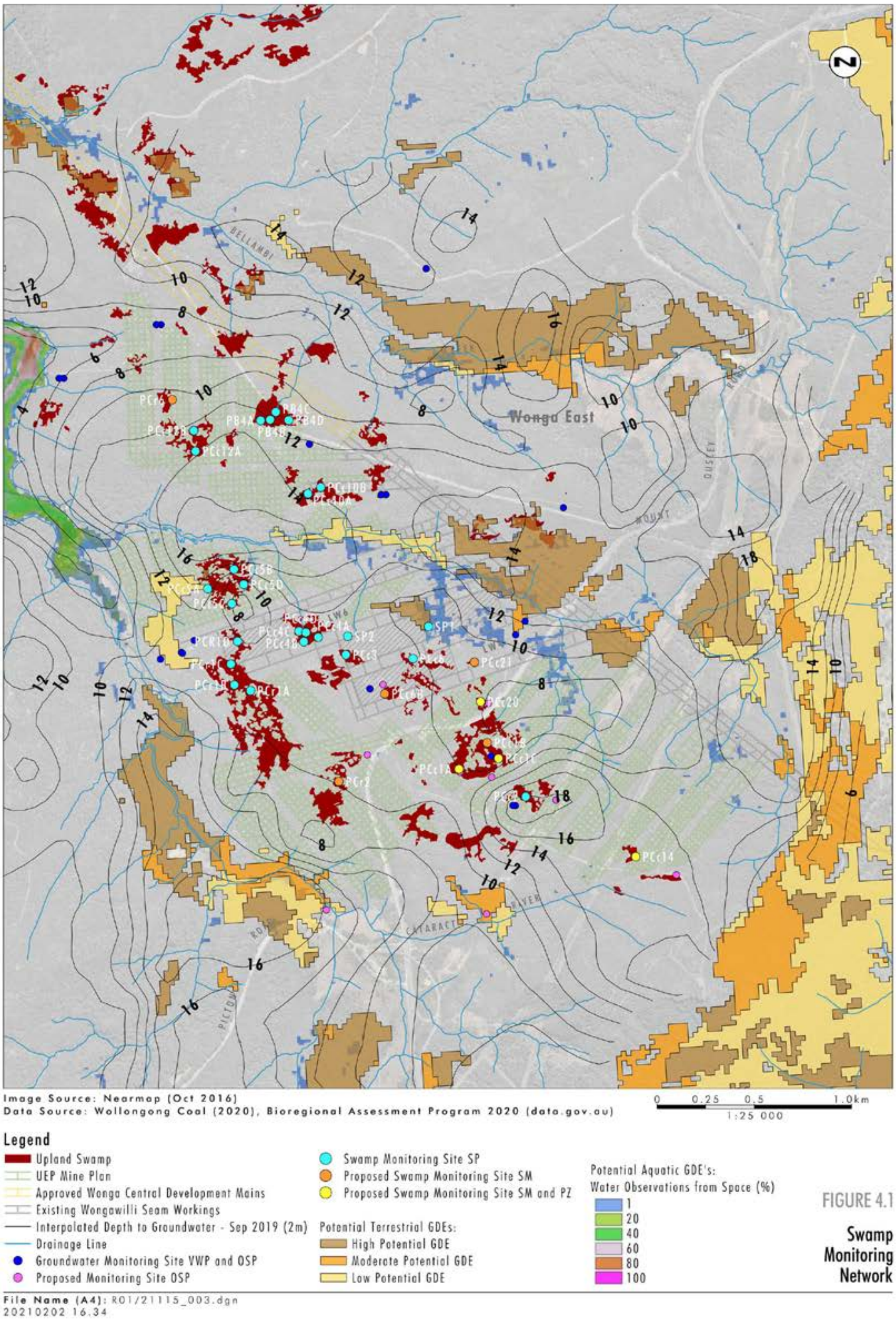
Table 6 Water Monitoring Network for Swamps

Site ID	Swamp Site	Installed	Easting GDA94 Z56	Northing GDA94 Z56	Ground Level mAHD[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

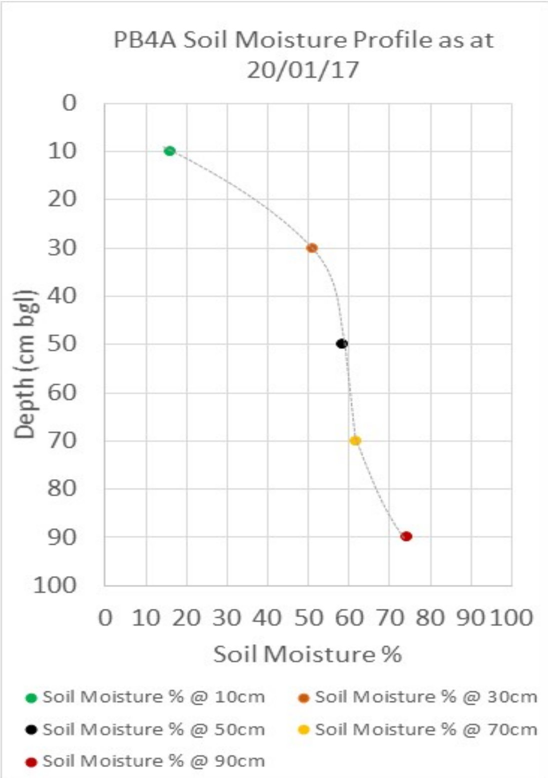
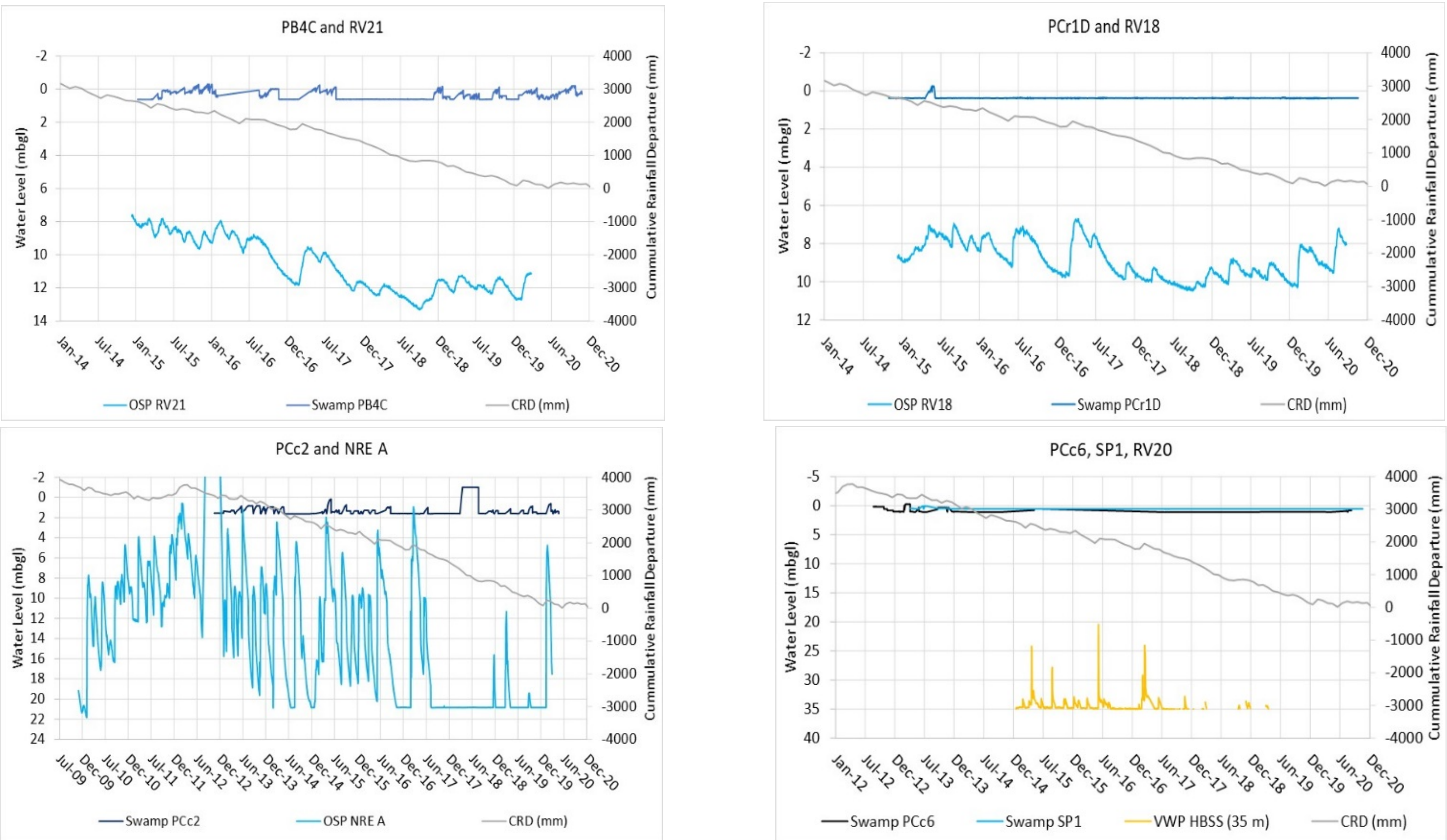


Figure 4-3 Paired bores in swamps and underlying Hawkesbury Sandstone



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.

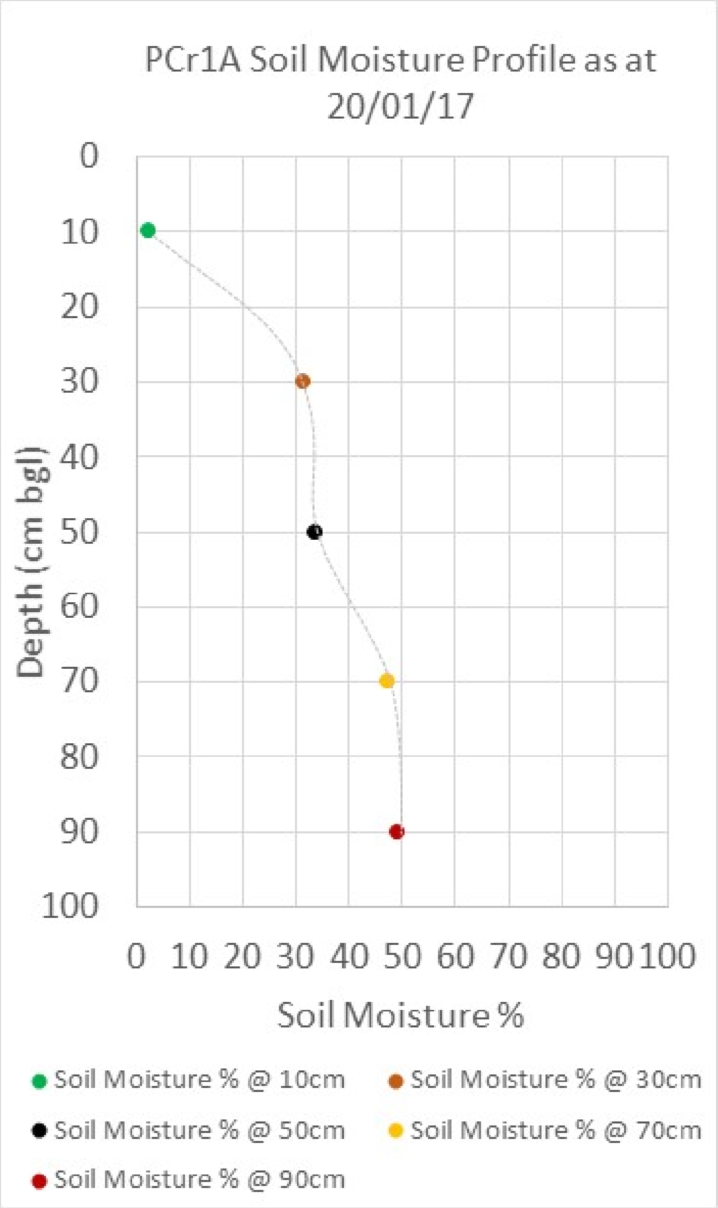
Swamp CRUS1

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 µS/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	5th Percentile	95th 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

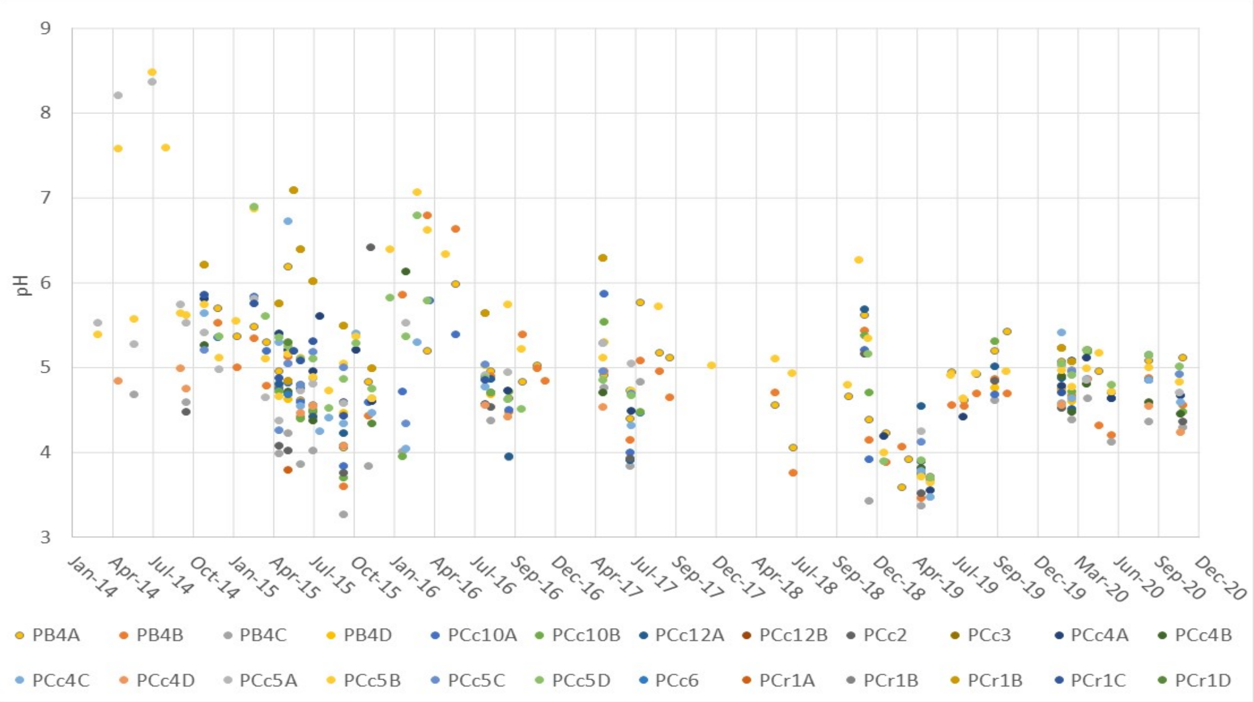
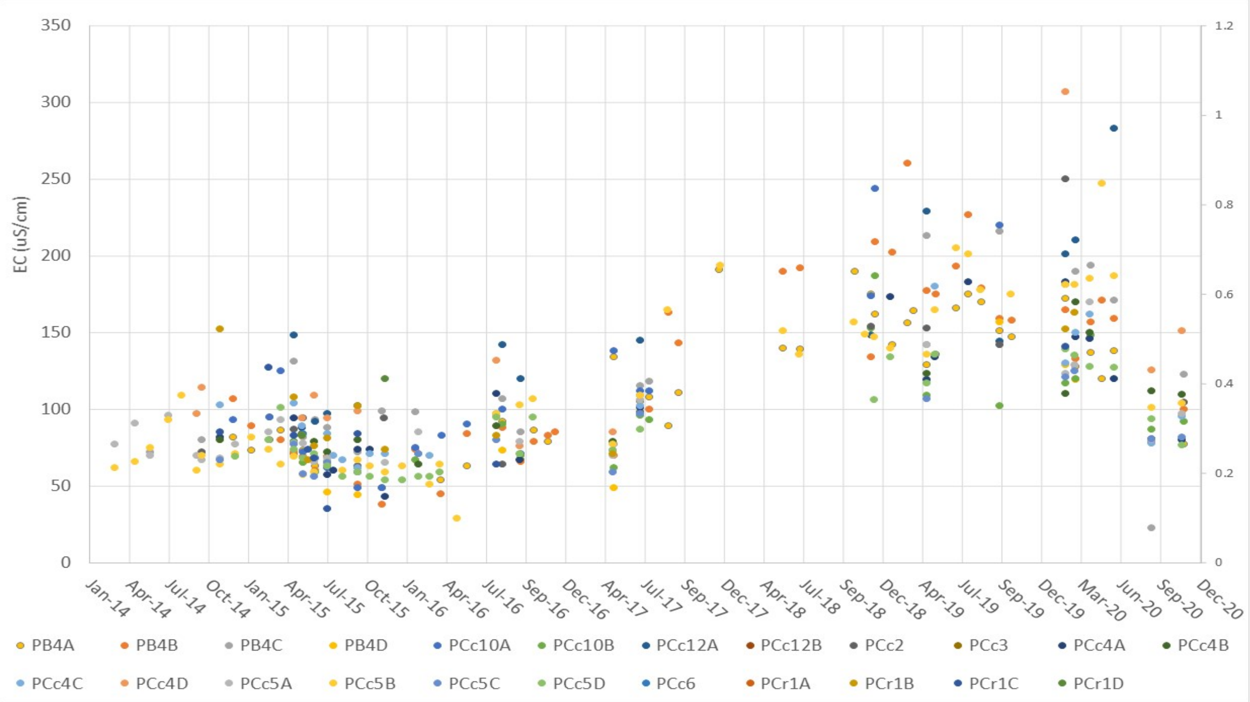


Figure 4-6 Swamp Field EC



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
					165	SBSS	2012
NRE 3 (905)	VWP	294803	6201954	360.23	100	HBSS	2009
					130	HBSS	2009
					155	HBSS	2009
					255	BGSS	2009
NRE1A*	VWP	303680	6196034	376.23	45	HBSS	2009
					60	BHCS	2009
					75	BGSS	2009
					140	BGSS	2009
NRE1B	VWP	303939	6197567	372.69	27.5	HBSS	2009
					43	BHCS	2009
					63	BGSS	2009
					168	BGSS	2009
NRE1D	VWP	301870	6198509	348	70	HBSS	2009

Site ID	Type[1]	Easting GDA94 Z56	Northing GDA94 Z56	Ground Level mAHD	Screen/ Sensor Depth mbgl	Geology[2]	Year Installed
(939)					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

Site ID	Type[1]	Easting GDA94 Z56	Northing GDA94 Z56	Ground Level mAHD	Screen/ Sensor Depth mbgl	Geology[2]	Year Installed
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
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
					423	WWCO	2018
RV27	VWP	298743	6201421	350.9	135	HBSS	2020
					149	NPF	2020
					178	BHCS	2020
					315	BGSS	2020
					330	SPCS	2020
					380	SBSS	2020
					475	WWCO	2020

Site ID	Type[1]	Easting GDA94 Z56	Northing GDA94 Z56	Ground Level mAHD	Screen/ Sensor Depth mbgl	Geology[2]	Year Installed
RV29	VWP	300533	6200938	386.7	90	HBSS	2018
					120	HBSS	2018
					140	BHCS	2018
					240	BGSS	2018
					295	SPCS	2018
					350	WMCS	2018
					443	WWCO	2018
RV35	VWP	291578	6205739	306.0	90	HBSS	2020
					155	HBSS	2020
					195	BHCS	2020
					300	BGSS	2020
					395	SPCS	2020
					422	SBSS	2020
					446	BUCO	2020
					485	WWCO	2020
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* ***VWP*** *– Vibrating Wire Piezometer*

2. ***HBSS*** *– Hawkesbury Sandstone* ***BHCS*** *– Bald Hill Claystone*

BGSS *– Bulgo Sandstone* ***SPCS*** *– Stanwell Park Claystone*

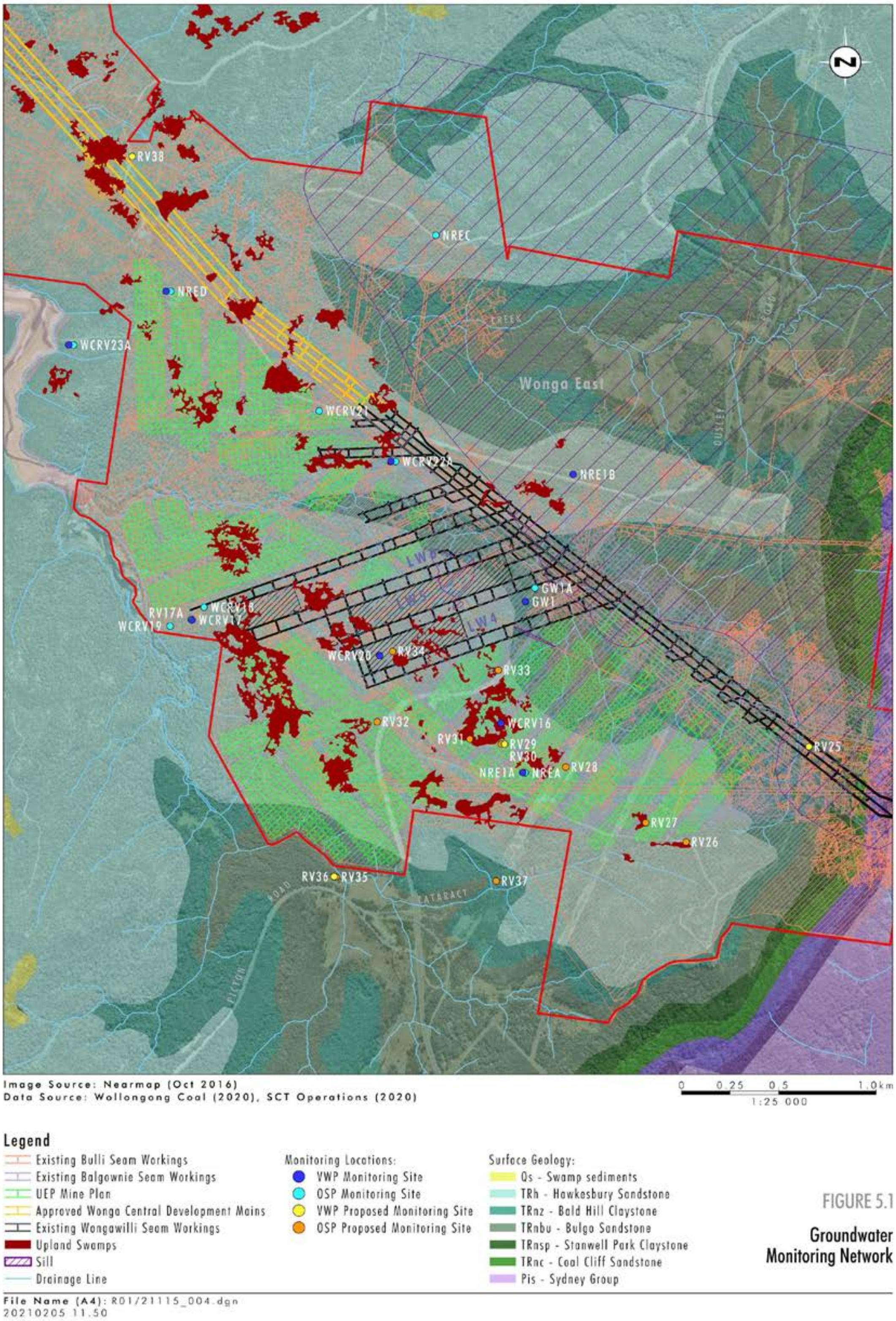
SBSS *– Scarborough Sandstone* ***NPFM*** *– Newport Formation*

BUCO *– Bulli Coal* ***WMCS*** *– Wombarra Claystone*

WWCO *– Wongawilli Coal*

* *NRE1A VWP failed in 2017, to be repaired in 2021*

Figure 5-1 Groundwater Monitoring Network



5.3 Groundwater Monitoring

5.2.1 Hawkesbury Sandstone

Groundwater Levels

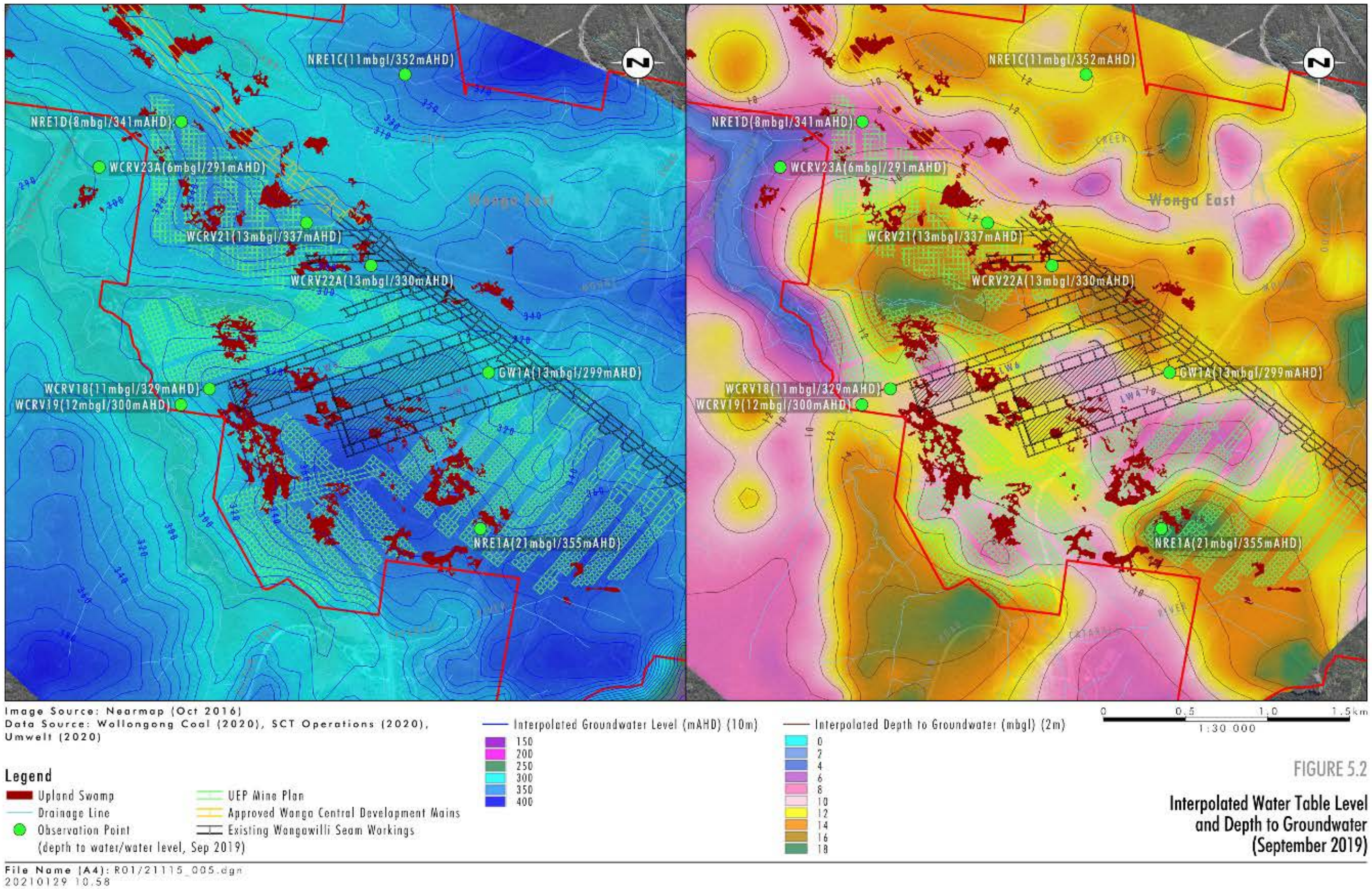
Groundwater levels within the Hawkesbury Sandstone are monitored across RVE UEP within open standpipes and VWPs (refer **Section 5.1**). Hydrographs of baseline water levels are presented in **Appendix D** and interpolated groundwater levels and depth to groundwater based on observation data from September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

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 µS/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	5th Percentile	95th 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

Analyte	ANZG 2018 95% species protection default value (mg/L)	Hawkesbury Sandstone Data				
		Range	Median	5th Percentile	95th Percentile	Population
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
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

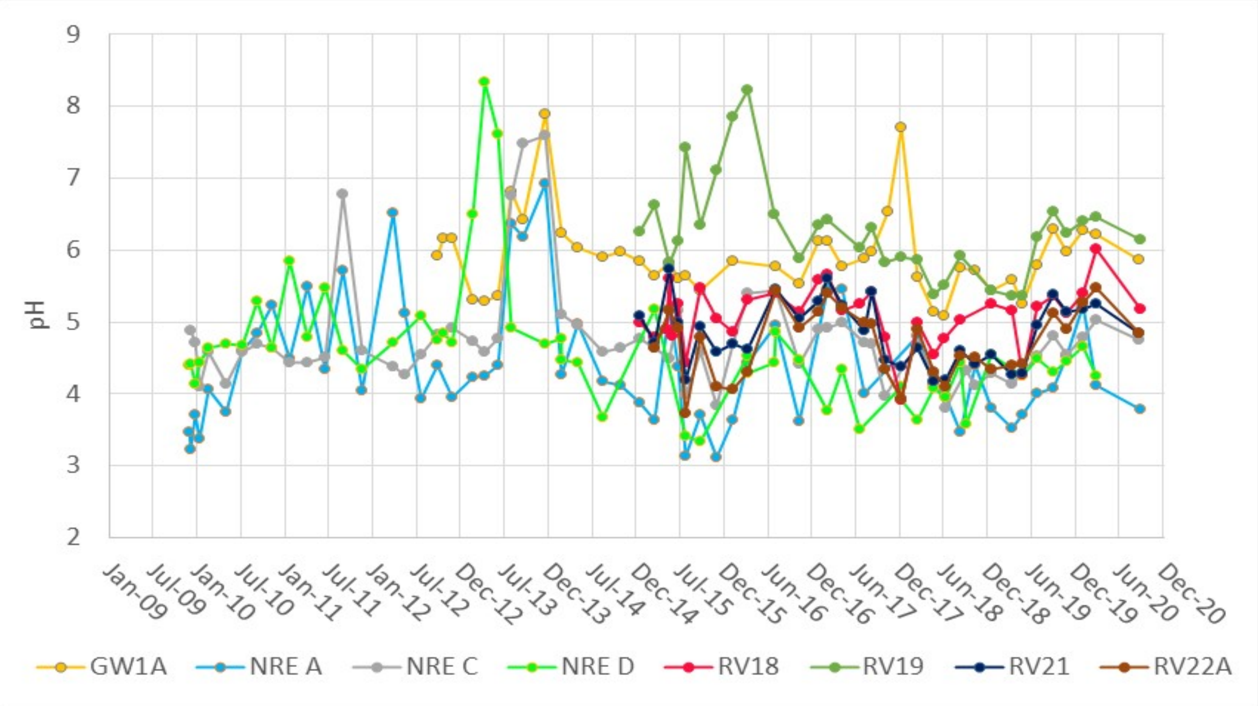
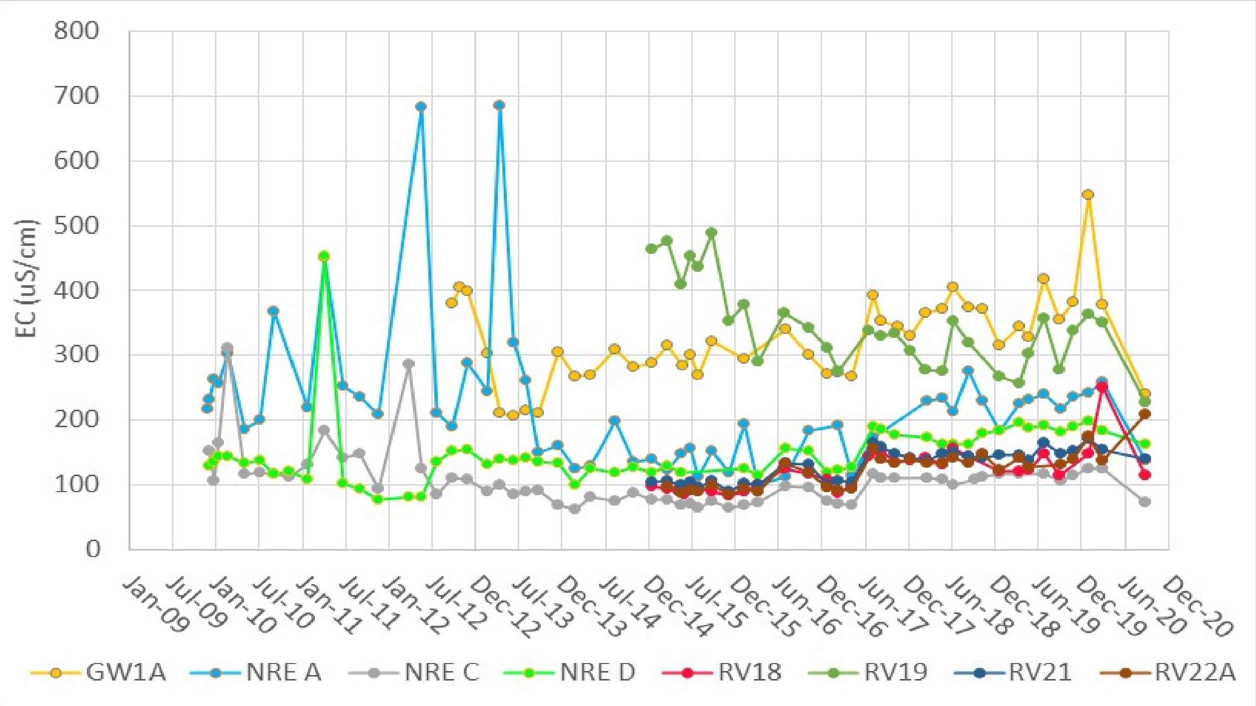


Figure 5-4 Hawkesbury Sandstone Field EC



5.2.2 Narrabeen Group

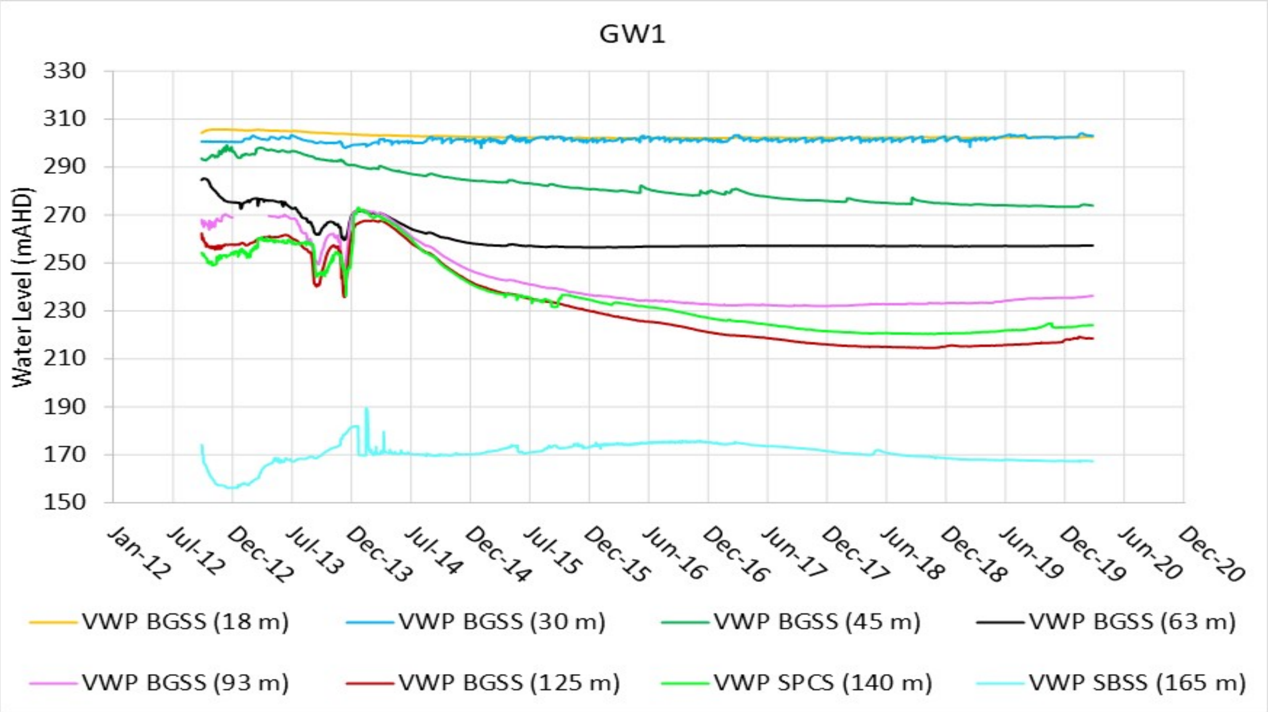
Groundwater Levels

Groundwater levels within the Narrabeen Group are monitored across RVE UEP within ten VWPs (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.

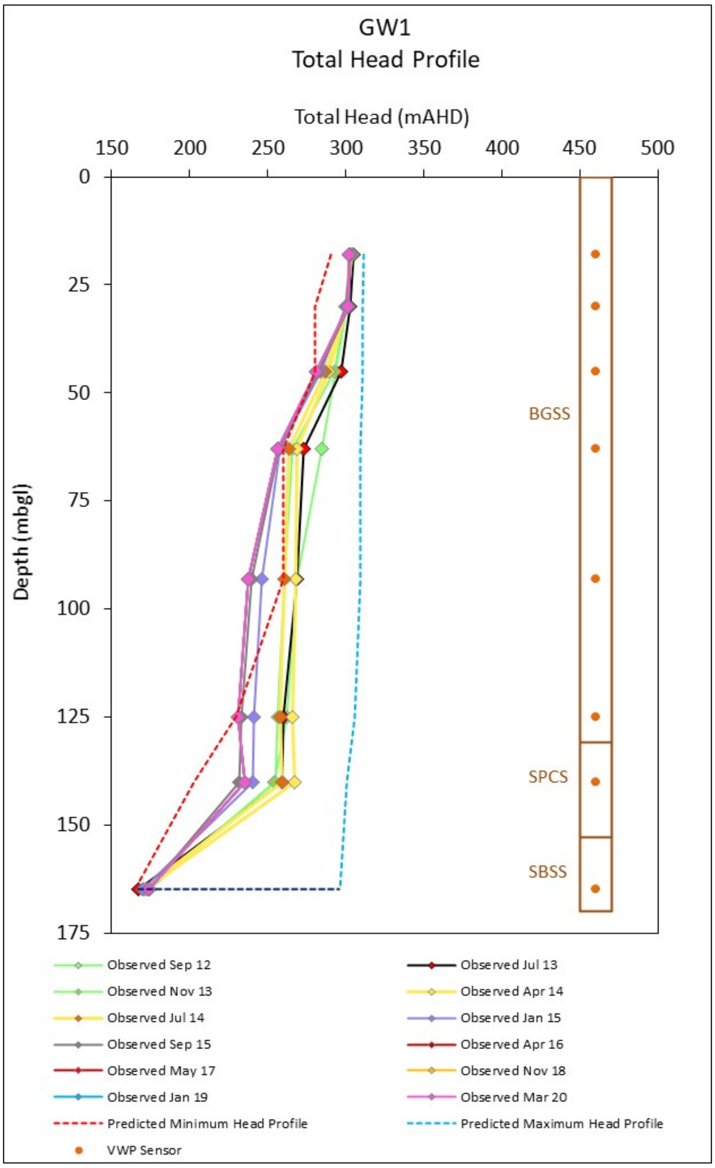
Figure 5-5 GW1 VWP Hydrograph



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 µS/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.

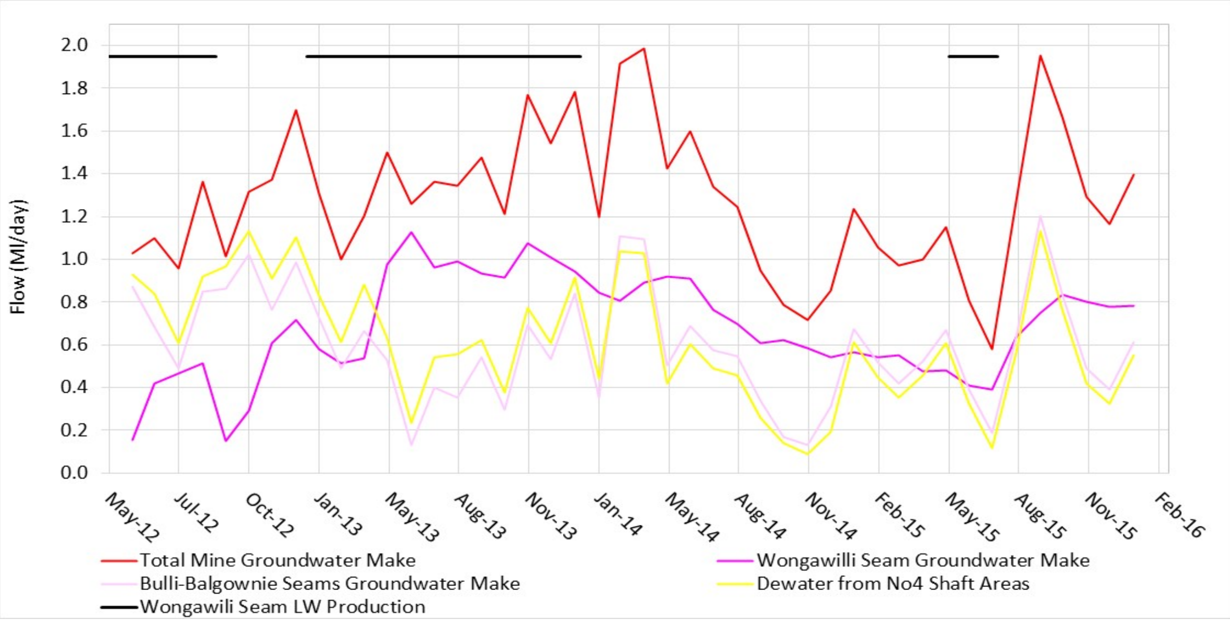
Groundwater within the Permian coal measures is recharged by rainfall where the seams outcrop along the escarpment, as well as downward seepage from the overlying Narrabeen Group. Downward seepage is restricted by the low permeability claystones within the Narrabeen Group, but is possible where the claystones 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 µS/cm) (5,226 µS/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 (µS/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)
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)

Analyte	Mine Inflow Range (Median)[1]	Illawarra Coal Measures (AGL,2013)	Geochemical assessment of rejects (WCL, 2020)
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 µS/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 an 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.

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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 (10^{th} and 90^{th} 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 commen-cement	RV42
PCc1B	CCUS1	303512	6196355	–	Swamp deposits	SM		
PCc1C	CCUS1	303609	6196292	~ 0.5 - 2	Swamp deposits	SM and PZ		

Site ID	Swamp Site	Easting GDA94 Z56	Northing GDA94 Z56	Depth mbgl	Intake Lithology	Type[1]	Install Timing[2]	Paired Bore[3]
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 commen-cement	RV41
PCc21	CCUS21	303481	6196772	–	Swamp deposits	SM	Prior to commen-cement	-
PCc6B	CCUS6	303020	6196609	~ 0.5 - 2	Swamp deposits	SM and PZ	Prior to commen-cement	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 VWPs 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 VWPs, 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.

Site ID	Type[1]	Easting GDA94 Z56	Northing GDA94 Z56	Screen/ Sensor Depth mbgl	Geology[2]	Install Timing[2]	Purpose
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.
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.

Site ID	Type[1]	Easting GDA94 Z56	Northing GDA94 Z56	Screen/ Sensor Depth mbgl	Geology[2]	Install Timing[2]	Purpose
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.
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 targetted 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, SO_4), F, HCO_3, $CaCO_3$, NO_3, 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 - 5th and 95th percentile of baseline swamp data (all RVE swamps)
	EC – 95th percentile of combined baseline swamp data (all RVE swamps)
	SWL – 95th percentile of site-specific baseline depth to groundwater, calculated with dry readings excluded
Hawkesbury Sandstone	pH - 5th and 95th percentile of baseline data (all RVE OSPs)
	EC – 95th percentile of combined baseline data (all RVE OSPs)
	WL – 95th percentile of site-specific baseline water levels ***New sites: initial trigger based on maximum 2 m groundwater level decline over 12 month period***
Bulga Sandstone	pH – 5th and 95th percentile of baseline data after 12 months of data collection. ***New sites: initial trigger based on Hawkesbury Sandstone trigger***
	EC – 95th percentile of baseline data after 12 months of data collection. ***New sites: initial trigger based on Hawkesbury Sandstone trigger***
	WL – 95th 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 - 95th of site baseline mine inflow data
	Sulfate – 95th of site baseline mine inflow data
	Dissolved Al - 95th of site baseline mine inflow data
	Dissolved As - 95th of site baseline mine inflow data
	Dissolved Mo - 95th of site baseline mine inflow data
	Dissolved Sb - 95th 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 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 with 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**.

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.

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 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 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

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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.

TERMS	
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.
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.

TERMS	
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.
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

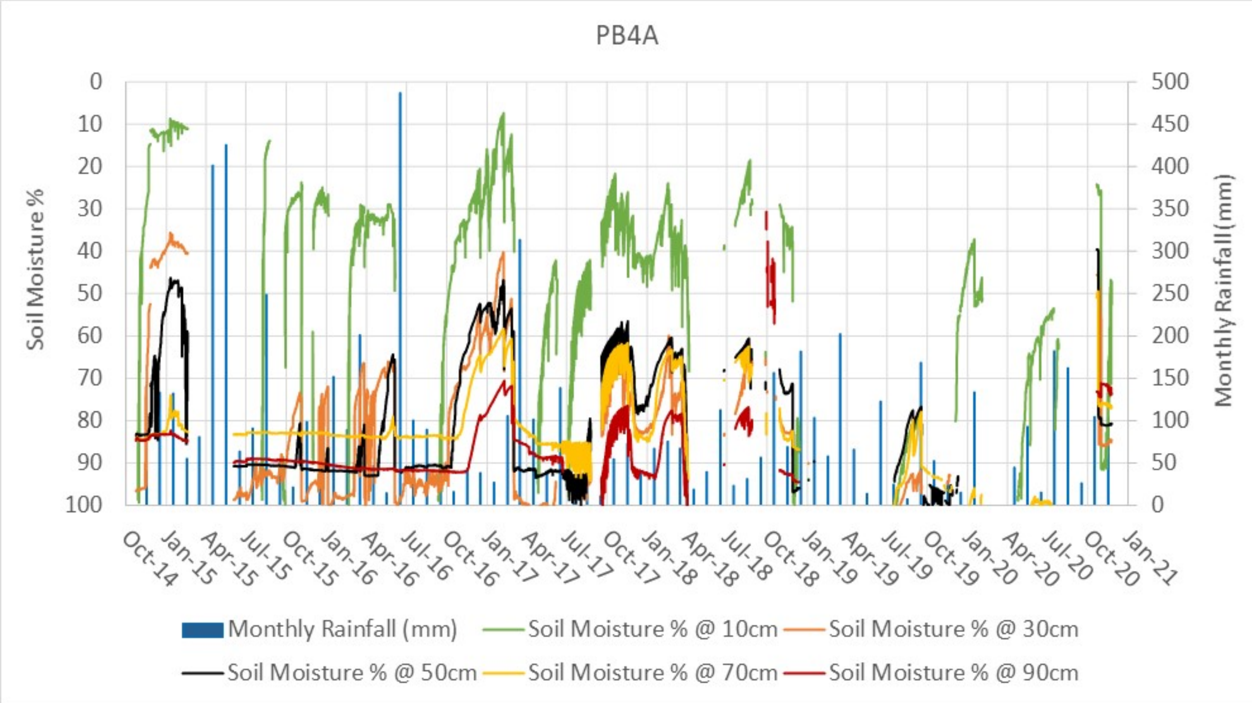
PROPERTY	VALUE
Approved by	Group Environment and Approvals Manager
Document Owner	Richard Sheehan
Effective Date	30/07/2021

Revisions

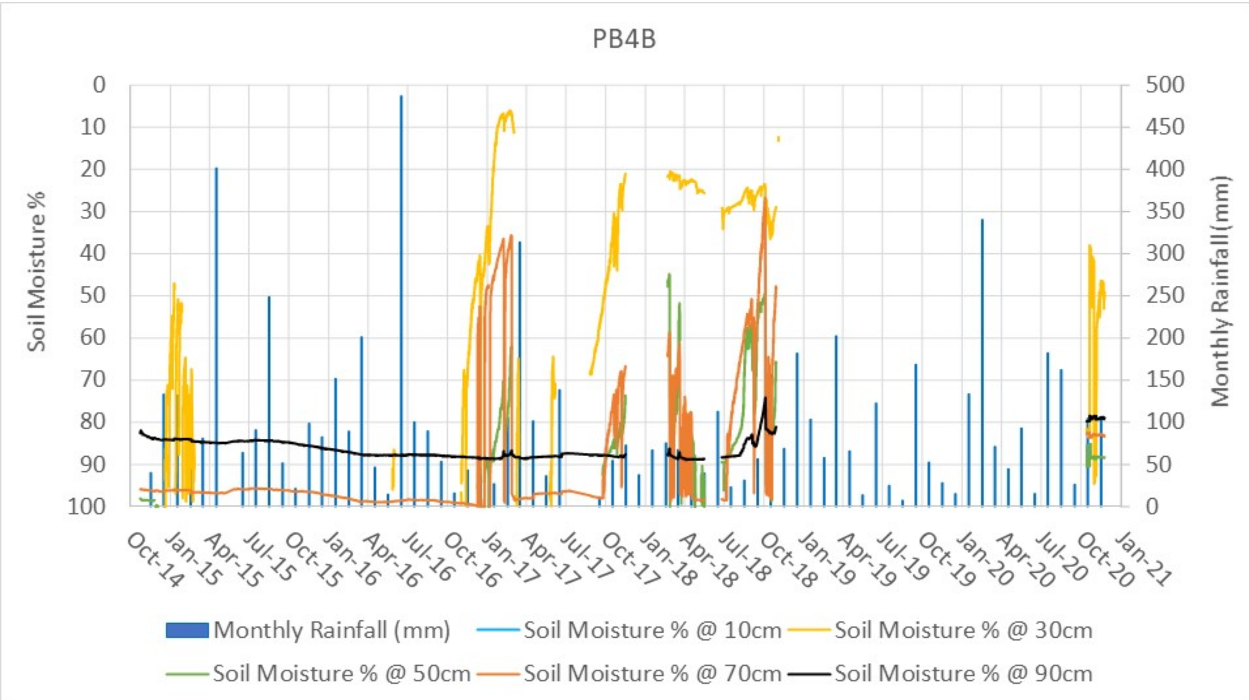
VERSION	DATE REVIEWED	REVIEW TEAM (CONSULTATION)	NATURE OF THE AMENDMENT
1	05/02/2021	Claire Stephenson	First draft document for review
2	05/03/2021	Claire Stephenson WCL	Version updated based on WCL comments on TARPS and alignment with other plans in preparation.
3	14/04/2021	Claire Stephenson WCL, 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.

APPENDIX A – SWAMP BASELINE DATA – SOIL MOISTURE

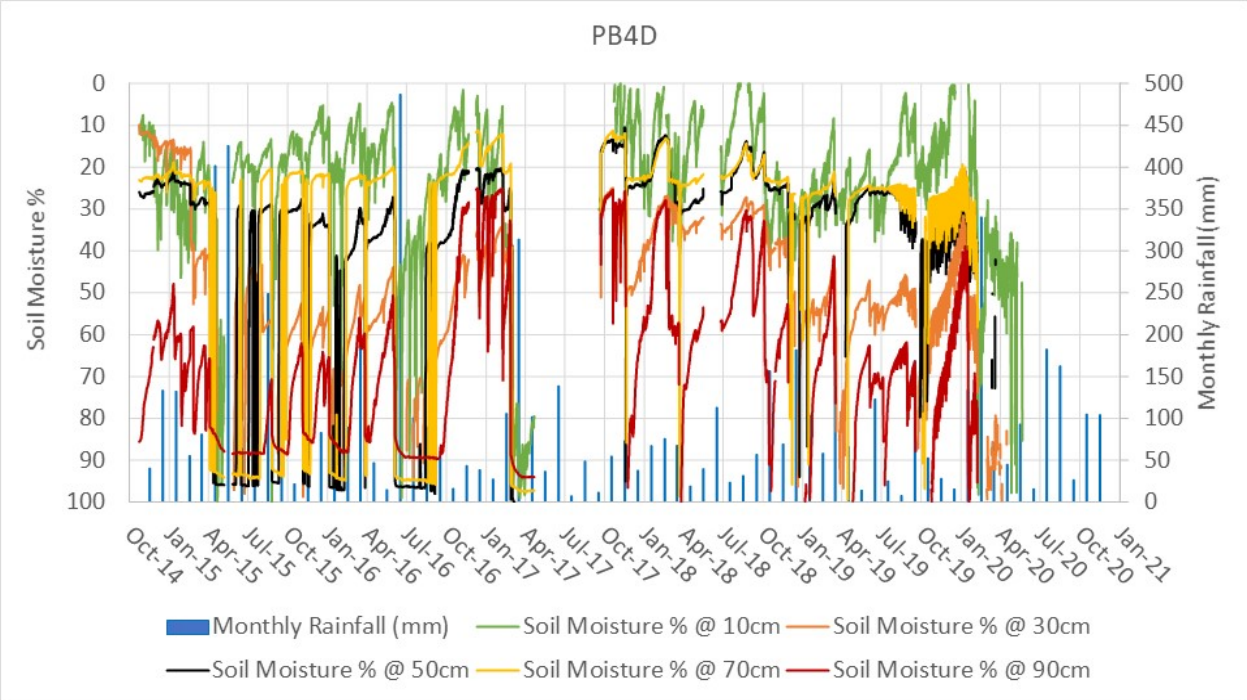
PB4 (A) near swamp BCUS4



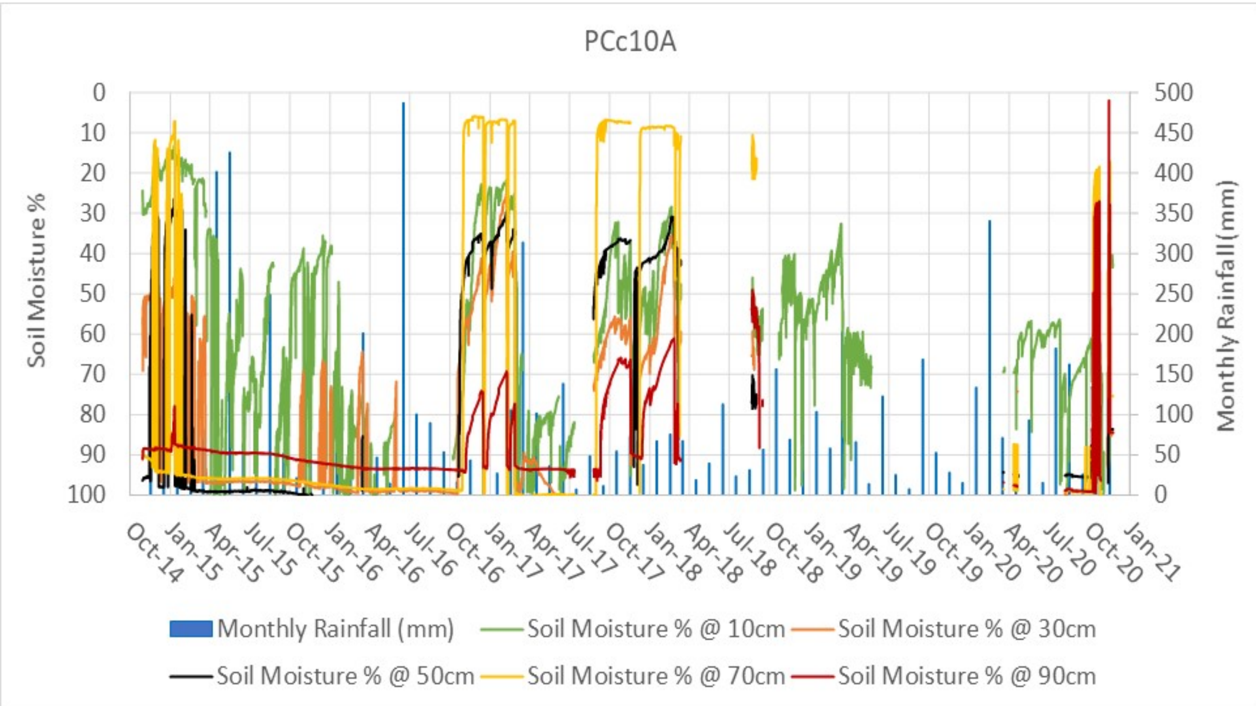
PB4 (B) near swamp BCUS4



PB4 (D) near swamp BCUS4



PCc10 (A) at CCUS10



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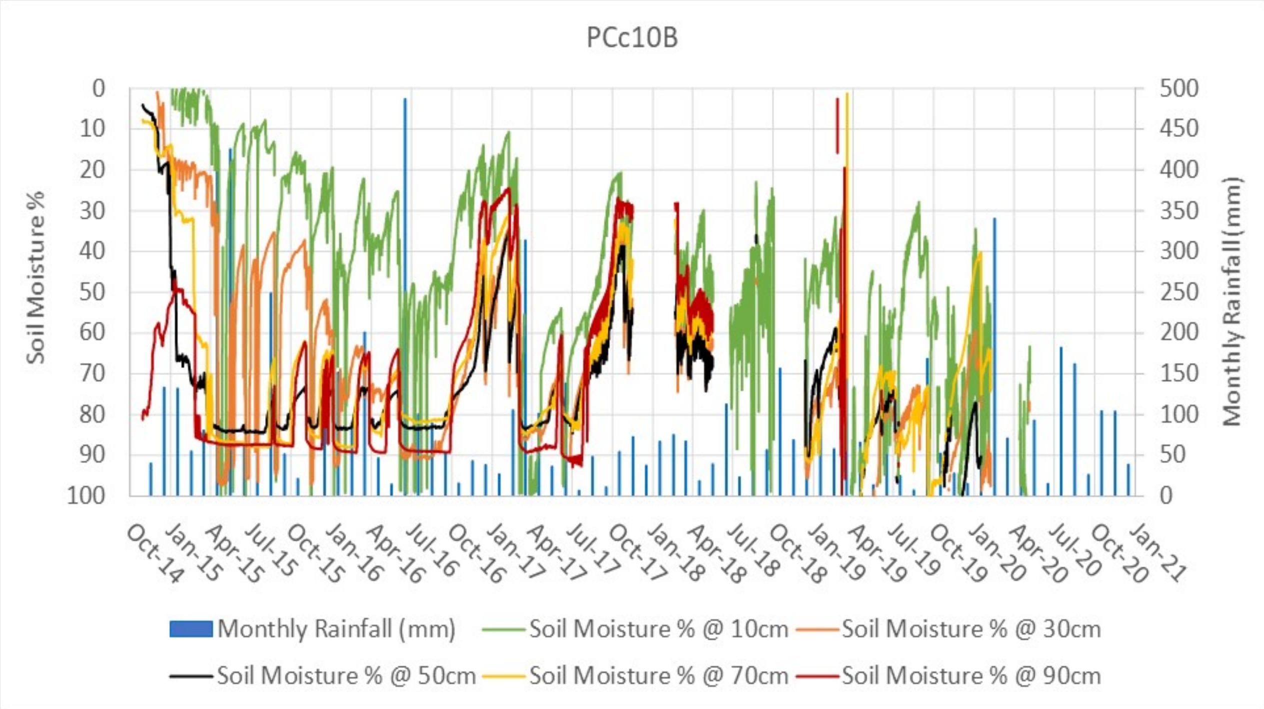
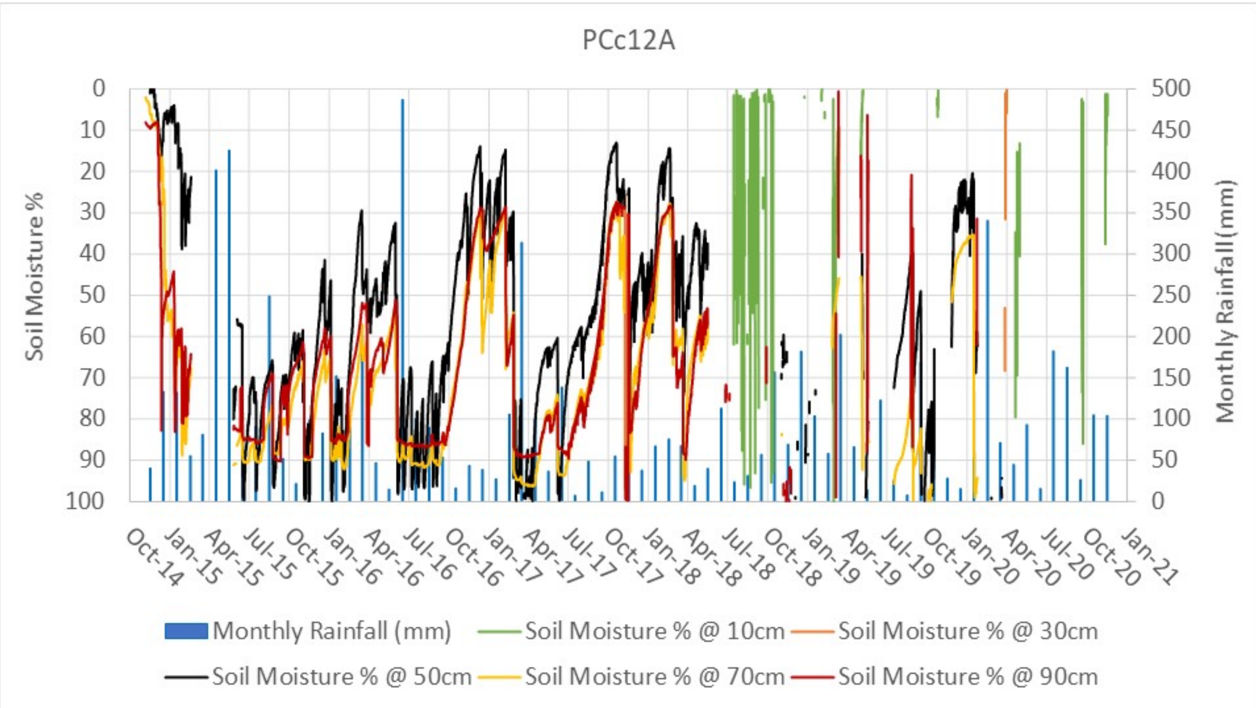


PCc12 (A) at CCUS12



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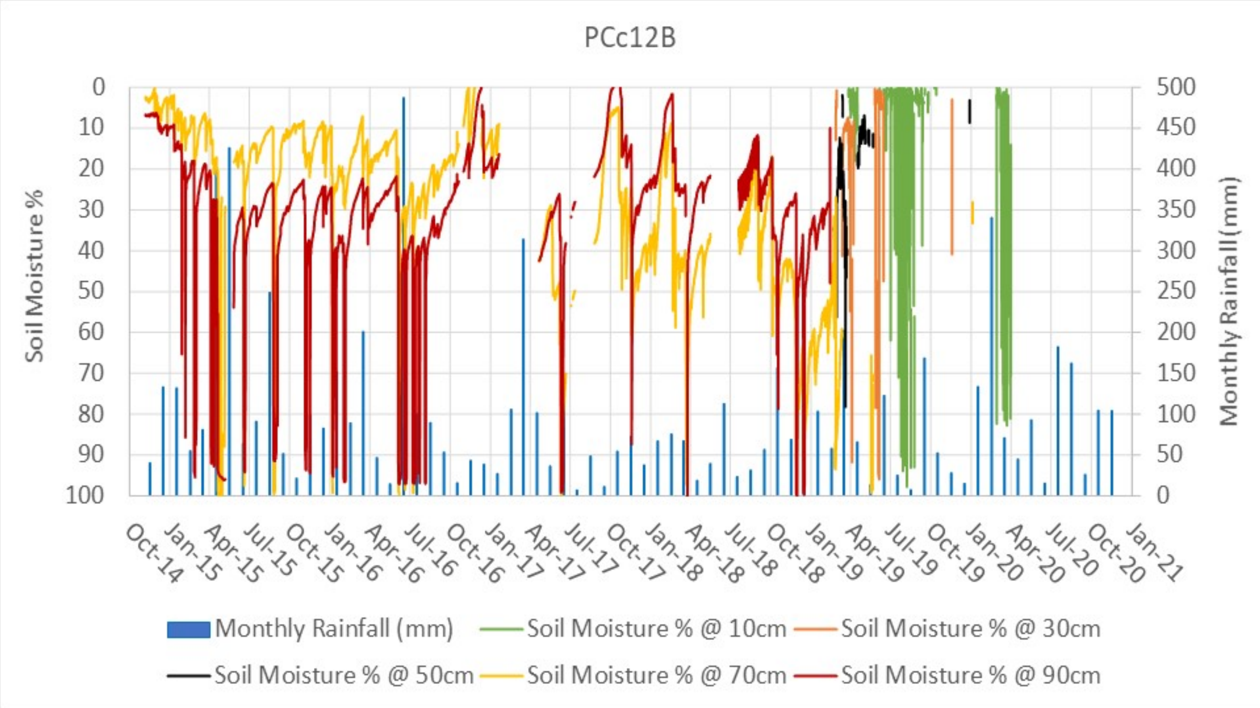
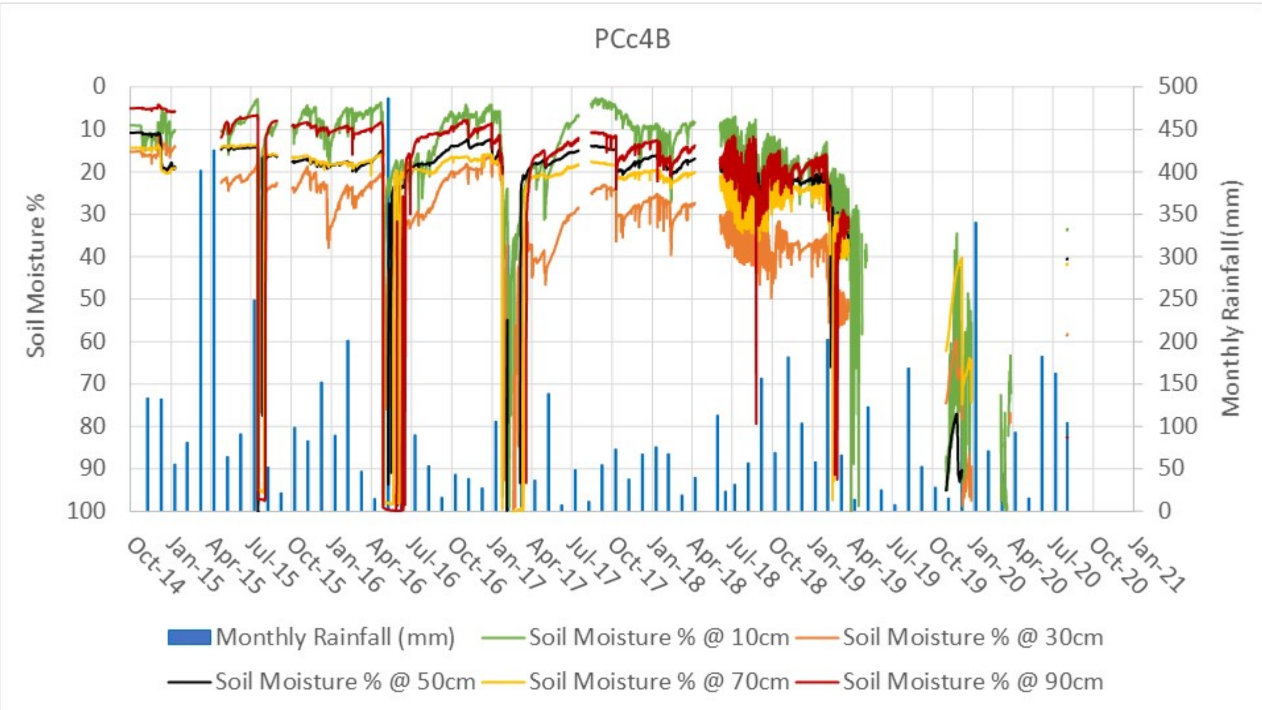
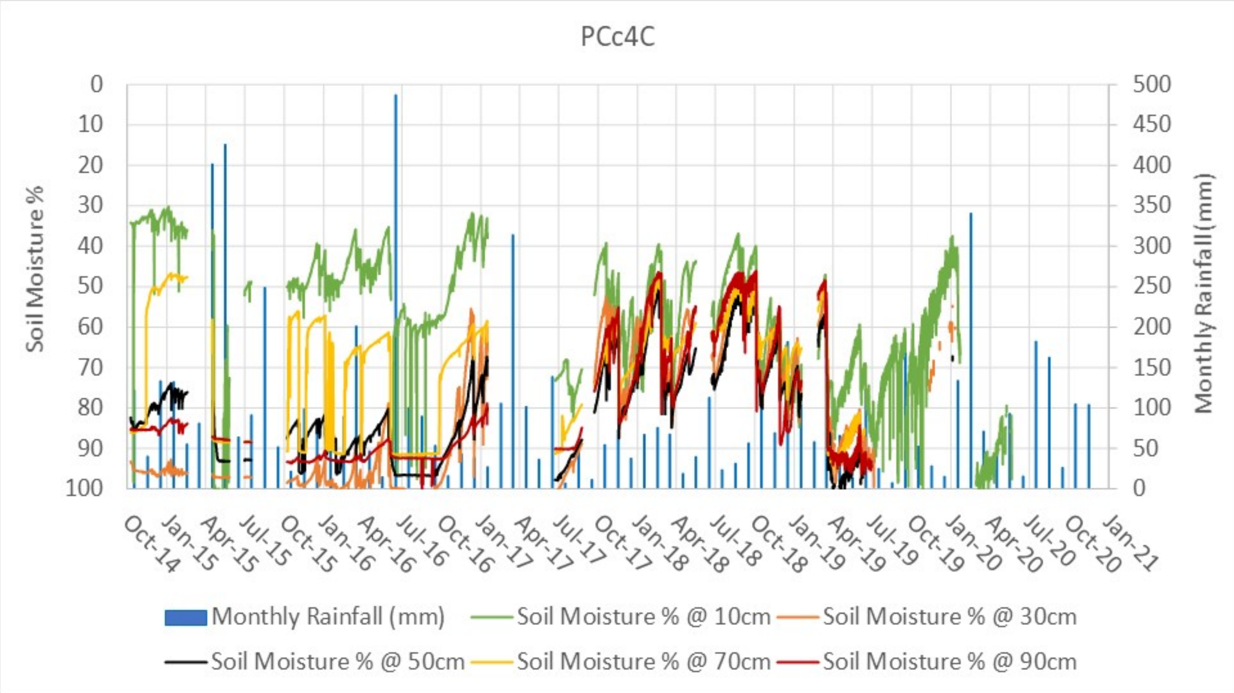


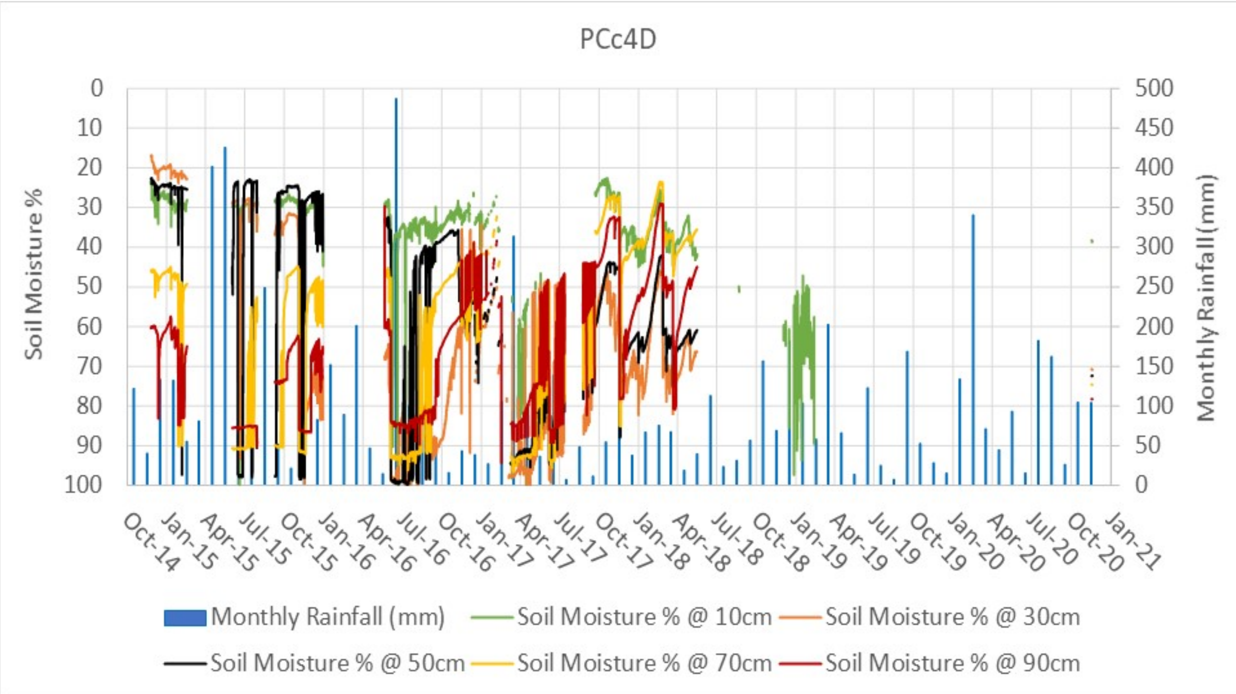
PCc4 (B) at CCUS4



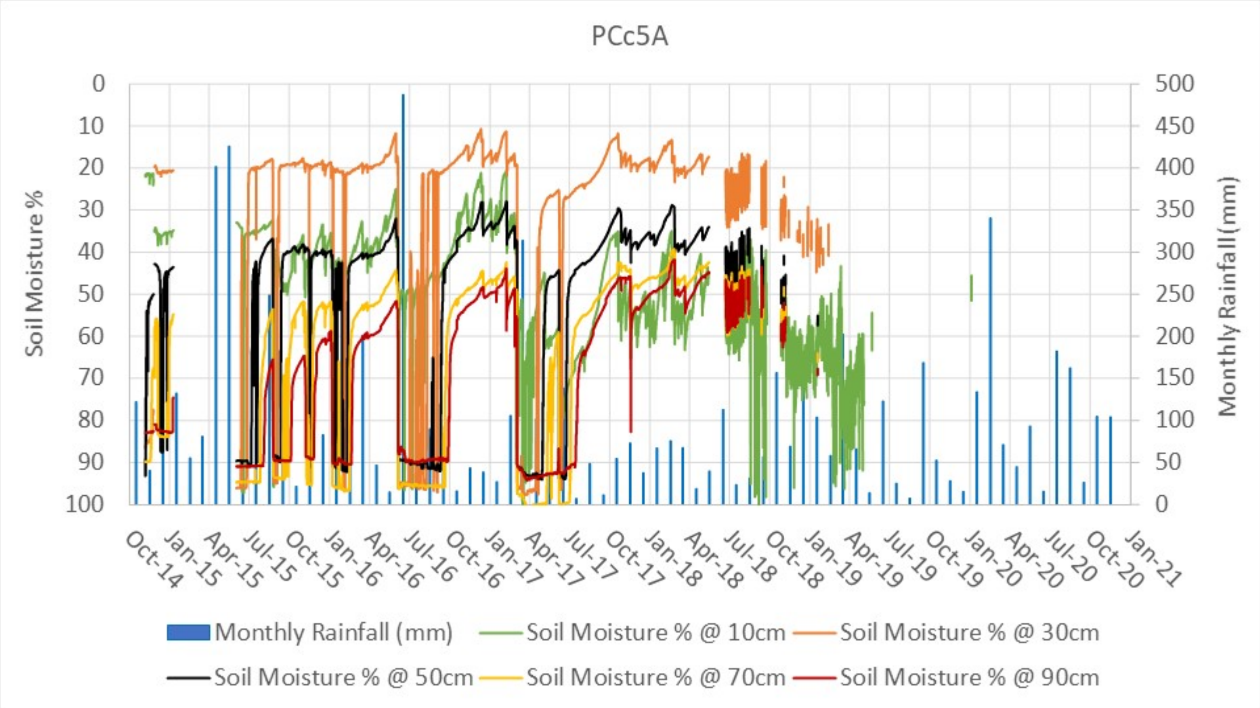
PCc4 (C) at CCUS4



PCc4 (D) at CCUS4



PCc5 (A) at CCUS5



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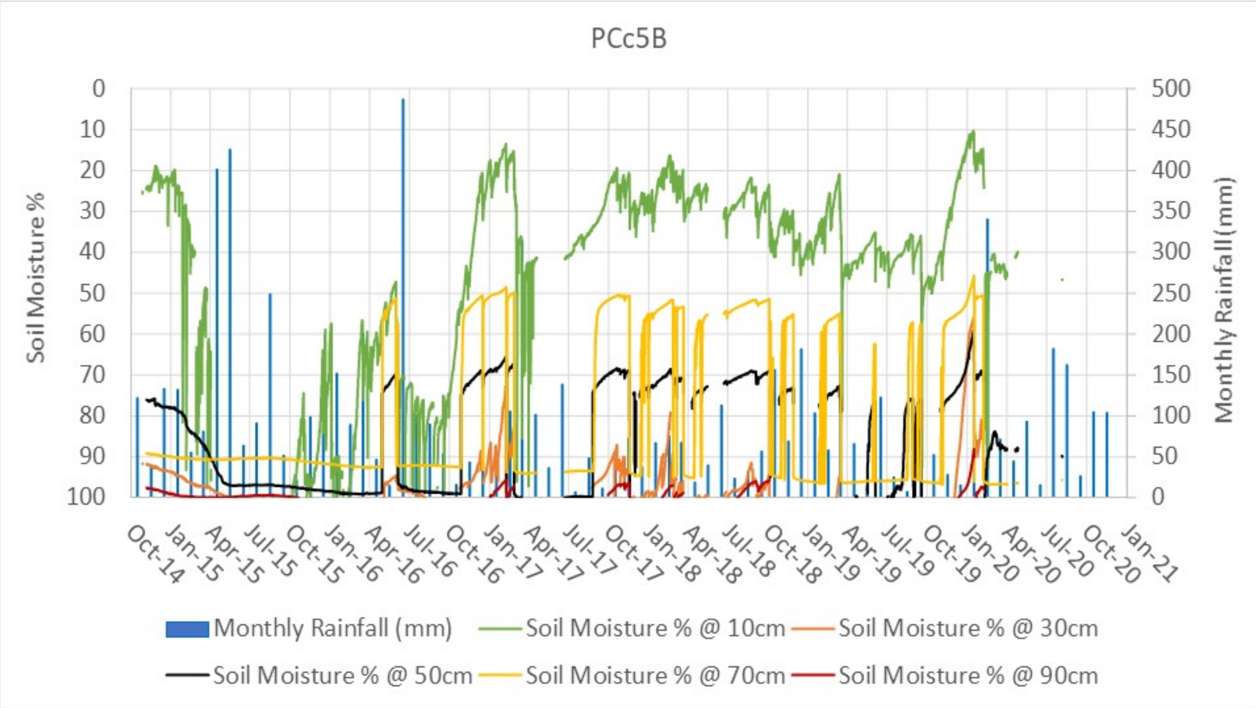

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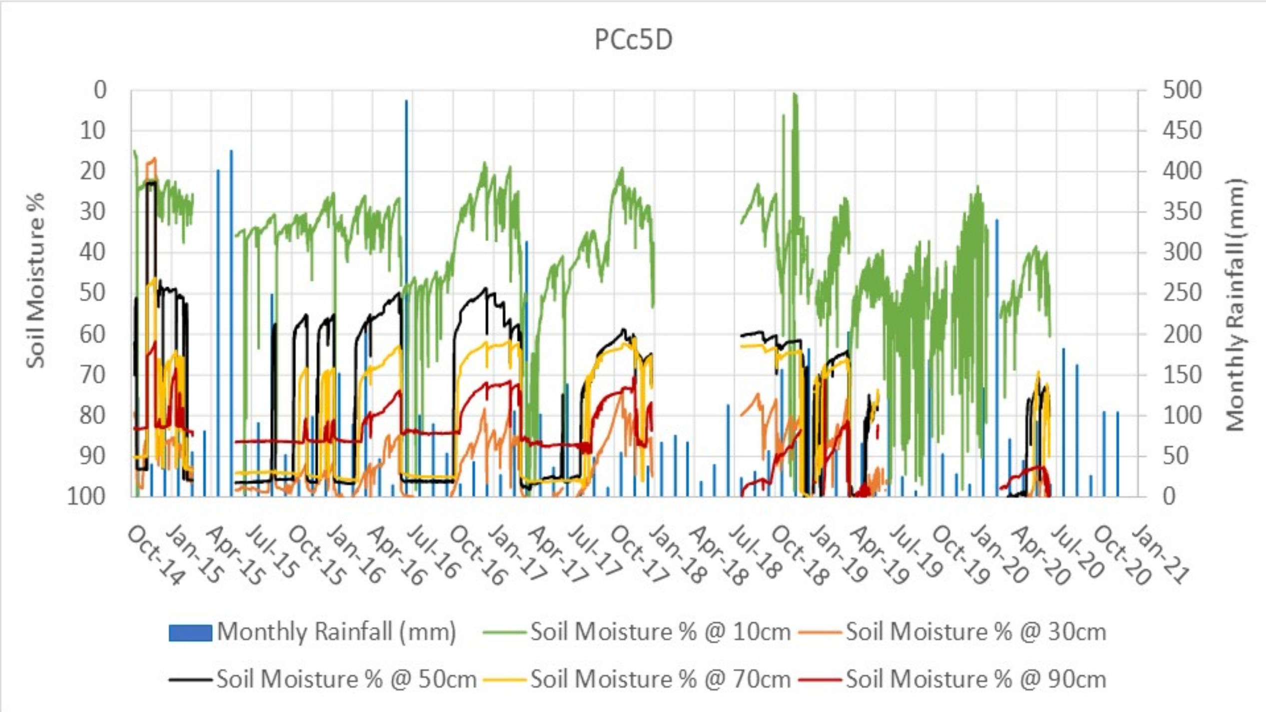
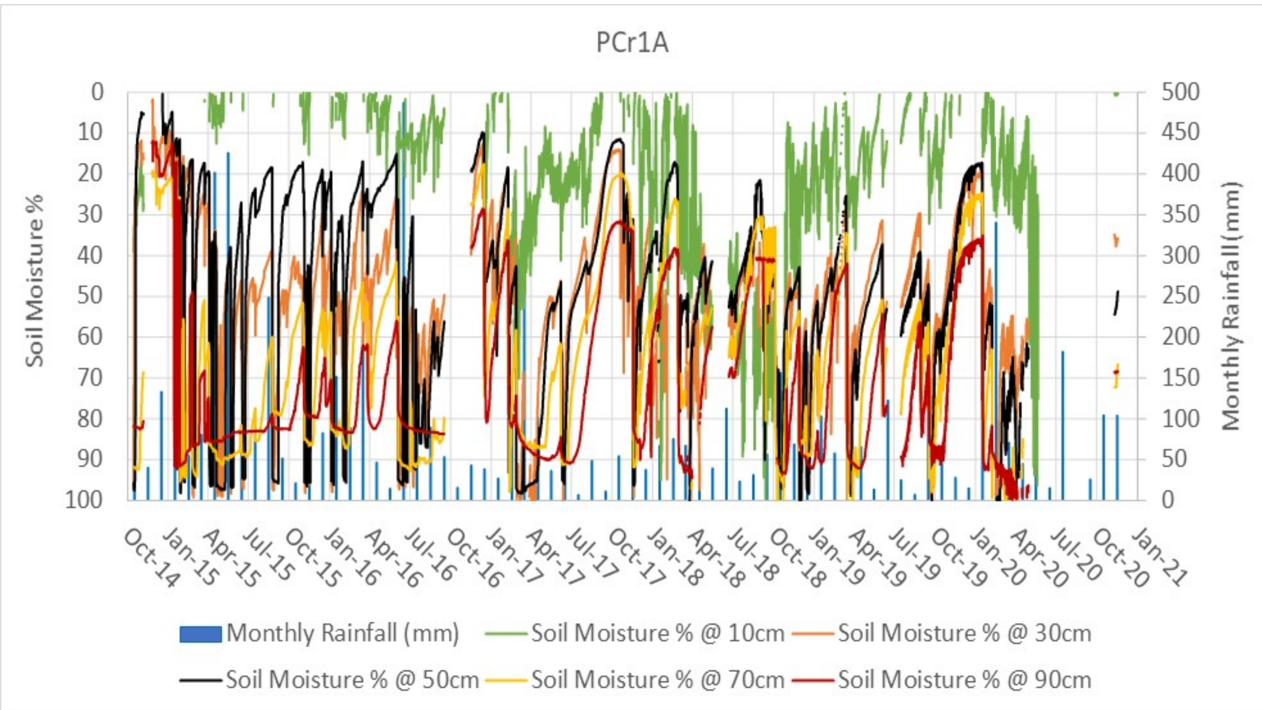
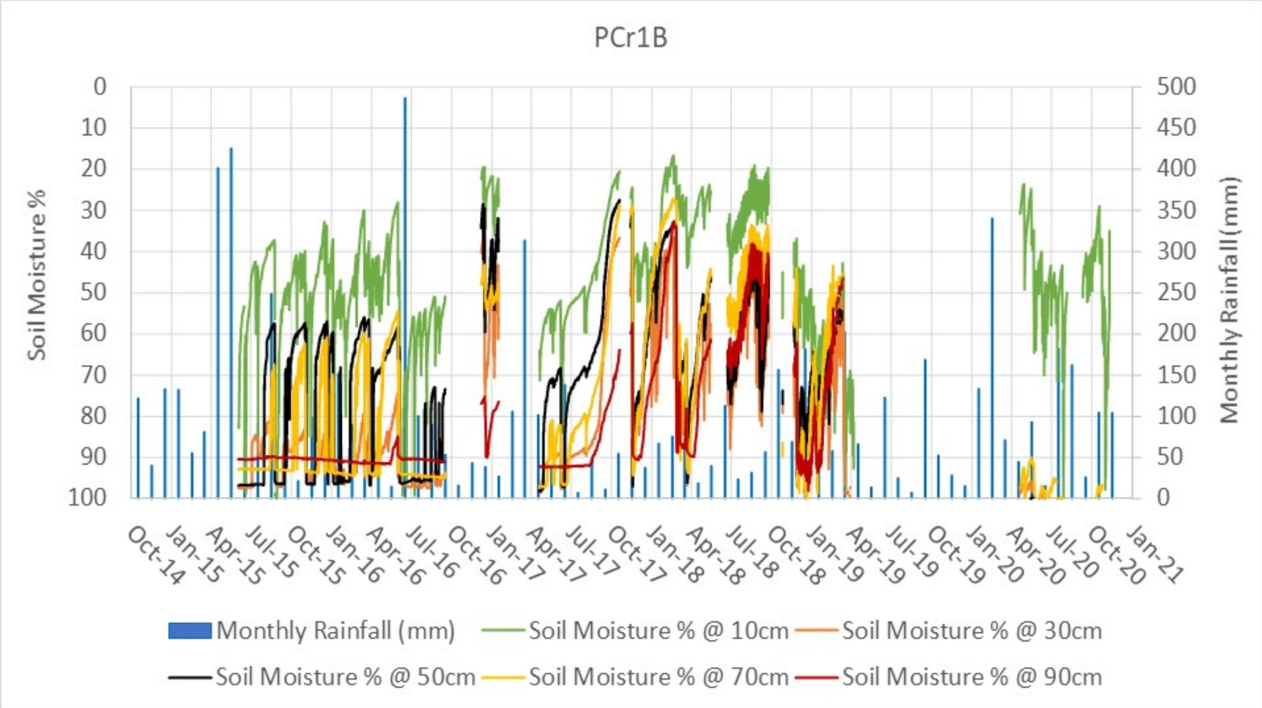


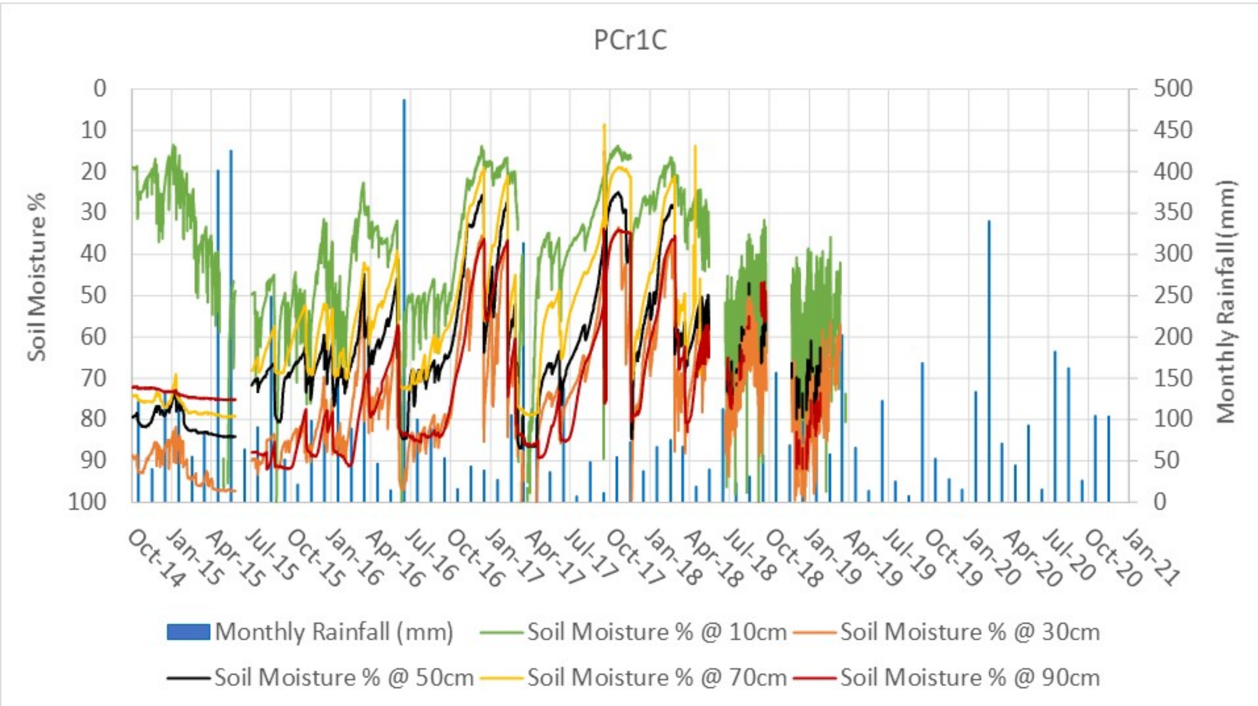
PCr1 (A) at CRUS1



PCr1 (B) at CRUS1

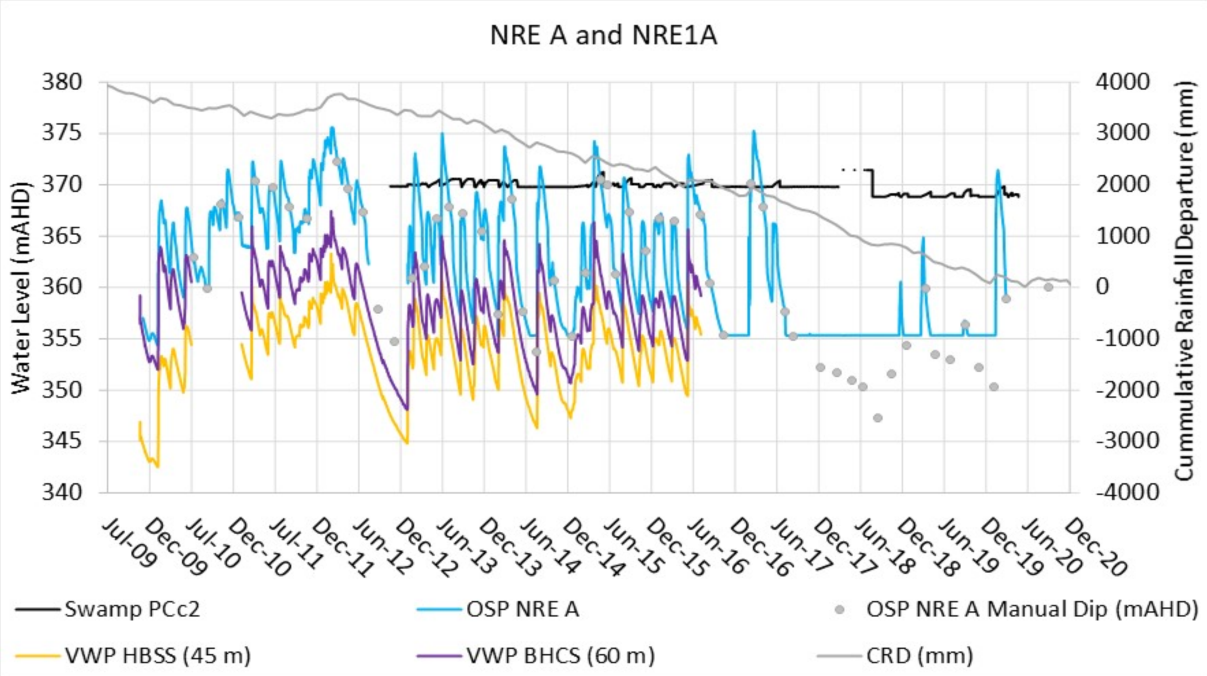


PCr1 (C) at CRUS1

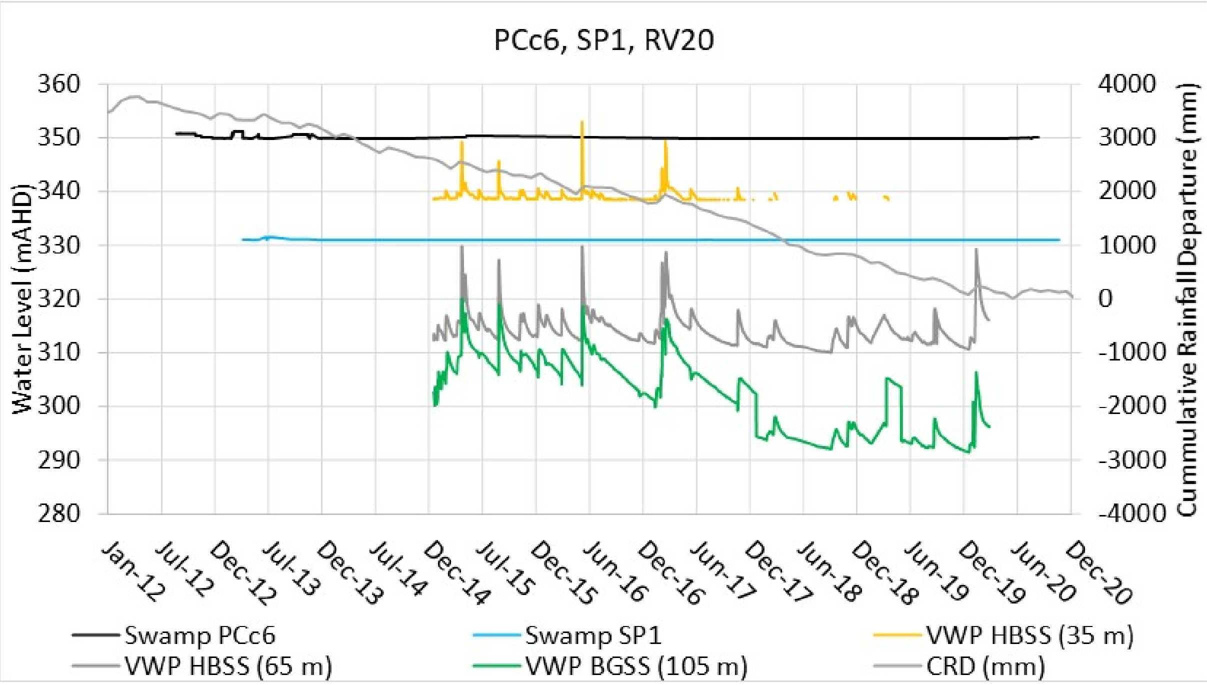


GROUNDWATER MONITORING SITES AT SWAMP LOCATIONS

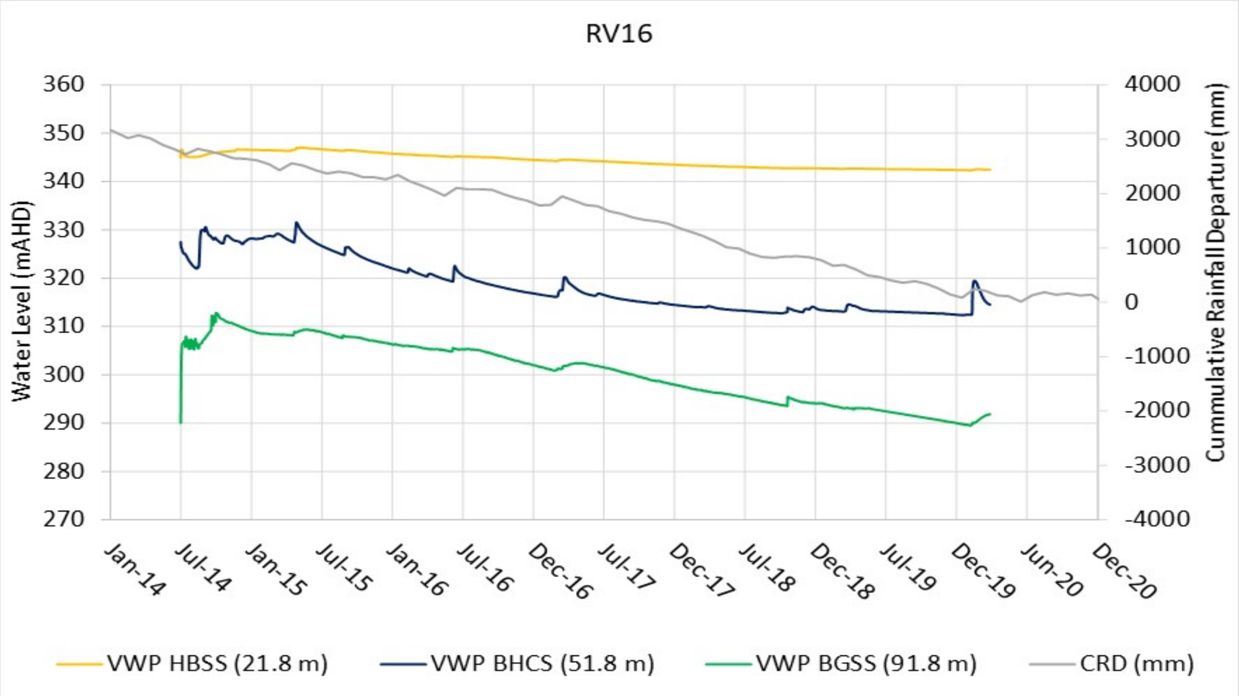
PCc2, NRE1A (OSP) and NREA (VWP) near CCUS2



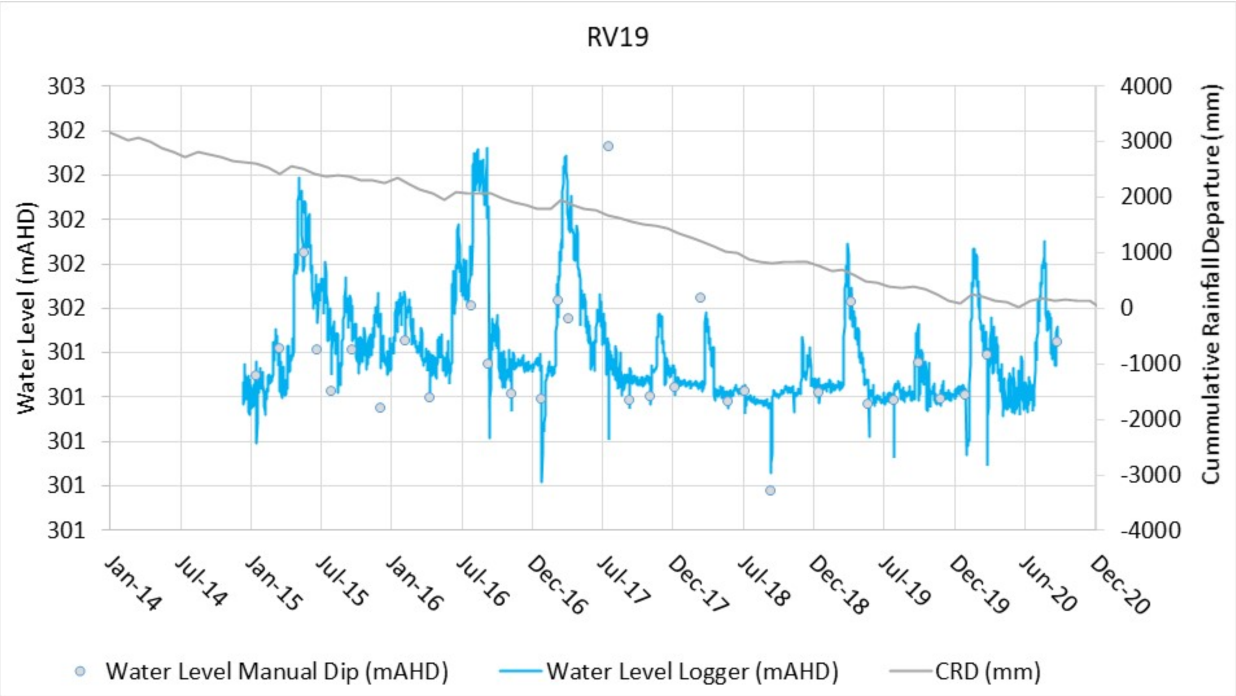
PCc6, SP1 and RV20 (VWP) near CCUS6



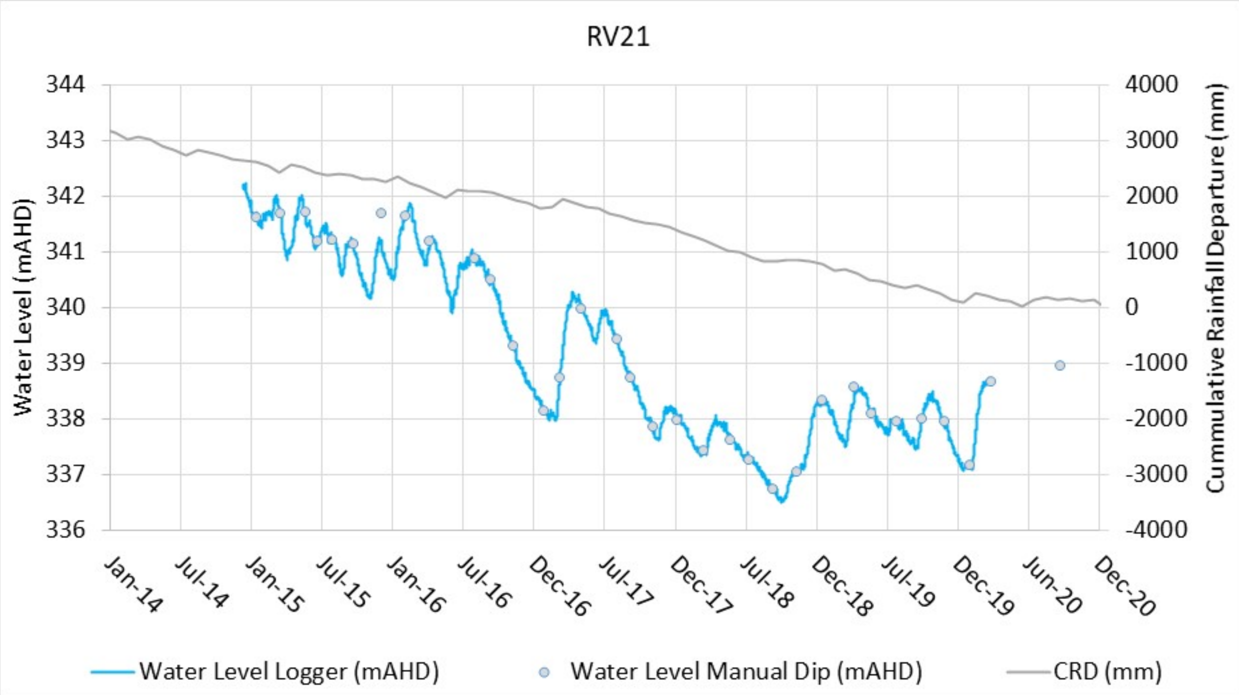
RV16 (VWP) within CCUS1



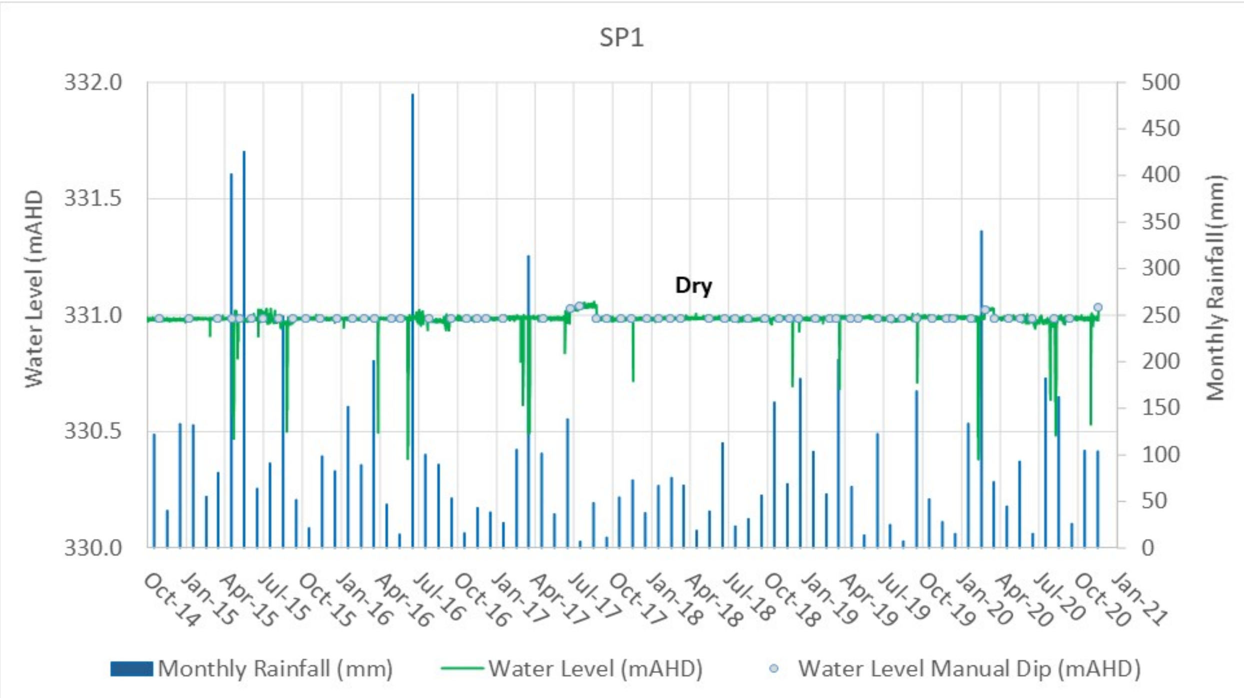
RV19 near CRUS1



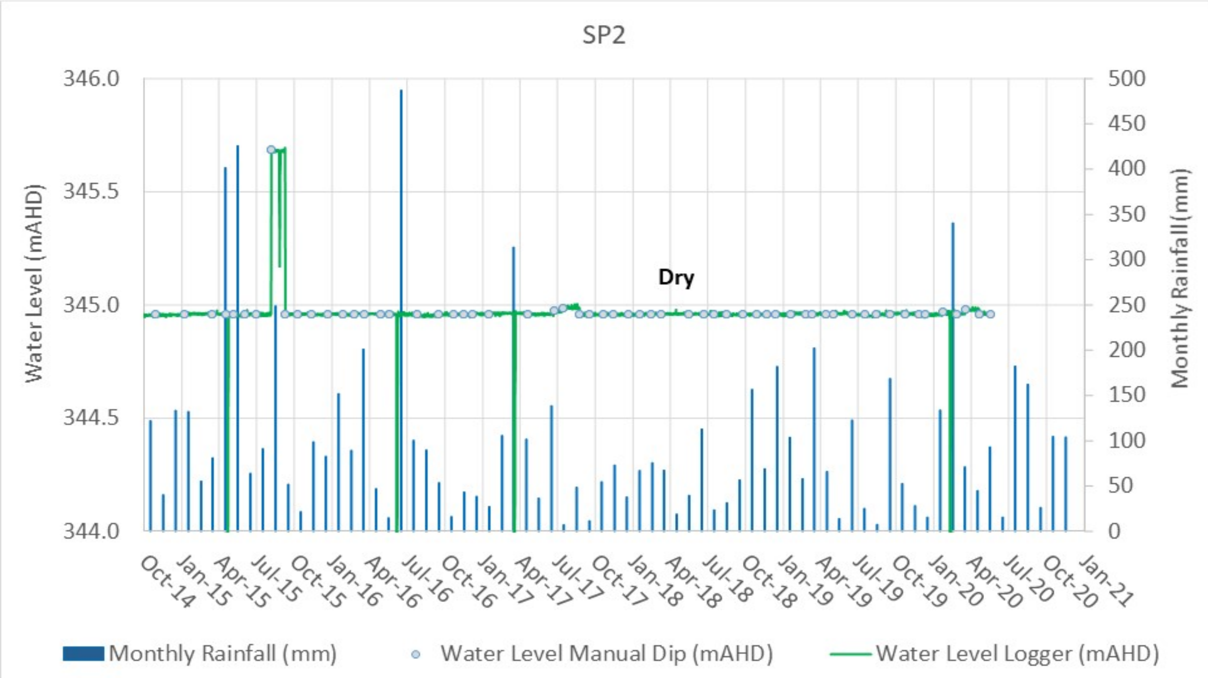
RV21 near BCUS4



SP1 near CCUS6



SP2 near CCUS4



APPENDIX B – SWAMP BASELINE DATA - WATER QUALITY

Date	Site	Comment	Temp (°C)	Field pH	Field EC (uS/cm)	Field TDS (mg/L)	Turbidity (NTU)	Field DO (% Sat)	Field DO (mg/L)	Eh (mV) ORP	pH (mV)	RES (Ohms.cm)	SAL
11/04/2012	SP1	Dry											
11/04/2012	SP2	Dry											
10/05/2012	PCc3	Dry											
14/05/2012	PCr1A	Dry											
22/06/2012	PCc3	Dry											
22/06/2012	SP1	Dry											
25/06/2012	SP2	Dry											
17/07/2012	SP1	Dry											
17/07/2012	SP2	Dry											
18/07/2012	PCc3	Dry											
18/07/2012	PCc4D	Flow: Low											
18/07/2012	PCr1A	Dry											
21/08/2012	PCc3	Dry											
21/08/2012	PCc4D	not enough water for sample, field test only											
21/08/2012	PCr1A	Dry											
22/08/2012	SP1	Dry											
22/08/2012	SP2	Dry											
11/09/2012	SP1	Dry											
11/09/2012	SP2	Dry											
12/09/2012	PCc3	Dry											
12/09/2012	PCc4D	Dry											
12/09/2012	PCc5A	Loggers changed due to probes being seing to measure in kpa and not m.											
12/09/2012	PCc6	Logger changed due to probe being set to measure in kpa not m.											
12/09/2012	PCr1A	Dry											
24/10/2012	SP1	Dry											
24/10/2012	SP2	Dry											
25/10/2012	PCc4D	Dry											
25/10/2012	PCc5A	ORP Done back at lab.											
25/10/2012	PCc6	ORP Measured back at lab.											
25/10/2012	PCr1A	Dry											
14/11/2012	SP1	Dry											
14/11/2012	SP2	Dry											
15/11/2012	PCc2	Dry; Field only											
15/11/2012	PCc3	Dry											
15/11/2012	PCc4D	Dry											
15/11/2012	PCc5A	Dry											
15/11/2012	PCr1A	Dry											
20/12/2012	SP1	Dry											
21/12/2012	PCc3	Dry											
21/12/2012	PCc4D	dry											
21/12/2012	PCc5A	Dry											
21/12/2012	PCc6	Field only not enough for bottle samples											
21/12/2012	PCr1A	Dry											
21/12/2012	SP2	Dry											
15/01/2013	PCc3	Dry. Time data not written on datasheet. Data listed as 12PM on datasight.											
15/01/2013	SP1	Dry. No time data written on datasheet. 12PM listed as time on datasight.											
15/01/2013	SP2	Dry. No time written on datasheet. 12PM listed as the time on datasight.											
22/01/2013	PCc4D	Dry											
22/01/2013	PCc5B	Dry											
22/01/2013	PCr1A	Dry											
31/01/2013	PCc3	Dry. "Logger not downloaded. Went to download logger and no data was logged. Not sure why logger did not started. Data corrupted screen displayed on screen"											
31/01/2013	SP1	Very little water took field sample. Downloaded but looked like only stored one record. Logger started again.											
31/01/2013	SP2	Dry. "Logger not downloaded. Went to download logger and no data was logged. Not sure why logger did not started. Data corrupted screen displayed on screen"											
6/02/2013	PCc3	Dry											
6/02/2013	SP1	Dry											
6/02/2013	SP2	Dry											
13/02/2013	PCc3	Dry											
13/02/2013	SP1	Dry											
13/02/2013	SP2	Dry											
19/02/2013	PCc3	Dry											
19/02/2013	SP1	Dy											
19/02/2013	SP2	Raw											
27/02/2013	PCc3	Dry											
27/02/2013	PCc4D	Cloudy											
27/02/2013	PCc5A	Cloudy											
27/02/2013	PCc5B	Cloudy											
27/02/2013	PCc6	Cloudy. Value may be incorrect. Refer to field sheet. This value may be SP1.											
27/02/2013	SP1	Cloudy. Value may be incorrect. Total depth exceeding usual total depth value. Refer to field sheet.											
27/02/2013	SP2	Value may be incorrect. Refer to field sheet.											
5/03/2013	SP1	Muddy											
5/03/2013	SP2	Dry											
15/03/2013	SP1	Dry											
15/03/2013	SP2	Dry											
22/03/2013	PCc2	Not enough sample for lab, field only											
22/03/2013	SP1	Dry											
22/03/2013	SP2	Dry											
28/03/2013	PCc3	Dry. Value listed may be incorrect. Assumed to be dry, dipper not working. Refer to data sheet.											
28/03/2013	PCc4D	Dry											
28/03/2013	PCr1A	Dry											
5/04/2013	PCc6	Dry											
5/04/2013	SP1	Dry											
9/04/2013	PCc6	Dry											
9/04/2013	SP1	Dry											
19/04/2013	PCc6	Dry											
19/04/2013	SP1	Dry											
26/04/2013	PCc6	Dry											
26/04/2013	SP1	Dry											
1/05/2013	PCc3	Dry											
1/05/2013	PCr1A	Dry											

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	5.3	83.0	53.0			6.2	48.0	51.8	14492.0	0.0
6/05/2015	PCc3	Dry											
6/05/2015	PCc5A		15.3	5.0	78.0	50.0			4.4	48.9	66.3	15625.0	0.0
6/05/2015	PCc5B		15.3	5.2	57.0	37.0			7.8	49.7	59.9	21276.0	0.0
6/05/2015	PCc5C		16.3	5.1	58.0	37.0			4.1	47.6	66.6	20408.0	0.0
6/05/2015	PCc5D		15.4	5.3	68.0	44.0			6.4	47.6	54.4	17857.0	0.0
6/05/2015	PCc6	Field Only											
6/05/2015	PCc6	Field Only	16.1	4.7	84.0	54.0			4.4	47.9	87.3	14285.0	0.0
6/05/2015	PCr1C	Forgot to press m+ on probe.											
6/05/2015	SP1	Dry											
6/05/2015	SP2	Dry											
7/05/2015	PB4A		15.4	6.2	73.0	47.0			7.3	48.0	1.0	16666.0	0.0
7/05/2015	PB4B	Battery changed, wouldnt connect or download	14.7	5.1	69.0	44.0			6.3	50.3	61.1	17857.0	0.0
7/05/2015	PB4C	Murky	14.3	4.2	82.0	53.0			6.4	51.8	112.0	15151.0	0.0
7/05/2015	PB4D	Battery fine, wont connect or download											
7/05/2015	PB4D	Battery fine, wont connect or download	14.1	4.6	65.0	42.0			5.9	48.7	90.0	19230.0	0.0
7/05/2015	PCc10A	Murky											
7/05/2015	PCc10A	Murky	14.0	4.8	72.0	46.0			6.9	50.1	78.8	17543.0	0.0
7/05/2015	PCc10B		14.1	4.7	65.0	42.0			7.0	49.9	86.2	19230.0	0.0
7/05/2015	PCc10B		14.1	4.7	65.0	42.0			6.9	49.8	86.2	19230.0	0.0
7/05/2015	PCc12B	Battery changed, wont connect or download											
7/05/2015	PCc2		15.3	4.0	94.0	61.0			4.6	53.4	124.5	12987.0	0.0
19/05/2015	PCr1B		13.1	7.1	67.0	43.0			7.4	38.5	-50.1	19230.0	0.0
19/05/2015	PCr1C		13.4	5.2	74.0	48.0			5.8	47.6	57.3	17241.0	0.0
2/06/2015	PCc3	Dry											
2/06/2015	PCc4A	Ignore comment. Delete.											
2/06/2015	PCc4A	Ignore comment. Delete.	13.1	5.1	68.0	44.0			6.4	41.5	61.1	18867.0	0.0
2/06/2015	PCc4B	Cloudy											
2/06/2015	PCc4B	Cloudy	13.7	4.8	80.0	52.0			8.4	42.8	78.6	15873.0	0.0
2/06/2015	PCc4B	Cloudy	13.8	4.8	78.0	50.0			8.3	42.8	78.1	16129.0	0.0
2/06/2015	PCc4C		12.4	4.5	68.0	44.0			6.6	43.0	91.8	19230.0	0.0
2/06/2015	PCc4D	Not enough for lab.											
2/06/2015	PCc4D	Not enough for lab.	12.4	4.5	109.0	70.0			8.6	43.6	96.2	12048.0	0.0
2/06/2015	PCc5A		12.8	4.7	66.0	42.0			5.4	43.4	81.5	19607.0	0.0
2/06/2015	PCc5B	Logger fell off, piezo removed and put back.											
2/06/2015	PCc5B	Logger fell off, piezo removed and put back.	12.0	5.1	59.0	38.0			8.8	43.3	60.2	22222.0	0.0
2/06/2015	PCc5C		11.6	4.8	56.0	36.0			5.8	39.8	76.9	23809.0	0.0
2/06/2015	PCc5D		11.7	5.1	71.0	46.0			8.1	41.9	60.8	18867.0	0.0
2/06/2015	PCc6	Dry											
2/06/2015	PCr1A	Dry											
2/06/2015	PCr1B		10.5	6.4	76.0	49.0			6.5	39.9	-9.6	18181.0	0.0
2/06/2015	PCr1C		11.6	5.1	68.0	44.0			6.8	43.7	61.8	19607.0	0.0
2/06/2015	PCr1D	Dry											
2/06/2015	SP1	Dry											
2/06/2015	SP2	Dry											
3/06/2015	PB4A		12.4	4.6	63.0	40.0			7.9	44.1	87.7	20833.0	0.0
3/06/2015	PB4B		11.3	4.4	60.0	39.0			7.7	44.0	97.9	22222.0	0.0
3/06/2015	PB4C		10.9	3.9	93.0	60.0			6.7	43.8	127.9	14705.0	0.0
3/06/2015	PB4D	not enough for lab											
3/06/2015	PCc10A	Not enough for lab. Murky.											
3/06/2015	PCc10A	Not enough for lab. Murky.	11.0	4.6	68.0	44.0			8.6	43.4	88.2	20000.0	0.0
3/06/2015	PCc10B		11.4	4.4	59.0	38.0			5.1	42.2	98.6	22727.0	0.0
3/06/2015	PCc12A	Not enough for lab. Murky.											
3/06/2015	PCc12A	Not enough for lab. Murky.	10.7	4.8	92.0	59.0			7.0	42.2	79.5	14925.0	0.0
3/06/2015	PCc2	not enough for field or lab											
1/07/2015	PCc2	Not enough for field or lab											
1/07/2015	PCc3	Dry											
1/07/2015	PCc4A	Cloudy Brown											
1/07/2015	PCc4A	Cloudy Brown	11.7	5.0	57.0	37.0			7.8	42.1	74.0	23255.0	0.0
1/07/2015	PCc4B	Cloudy Grey.											
1/07/2015	PCc4B	Cloudy Grey.	12.4	4.4	72.0	46.0			8.1	45.3	108.0	18181.0	0.0
1/07/2015	PCc4C	Muddy											
1/07/2015	PCc4C	Muddy	11.0	4.9	84.0	54.0			4.8	41.6	78.8	16129.0	0.0
1/07/2015	PCc4D	Muddy											
1/07/2015	PCc4D	Muddy	10.4	4.5	94.0	61.0			8.8	42.6	97.2	14705.0	0.0
1/07/2015	PCc5A		11.9	4.8	68.0	44.0			6.8	335.4	99.6	19607.0	0.0
1/07/2015	PCc5B	Cloudy											

1/07/2015	PCc5B	Cloudy	11.9	4.9	65.0	42.0			8.7	346.0	95.9	20408.0	0.0
1/07/2015	PCc5C	Murkey											
1/07/2015	PCc5C	Murkey	11.1	5.2	65.0	42.0			6.8	286.3	81.4	20833.0	0.0
1/07/2015	PCc5D		12.2	5.1	63.0	40.0			7.7	323.6	85.6	20833.0	0.0
1/07/2015	PCc6	Dry											
1/07/2015	PCr1A	Dry											
1/07/2015	PCr1B	Not enough for lab samples. Milky.											
1/07/2015	PCr1B	Not enough for lab samples. Milky.	10.6	6.0	81.0	52.0			8.1	279.7	41.2	16949.0	0.0
1/07/2015	PCr1C	Not enough for lab samples. "Choc Milk" in colour.											
1/07/2015	PCr1C	Not enough for lab samples. "Choc Milk" in colour.	11.3	5.3	35.0	22.0			7.5	242.7	75.6	38461.0	0.0
1/07/2015	PCr1D	Dry											
1/07/2015	SP1	Dry											
1/07/2015	SP2	Dry											
2/07/2015	PB4A	Clear/Cloudy	12.2	4.6	66.0	42.0			7.7	44.9	97.0	20000.0	0.0
2/07/2015	PB4B	Cloudy Brown	10.8	4.5	69.0	44.0			7.7	43.9	100.7	19607.0	0.0
2/07/2015	PB4C		10.5	4.0	88.0	57.0			7.5	44.1	127.3	15625.0	0.0
2/07/2015	PB4D	Not enough water for lab. Dipper playing up. Brown	10.2	4.5	46.0	29.0			8.0	43.0	102.0	30303.0	0.0
2/07/2015	PCc10A	Cloudy Brown											
2/07/2015	PCc10A	Cloudy Brown	10.3	4.5	62.0	40.0			8.5	43.1	100.3	22222.0	0.0
2/07/2015	PCc10B		10.4	4.5	63.0	40.0			5.6	42.1	99.6	21739.0	0.0
2/07/2015	PCc12A	Brown											
2/07/2015	PCc12A	Brown	10.2	4.4	97.0	63.0			4.1	41.1	104.3	14285.0	0.0
16/07/2015	PCc4A		11.3	5.6	60.0	39.0			7.6	199.0	60.8	22222.0	0.0
16/07/2015	PCc4C		10.4	4.3	70.0	45.0			5.3	389.7	125.7	19607.0	0.0
6/08/2015	PCc2	Dry											
6/08/2015	PCc3	Dry											
6/08/2015	PCc4A	Insufficient Water for Sample											
6/08/2015	PCc4B	Dry											
6/08/2015	PCc4C	Black											
6/08/2015	PCc4C	Black	10.0	4.4	67.0	43.0			5.5	296.1	117.8	20833.0	0.0
6/08/2015	PCc4D	Dry											
6/08/2015	PCc5A	Insufficient for field samples. Cloudy.											
6/08/2015	PCc5B		10.6	4.7	60.0	39.0			9.1	300.2	102.9	22727.0	0.0
6/08/2015	PCc5C	Dry											
6/08/2015	PCc5D		10.9	4.5	56.0	36.0			8.4	307.6	113.2	24390.0	0.0
6/08/2015	PCc6	Dry											
6/08/2015	PCr1A	Dry											
6/08/2015	PCr1B	Not enough for F											
6/08/2015	PCr1C	Dry											
6/08/2015	PCr1D	Dry											
6/08/2015	SP1	Dry											
6/08/2015	SP2	Dry											
9/09/2015	PCc3	Dry											
9/09/2015	PCc4A		12.9	4.6	74.0	48.0			8.2	363.4	179.6	17543.0	0.0
9/09/2015	PCc4B		13.2	4.1	80.0	52.0			8.2	409.5	207.3	16129.0	0.0
9/09/2015	PCc4C		12.6	4.3	62.0	40.0			5.7	379.9	192.9	20833.0	0.0
9/09/2015	PCc4D	Soil Moisture Battery Changed											
9/09/2015	PCc4D	Soil Moisture Battery Changed	12.5	4.1	99.0	64.0			7.9	404.0	207.0	13157.0	0.0
9/09/2015	PCc5A		12.5	4.6	59.0	38.0			7.5	377.2	180.2	22222.0	0.0
9/09/2015	PCc5B		12.9	5.0	67.0	43.0			8.1	321.8	155.3	19230.0	0.0
9/09/2015	PCc5C		13.1	5.0	59.0	38.0			7.6	338.9	157.7	21739.0	0.0
9/09/2015	PCc5D		12.5	4.9	59.0	38.0			7.4	333.5	165.0	22222.0	0.0
9/09/2015	PCc6	Dry											
9/09/2015	PCr1A	Dry											
9/09/2015	PCr1B		11.8	5.5	102.0	66.0			4.6	319.8	131.2	12987.0	0.0
9/09/2015	PCr1C	Muddy											
9/09/2015	PCr1C	Muddy	11.6	4.4	84.0	54.0			8.1	392.4	187.4	15873.0	0.0
9/09/2015	PCr1D	Dry											
9/09/2015	SP1	Dry											
9/09/2015	SP2	Dry											
10/09/2015	PB4A	Depth from spreadsheet doesnt match the fieldsheet value of 1.40	13.3	4.1	59.0	38.0			7.1	391.9	208.9	21739.0	0.0
10/09/2015	PB4B		12.6	3.6	51.0	33.0			6.3	427.6	232.4	25641.0	0.0
10/09/2015	PB4C		13.0	3.3	72.0	46.0			6.7	442.3	250.7	17857.0	0.0
10/09/2015	PB4D	Muddy.Comment: "Check total depth and stick up height"?.	12.9	4.5	44.0	28.0			5.1	346.9	186.4	29411.0	0.0
10/09/2015	PCc10A		11.4	3.8	49.0	31.0			7.1	405.3	219.1	27027.0	0.0
10/09/2015	PCc10B		11.8	3.7	62.0	40.0			5.1	421.9	226.9	21276.0	0.0
10/09/2015	PCc12A	Cloudy											
10/09/2015	PCc12A	Cloudy	11.8	4.2	102.0	66.0			5.3	400.4	198.5	12987.0	0.0
10/09/2015	PCc12B	Dry											
10/09/2015	PCc2		13.9	3.8	63.0	40.0			7.3	417.7	224.8	20000.0	0.0
3/10/2015	PCc2	Field only											
7/10/2015	PCc3	Dry											
7/10/2015	PCc4A		13.6	5.2	74.0	48.0			6.5	39.2	60.9	17241.0	0.0
7/10/2015	PCc4B	Not enough for field											
7/10/2015	PCc4C		13.8	5.4	71.0	46.0			2.9	39.2	49.6	17857.0	0.0
7/10/2015	PCc4D	Dry											
7/10/2015	PCc5A	Not enough for F											
7/10/2015	PCc5B		14.0	5.4	63.0	40.0			8.2	41.8	51.8	20000.0	0.0
7/10/2015	PCc5C	Not enough for field											
7/10/2015	PCc5D		13.3	5.3	56.0	36.0			7.8	42.4	56.2	22727.0	0.0
7/10/2015	PCc6	Dry											
7/10/2015	PCr1A	Dry											
7/10/2015	PCr1B	Not enough for field											
7/10/2015	PCr1C	Dry; Check TD											
7/10/2015	PCr1D	Dry											
7/10/2015	SP1	Dry											
7/10/2015	SP2	Dry											
4/11/2015	PB4A		15.7	4.8	49.0	31.0			5.5	39.9	82.8	24390.0	0.0
4/11/2015	PB4B		15.2	4.4	38.0	24.0			5.4	40.9	106.1	32258.0	0.0
4/11/2015	PB4C		15.1	3.8	99.0	64.0			6.7	42.1	140.4	12345.0	0.0
4/11/2015	PCc10A		15.8	4.6	49.0	31.0			3.8	39.2	97.4	24390.0	0.0
9/11/2015	PCc10B	No field data											
9/11/2015	PCc12B	Dry											
9/11/2015	PCc2	Cloudy	17.6	6.4	94.0	61.0			6.8	38.2	-8.4	12345.0	0.0
9/11/2015	PCc2	Cloudy											
11/11/2015	PCc3	Dry											
11/11/2015	PCc4A		16.7	4.6	43.0	27.0			6.2	43.3	97.1	27027.0	0.0
11/11/2015	PCc4B	Dry											
11/11/2015	PCc4C		15.0	4.5	71.0	46.0			4.4	41.7	104.0	17241.0	0.0
11/11/2015	PCc4D	Not enough for field or lab											
11/11/2015	PCc5A		16.0	4.6	65.0	42.0			6.8	42.7	94.3	18518.0	0.0
11/11/2015	PCc5B		15.9	4.6	59.0	38.0			4.5	41.9	95.0	20408.0	0.0
11/11/2015	PCc5C	Not enough for lab											
11/11/2015	PCc5D		15.3	4.8	54.0	35.0			5.0	39.3	87.5	22727.0	0.0
11/11/2015	PCc6	Dry											

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 restarded? 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											

20/10/2016	PCc4B	dry											
20/10/2016	PCc6	Dry											
20/10/2016	SP1	Dry											
20/10/2016	SP2	Dry											
31/10/2016	PCc10A	Too low for field samples											
6/11/2016	PCr1B	Dry											
16/11/2016	PCc3	Dry											
16/11/2016	PCc4A	Dry											
16/11/2016	PCc4B	Dry											
16/11/2016	PCc4C	Dry											
16/11/2016	PCc4D	Dry											
16/11/2016	PCc5A	Dry											
16/11/2016	PCc5B	Not enough water to take WQ or Lab sample; milky brown colour											
16/11/2016	PCc5C	Dry											
16/11/2016	PCc5D	Dry											
16/11/2016	PCc6	Dry											
16/11/2016	PCr1A	Dry											
16/11/2016	PCr1C	Dry											
16/11/2016	PCr1D	Dry											
16/11/2016	SP1	Dry											
16/11/2016	SP2	Dry											
21/11/2016	PB4A	200ml collected in solids bottle. Milky Brown.	17.9	5.0	79.0	51.0			2.2	123.2	76.6	14492.0	0.0
21/11/2016	PB4A	200ml collected in solids bottle. Milky Brown.											
21/11/2016	PB4B	small black colloid; looks organic	17.7	5.0	83.0	53.0			3.9	112.6	78.2	13888.0	0.0
21/11/2016	PB4C	Dry											
21/11/2016	PB4D	Data missing see field sheets for details. "Logger appears not to have been restarted on the 21/11/17"											
21/11/2016	PCc10A	No data?											
21/11/2016	PCc10B	Dry											
21/11/2016	PCc12A	Dry											
21/11/2016	PCc12B	Dry											
21/11/2016	PCc2	Dry											
7/12/2016	PCc3	Dry											
7/12/2016	PCc4A	Dry											
7/12/2016	PCc4B	dry											
7/12/2016	PCc4C	Dry											
7/12/2016	PCc4D	Dry											
7/12/2016	PCc5A	Dry											
7/12/2016	PCc5B	Dry											
7/12/2016	PCc5D	Dry											
7/12/2016	PCc6	Dry											
7/12/2016	PCr1A	QA/QC up to here (AD)											
7/12/2016	PCr1B	Dry											
7/12/2016	PCr1C	Dry											
7/12/2016	PCr1D	Dry											
7/12/2016	SP1	Dry											
7/12/2016	SP2	Dry											
8/12/2016	PB4A	Dry											
8/12/2016	PB4B	Clear with brown particles	19.9	4.8	85.0	55.0			1.9	138.7	87.2	12987.0	0.0
8/12/2016	PB4C	Dry											
8/12/2016	PB4D	Dry											
8/12/2016	PCc10A	Dry											
8/12/2016	PCc10B	Dry											
8/12/2016	PCc12A	Dry											
8/12/2016	PCc12B	Dry											
8/12/2016	PCc2	Dry											
7/01/2017	PCc4C	Dry											
16/01/2017	PCc3	Dry											
16/01/2017	PCc4A	Dry											
16/01/2017	PCc4B	Dry											
16/01/2017	PCc4C	Dry											
16/01/2017	PCc4D	QA/QC up to here (AD)											
16/01/2017	PCc5A	QA/QC up to here (AD)											
16/01/2017	PCc5B	QA/QC up to here (AD)											
16/01/2017	PCc5C	Dry											
16/01/2017	PCc5D	QA/QC up to here (AD)											
16/01/2017	PCc6	Dry											
16/01/2017	PCr1A	Dry											
16/01/2017	PCr1B	QA/QC up to here (AD)											
16/01/2017	PCr1C	QA/QC up to here (AD)											
16/01/2017	PCr1D	Dry											
16/01/2017	SP1	Dry											
16/01/2017	SP2	Dry											
20/01/2017	PB4A	QA/QC up to here (AD)											
20/01/2017	PB4B	QA/QC up to here (AD)											
20/01/2017	PB4C	Dry											
20/01/2017	PB4D	QA/QC up to here (AD)											
20/01/2017	PCc10A	QA/QC up to here (AD)											
20/01/2017	PCc10B	QA/QC up tp here (AD)											
20/01/2017	PCc12A	QA/QC up to here (AD)											
20/01/2017	PCc12B	QA/QC up to here (AD)											
20/01/2017	PCc2	Dry											
19/04/2017	PCc4B		18.3	4.7	79.0	51.0	5.6	77.9	7.1	306.8	88.5	14492.0	0.0
19/04/2017	PCc4C	Battery dead											
19/04/2017	PCc4C	Battery dead	17.7	5.3	73.0	47.0	10.2	53.2	4.9	298.6	60.0	15873.0	0.0
19/04/2017	PCc4D		16.8	4.5	85.0	55.0	8.8	57.8	5.5	312.9	96.2	13888.0	0.0
19/04/2017	PCc5A		18.0	5.3	70.0	45.0	1.5	40.1	3.7	277.5	60.4	16393.0	0.0
19/04/2017	PCc5B	Battery appeared to be dead on the 19/4/17, logger not downloaded - looks like logger was not able to be restarted. Looks like the probe stopped logging between the 19/4/17 - 22/6/17 due to the attempted DL on the 19th. Data block dates are 16/1/17 - 22/6/17 from the download on the 22ed.	17.9	5.1	77.0	50.0	5.8	82.1	7.6	290.9	68.6	14925.0	0.0
19/04/2017	PCc5B	Battery appeared to be dead on the 19/4/17, logger not downloaded - looks like logger was not able to be restarted. Looks like the probe stopped logging between the 19/4/17 - 22/6/17 due to the attempted DL on the 19th. Data block dates are 16/1/17 - 22/6/17 from the download on the 22ed.											
19/04/2017	PCc5C		18.1	5.0	59.0	38.0	3.1	52.5	4.8	292.2	76.3	19230.0	0.0
19/04/2017	PCc5D		17.7	4.9	73.0	47.0	3.2	57.9	5.4	295.5	81.0	15873.0	0.0
19/04/2017	PCc6	Dry											
19/04/2017	PCr1A	Dry											
19/04/2017	PCr1B	Probe pls, wachiness	16.6	6.3	71.0	46.0	15.3	50.5	4.8	251.8	10.7	16666.0	0.0
19/04/2017	PCr1C	Dry; Not enough to bail											
19/04/2017	PCr1D	Dry											

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											

18/09/2017	PB4A	Cloudy with white material	15.0	5.1	111.0	72.0	178.0	68.4	6.6	285.8	91.9	11111.0	0.0
18/09/2017	PB4B	Clear with small black specks.	14.2	4.7	143.0	92.0	44.6	66.5	6.6	270.7	117.8	8771.0	0.1
18/09/2017	PB4C	Dry											
18/09/2017	PB4D	Probe cooked, to be replaced											
18/09/2017	PCc10B	Dry											
18/09/2017	PCc12A	Dry											
18/09/2017	PCc12B	Dry											
18/09/2017	PCc2	Dry											
27/09/2017	PCc10A	Not enough to sample											
19/10/2017	PCc12A	Dry											
19/10/2017	PCc12B	Dry											
19/10/2017	PCc3	Dry											
19/10/2017	PCc4A	Dry											
19/10/2017	PCc4B	Dry; logger lost down pipe											
19/10/2017	PCc4C	Dry											
19/10/2017	PCc4D	Dry											
19/10/2017	PCc5A	Dry											
19/10/2017	PCc5B	Dry											
19/10/2017	PCc5C	Dry											
19/10/2017	PCc5D	Dry											
19/10/2017	PCc6	Dry. Subsidence hole just before site has increased in size.											
19/10/2017	PCr1A	Dry											
19/10/2017	PCr1B	No data until 13.11.17 - fieldsheet reads: "battery tested ok - DL without message - not in folder".											
19/10/2017	PCr1C	Dry											
19/10/2017	PCr1D	Dry											
19/10/2017	SP1	Dry											
19/10/2017	SP2	Dry											
20/10/2017	PB4A	Dry											
20/10/2017	PB4C	Dry											
20/10/2017	PB4D	Not enough to bail for probe. Brown.											
20/10/2017	PCc10A	Dry											
20/10/2017	PCc10B	Logger was not communicating with the laptop, could not download data - 15/11/17											
13/11/2017	PCc3	dry											
13/11/2017	PCc4A	Dry											
13/11/2017	PCc4B	Dry; logger lost down pipe											
13/11/2017	PCc4C	Dry											
13/11/2017	PCc4D	Dry											
13/11/2017	PCc5A	Dry											
13/11/2017	PCc5B	Dry											
13/11/2017	PCc5C	Dry											
13/11/2017	PCc5D	Dry											
13/11/2017	PCr1A	Dry											
13/11/2017	PCr1B	Dry											
13/11/2017	SP1	Dry											
13/11/2017	SP2	Dry											
15/11/2017	PB4A	Dry											
15/11/2017	PB4B	Dry											
15/11/2017	PB4C	Dry											
15/11/2017	PB4D	battery ok (no value mentioned, wrote default value (7))											
15/11/2017	PCc10A	Dry; Logger did not download											
15/11/2017	PCc10B	Dry. Logger did not download.											
15/11/2017	PCc12A	Dry. "Check graph - looks bad"											
15/11/2017	PCc12B	Dry											
15/11/2017	PCc2	Dry. Logger did not download.											
20/12/2017	PB4A	Soil Moisture not downloaded. Cable not working.	21.3	8.2	191.0	124.0	13.2	96.0	8.1	270.2	-83.3	5617.0	0.1
20/12/2017	PB4B	Not enough to bail											
20/12/2017	PB4C	Dry											
20/12/2017	PB4D	Dry											
20/12/2017	PCc10A	Dry											
20/12/2017	PCc10B	Dry											
20/12/2017	PCc12A	Dry											
20/12/2017	PCc12B	Dry											
20/12/2017	PCc2	Dry											
21/12/2017	PCc3	Dry											
21/12/2017	PCc4A	Dry											
21/12/2017	PCc4B	levelogger down the pipe											
21/12/2017	PCc4C	Dry											
21/12/2017	PCc4D	Dry											
21/12/2017	PCc5A	Dry											
21/12/2017	PCc5B		17.4	5.0	194.0	126.0	42.8	38.9	3.6	248.8	72.1	6024.0	0.1
21/12/2017	PCc5C	Dry											
21/12/2017	PCc5D	Not enough to bail											
21/12/2017	PCc6	Dry											
21/12/2017	PCr1A	Dry											
21/12/2017	PCr1B	Dry											
21/12/2017	PCr1C	Dry											
21/12/2017	PCr1D	Dry											
21/12/2017	SP1	Dry											
21/12/2017	SP2	Dry											
17/01/2018	PCc12A	dry											
17/01/2018	PCc12B	Dry											
17/01/2018	PCc3	Dry											
17/01/2018	PCc4A	Dry											
17/01/2018	PCc4C	Dry											
17/01/2018	PCc4D	Dry											
17/01/2018	PCc5A	Dry											
17/01/2018	PCc5B	Not enough water; water smelt like methane											
17/01/2018	PCc5C	Dry											
17/01/2018	PCc5D	Dry. Logger not connecting. Logger replaced 18/1/18											
17/01/2018	PCc6	Dry											
17/01/2018	PCr1A	Dry											
17/01/2018	PCr1B	Dry											
17/01/2018	PCr1C	Dry											
17/01/2018	PCr1D	Dry											
17/01/2018	SP1	Dry											
17/01/2018	SP2	Dry											
18/01/2018	PB4A	Dry											
18/01/2018	PB4B	Dry											
18/01/2018	PB4D	Dry											
18/01/2018	PCc10A	Dry											
18/01/2018	PCc10B	Dry											
18/01/2018	PCc2	Dry											
18/01/2018	PCc4B	Logger retrieved, using DIY fish hook											

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 containmination 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 containmination 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 flluctuate 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											

16/07/2018	PCc4D	Dry											
16/07/2018	PCc5A	Dry											
16/07/2018	PCc5B	Not enough water to bail											
16/07/2018	PCc5C	Dry											
16/07/2018	PCc5D	Dry											
16/07/2018	PCc6	Dry											
16/07/2018	PCr1A	Dry. Level logger dented a bit in the mid body (see photos)											
16/07/2018	PCr1B	Dry											
16/07/2018	PCr1C	Dry											
16/07/2018	PCr1D	Dry											
16/07/2018	SP1	Dry											
16/07/2018	SP2	Dry											
20/07/2018	PB4A	Dry											
20/07/2018	PB4B	Not enough water; total depth seems wrong											
20/07/2018	PB4C	Dry											
20/07/2018	PB4D	logger did not restart after downloading - restarting laptop and unscrewing battery did not work. Logger successfully restarted after unscrewing the logger											
20/07/2018	PCc10A	Dry											
20/07/2018	PCc10B	Dry											
20/07/2018	PCc12A	Dry											
20/07/2018	PCc12B	Dry											
20/07/2018	PCc2	Dry											
6/08/2018	PCc4B	Dry											
14/08/2018	PCc3	Dry											
14/08/2018	PCc4A	Dry											
14/08/2018	PCc4B	Dry											
14/08/2018	PCc4C	Dry											
14/08/2018	PCc4D	Dry											
14/08/2018	PCc5A	Dry											
14/08/2018	PCc5B	Dry											
14/08/2018	PCc5C	Dry											
14/08/2018	PCc5D	Dry											
14/08/2018	PCc6	Dry											
14/08/2018	PCr1A	Dry											
14/08/2018	PCr1B	Dry											
14/08/2018	PCr1C	Dry											
14/08/2018	PCr1D	Dry											
14/08/2018	SP1	Dry											
14/08/2018	SP2	Dry											
20/08/2018	PB4A	Dry											
20/08/2018	PB4B	Dry											
20/08/2018	PB4C	Dry											
20/08/2018	PB4D	everything ok											
20/08/2018	PCc10A	Dry											
20/08/2018	PCc10B	Dry											
20/08/2018	PCc12A	Solinst fell down pipe, had to pull out pipe, get the looger and then re-insert											
20/08/2018	PCc12B	Dry											
20/08/2018	PCc2	Dry											
24/09/2018	PCc3	Dry											
24/09/2018	PCc4A	Dry											
24/09/2018	PCc4B	Dry											
24/09/2018	PCc4C	Dry											
24/09/2018	PCc4D	Dry											
24/09/2018	PCc5A	Logger was not responding.											
24/09/2018	PCc5B	Dry											
24/09/2018	PCc5C	Dry											
24/09/2018	PCc5D	Dry											
24/09/2018	PCc6	Dry											
24/09/2018	PCr1A	Dry											
24/09/2018	PCr1B	Dry											
24/09/2018	PCr1C	Dry											
24/09/2018	PCr1D	Dry											
24/09/2018	SP1	Dry											
24/09/2018	SP2	Dry											
26/10/2018	PB4A	Old batt was 1.7V and couldnt connect to logger. Replaced battery, new voltage was 6.8V											
26/10/2018	PB4B	Dry											
26/10/2018	PB4C	Dry											
26/10/2018	PB4D	Dry											
26/10/2018	PCc10A	Dry											
26/10/2018	PCc10B	Dry											
26/10/2018	PCc12A	Dry											
26/10/2018	PCc12B	Dry											
26/10/2018	PCc2	Not enough water to bail											
26/10/2018	PCc3	Dry											
26/10/2018	PCc4A	Dry											
26/10/2018	PCc4B	Dry											
26/10/2018	PCc4C	Dry											
26/10/2018	PCc4D	Dry											
26/10/2018	PCc5A	Couldnt download. Didnt restart last time. Data stopped 24/9/18 due to restart failure. Restarted successfully this time.											
26/10/2018	PCc5B		17.5	4.8	157.0	102.0	1.7	71.7	6.6	309.9	100.4	7407.0	0.1
26/10/2018	PCc5C	Dry											
26/10/2018	PCc5D	Dry											
26/10/2018	PCc6	Dry											
26/10/2018	PCr1A	Dry											
26/10/2018	PCr1C	Data stopped at 24/9/18 due to restart faiure. Restarted successfully											
26/10/2018	PCr1D	Dry											
26/10/2018	SP1	Dry											
26/10/2018	SP2	Dry											
29/10/2018	PB4A		15.6	4.7	190.0	123.0	2.5	93.9	9.0	363.2	107.8	6410.0	0.1
21/11/2018	PCc3	Dry											
21/11/2018	PCc4A	Dry											
21/11/2018	PCc4B	Dry											
21/11/2018	PCc4C	Dry											
21/11/2018	PCc4D	Dry											
21/11/2018	PCc5A	Dry											
21/11/2018	PCc5B		18.3	6.3	149.0	96.0	30.1	36.1	3.2	356.3	7.1	7692.0	0.1
21/11/2018	PCc5C	Dry											
21/11/2018	PCc5D	Dry											
21/11/2018	PCc6	Dry											
21/11/2018	PCr1A	Dry											

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 attemt	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. Consendation 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/l 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	Alll 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 sensosrs reading zero											
24/02/2020	PCc5D	Battery Changed new vltage 7.23 V, All sensosrs 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

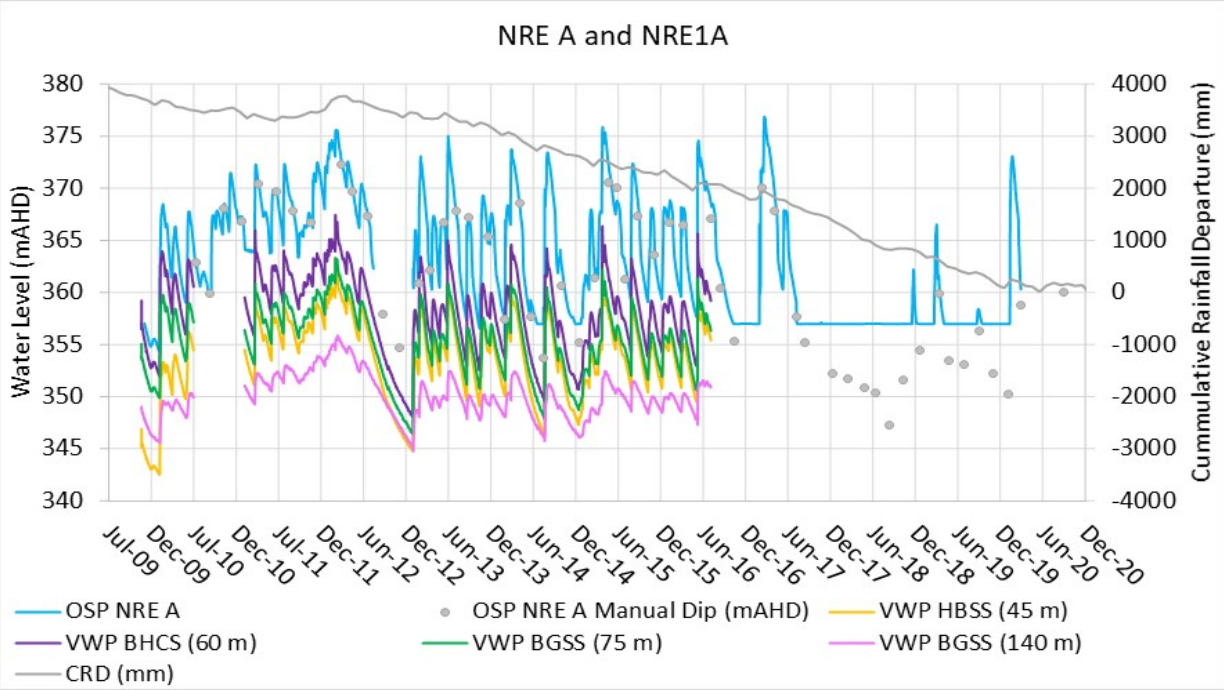
25/02/2020	PCc12A	Block already downloaded, sensor 2 to 5 reading mostly zeros	20.6	4.9	201.0	130.0	439.0	61.8	5.3	244.8	67.7	5405.0	0.1
25/02/2020	PCc12A	Block already downloaded, sensor 2 to 5 reading mostly zeros											
25/02/2020	PCc12B	Dark Brown											
25/02/2020	PCc2	milky											
25/02/2020	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 senors 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 senors reading zero											
20/04/2020	PCc5A	Fluctuations in sensor 1 data, rest all senors 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 picls up moisture											
15/06/2020	PCc5D	murky grey, dipper not detecting water depth, approx depth obtained from lowering the dipper until it picls 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											

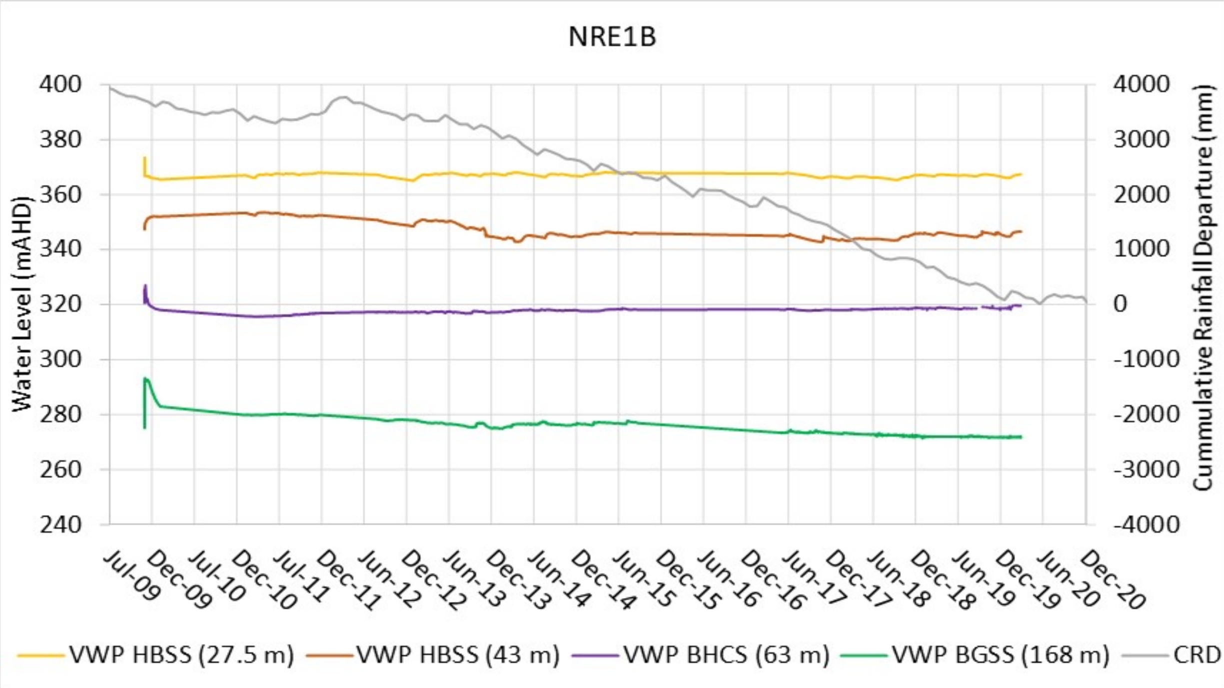
10/09/2020	PCc4C	slightly cloudy	13.4	4.9	77.7		21.1	29.1	3.0	335.4			
10/09/2020	PCc4D	Black											
10/09/2020	PCc4D	Black	12.6	4.5	125.8		533.5	62.2	6.5	383.0			
10/09/2020	PCc5A	Mlky											
10/09/2020	PCc5A	Mlky	14.3	5.1	80.1		221.1	49.9	5.0	344.4			
10/09/2020	PCc5B	only 3 data rows, rusty 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			

APPENDIX C – GROUNDWATER BASELINE DATA – WATER LEVEL

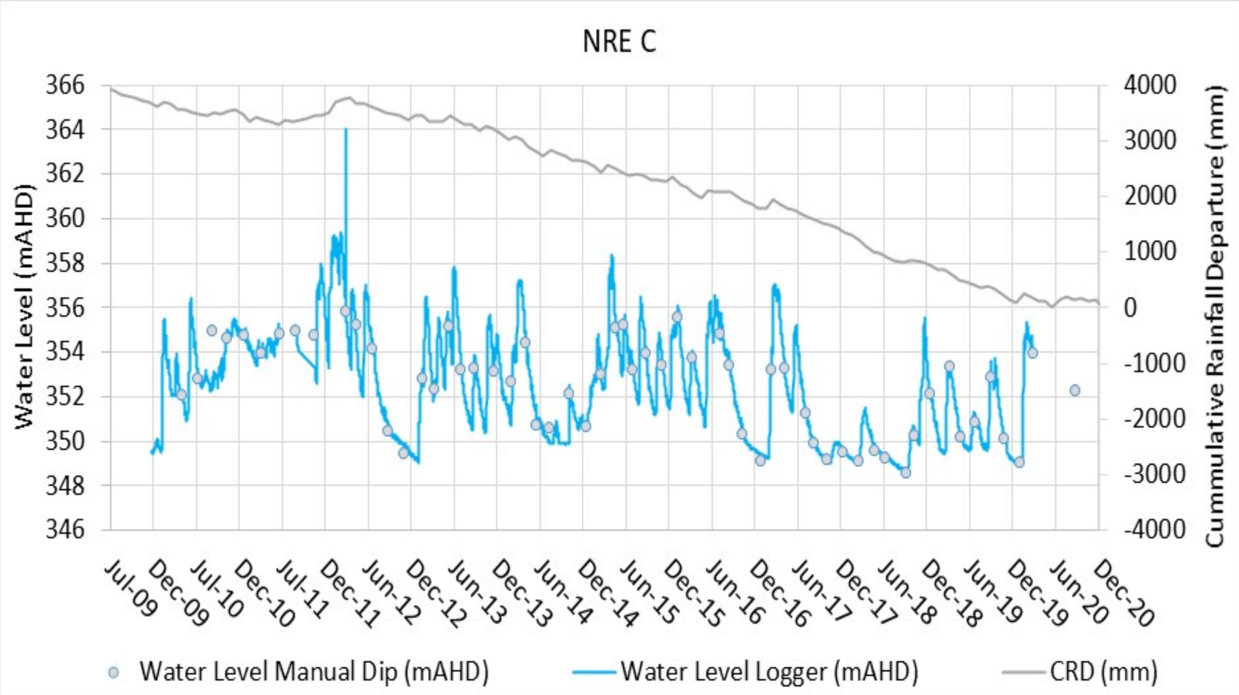
NRE A and NRE1A (VWP)



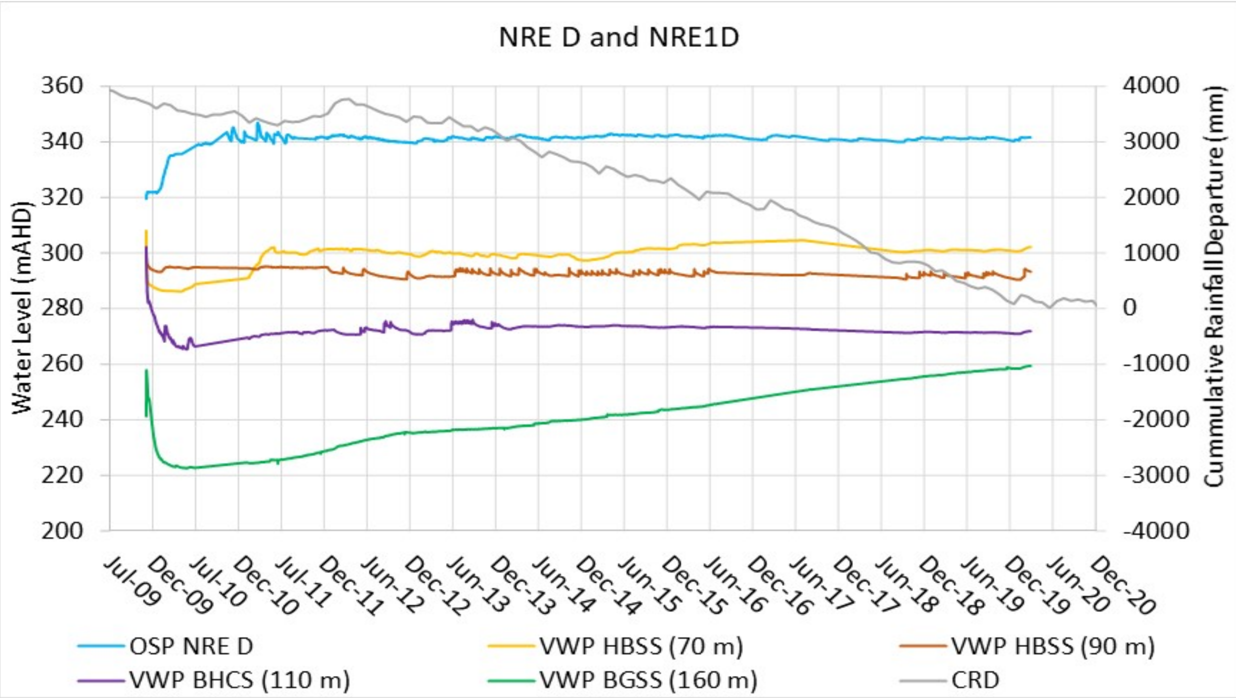
NRE1B (VWP)



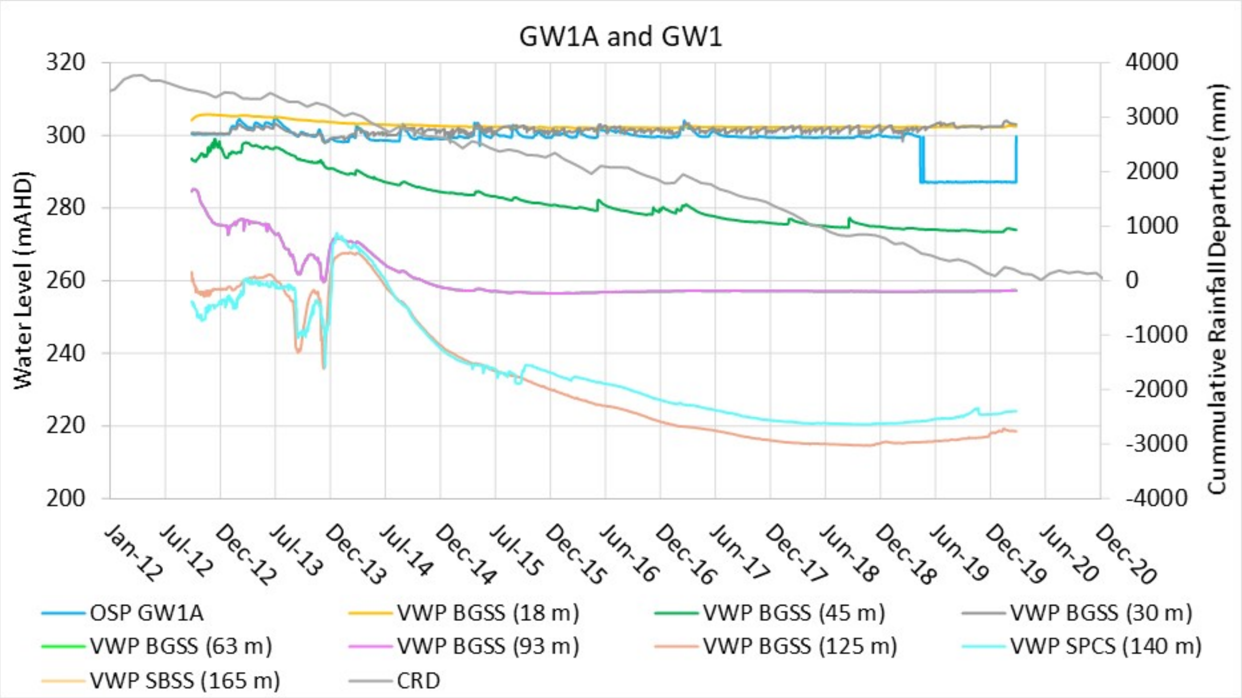
NRE C



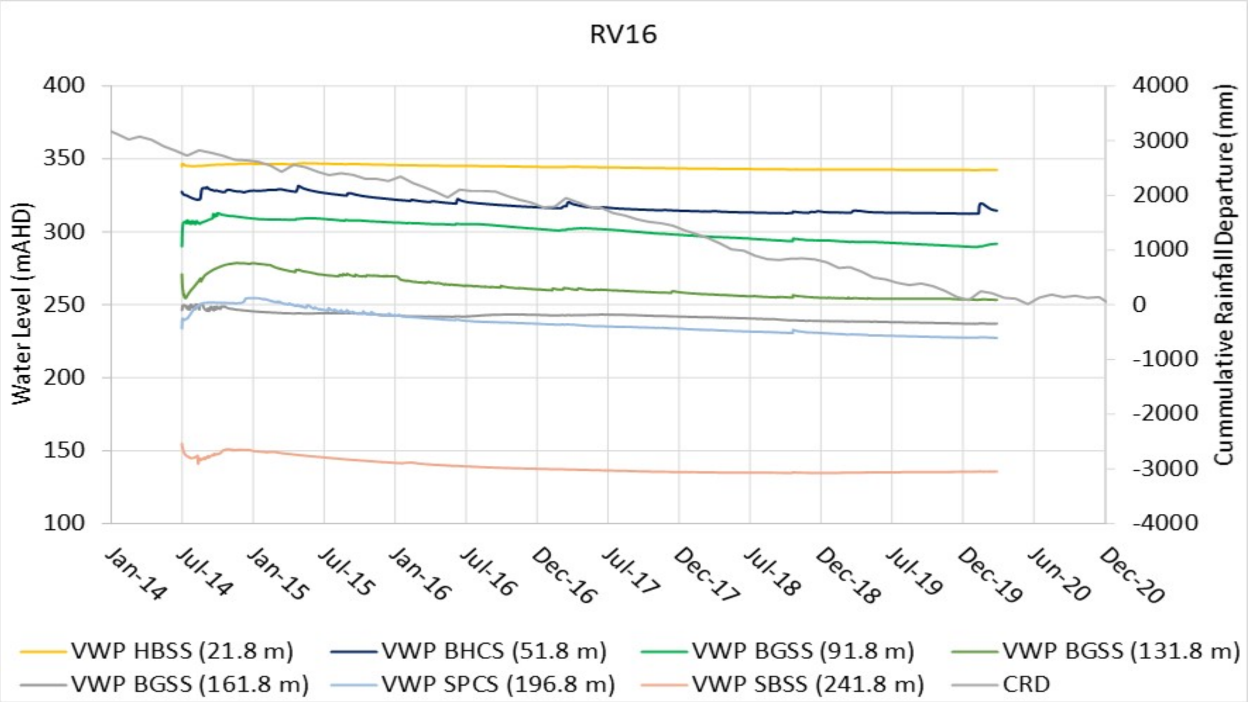
NRE D and NRE1D (VWP)



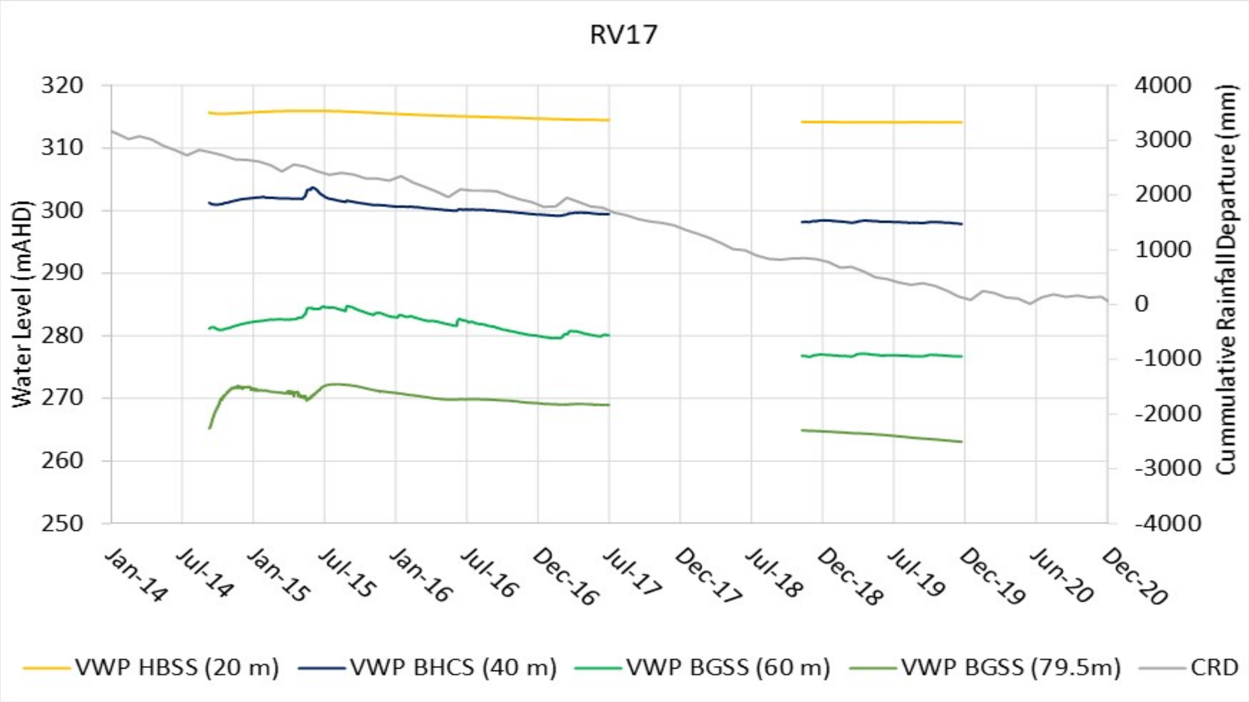
GW1A and GW1 (VWP)



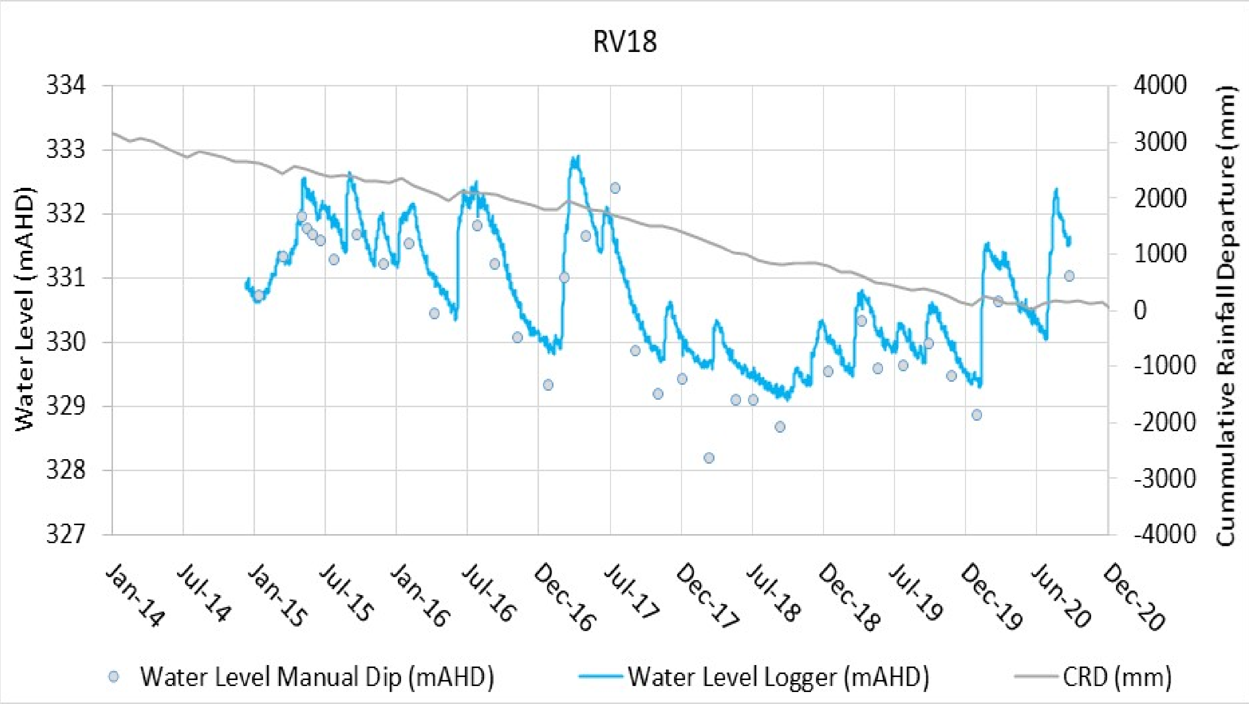
RV16 (VWP)



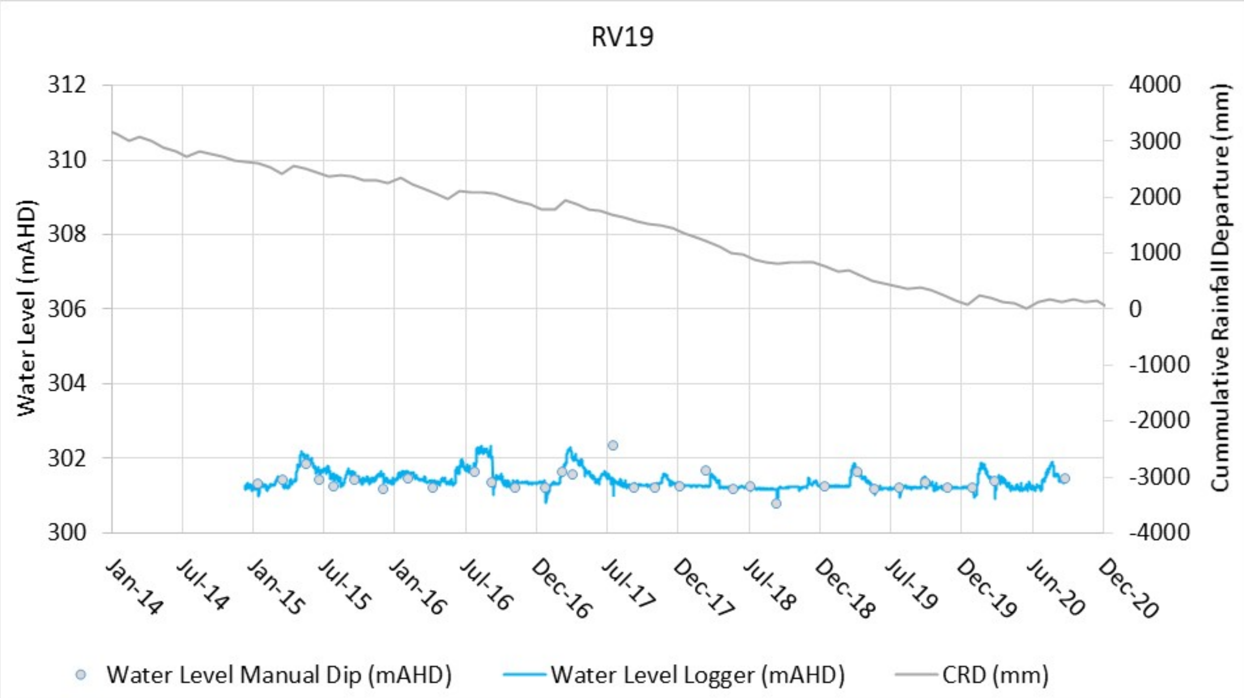
RV17 (VWP)



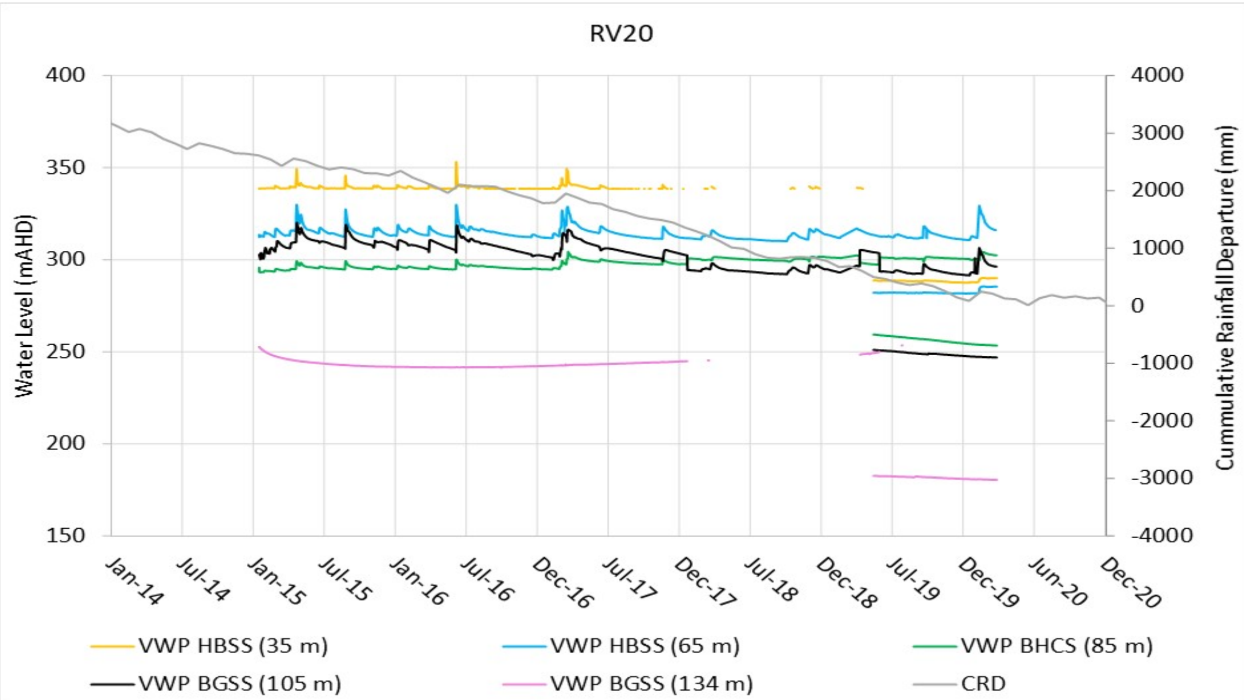
RV18



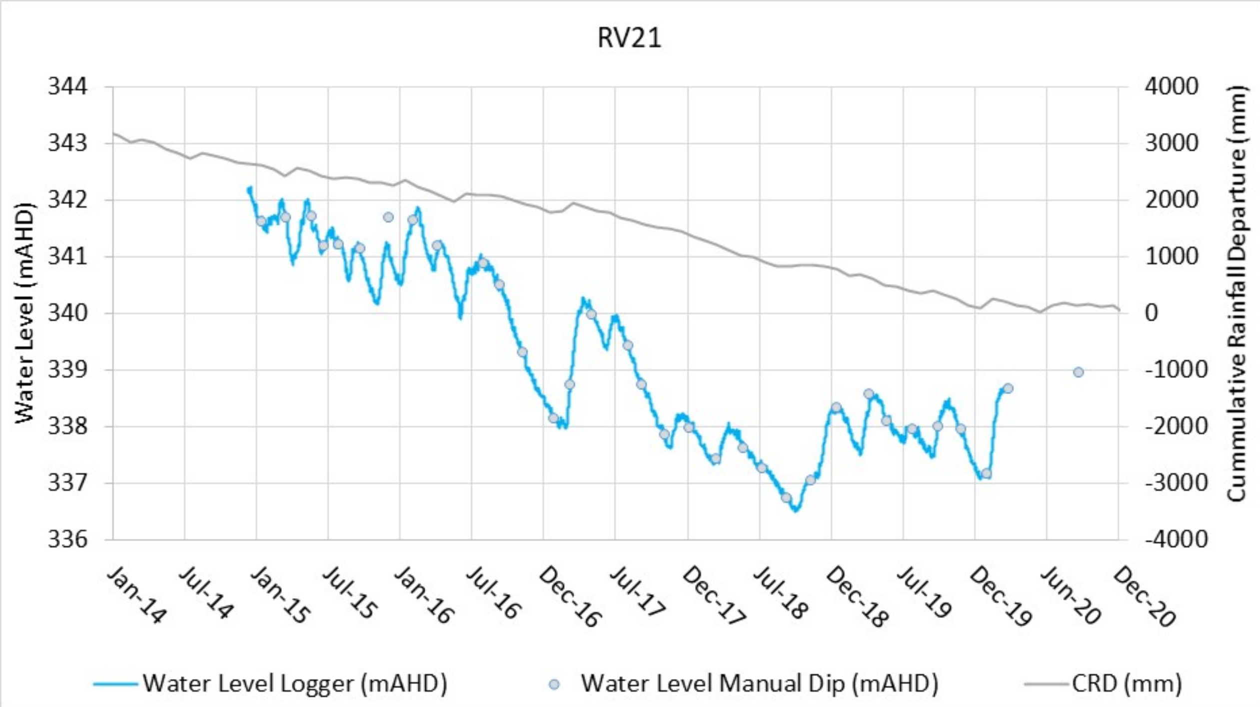
RV19



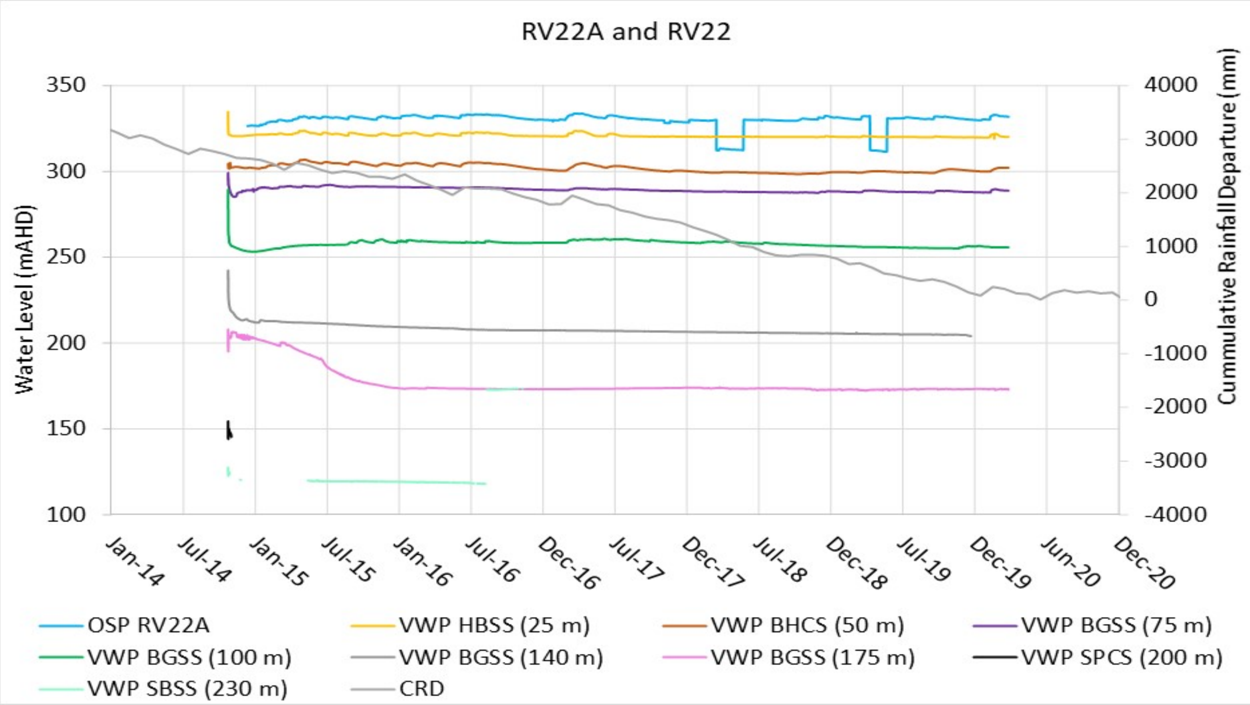
RV20 (VWP)



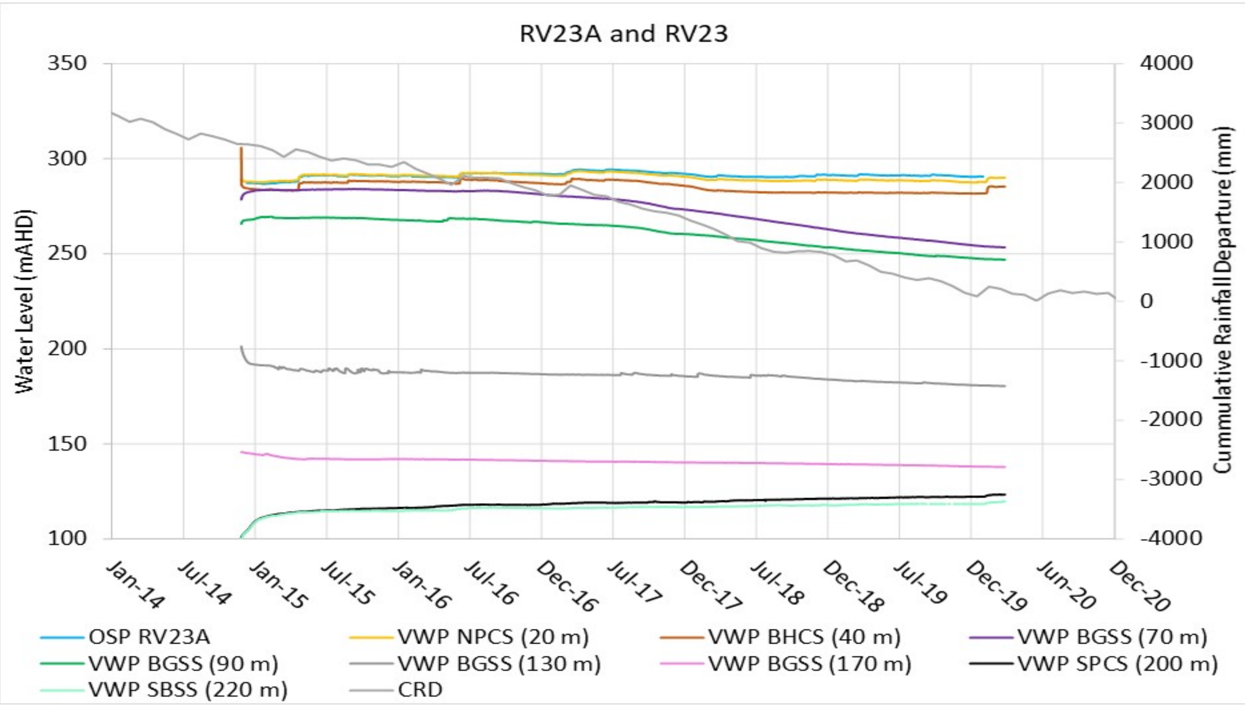
RV21



RV22A and RV22 (VWP)



RV23A and RV23 (VWP)



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 Filt (mg/L)	Mn T (mg/L)	Filt Mn (mg/L)	Filt Cu (mg/L)	Filt Pb (mg/L)	Filt Zn (mg/L)	Filt Ni (mg/L)	Filt Al (mg/L)	Filt As (mg/L)	Filt Li (mg/L)	Filt Ba (mg/L)	Filt 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	0.012	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	0.096	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	0.017	0.116	0.043	2	0.3	0.33		1.59	1.61
1/08/2013	NRE A	9:30:00 AM						157.0							11	23	1	3	13	0.1	72	1	11.8	0.48	0.115	0.11	0.015	0.017	0.058	0.008	1.24	0.001	0.001	0.01	0.106	2	1	0.07		1.9	1.87
1/08/2013	NRE C							56.0							9	1	1	1	13	0.1	16	1	0.43	0.05	0.024	0.021	0.002	0.002	0.01	0.001	0.24	0.001	0.001	0.004	0.006	2	8.1	0.06		0.47	0.7
1/08/2013	NRE D							68.0							15	1	1	2	28	0.1	5	1	0.53	0.07	0.028	0.025	0.002	0.008	0.02	0.001	0.51	0.001	0.001	0.008	0.013	1	0.2	0.01		0.82	0.89
1/08/2013	NRE E							139.0							30	13	1	4	51	0.1	33	1	7.09	0.54	0.095	0.088	0.002	0.001	0.015	0.002	0.1	0.001	0.001	0.016	0.057	2	1.6	0.1		2.28	2.13
1/08/2013	NRE F							87.0							20	1	1	2	33	0.1	11	1	0.9	0.21	0.036	0.033	0.002	0.001	0.012	0.001	0.16	0.001	0.001	0.007	0.008	2	1.4	0.01		1.08	1.16
1/08/2013	NRE G							108.0							24	4	1	3	42	0.1	16	1	0.61	0.05	0.09	0.082	0.003	0.004	0.056	0.005	0.31	0.001	0.001	0.012	0.073	1	0.2	0.01		1.49	1.52
26/02/2014	GW1A		16.1	6.2	268.0		174.0	189.0		3.8	105.1	28.2	4484.0	0.1	27	12	5	8	50	0.1	18	44	19.5	16.5	1.03	1.01	0.01	<0.001	0.086	0.029	0.01	<0.001	0.02	0.229	0.08	3	2.7	0.36	8.49	2.56	2.66
26/02/2014	NRE C	11:03:37 AM	19.6	5.1	62.0		40.0			6.0	318.5	92.7	17857.0	0.0																											
26/02/2014	NRE C		19.6	5.1	62.0		40.0	47.0		6.0	318.5	92.7	17857.0	0.0	12	1	<1	1	22	<0.1	5	<1	11	0.57	0.11	0.108	0.002	<0.001	0.012	0.002	0.17	<0.001	<0.001	0.006	0.008	1	0.1	<0.01	5.27	0.65	0.72
26/02/2014	NRE D		19.3	4.9	100.0		65.0	67.0		7.9	329.4	103.0	11111.0	0.0	19	2	<1	2	33	<0.1	5	<1	7.46	0.24	0.044	0.032	0.004	0.007	0.022	0.001	0.47	<0.001	<0.001	0.009	0.017	1	0.3	0.02	7.15	1.09	1.03
26/02/2014	NRE E							208.0							40	10	2	10	80	<0.1	8	34	62.4	19.2	0.863	0.885	0.003	<0.001	0.033	0.017	<0.01	<0.001	0.009	0.211	0.054	2	2.8	0.02	9.68	3.11	3.1
26/02/2014	NRE F							147.0							42	2	2	7	72	<0.1	6	3	3.31	0.6	0.467	0.463	0.005	<0.001	0.102	0.014	0.07	<0.001	0.004	0.018	0.016	2	1	0.03	9.21	2.55	2.53
26/02/2014	NRE G							108.0							30	<1	1	4	50	<0.1	4	<1	0.32	0.06	0.135	0.133	0.005	0.005	0.1	0.008	0.21	0.001	0.001	0.016	0.01	2	0.5	<0.01	0.32	1.66	1.49
1/05/2014	NRE A	2:35:00 PM	16.1	4.3	124.0		80.0			6.7	374.2	138.4	9708.0	0.0																											
1/05/2014	NRE C	3:08:04 PM	17.9	5.0	82.0		53.0			7.0	389.8	96.2	14084.0	0.0																											
13/08/2014	GW1A	12:05:42 PM	15.0	6.0	270.0		175.0			6.6	146.1	34.3	4566.0	0.1																											
13/08/2014	GW1A		14.4	5.9	308.0		200.0	219.0		5.6	33.0	33.5	4065.0	0.1	25	13	2	8	51	0.1	18	56	18.4	16.8	0.92	0.926	0.001	0.001	0.017	0.018	0.02	0.001	0.02	0.265	0.096	1	0.6	0.22	8.46	2.52	2.93
13/08/2014	NRE A	1:16:00 PM	17.2	5.0	129.0		83.0			6.4	300.8	95.3	9090.0	0.0																											
13/08/2014	NRE A		15.9	4.2	198.0		128.0	134.0		4.0	357.3	130.9	6097.0	0.1	10	8	1	3	24	0.1	55	1	19	6.86	0.242	0.232	0.01	0.008	0.048	0.007	0.32	0.001	0.001	0.012	0.046	1	0.4	0.02	6.9	1.54	1.82
13/08/2014	NRE C	1:07:44 PM	17.9	5.0	82.0		53.0			7.0	389.8	96.2	14084.0	0.0																											
13/08/2014	NRE C	1:07:44 PM	17.0	4.6	75.0		48.0			6.6	381.2	108.5	15625.0	0.0																											
13/08/2014	NRE C		17.0	4.6	75.0		48.0	68.0		6.6	381.2	108.5	15625.0	0.0	9	1	1	1	25	0.1	5	1	3.76	0.08	0.118	0.124	0.001	0.002	0.01	0.001	0.14	0.001	0.001	0.007	0.008	1	1.1	0.01	5.35	0.53	0.81
13/08/2014	NRE D	12:38:06 PM	17.9	4.7	126.0		81.0			8.2	358.2	111.7	9174.0	0.0																											
13/08/2014	NRE D		15.6	4.8	119.0		77.0	84.0		9.1	356.1	96.9	10204.0	0.0	14	1	1	2	37	0.1	6	1	2.85	0.05	0.032	0.025	0.002	0.008	0.024	0.002	0.57	0.001	0.001	0.01	0.014	1	0.3	0.01	6.24	0.91	1.17
13/08/2014	NRE E							210.0							31	10	1	8	82	0.1	18	32	20.7	7.82	0.75	0.731	0.001	0.001	0.012	0.012	0.01	0.001	0.008	0.128	0.071	1	0.6	0.03	6.66	2.99	3.33
13/08/2014	NRE F							154.0							37	2	1	6	79	0.1	6	4	3.8	0.61	0.462	0.453	0.001	0.001	0.054	0.011	0.06	0.001	0.005	0.019	0.018	1	0.4	0.01	8.68	2.27	2.43
13/08/2014	NRE G							117.0							25	1	1	3	55	0.1	5	2	0.05	0.16	0.148	0.145	0.004	0.004	0.098	0.009	0.21	0.001	0.001	0.018	0.013	1	0.4	0.01	8.79	1.44	1.7
9/09/2014	RV18							309.0							12	40	9	1	28	0.1	60	45	444	0.1	8.44	0.006	0.001	0.001	0.005	0.001	0.02	0.001	0.004	0.014	0.052	2	1.7	2.98	12.5	2.83	2.94
16/09/2014	RV19		15.1	5.2	114.5	151.9			73.4	7.1	356.2				20	2	11	2	46	<1.0	6	688	2650	2.14	70.9	0.945	0.001	0.001	0.007	0.014	<0.01	0.001	0.011	0.015	0.013	2	30.1	620	8.33		
8/10/2014	RV22A		17.1	4.8	139.4	16.7		4320.0	41.5	3.8	358.3				26	2	38	<1	27	<5.0	21	1540	10400	2.14	218	0.43	<0.010	<0.010	<0.050	<0.010	0.7	<0.010	0.028	0.019	0.04	8	103	33.2	5.76		
30/10/2014	RV23A		17.3	4.8	208.4	102.8		264.0	72.0	6.6	348.4				20	30	5	6	29	0.1	11	108	51.4	0.05	2.4	0.772	0.001	0.001	0.005	0.006	0.01	0.001	0.005	0.283	0.174	4	0.9	0.54	7.22	2.99	3.2
31/10/2014	GW1A		16.8	6.0	281.0		182.0	140.0		4.7	92.1	39.4	4219.0	0.1	23	14	2	8	49	0.1	18	45	8.96	6.88	0.948	0.956	0.001	0.001	0.033	0.019	0.02	0.001	0.02	0.243	0.092	2	0.6	0.09	8.85	2.41	2.66
31/10/2014	NRE A	11:40:00 AM	18.6	4.1	135.0		87.0	62.0		4.5	433.2	142.9	8403.0	0.0	9	4	2	3	15	0.1	25	1	5.66	0.1	0.166	0.157	0.004	0.003	0.051	0.007	0.83	0.001	0.001	0.007	0.022	3	0.6	0.01	7.04	0.89	0.94
31/10/2014	NRE C	9:55:19 AM	18.4	4.6	88.0		57.0			6.1	365.7	114.2	12987.0	0.0																											
31/10/2014	NRE C		18.4	4.6	88.0		57.0	44.0		6.1	365.7	114.2	12987.0	0.0	10	1	1	1	17	0.1	6	1	3.26	0.16	0.054	0.052	0.006	0.001	0.063	0.003	0.22	0.001	0.001	0.006	0.007	3	1	0.01	4.83	0.59	0.6
31/10/2014	NRE D		17.7	4.5	127.0		82.0	68.0		7.7	385.8	122.6	9090.0	0.0	15	1	1	2	31	0.1	6	1	1.05	0.05	0.032	0.029	0.002	0.008	0.026	0.001	0.65	0.001	0.001	0.009	0.014	1	0.5	0.01	6.84	0.87	1
31/10/2014	NRE E							137.0							26	7	1	3	49	0.1	24	1	17.6	0.57	0.091	0.08	0.001	0.001	0.021	0.001	0.09	0.001	0.001	0.014	0.029	3	0.9	0.03	6.5	1.75	1.88
31/10/2014	NRE F							91.0							22	2	2	3	44	0.1	6	2	1.12	0.28	0.065	0.067	0.001	0.001	0.022	0.003	0.23	0.001	0.002	0.011	0.011	3	0.4	0.01	7.84	1.35	1.41
31/10/2014	NRE G							112.0							24	8	1	4	51	0.1	22	1	0.91	0.4	0.146	0.143	0.004	0.006	0.09	0.008	0.4	0.001	0.001	0.017	0.096	1	0.4	0.01	8.53	1.9	1.8
28/11/2014	RV21							77.0							13	6	7	1	23	<0.1	9	26	462	3.74	23	4.24	0.001	0.001	0.005	0.006	0.01	0.001	0.003	0.055	0.032	2	6.6	7.54	6.04	1.13	1.36
4/12/2014	RV20		15.3	6.2	228.5	27.4		1400.0	44.1	4.3	156.9				558	6	5	4	49	0.8	39	1140	454	0.1	9.29	0.021	0.004	0.001	0.005	0.014	0.06	0.013	0.293	0.087	0.154	8.25	5.8	6.48	6.07	25	25
16/01/2015	NRE C	12:35:46 PM	19.0	4.8	76.0		49.0			4.9	286.6	89.7	14705.0	0.0																											
16/01/2015	RV18		16.2	5.0	97.0		63.0	74.0		3.7	245.0	75.6	12345.0	0.0	12	1	1	2	28	0.1	3	4	0.23	0.05	0.386	0.405	0.002	0.007	0.029	0.004	0.02	0.001	0.001	0.012	0.008	6	0.6	0.1	7.46	0.74	0.93
16/01/2015	RV19		15.7	6.3	464.0		301.0	295.0		3.4	16.5	2.1	2617.0	0.2	46	36	3	7	46	0.1	37	126	6.85	5.97	1.54	1.57	0.004	0.065	0.075	0.012	0.04	0.001	0.033	0.167	0.106	22	2.6	0.02	14.1	4.45	4.59
16/01/2015	RV21		17.4	5.1	105.0		68.0	87.0		6.4	236.8	70.4	11111.0	0.0	13	2	2	2	28	0.1	6	4	0.84	0.18	2.18	2.3	0.008	0.14	0.059	0.009	0.06	0.028	0.001	0.042	0.009	12	0.4	0.2	5.72	0.88	0.99
16/01/2015	RV22A		16.8	4.8	99.0		64.0	73.0		4.8	269.1	84.9	11904.0	0.0	13	1	1	2	28	0.1	3	2	0.81	0.05	0.135	0.128	0.004	0.052	0.029	0.003	0.06	0.001	0.001	0.011	0.006	4	0.8	0.06	7.01	0.78	0.89
16/01/2015	RV23A		17.8	6.7	406.0		263.0	245.0		2.9	152.4	-20.2	2849.0	0.1	35	43	3	8	24	0.1	7	158	0.32	0.06	0.127	0.134	0.003	0.17	0.04	0.02	0.01	0.007	0.005	0.748	0.319	15	0.3	0.12	7.77	4.4	4.19
18/03/2015	GW1A	8:53:17 AM	17.9	5.8	289.0		187.0			3.3	-40.2	26.7	4000.0	0.1																											
18/03/2015	GW1A		15.2	5.7	316.0		205.0	120.0		3.5	100.8	45.8	3891.0	0.1	22	13	2	9	50	0.1	20	44	17.7	16.7	1.08	1.02	0.001	0.001	0.017	0.018	0.01	0.001	0.018	0.231	0.084	2	0.8	0.14	8.6	2.4	2.71
18/03/2015	NRE A	12:55:00 PM	22.0	3.9	140.0		91.0	102.0		5.6	388.9	143.9	7575.0	0.0	10	4	1	3	25	0.1	26	1	22.9	0.12	0.16	0.153	0.008	0.002	0.074	0.01	0.78	0.001	0.001	0.011	0.022	2	0.4	0.01	7.12	0.88	1.25
18/03/2015	NRE C	10:55:04 AM	19.0	4.8	76.0		49.0			4.9	286.6	89.7	14705.0	0.0																											

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
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
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
18/03/2015	NRE F							179.0						
18/03/2015	RV18		16.2	4.8	94.0		61.0	59.0		4.3	298.2	88.1	12658.0	0.0
18/03/2015	RV19		15.8	6.6	477.0		310.0	283.0		4.5	-41.9	-1.2	2538.0	0.2
18/03/2015	RV21		17.3	4.7	107.0		69.0	71.0		6.1	341.5	92.6	10869.0	0.0
18/03/2015	RV22A		15.8	4.6	97.0		63.0	80.0		4.6	358.9	95.7	12500.0	0.0
18/03/2015	RV23A		17.6	6.5	423.0		274.0	293.0		4.3	130.6	3.9	2747.0	0.1
19/03/2015	NRE E							282.0						
19/03/2015	NRE G							162.0						
19/05/2015	RV18	11:24:59 AM	16.3	4.9	92.0		59.0			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
19/05/2015	RV19		15.1	5.8	409.0		265.0	253.0		3.6	1.9	22.8	3012.0	0.1
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
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
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
20/05/2015	RV21		17.5	5.7	101.0		65.0	76.0		4.7	40.9	27.6	11494.0	0.0
20/05/2015	RV22A		16.6	5.2	88.0		57.0	61.0		6.1	42.1	60.0	13513.0	0.0
20/05/2015	RV23A		17.5	5.8	410.0		266.0	251.0		4.5	10.5	25.3	2840.0	0.1
21/05/2015	GW1A		16.3	5.8	284.0		184.0	168.0		5.3	34.9	22.0	4219.0	0.1
21/05/2015	NRE E							160.0						
21/05/2015	NRE F							105.0						
21/05/2015	NRE G							296.0						
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
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
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
23/06/2015	NRE F							76.0						
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
23/06/2015	RV19		13.1	6.1	454.0		295.0	256.0		2.9	11.6	5.1	2849.0	0.1
23/06/2015	RV21		16.3	5.0	104.0		67.0	74.0		4.2	39.2	68.6	11494.0	0.0
23/06/2015	RV22A		14.5	4.9	92.0		59.0	73.0		5.2	38.6	71.7	13513.0	0.0
23/06/2015	RV23A		16.1	5.9	426.0		276.0	246.0		4.0	36.6	20.8	2824.0	0.1
24/06/2015	GW1A		14.6	5.6	300.0		195.0	137.0		3.2	35.0	33.5	4149.0	0.1
24/06/2015	NRE E							136.0						
24/06/2015	NRE G							272.0						
28/07/2015	NRE A	2:30:00 PM	16.7	4.4	156.0		101.0			5.3	42.1	102.9	7575.0	0.1
28/07/2015	NRE C	1:49:27 PM	17.3	4.0	65.0		42.0			6.7	400.6	141.4	17857.0	0.0
28/07/2015	RV18	11:33:32 AM	15.0	5.6	92.0		59.0			3.7	40.0	40.5	13333.0	0.0
22/09/2015	GW1A	10:23:59 AM	14.9	5.7	270.0		175.0			5.9	161.8	60.1	4587.0	0.1
22/09/2015	NRE A	1:20:00 PM	16.1	3.1	112.0		72.0			5.9	438.2	182.5	10752.0	0.0
22/09/2015	NRE A	1:32:48 PM	17.3	3.7	153.0		99.0			2.3	46.3	149.3	7633.0	0.1
22/09/2015	NRE C	12:31:27 PM	17.3	4.0	65.0		42.0			6.7	400.6	141.4	17857.0	0.0
22/09/2015	NRE C	12:31:27 PM	17.3	4.6	75.0		48.0			4.7	47.3	98.4	15625.0	0.0
22/09/2015	NRE D	11:42:02 AM	17.3	3.9	102.0		66.0			7.3	371.2	148.4	11494.0	0.0
22/09/2015	RV18	9:42:19 AM	15.5	4.4	96.0		62.0			5.1	274.9	118.9	12658.0	0.0
22/09/2015	RV19	9:28:11 AM	15.7	7.4	437.0		284.0			5.0	-42.1	-24.7	2777.0	0.1
22/09/2015	RV21	11:26:15 AM	16.8	4.2	96.0		62.0			4.5	323.2	131.0	12345.0	0.0
22/09/2015	RV22A	11:13:30 AM	15.6	3.7	90.0		58.0			5.3	364.6	154.2	13513.0	0.0
22/09/2015	RV23A	12:03:42 PM	15.9	6.4	430.0		279.0			2.9	159.5	22.6	2808.0	0.1
2/12/2015	GW1A	9:29:58 AM	16.1	5.4	322.0		209.0			3.8	38.6	48.0	3731.0	0.1
2/12/2015	GW1A		15.5	6.3	272.0		176.0	198.0		3.9	138.7	18.0	4484.0	0.1
2/12/2015	NRE A	2:10:00 PM	16.5	3.1	119.0		77.0	135.0		4.8	459.0	185.4	10000.0	0.0
2/12/2015	NRE C	12:36:03 PM	17.3	4.6	75.0		48.0			4.7	47.3	98.4	15625.0	0.0
2/12/2015	NRE C	12:36:03 PM	16.1	3.8	65.0		42.0			6.4	407.5	148.0	18518.0	0.0
2/12/2015	NRE C		16.1	3.8	65.0		42.0	77.0		6.4	407.5	148.0	18518.0	0.0
2/12/2015	NRE D	11:18:30 AM	16.1	4.3	133.0		86.0			6.9	46.0	113.0	9009.0	0.0
2/12/2015	NRE D		16.7	2.7	120.0		78.0	260.0		8.3	481.5	205.1	9900.0	0.0
2/12/2015	RV18	8:14:16 AM	14.7	5.5	89.0		57.0			5.6	39.5	45.5	13888.0	0.0
2/12/2015	RV18		15.8	5.0	84.0		54.0	69.0		7.2	248.9	85.3	14285.0	0.0
2/12/2015	RV19	8:34:13 AM	15.4	6.4	488.0		317.0			2.7	10.9	-5.5	2506.0	0.2
2/12/2015	RV19		15.6	7.1	353.0		229.0	238.0		1.7	46.6	-22.0	3448.0	0.1
2/12/2015	RV21	10:50:40 AM	17.3	4.9	107.0		69.0			4.3	45.5	77.2	10869.0	0.0
2/12/2015	RV21		16.3	4.6	89.0		57.0	118.0		6.2	336.1	109.4	13333.0	0.0
2/12/2015	RV22A	10:36:02 AM	17.0	4.8	100.0		65.0			4.2	45.3	86.1	11764.0	0.0
2/12/2015	RV22A		15.6	4.1	85.0		55.0	112.0		6.4	363.0	134.0	14285.0	0.0
2/12/2015	RV23A	12:05:32 PM	16.7	6.0	480.0		312.0			3.0	38.9	15.1	2475.0	0.2
2/12/2015	RV23A		15.9	6.0	418.0		271.0	4.0		4.5	243.5	34.2	2890.0	0.1
3/12/2015	NRE E							200.0						
3/12/2015	NRE F							183.0						
3/12/2015	NRE G							192.0						
4/02/2016	NRE C	10:53:24 AM	17.1	4.7	69.0		44.0			4.2	384.5	103.2	16949.0	0.0
7/04/2016	NRE A	12:25:00 PM	17.3	3.6	194.0		126.0			3.5	434.1	158.6	6024.0	0.1
7/04/2016	NRE C	11:43:23 AM	17.1	4.7	69.0		44.0			4.2	384.5	103.2	16949.0	0.0
7/04/2016	NRE C	11:43:23 AM	17.8	5.4	73.0		47.0			5.8	315.9	73.0	15873.0	0.0
7/04/2016	NRE D	11:07:05 AM	17.8	3.4	125.0		81.0			8.2	438.9	170.8	9259.0	0.0
7/04/2016	RV21	10:50:19 AM	16.6	4.7	102.0		66.0			3.7	302.9	103.2	11627.0	0.0
7/04/2016	RV22A	10:39:50 AM	16.1	4.1	93.0		60.0			6.3	375.0	135.8	12820.0	0.0
7/04/2016	RV23A	11:21:26 AM	17.0	6.6	468.0		304.0			3.3	176.7	7.1	2518.0	0.2
8/04/2016	GW1A	10:43:29 AM	15.8	5.8	294.0		191.0			4.1	180.4	44.1	4115.0	0.1
8/04/2016	RV18	10:00:40 AM	16.3	4.9	89.0		57.0			6.6	283.9	94.4	13333.0	0.0
8/04/2016	RV19	9:44:24 AM	15.9	7.9	377.0		245.0			4.1	-2.9	-60.7	3205.0	0.1
27/07/2016	RV18	10:41:15 AM	16.5	5.3	100.0		65.0			6.1	276.2	78.5	11904.0	0.0
27/07/2016	RV18		14.8	5.4	124.0	46.1	80.0	75.0	44.9	4.3	300.9	69.8	10000.0	0.0

Date	Bore	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 Filt (mg/L)	Mn T (mg/L)	Filt Mn (mg/L)	Filt Cu (mg/L)	Filt Pb (mg/L)	Filt Zn (mg/L)	Filt Ni (mg/L)	Filt Al (mg/L)	Filt As (mg/L)	Filt Li (mg/L)	Filt Ba (mg/L)	Filt 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																											
18/03/2015	NRE C	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																											
18/03/2015	NRE D	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	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	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	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	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	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	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	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	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																											
19/05/2015	RV18	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	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	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																											
20/05/2015	NRE C	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	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	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	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	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	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	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	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	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																											
23/06/2015	NRE A	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																											
23/06/2015	NRE C	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	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	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																											
23/06/2015	RV18	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	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	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	12	<1	<1	2	22	<0.1	3	3	0.11	0.05	0.119	0.107	0.002	0.039	0.021	0.001	0.07	<0.001	<0.001	0.009	0.005	<1	0.2	<0.01	7.07	0.69	0.74
23/06/2015	RV23A	36	50	3	8	22	<0.1	4	205	0.44	0.16	0.148	0.113	<0.001	0.041	0.011	0.004	0.02	0.002	0.006	0.715	0.381	10	1.2	0.04	7.95	4.8	4.8
24/06/2015	GW1A	22	13	2	8	46	<0.1	16	42	18.7	16.8	1.2	1.15	<0.001	<0.001	0.038	0.018	0.02	<0.001	0.017	0.215	0.077	<1	0.3	0.08	9.25	2.32	2.47
24/06/2015	NRE E	23	20	<1	3	42	<0.1	6.34	8	11.3	1.11	0.086	0.075	<0.001	<0.001	0.015	0.001	0.09	<0.001	<0.001	0.011	0.079	<1	0.2	<0.01	6.34	2.24	2.24
24/06/2015	NRE G	22	66	<1	4	42	<0.1	134	8	0.9	<0.05	0.142	0.13	0.002	0.004	0.068	0.006	0.3	<0.001	<0.001	0.019	0.646	<1	0.2	<0.01	8.77	4.58	4.13
28/07/2015	NRE A																											
28/07/2015	NRE C																											
28/07/2015	RV18																											
22/09/2015	GW1A																											
22/09/2015	NRE A																											
22/09/2015	NRE A																											
22/09/2015	NRE C																											
22/09/2015	NRE C																											
22/09/2015	NRE D																											
22/09/2015	RV18																											
22/09/2015	RV19																											
22/09/2015	RV21																											
22/09/2015	RV22A																											
22/09/2015	RV23A																											
2/12/2015	GW1A																											
2/12/2015	GW1A	20	12	2	8	49	0.2	26	32	17.5	15.3	1.15	1.1	0.008	<0.001	0.049	0.02	0.01	<0.001	0.021	0.232	0.082	2	4.4	0.08	8.98	2.18	2.56
2/12/2015	NRE A	9	4	<1	3	17	<0.1	34	<1	16.2	0.23	0.166	0.139	0.007	0.003	0.074	0.008	0.97	<0.001	<0.001	0.018	0.022	2	2.6	<0.01	6.77	0.84	1.19
2/12/2015	NRE C																											
2/12/2015	NRE C																											
2/12/2015	NRE C	8	<1	<1	1	17	<0.1	9	<1	3.71	<0.05	0.038	0.027	0.003	0.002	0.023	<0.001	0.26	<0.001	<0.001	0.007	0.006	2	0.4	<0.01	4.4	0.43	0.67
2/12/2015	NRE D																											
2/12/2015	NRE D	15	<1	<1	2	32	<0.1	21	<1	0.15	<0.05	0.05	0.038	<0.001	0.007	<0.005	<0.001	<0.001	<0.001	<0.001	0.008	0.013	<1	0.5	<0.01	6.82	0.82	1.34
2/12/2015	RV18																											
2/12/2015	RV18	11	1	2	2	24	<0.1	12	<1	0.41	<0.05	0.421	0.427	0.004	0.008	0.044	0.005	0.02	<0.001	<0.001	0.009	0.007	2	0.9	<0.01	7.15	0.74	0.93
2/12/2015	RV19																											
2/12/2015	RV19	34	26	3	7	39	0.2	37	106	17.2	14.9	1.77	1.63	0.001	<0.001	0.052	0.002	<0.01	<0.001	0.021	0.114	0.073	4	1.5	<0.01	13.6	4.23	3.99
2/12/2015	RV21																											
2/12/2015	RV21	10	2	2	2	24	<0.1	19	<1	0.17	<0.05	2.4	2.27	0.01	0.079	0.13	0.01	0.01	0.001	0.002	0.046	0.01	5	2.3	<0.01	5.67	0.75	1.07
2/12/2015	RV22A																											
2/12/2015	RV22A	12	1	1	2	25	<0.1	15	<1	0.22	<0.05	0.117	0.102	0.009	0.026	0.066	0.002	0.06	<0.001	0.001	0.011	0.006	1	0.7	<0.01	7.25	0.76	1.02
2/12/2015	RV23A																											
2/12/2015	RV23A	38	48	4	8	27	<0.1	21	184	0.27	<0.05	0.087	0.075	0.007	0.162	0.062	0.013	<0.01	0.003	0.007	0.93	0.378	4	11.3	0.04	7.99	4.81	4.88
3/12/2015	NRE E	31	16	<1	8	60	<0.1	42	4	11.3	0.6	0.587	0.565	0.002	<0.001	0.019	0.008	<0.01	<0.001	0.004	0.056	0.077	1	4.3	<0.01	4.26	2.8	2.65
3/12/2015	NRE F	36	2	1	7	64	<0.1	6	3	0.81	0.84	0.499	0.466	0.003	<0.001	0.054	0.01	0.07	<0.001	0.004	0.021	0.016	1	0.3	<0.01	9.6	2.27	2.01
3/12/2015	NRE G	24	2	<1	3	43	<0.1	12	<1	1.18	<0.05	0.148	0.137	0.008	0.004	0.095	0.008	0.22	<0.001	0.001	0.016	0.021	1	0.6	<0.01	9.35	1.39	1.46
4/02/2016	NRE C																											
7/04/2016	NRE A																											
7/04/2016	NRE C																											
7/04/2016	NRE C																											
7/04/2016	NRE D																											
7/04/2016	RV21																											
7/04/2016	RV22A																											
7/04/2016	RV23A																											
8/04/2016	GW1A																											
8/04/2016	RV18																											
8/04/2016	RV19																											
27/07/2016	RV18																											
27/07/2016	RV18	11	1	<1	2	24	<0.1	4	7	0.28	<0.05	0.352	0.333	0.004	0.005	0.101	0.003	0.02	<0.001	<0.001	0.011	0.006	<1	1	0.02	7.22	0.72	0.9

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 Filt (mg/L)	Mn T (mg/L)	Filt Mn (mg/L)	Filt Cu (mg/L)	Filt Pb (mg/L)	Filt Zn (mg/L)	Filt Ni (mg/L)	Filt Al (mg/L)	Filt As (mg/L)	Filt Li (mg/L)	Filt Ba (mg/L)	Filt 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 PM	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	0.190	0.003	0.01	<0.001	<0.001	0.010	0.008	2	1.6	<0.01	7.00	1.06	0.84
25/01/2017	RV19	9:43:00 AM	16.5	5.9	342.0	17.0	222.0		44.6	4.2	-13.0	40.2	3484.0	0.1																											
25/01/2017	RV19		16.2	6.4	310.0		201.0	172.0	38.2	3.6	-36.3	8.0	3875.0	0.1	34	13	3	6	37	0.2	10	71	14.0	14.3	1.11	0.971	0.002	0.004	0.064	0.004	<0.01	<0.001	0.010	0.068	0.036	3	2.0	0.02	10.9	2.70	2.67
25/01/2017	RV21	12:39:00 AM	16.6	5.1	132.0	13.4	85.0		55.5	5.1	344.4	89.1	9009.0	0.0																											
25/01/2017	RV21		18.0	5.3	101.0		65.0	83.0	49.7	4.5	268.2	59.6	11363.0	0.0	16	2	2	2	24	<0.1	7	9	2.51	<0.05	2.06	2.00	0.004	0.006	0.181	0.011	<0.01	<0.001	0.001	0.045	0.012	2	0.8	0.01	5.66	1.01	1
25/01/2017	RV22A	12:05:00 AM	16.5	4.9	118.0	25.0	76.0		67.5	6.3	357.4	97.7	10101.0	0.0																											
25/01/2017	RV22A		17.0	5.1	95.0		61.0	74.0	59.9	5.6	294.1	66.9	12345.0	0.0	17	1	<1	2	25	<0.1	3	2	0.22	<0.05	0.100	0.096	0.009	0.035	0.112	0.003	0.06	<0.001	<0.001	0.013	0.007	1	0.9	0.04	7.06	0.95	0.81
25/01/2017	RV23A	2:19:00 PM	17.1	6.3	505.0	16.3	328.0		54.7	5.0	281.4	18.1	2331.0	0.2																											
25/01/2017	RV23A		18.3	6.2	459.0		298.0	335.0	49.5	4.5	196.4	13.6	2493.0	0.2	47	45	4	10	28	<0.1	4	190	0.13	<0.05	0.014	0.005	0.002	0.007	0.031	0.004	<0.01	0.002	0.007	1.14	0.485	1	1.1	<0.01	7.92	5.22	4.73
27/01/2017	NRE A	9:27:00 AM	17.3	3.6	170.0		110.0		63.7	5.9	395.1	143.0	6896.0	0.1																											
8/03/2017	NRE A	5:23:00 PM	17.6	5.5	192.0	202.0	124.0		37.6	3.4	206.9	51.5	6060.0	0.1																											
8/03/2017	NRE C	4:30:00 PM	17.9	4.9	75.0		48.0		58.4	5.3	335.9	79.4	15384.0	0.0																											
8/03/2017	NRE C	4:30:00 PM	17.3	4.9	70.0	12.1	45.0		48.3	4.5	307.7	77.4	16666.0	0.0																											
8/03/2017	NRE D	3:45:00 PM	18.2	4.4	119.0		77.0		99.9	9.1	350.3	101.3	9615.0	0.0																											
3/05/2017	GW1A	1:40:00 PM	15.7	6.1	273.0	20.0	177.0		38.9	3.7	160.2	18.3	4444.0	0.1																											
3/05/2017	NRE C	3:05:00 PM	17.3	4.9	70.0	12.1	45.0		48.3	4.5	307.7	77.4	16666.0	0.0																											
3/05/2017	NRE C	3:05:00 PM	17.3	5.0	68.0	12.5	44.0		69.3	6.4	295.4	74.2	17241.0	0.0																											
3/05/2017	NRE D	2:30:00 PM	18.7	4.9	123.0	11.9	79.0		84.3	7.6	292.5	80.5	9174.0	0.0																											
3/05/2017	RV18	12:30:00 PM	16.2	5.7	87.0	11.0	56.0		65.9	6.3	246.3	41.3	13698.0	0.0																											
3/05/2017	RV19	12:37:00 PM	16.0	6.4	276.0	6.5	179.0		35.4	3.4	90.3	4.1	4366.0	0.1																											
3/05/2017	RV21	2:15:00 PM	17.7	5.6	106.0	7.5	68.0		51.9	4.8	255.2	44.4	10869.0	0.0																											
3/05/2017	RV22A	2:00:00 PM	16.3	5.4	92.0	0.5	59.0		62.0	5.9	286.5	53.6	12987.0	0.0																											
3/05/2017	RV23A	2:45:00 PM	19.0	6.5	483.0	13.0	313.0		40.9	3.7	198.7	0.4	2336.0	0.2																											
18/07/2017	RV18	10:07:00 AM	16.6	5.2	98.0	40.5	63.0		59.8	5.7	274.4	65.6	12048.0	0.0																											
18/07/2017	RV19	10:22:00 AM	16.0	6.0	274.0	3.0	178.0		33.7	3.2	139.5	23.8	4405.0	0.1																											
4/08/2017	GW1A	10:50:13 AM	15.8	5.8	268.0	7.7	174.0		36.8	3.6	198.8	35.6	4524.0	0.1																											
4/08/2017	GW1A		14.9	5.9	392.0	7.1	254.0	122.0	32.3	3.1	121.9	17.1	3154.0	0.1	25	11	3	8	46	<0.1	15	44	9.66	5.94	0.953	0.911	0.004	<0.001	0.069	0.018	0.02	<0.001	0.018	0.219	0.081	3	0.9	0.09	9.22	2.37	2.49
4/08/2017	NRE A	1:35:00 PM	17.1	5.5	115.0	453.0	74.0	58.0	42.9	4.0	168.7	51.2	10204.0	0.0	10	5	<1	2	16	<0.1	23	<1	64.8	0.64	0.201	0.213	0.007	0.001	0.079	0.006	0.41	<0.001	<0.001	0.012	0.028	2	0.7	0.03	9.02	0.85	0.93
4/08/2017	NRE C	1:25:04 PM	17.3	5.0	68.0	12.5	44.0		69.3	6.4	295.4	74.2	17241.0	0.0																											
4/08/2017	NRE C	1:25:04 PM	16.7	4.7	116.0	16.7	75.0		81.4	7.5	462.0	83.7	10204.0	0.0																											
4/08/2017	NRE C		16.7	4.7	116.0	16.7	75.0	44.0	81.4	7.5	462.0	83.7	10204.0	0.0	9	<1	<1	1	17	<0.1	4	<1	2.29	<0.05	0.04	0.04	0.003	0.002	0.021	0.001	0.23	<0.001	<0.001	0.008	0.005	1	0.6	0.03	5.26	0.47	0.56
4/08/2017	NRE D	12:19:12 PM	18.1	4.5	127.0	0.0	82.0		88.0	8.1	303.5	99.8	9009.0	0.0																											
4/08/2017	NRE D		15.5	3.8	189.0	11.3	122.0	80.0	87.5	8.3	519.4	137.3	6451.0	0.1	15	<1	<1	2	30	<0.1	7	<1	0.22	<0.05	0.038	0.04	0.003	0.009	0.027	0.001	0.73	<0.001	<0.001	0.007	0.014	<1	0.2	<0.01	7.06	0.82	0.99
4/08/2017	RV21	11:46:00 AM	17.1	5.2	104.0	4.0	67.0		46.1	4.3	284.7	62.2	11235.0	0.0																											
4/08/2017	RV21		16.6	4.9	164.0	16.7	106.0	73.0	37.8	3.5	410.2	74.2	7246.0	0.1	12	2	1	2	24	<0.1	6	4	0.19	<0.05	2	1.87	0.009	0.013	0.257	0.011	0.01	<0.001	0.001	0.046	0.012	2	1.4	<0.01	6.01	0.81	0.88
4/08/2017	RV22A	11:30:12 AM	16.4	5.2	93.0	0.5	60.0		63.5	6.1	279.3	63.9	12820.0	0.0																											
4/08/2017	RV22A		15.4	5.0	156.0	7.6	101.0	220.0	52.6	5.0	351.2	67.2	7812.0	0.1	15	1	1	1	25	<0.1	102	<1	0.17	<0.05	0.088	0.09	0.018	0.064	0.176	0.005	0.06	<0.001	<0.001	0.018	0.007	2	1.2	<0.01	7.2	0.81	2.83
4/08/2017	RV23A	12:52:53 PM	17.8	6.3	484.0	8.4	314.0		47.8	4.4	209.4	13.1	2392.0	0.2																											
4/08/2017	RV23A		15.0	6.7	537.0	16.7	349.0	305.0	81.7	7.9	434.2	-28.5	2298.0	0.2	45	42	4	10	28	0.2	4	222	0.14	<0.05	0.013	0.01	0.004	0.007	0.033	0.004	0.02	0.002	0.008	1.12	0.424	2	1.4	0.02	8.57	4.98	5.31
8/09/2017	NRE A	1:10:00 PM	16.0	4.0	173.0	485.0	112.0		47.3	4.4	476.1	123.9	6944.0	0.1																											
8/09/2017	NRE C	1:29:55 PM	18.7	4.7	111.0	14.0	72.0		83.4	7.5	332.2	118.6	10204.0	0.0																											
8/09/2017	RV18	10:07:42 AM	15.3	5.3	144.0		93.0		44.0	4.2	311.1	50.1	8474.0	0.1																											
8/09/2017	RV19	10:31:04 AM	15.0	6.0	338.0		219.0		31.5	3.1	101.4	8.6	3649.0	0.1																											
3/11/2017	NRE C	2:30:55 PM	18.7	4.7	111.0	14.0	72.0		83.4	7.5	332.2	118.6	10204.0	0.0																											
3/11/2017	NRE C	2:30:55 PM	19.0	4.0	110.0	-3.4	71.0		55.2	4.9	440.8	125.2	10204.0	0.0																											
3/11/2017	NRE D	1:52:03 PM	17.7	4.3	185.0	7.8	120.0		95.8	8.7	328.8	138.5	6250.0	0.1																											
3/11/2017	RV18	11:25:20 AM	15.9	5.4	152.0	4.6	98.0		62.5	5.9	268.7	75.0	7936.0	0.1																											
3/11/2017	RV19	11:48:12 AM	16.3	6.3	330.0	7.6	214.0		49.9	4.7	34.8	23.0	3636.0	0.1																											
3/11/2017	RV21	1:34:46 PM	18.7	5.4	159.0	9.4	103.0		58.2	5.2	262.7	75.3	7142.0	0.1																											
3/11/2017	RV22A	1:20:34 PM	17.7	5.0	139.0	8.9	90.0		74.4	6.8	273.7	100.8	8333.0	0.0																											
13/11/2017	GW1A	2:49:00 PM	16.9	6.0	353.0	11.7	229.0		37.5	3.5	-49.1	42.8	3344.0	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 Filt (mg/L)	Mn T (mg/L)	Filt Mn (mg/L)	Filt Cu (mg/L)	Filt Pb (mg/L)	Filt Zn (mg/L)	Filt Ni (mg/L)	Filt Al (mg/L)	Filt As (mg/L)	Filt Li (mg/L)	Filt Ba (mg/L)	Filt 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)
5/01/2018	RV18	11:49:00 AM	17.8	4.8	135.0	-6.1	87.0		62.3	5.6	404.3	77.9	8547.0	0.0																											
5/01/2018	RV19	12:07:00 PM	17.8	5.8	335.0	-1.0	217.0		51.6	4.7	110.1	17.6	3460.0	0.1																											
5/01/2018	RV21	1:37:00 PM	18.7	4.5	148.0	-1.0	96.0		47.1	4.2	390.1	95.9	7633.0	0.1																											
5/01/2018	RV22A	1:21:00 PM	18.3	4.3	133.0	-1.2	86.0		54.7	4.9	381.1	103.4	8620.0	0.0																											
5/01/2018	RV23A	2:31:00 PM	18.4	5.6	563.0	0.0	365.0		80.2	7.2	387.0	28.0	2036.0	0.2																											
8/01/2018	GW1A	10:25:00 AM	16.7	6.5	344.0	5.0	223.0		20.6	1.9	-90.4	5.5	3448.0	0.1																											
15/03/2018	GW1A	1:33:34 PM	16.8	7.7	329.0	25.9	213.0		40.5	3.8	-38.2	-75.3	3597.0	0.1																											
15/03/2018	RV18	12:06:33 PM	19.2	3.9	137.0	-3.8	89.0		75.2	6.7	389.7	128.8	8196.0	0.0																											
15/03/2018	RV19	12:23:04 PM	19.0	5.9	306.0	6.9	198.0		32.9	2.9	161.1	18.0	3690.0	0.1																											
16/03/2018	NRE A	8:30:00 AM	18.5	4.2	231.0	128.0	150.0		71.2	6.4	366.7	130.6	4926.0	0.1																											
16/03/2018	NRE C	12:26:03 PM	19.0	4.0	110.0	-3.4	71.0		55.2	4.9	440.8	125.2	10204.0	0.0																											
16/03/2018	NRE C	12:26:03 PM	18.5	4.7	110.0	55.2	71.0		53.7	4.8	305.0	116.2	10309.0	0.0																											
16/03/2018	NRE D	10:12:11 AM	18.7	3.5	178.0	-6.9	115.0		101.8	9.1	428.4	151.6	6369.0	0.1																											
16/03/2018	RV21	9:56:37 AM	19.2	4.4	142.0	7.7	92.0		51.2	4.5	389.4	103.0	7874.0	0.1																											
16/03/2018	RV22A	9:44:23 AM	17.6	3.9	140.0	13.7	91.0		60.1	5.5	390.0	127.0	8264.0	0.0																											
16/03/2018	RV23A	10:29:55 AM	18.7	5.2	570.0	15.1	370.0		61.7	5.5	384.1	59.9	1992.0	0.2																											
23/05/2018	GW1A	3:08:27 PM	18.7	5.6	366.0	10.7	237.0		25.2	2.3	-23.4	62.5	3105.0	0.1																											
23/05/2018	NRE A	5:22:00 PM	17.2	4.8	230.0	130.0	149.0		51.9	4.8	222.6	109.6	5102.0	0.1																											
23/05/2018	NRE C	5:25:05 PM	18.5	4.7	110.0	55.2	71.0		53.7	4.8	305.0	116.2	10309.0	0.0																											
23/05/2018	NRE C	5:25:05 PM	16.3	4.3	109.0	45.1	70.0		56.0	5.3	375.2	123.1	10989.0	0.0																											
23/05/2018	NRE D	4:38:25 PM	18.5	4.1	174.0	37.0	113.0		90.8	8.2	326.7	151.1	6535.0	0.1																											
23/05/2018	RV18	1:17:52 PM	20.3	5.0	141.0	27.0	91.0		48.8	4.2	295.6	100.2	7751.0	0.0																											
23/05/2018	RV19	1:49:11 PM	19.7	5.9	277.0	9.5	180.0		52.0	4.6	73.1	49.5	4016.0	0.1																											
23/05/2018	RV21	4:20:42 PM	17.6	4.6	137.0	23.5	89.0		32.6	3.0	282.7	118.9	8474.0	0.0																											
23/05/2018	RV22A	3:53:15 PM	17.2	4.9	133.0	10.2	86.0		82.0	7.6	278.0	104.3	8771.0	0.0																											
23/05/2018	RV23A	4:56:54 PM	18.8	7.0	512.0	17.1	332.0		46.1	4.1	200.1	-14.1	2212.0	0.2																											
6/07/2018	GW1A	3:51:31 PM	15.9	5.1	371.0	2.5	241.0		37.8	3.6	4.5	72.7	3257.0	0.1																											
6/07/2018	GW1A		15.4	5.1	405.0	10.4	263.0	190.0	41.6	4.0	-40.3	75.8	3021.0	0.1	21	11	1	7	46	<0.1	16	69	20.4	17.9	1.01	0.941	<0.001	<0.001	0.014	0.019	0.01	<0.001	0.016	0.218	0.079	2	0.5	0.1	8.69	3.01	3.03
6/07/2018	NRE E							190.0							31	15	<1	8	74	<0.1	13	46	19.2	10	0.818	0.735	<0.001	<0.001	0.017	0.013	<0.01	<0.001	0.007	0.126	0.072	<1	0.3	0.03	7.85	3.28	3.29
6/07/2018	NRE F							148.0							32	2	2	6	69	<0.1	12	<1	3	0.24	0.6	0.547	<0.001	<0.001	0.061	0.013	0.04	<0.001	0.004	0.044	0.023	<1	<0.1	<0.01	9.14	2.2	2.04
6/07/2018	NRE G							114.0							25	<1	<1	3	54	<0.1	6	<1	1.61	<0.05	0.166	0.149	0.001	0.001	0.059	0.006	0.33	<0.001	<0.001	0.021	0.006	<1	<0.1	<0.01	8.85	1.65	1.33
6/07/2018	RV18	1:49:57 PM	17.2	4.6	132.0	11.9	85.0		45.5	4.2	309.4	107.0	8849.0	0.0																											
6/07/2018	RV18		17.4	4.8	156.0	25.0	101.0	88.0	59.1	5.4	330.5	94.5	7462.0	0.1	13	3	2	2	28	<0.1	4	7	1.5	<0.05	0.14	0.027	0.006	0.003	0.163	0.006	0.04	<0.001	<0.001	0.01	0.007	3	2.4	0.02	7.19	1.01	0.93
6/07/2018	RV19	2:23:28 PM	17.0	5.4	275.0	6.4	178.0		48.3	4.5	101.8	59.2	4291.0	0.1																											
6/07/2018	RV19		17.2	5.5	352.0	36.9	228.0	141.0	68.4	6.3	74.0	52.1	3333.0	0.1	28	9	2	4	43	0.1	6	58	12.6	12.2	1.04	0.957	0.002	0.008	0.163	0.009	0.02	<0.001	0.006	0.05	0.021	2	2.4	0.12	8.85	2.5	2.7
9/07/2018	NRE A	1:38:00 PM	16.2	4.1	233.0	671.0	151.0	111.0	48.7	4.6	285.2	130.3	5154.0	0.1	12	4	<1	3	19	<0.1	44	<1	83.8	11.3	0.223	0.169	0.001	<0.001	0.024	0.002	0.06	<0.001	<0.001	0.011	0.022	1	0.5	0.03	10.8	1.58	1.45
9/07/2018	NRE C	1:00:33 PM	16.3	4.3	109.0	45.1	70.0		56.0	5.3	375.2	123.1	10989.0	0.0																											
9/07/2018	NRE C	1:00:33 PM	17.0	3.8	100.0	116.0	65.0		46.0	4.3	368.7	145.4	11764.0	0.0																											
9/07/2018	NRE C		17.0	3.8	100.0	116.0	65.0	54.0	46.0	4.3	368.7	145.4	11764.0	0.0	9	<1	<1	1	19	<0.1	4	<1	7.5	0.23	0.101	0.086	<0.001	0.001	0.008	<0.001	0.11	<0.001	<0.001	0.008	0.005	<1	0.2	<0.01	6.23	0.47	0.62
9/07/2018	NRE D	12:01:49 PM	17.2	3.9	163.0		105.0		49.2	4.6	374.4	143.9	7194.0	0.1																											
9/07/2018	NRE D		17.0	3.6	162.0	754.0	105.0	68.0	58.7	5.5	377.8	155.8	7246.0	0.1	15	<1	<1	2	31	<0.1	4	<1	59.6	0.8	0.126	0.11	<0.001	0.002	0.012	0.002	0.38	<0.001	<0.001	0.007	0.008	<1	0.3	0.22	7.6	0.82	0.96
9/07/2018	RV21	11:38:12 AM	16.9	4.2	149.0	8.9	96.0		40.5	3.8	321.4	128.4	7936.0	0.1																											
9/07/2018	RV21		16.2	4.2	150.0	17.8	97.0	64.0	38.4	3.6	334.4	122.4	8000.0	0.1	13	1	<1	2	27	<0.1	5	5	1.46	0.08	1.06	1.48	0.003	0.015	0.121	0.008	0.02	<0.001	<0.001	0.035	0.007	<1	0.4	0.12	6.46	0.78	0.96
9/07/2018	RV22A	11:08:49 AM	16.5	4.3	133.0	2.3	86.0		27.2	2.6	321.3	121.3	8928.0	0.0																											
9/07/2018	RV22A		15.5	4.1	141.0	14.8	91.0	62.0	35.2	3.4	387.8	127.9	8620.0	0.0	14	2	<1	2	27	<0.1	3	<1	0.97	<0.05	0.053	0.058	0.01	0.045	0.138	0.005	0.05	<0.001	<0.001	0.014	0.006	1	1.1	<0.01	7.32	0.87	0.82
9/07/2018	RV23A	12:23:50 PM	16.8	6.2	566.0	9.0	367.0		37.9	3.6	210.2	15.9	2092.0	0.2																											
9/07/2018	RV23A		16.7	6.6	564.0	18.1	366.0	265.0	49.3	4.7	322.4	-13.4	2105.0	0.2	54	42	3	8	30	<0.1	3	245	0.96	<0.05	0.036	0.013	<0.001	0.001	0.023	0.003	<0.01	<0.001	0.007	1.04	0.397	<1	0.8	<0.01	8.66	5.18	5.8
11/09/2018	NRE A	5:08:00 PM	16.1	4.0	213.0	110.0	138.0		16.9	1.6	283.0	135.8	5649.0	0.1																											
3/10/2018	NRE C	3:39:48 PM	17.4	4.3	109.0	0.0	70.0		53.9	4.9	309.5	127.9	10638.0	0.0																											
8/11/2018	RV18	3:07:08 PM	16.6	5.0	143.0	16.2	92.0		24.3	2.3	249.7	87.4	8333.0	0.1																											
8/11/2018	RV19	4:16:54 PM	17.1	5.9	319.0	22.0	207.0		33.9	3.2	-74.4	36.7	3690.0	0.1																											
9/11/2018	GW1A	12:01:40 PM	15.8	5.8	373.0	9.5	242.0		11.7	1.1	-78.3	46.3	3246.0	0.1																											
9/11/2018	NRE A	3:50:00 PM	16.2	3.5	276.0	97.1	179.0		19.9	1.9	459.9	175.7	4347.0	0.1																											
9/11/2018	NRE C	2:47:09 PM	17.4	4.3	109.0	0.0	70.0		53.9	4.9	309.5	127.9	10638.0	0.0																											
9/11/2018	NRE C	2:47:09 PM	17.8	4.1	113.0	51.7	73.0		88.8	8.1	563.9	127.1	10204.0	0.0																											
9/11/2018	NRE D	1:40:40 PM	17.1	4.1	163.0	2074.0	105.0		46.1	4.3	351.4	141.8	7194.0	0.1																											
9/11/2018	RV21	1:12:01 PM	17.0	4.6	144.0	35.5	93.0		11.0	1.0	276.5	111.3	8196.0	0.1																											
9/11/2018	RV22A	12:53:30 PM	16.9	4.5	134.0	22.3	87.0		26.9	2.5	292.5	115.9	8771.0	0.0																											
9/11/2018	RV23A	2:15:29 PM	16.3	7.3	569.0	15.6	369.0		58.6	5.5	156.4	-38.2	2105.0	0.2																											
15/01/2019	GW1A	12:02:45 PM	17.2	5.7	372.0	-5.8	241.0		42.2	3.9	209.0	38.0	3164.0	0.1																											
15/01/2019	NRE A	4:30:00 PM	16.5	4.4	230.0	-4.5	149.0	87.0	30.9	2.9	385.0	111.1	5181.0	0.1	10	5	<1	3	17	<0.1	34	<1	22.7	0.34	0.255	0.226	0.005	0.004	0.04	0.009	1.47	<0.001	<0.001	0.014	0.026	1	0.2	0.05	7.47	0.93	1.19
15/01/2019	NRE C	3:29:13 PM	17.8	4.1	113.0	51.7	73.0		88.8	8.1	563.9	127.1	10204.0	0.0																											
15/01/2019	NRE C	3:29:13 PM	19.9	4.3	117.0	0.0	76.0		57.2	5.0	404.9	129.7	9433.0	0.0																											
15/01/2019	NRE D	2:31:37 PM	16.9	4.0	179.0	62.6	116.0		93.2	8.7	497.2	136.3	6578.0	0.1																											
15/01/2019	RV18	10:11:30 AM	16.6	4.8	132.0	0.0	85.0		38.6	3.6	314.1	101.2	9009.0	0.0																											
15/01/2019	RV19	10:42:50 AM	19.8	5.7	45.0	145.0	29.0		73.8	6.5	77.7	52.6	24390.0	0.0																											
15/01/2019	RV21	2:01:28 PM	18.7	4.4	142.0	41.2	92.0		96.6	8.7	500.9	111.6	8000.0	0.1																											
15/01/2019	RV22A	1:39:12 PM	17.7	4.5	147.0	14.4	95.0		97.8	9.0	508.9	105.6	7874.0	0.1																											
15/01/2019	RV23A	2:52:11 PM	17.9	6.9	593.0	-7.6	385.0		85.6	7.8	488.1	-27.1	1949.0	0.3																											
4/04/2019	GW1A		20.9	5.4	316.0	0.0	205.0	174.0	43.9	3.8	114.4	62.8	3424.0	0.1	24	14	2	8	45	<0.1	18	34	17.6	11.2	1.37	1.16	0.002	<0.001	0.087	0.02	0.02	<0.001	0.017	0.201	0.086	2	1.3	0.14	8.56	2.45	2.32
4/04/2019	NRE C		19.9	4.3	117.0	0.0	76.0	48.0	57.2	5.0	404.9	129.7	9433.0	0.0	10	1	<1	1	19	<0.1	4	<1	13	0.06	0.073	0.057	<0.001	<0.001	0.007	0.001	0.26	<0.001	<0.001	0.014	0.008	<1	<0.1	0.06	4.84	0.57	0.62
4/04/2019	NRE D		24.2	4.4	183.0	477.0	118.0	92.0	83.6	6.7	363.0	122.9	5524.0	0.1	15	1	<1	2	30	<0.1	8	<1	0.44	<0.05	0.059	0.05	0.002	0.01	0.021	0.001	0.72	<0.001	<0.001	0.014	0.016	<1	<0.1	<0.01	7.27	0.87	1.01
4/04/2019	NRE E							191.0							33	13	<1	10	72	<0.1	17	28	24.8	10.6	0.851	0.757	<0.001	<0.001	0.017	0.012	<0.01	<0.001	0.008	0.165	0.064	<1	<0.1	<0.01	8.2	2.91	2.94
4/04/2019	NRE F							113.0							30	3	<1	8	57	<0.1	23	<1	4.41	1.33	0.96	0.921	<0.001	<0.001	0.073	0.016	0.03	<0.001	0.002	0.024	0.027	<1	<0.1	0.01	7.54	2.11	2.09
4/04/2019	NRE G							83.0							28	<1	<1	4	52	<0.1	3	<1	0.98	<0.05	0.183	0.172	0.002	<0.001	0.046	0.006	0.34	<0.001	<0.001	0.017	0.006	<1	<0.1	<0.01	8.36	1.55	1.53
4/04/2019	RV18		18.8	5.3	121.0	0.0	78.0	66.0	38.3	3.4	270.8	72.6	9345.0	0.0	12	2	1	2	22	<0.1	4	<1	0.11	<0.05	0.03	0.019	0.003	<0.001	0.294	0.005	0.02	<0.001	<0.001	0.009	0.006	<1	1	<0.01	6.91	0.81	0.7
4/04/2019	RV19		19.5	5.4	267.0	0.0	173.0	121.0	26.9	2.4	148.6	62.4	4184.0	0.1	24	10	2	4	35	0.1	5	40	4.69	3.32	0.945	0.846	0.002	0.001	0.665	0.007	<0.01	<0.001	0.006	0.067	0.028	<1	2	0.04	8.8	1.92	1.89
4/04/2019	RV21		20.6	4.6	145.0	0.0	94.0	56.0	48.8	4.2	355.1	114.0	7518.0	0.1	13	1	<1	2	25	<0.1	4	<1	0.44	<0.05	1.59	1.46	0.002	0.014	0.076	0.005	0.03	<0.001	<0.001	0.034	0.007	<1	0.3	0.01	6.74	0.78	0.79
4/04/2019	RV22A		19.4	4.4	122.0	0.0	79.0	64.0	56.5	5.0	366.2	125.0	9174.0	0.0	13	2	<1	2	24	<0.1	3	<1	0.26	<0.05	0.067	0.06	0.007	0.045	0.166	0.005	0.08	<0.001	<0.001	0.014	0.007	<1	0.8	0.02	7.13	0.83	0.74
4/04/2019	RV23A		20.8	7.2	544.0	0.0	353.0	261.0	68.1	5.8	303.8	-37.4	1996.0	0.2	58	44	3	9	28	<0.1	3	208	0.2	<0.05	0.008	0.007	<0.001	<0.001	0.019	0.002	0.02	<0.001	0.008	1.11	0.434	<1	0.6	<0.01	8.62	5.54	5.01
9/04/2019	NRE A	4:33:00 PM	21.5	3.8	184.0	0.0	119.0		67.9	5.7	441.6	158.1	5813.0	0.1																											
9/04/2019	NRE C	4:36:23 PM	17.3	4.1	117.0	0.0	76.0		61.0	5.6	354.2	134.2	10000.0	0.0																											
22/05/2019	GW1A	3:26:14 PM	17.0	5.6	344.0		223.0		64.7	6.0	104.2	52.8	3424.0	0.1																											
22/05/2019	RV18	2:14:39 PM	17.6	5.2	121.0		78.0		45.9	4.2	277.3	77.9	9615.0	0.0																											
22/05/2019	RV19	1:51:22 PM	17.5	5.4	257.0	0.0	167.0		37.4	3.4	116.0	66.0	4524.0	0.1																											
22/05/2019	RV21	4:36:59 PM	17.9	4.3	146.0	0.0	94.0		23.4	2.1	287.6	127.2	7874.0	0.1																											
22/05/2019	RV22A	4:05:08 PM	17.0	4.4	141.0	0.0	91.0		56.8	5.2	287.8	119.1	8333.0	0.0																											
24/05/2019	NRE A	12:40:00 PM	16.3	3.5	226.0	0.0	146.0		47.7	4.5	455.2	167.1	5291.0	0.1																											
24/05/2019	NRE C	11:50:52 AM	17.3	4.1	117.0	0.0	76.0		61.0	5.6	354.2	134.2	10000.0	0.0																											

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 Filt (mg/L)	Mn T (mg/L)	Filt Mn (mg/L)	Filt Cu (mg/L)	Filt Pb (mg/L)	Filt Zn (mg/L)	Filt Ni (mg/L)	Filt Al (mg/L)	Filt As (mg/L)	Filt Li (mg/L)	Filt Ba (mg/L)	Filt 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	2	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	<0.1	50	8	22.4	11.6	0.189	0.194	<0.001	0.001	0.046	0.003	0.05	<0.001	<0.001	0.017	0.024	<1	<0.1	<0.01	10.4	1.14	1.71
31/01/2020	NRE C	12:11:39 PM	18.9	4.5	115.0	42.0	74.0		66.1	5.8	327.7	92.2	9803.0	0.0																											
31/01/2020	NRE C	12:11:39 PM	21.0	4.8	124.0	15.0	80.0		54.2	4.6	316.3	72.6	8695.0	0.0																											
31/01/2020	NRE C		21.0	4.8	124.0	15.0	80.0	52.0	54.2	4.6	316.3	72.6	8695.0	0.0	11	<1	<1	1	20	<0.1	5	4	2.42	<0.05	0.093	0.09	<0.001	0.002	0.008	<0.001	0.12	<0.001	<0.001	0.01	0.005	<1	<0.1	<0.01	6.46	0.56	0.75
31/01/2020	NRE D	11:13:55 AM	18.5	4.3	190.0	0.0	123.0		85.9	7.6	309.5	104.5	5988.0	0.1																											
31/01/2020	NRE D		20.4	4.5	199.0	0.5	129.0	76.0	92.0	8.0	298.2	90.4	5494.0	0.1	16	1	<1	2	32	<0.1	9	1	3.14	<0.05	0.127	0.073	<0.001	0.009	0.022	0.001	0.7	<0.001	<0.001	0.01	0.019	<1	<0.1	<0.01	7.16	0.91	1.11
31/01/2020	NRE E							194.0							34	10	2	10	76	<0.1	12	34	16.2	12.9	0.85	0.792	<0.001	<0.001	0.03	0.013	<0.01	<0.001	0.007	0.211	0.052	<1	0.3	<0.01	9.25	2.85	3.07
31/01/2020	NRE F							134.0							29	4	1	9	55	<0.1	13	15	12.6	0.08	0.888	0.858	<0.001	<0.001	0.051	0.01	0.01	<0.001	0.002	0.026	0.027	<1	0.1	0.01	6.6	2.23	2.12
31/01/2020	NRE G							113.0							29	<1	<1	4	55	<0.1	4	4	0.57	<0.05	0.204	0.188	0.003	<0.001	0.053	0.006	0.4	<0.001	0.001	0.018	0.006	<1	0.2	<0.01	8.99	1.59	1.71
31/01/2020	RV18		23.9	5.4	148.0	13.5	96.0	69.0	61.7	5.0	193.1	39.8	6896.0	0.1	14	2	2	2	25	<0.1	5	8	1.34	<0.05	0.281	0.035	0.005	0.001	0.132	0.004	0.03	<0.001	<0.001	0.009	0.007	2	2.9	0.02	7.01	0.92	0.97
31/01/2020	RV19		21.6	6.4	363.0	6.6		137.0		2.9	38.1				27	13	2	5	39	0.1	7	60	15.7	15.3	1.05	1	<0.001	0.002	0.054	0.006	0.03	0.001	0.005	0.1	0.031	3	1	0.1	9.99	2.28	2.44
31/01/2020	RV21	10:52:06 AM	18.7	5.1	152.0	29.2	98.0		41.1	3.6	143.2	58.1	7462.0	0.1																											
31/01/2020	RV21		19.8	5.2	170.0	9.8	110.0	69.0	35.4	3.1	221.9	51.2	6493.0	0.1	15	1	<1	3	30	<0.1	5	8	0.6	<0.05	1.72	1.69	0.001	0.003	0.086	0.008	0.02	<0.001	<0.001	0.04	0.008	<1	0.3	<0.01	6.85	0.95	1.11
31/01/2020	RV22A	10:28:33 AM	18.3	4.9	140.0	25.5	91.0		50.9	4.5	217.6	71.6	8196.0	0.0																											
31/01/2020	RV22A		20.5	5.3	176.0	68.7	114.0	70.0	61.1	5.3	182.1	46.3	6211.0	0.1	14	2	<1	2	26	<0.1	4	4	1.2	<0.05	0.078	0.068	0.003	0.041	0.096	0.003	0.08	<0.001	<0.001	0.015	0.006	<1	1.2	0.01	7.36	0.87	0.9
31/01/2020	RV23A	11:34:19 AM	17.9	7.5	602.0	2.2	391.0		67.0	6.0	225.2	-77.0	1919.0	0.3																											
31/01/2020	RV23A		18.7	7.8	666.0	0.0	432.0	322.0	65.5	5.9	212.3	-89.7	1709.0	0.3	59	43	3	9	29	<0.1	3	248	0.34	<0.05	0.03	0.007	<0.001	<0.001	0.014	0.001	0.02	<0.001	0.006	0.946	0.376	<1	1	<0.01	8.91	5.53	5.84
26/03/2020	RV23A	12:56:24 PM	19.0	7.0	613.0	0.0	398.0		70.3	6.4	147.2	-24.7	1845.0	0.3																											
27/03/2020	NRE A	11:15:00 AM	18.8	5.2	243.0	66.9	157.0	113.0	43.1	3.8	213.1	47.0	4651.0	0.1	10	11	1	2	17	0.1	40	1	30.5	0.14	0.098	0.096	0.007	0.013	0.049	0.006	1.23	0.001	0.001	0.005	0.05	1	0.4	0.03	6.18	1.15	1.31
27/03/2020	NRE A	11:25:58 AM	16.8	4.1	259.0	91.8	168.0		31.5	3.0	390.1	137.8	4566.0	0.1																											
27/03/2020	NRE C	9:02:25 AM	17.6	5.0	124.0	398.0	80.0		53.1	4.9	187.5	86.3	9345.0	0.0																											
23/09/2020	GW1A	12:52:34 PM	16.3	6.2	377.0	125.0	245.0		53.3	5.0	43.7	19.2	3174.0	0.1																											
23/09/2020	NRE C	3:07:23 PM	17.6	5.0	124.0	398.0	80.0		53.1	4.9	187.5	86.3	9345.0	0.0																											
23/09/2020	NRE C	3:07:23 PM	17.1	4.7	72.3	722.7			57.6	5.3	333.4																														
23/09/2020	NRE D	2:15:24 PM	18.4	4.7	183.0	121.0	118.0		66.6	6.1	258.4	108.1	6250.0	0.1																											
23/09/2020	RV21	1:55:21 PM	17.4	5.3	154.0	8.6	100.0		28.5	2.6	206.3	74.0	7575.0	0.1																											
23/09/2020	RV22A	1:39:35 PM	16.2	5.5	138.0	18.3	89.0		45.3	4.3	187.1	60.3	8695.0	0.0																											
23/09/2020	RV23A	2:39:09 PM	15.9	7.8	488.3	106.7			75.9	7.2	270.1																														
24/09/2020	NRE A	11:54:00 AM	16.6	3.8	137.7	23.0		190.0	48.0	4.5	374.8				11	20	1	3	21	0.1	58	1	10.1	0.09	0.204	0.197	0.005	0.004	0.058	0.009	0.93	0.001	0.001	0.008	0.094	4	0.3	0.02	6.87	1.72	1.8
24/09/2020	RV18	9:21:24 AM	16.3	6.0	250.0	0.0	162.0		39.9	3.8	151.9	30.7	4784.0	0.1																											
24/09/2020	RV19	10:06:54 AM	15.9	6.5	351.0	8.2	228.0		47.4	4.6	-32.3	5.5	3448.0	0.1																											

APPENDIX E – GROUNDWATER MONITORING PROGRAM

Monitoring Requirement	Monitoring Location	Timing/ Frequency			Parameters	Purpose
		Prior to Mining	During Mining	Post Mining		
Monitoring of swamp soil moisture and shallow water	Swamp sites with soil moisture probes and piezometers, including: **Moisture probes and piezometers:** PB4 (A/B/D) near swamp BCUS4 PCc10 (A/B) at CCUS10 PCc12 (A/B) at CCUS12 PCc4 (B/C/D) at CCUS4 PCc5 (A/B/D) at CCUS5 PCr1 (A/B/C) at CRUS1 **Piezometers only:** PB4C near swamp BCUS4 PCc2 at CCUS2 PCc3 at CCUS3 PCc4A at CCUS4 PCc5C at CCUS5 PCc6 at CCUS6 PCr1D at CRUS1	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 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 Quarterly – discrete analysis 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 Quarterly – discrete analysis	**Field analysis*** **Discrete#** **Full metals suite^**	Verify predicted swamp water level/moisture response and water quality changes to existing operations and inform future model iterations and updates. Verify predicted swamp water level/moisture response to mine closure.

Monitoring Requirement	Monitoring Location	Timing/ Frequency			Parameters	Purpose
		Prior to Mining	During Mining	Post Mining		

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	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.

Monitoring Requirement	Monitoring Location	Timing/ Frequency			Parameters	Purpose
		Prior to Mining	During Mining	Post Mining		
	PCr6 (SM) at CRUS6					
Monitoring of groundwater levels and head gradients near swamps	Swamp monitoring paired open standpipes and VWPs 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 2 monthly – field analysis for open standpipes Quarterly – discrete analysis for open standpipes 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 Quarterly – discrete analysis for open standpipes Annual – full metals suite analysis	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 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	**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. 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

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	**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	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		
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,	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	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	**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

Monitoring Requirement	Monitoring Location	Timing/ Frequency			Parameters	Purpose
		Prior to Mining	During Mining	Post Mining		
		reducing to quarterly frequency Annual – full metals suite analysis	standpipes within first 12 months of installation, reducing to quarterly frequency 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		subsidence monitoring (where applicable) 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	**Field analysis*** **Full metals suite ^**	Visualise and verify post closure seepage conditions.

Monitoring Requirement	Monitoring Location	Timing/ Frequency			Parameters	Purpose
		Prior to Mining	During Mining	Post Mining		
				Quarterly – full metals analysis for an agreed period (minimum 1 year) 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, HCO_3, $CaCO_3$, NO_3, 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*

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.

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: • 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 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). 3. One to two months depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)

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	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 quality		pH	Field analysis when piezometers are manually dipped: • 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	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 3 criteria identified	Russell Vale Colliery (Environmental Manager)

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					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). 3. One to two months depending on timing of review of second data period.	
					Level 3: Two consecutive readings outside of the trigger range of 3.8 to 6.3	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)

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: • 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 below the water level trigger during a period with rainfall above 20 mm/month	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). 3. One to two months depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)

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* during a period with rainfall above 20 mm/month	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 parameter 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)
Hawkes-bury 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	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)

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). 3. One to two months depending on timing of review of second data period.	
					Level 3: Two consecutive readings above the trigger level of 376 µS/cm	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)

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
Hawkes-bury 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	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). 3. One to two months depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
					Level 3: Two consecutive readings outside of the trigger range of 3.7 to 6.5	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)
Hawkes-bury 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.	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)

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
						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.	(see Level 3 reporting requirements). 3. One to two months depending 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)

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
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, 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). 3. One to two months depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)

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 µS/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 include: RV43A and RV44	pH	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	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 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	Russell Vale Colliery (Environmental Manager)

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.	(see Level 3 reporting requirements). 3. One to two months 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 within the first 12 months of installation	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 levels	Newly installed open standpipes, which may	Water level	Monthly manual dipped water levels	Detection of changes in Bulgo Sandstone groundwater	Level 1: No exceedance of Level 2 or Level 3 triggers	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
	include: RV43A and RV44			level post mining and closure, outside of predicted impacts	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). 3. One to two months depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)
					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	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	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	Extraction Plan approval	
Groundwater levels and vertical head profile	Existing VWPs: 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 one VWP sensor, as indicated by movement of the head profile below (to the left) of	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	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).	Russell Vale Colliery (Environmental Manager)

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
					the minimum predicted head profile and baseline observation data (refer Appendix H)	is identified progress to Level 3.	3. One to two months depending on timing of review of second data period.	
					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 levels (refer Appendix H)	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)

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
Groundwater levels and vertical head profile	Newly installed VWPs, 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). 3. One to two months depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)

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	Continue monitoring.	Report negligible impact in routine reporting.	Russell Vale Colliery (Environmental Manager)

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
					equipment maintenance.			
					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). 3. One to two months depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
					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	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if exceedance of Level	Russell Vale Colliery (Environmental Manager)

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). 3. One to two months 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	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)

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
Underground workings	Mine inflows	EC	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 above the trigger level of 5,226 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 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). 3. One to two months depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)

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 5,226 µS/cm	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	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	1. One week 2. Two weeks to assess whether further investigation is required. Commence investigation if	Russell Vale Colliery (Environmental Manager)

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
						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.	exceedance of Level 3 criteria identified (see Level 3 reporting requirements). 3. One to two months depending 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)

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
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 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). 3. One to two months depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)

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 0.11 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 As	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 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)

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
						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). 3. One to two months 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)
Underground workings	Mine inflows	Dissolved Mo	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)

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 0.09 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 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). 3. One to two months depending on timing of review of second data period.	Russell Vale Colliery (Environmental Manager)
					Level 3: Two consecutive readings above the trigger level of 0.09 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 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 mine water quality and inflow data, groundwater data and geotechnical/subsidence records to identify any adverse trends that may indicate 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). 3. One to two months depending on timing of	Russell Vale Colliery (Environmental Manager)

Feature	Trigger Monitoring Location	Unit	Timing/ Frequency During Mining	Purpose	Criteria	Action/ Reporting	Reporting	Responsibility
						beyond previous predictions. If an impact due to mining is identified progress to Level 3.	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

APPENDIX G – WATER LEVEL TRIGGERS

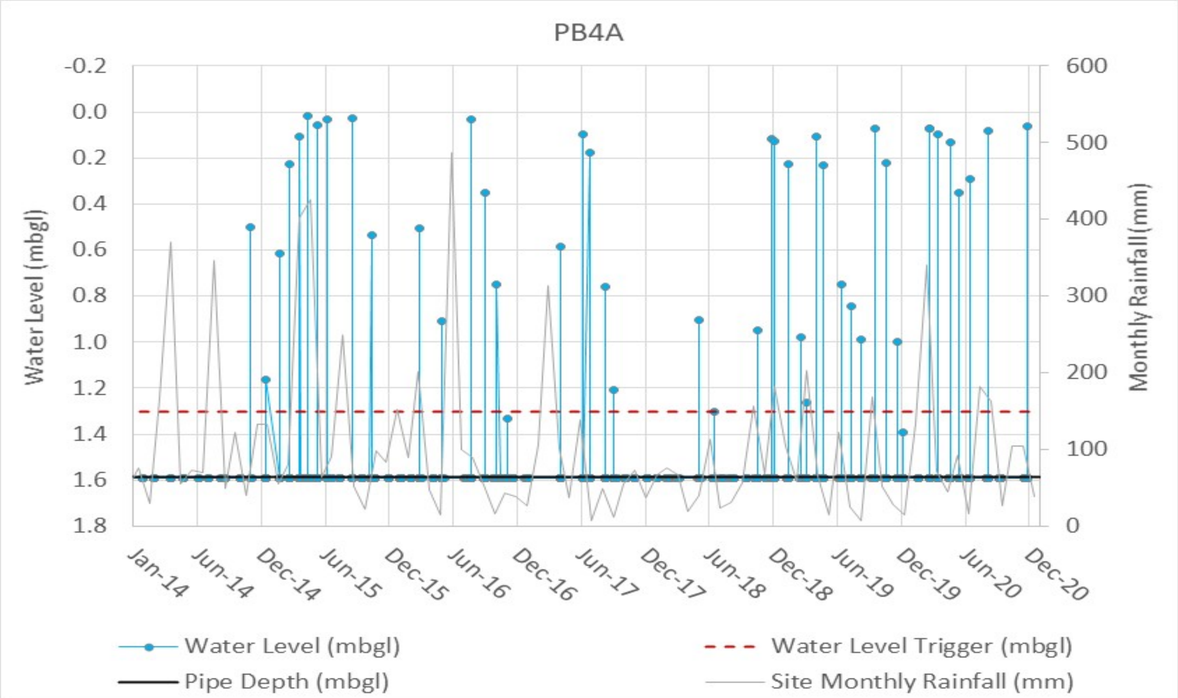
Swamp Water Level Trigger

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]

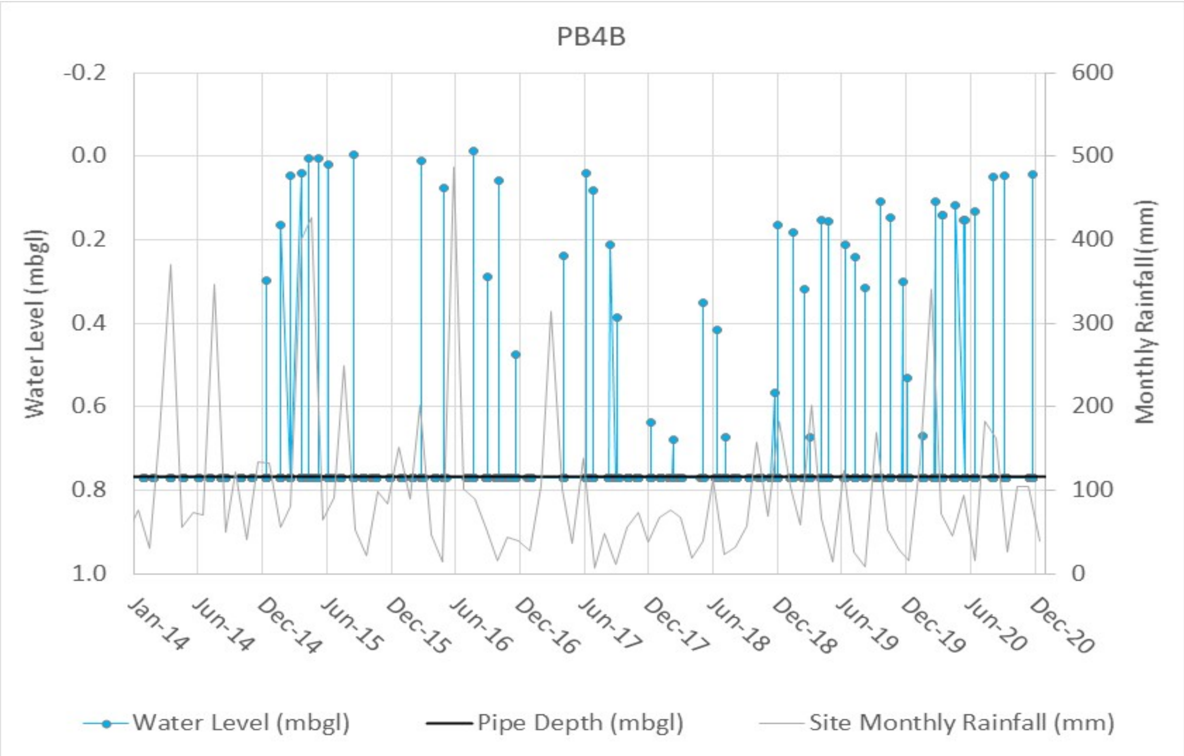
Notes:

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

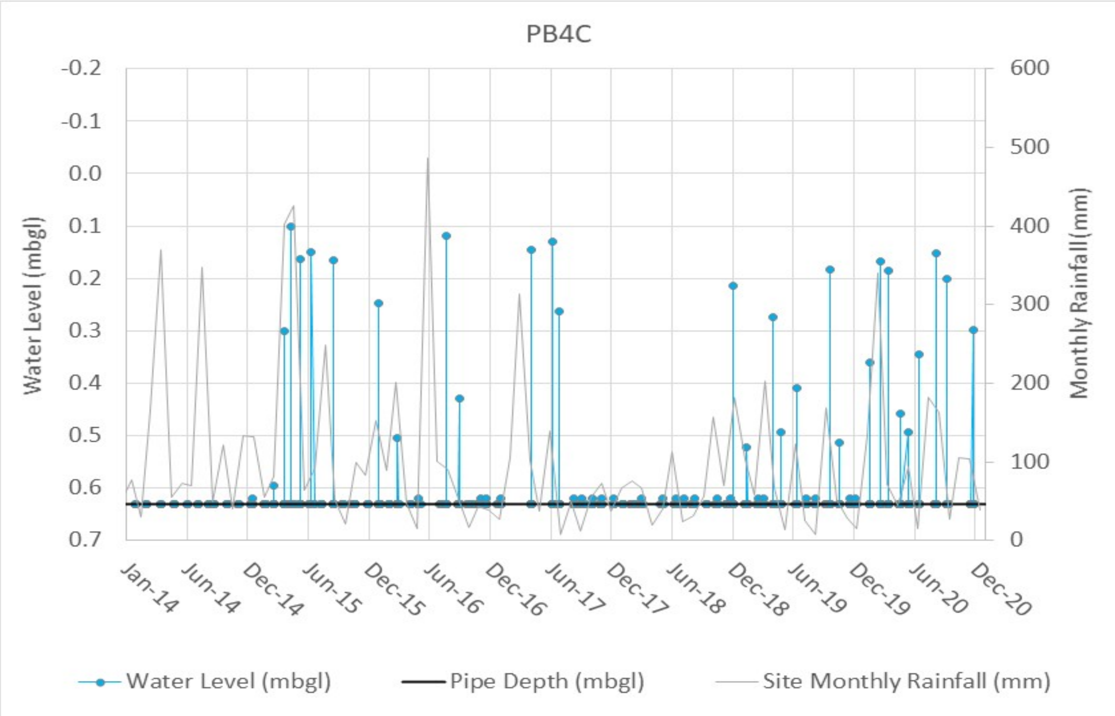
PB4A near BCUS4



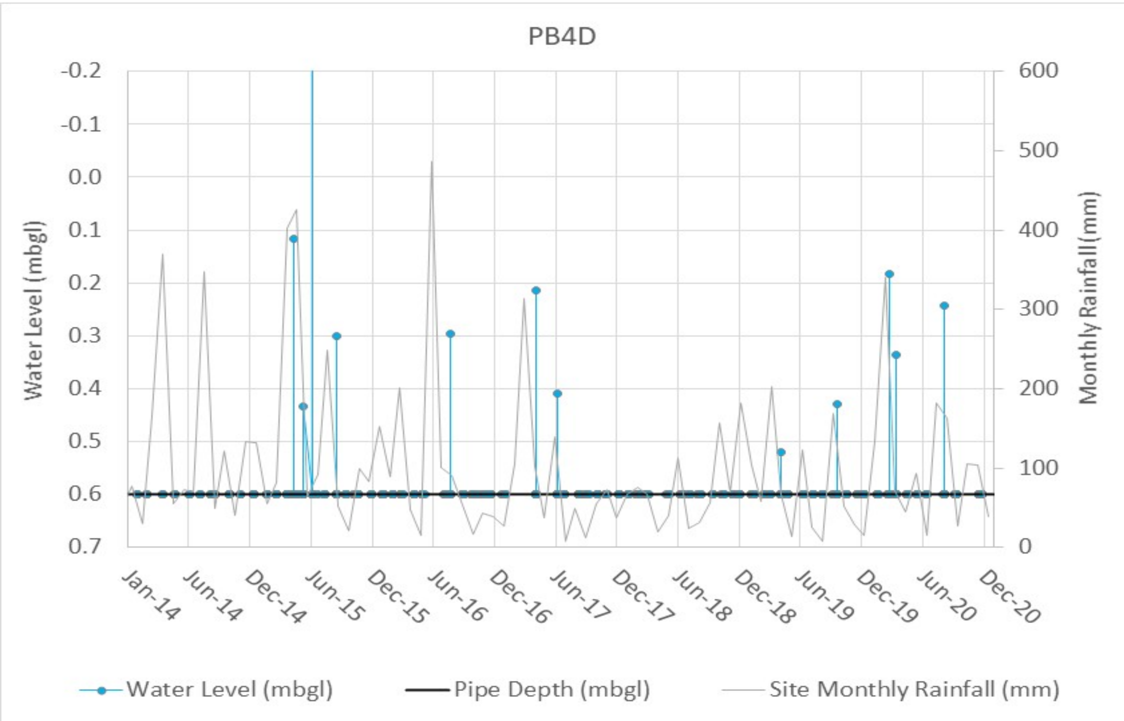
PB4B near BCUS4



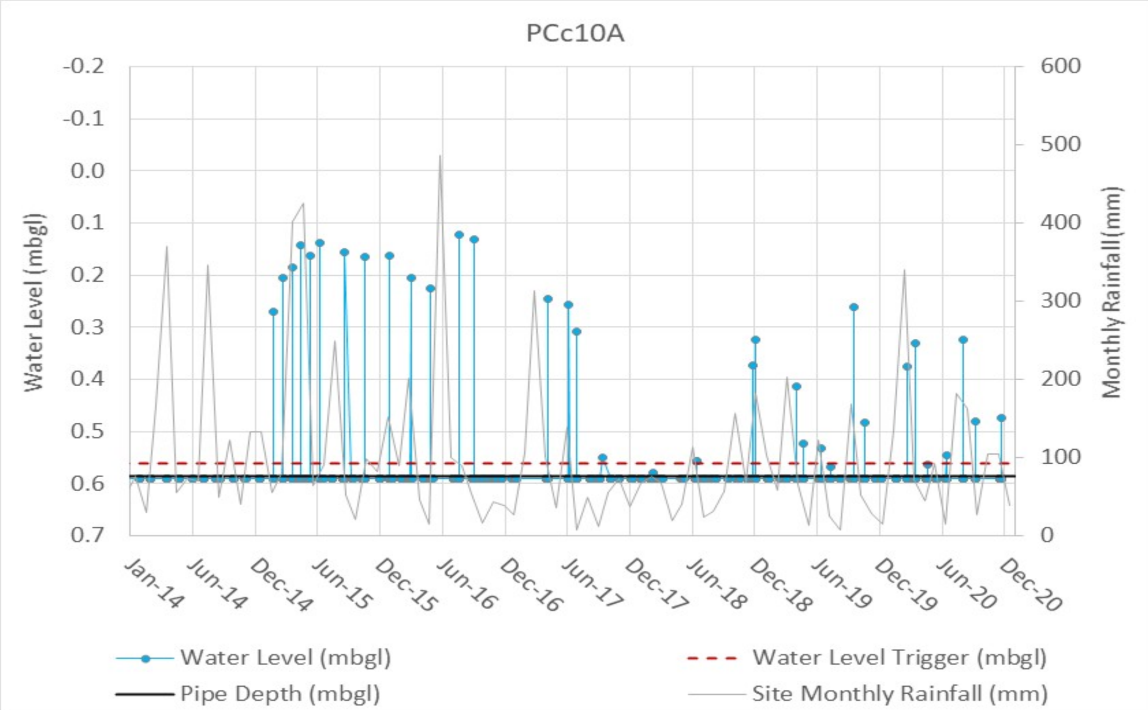
PB4C near BCUS4



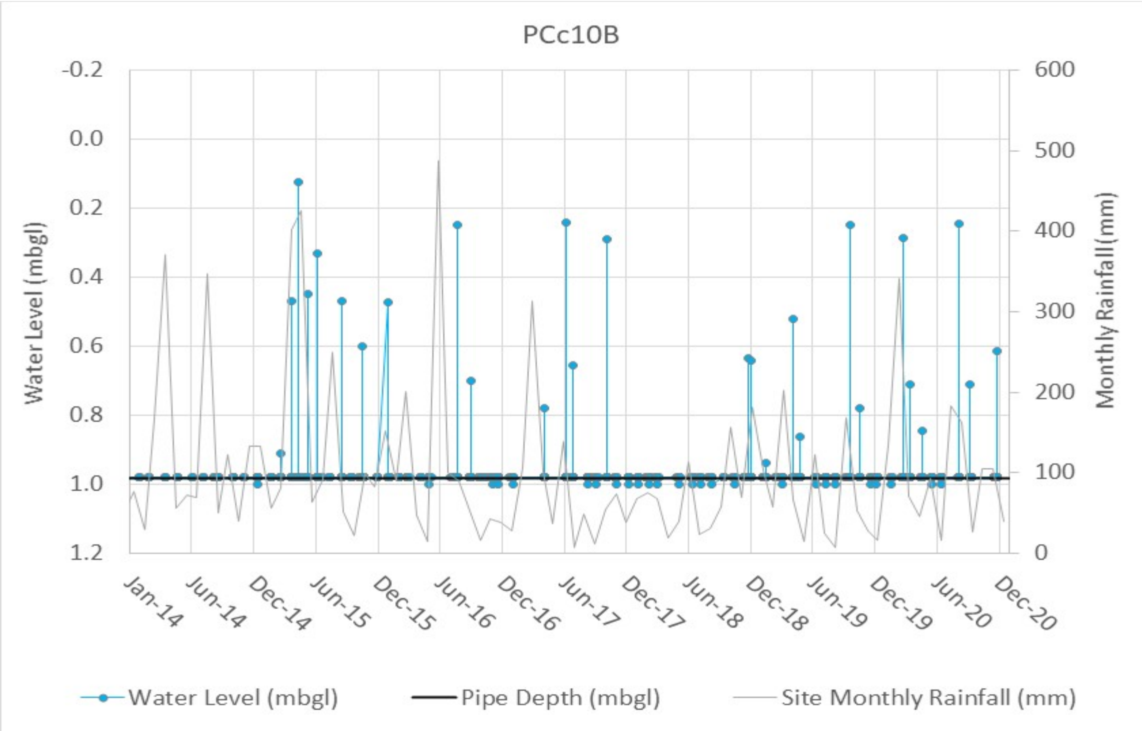
PB4D near BCUS4



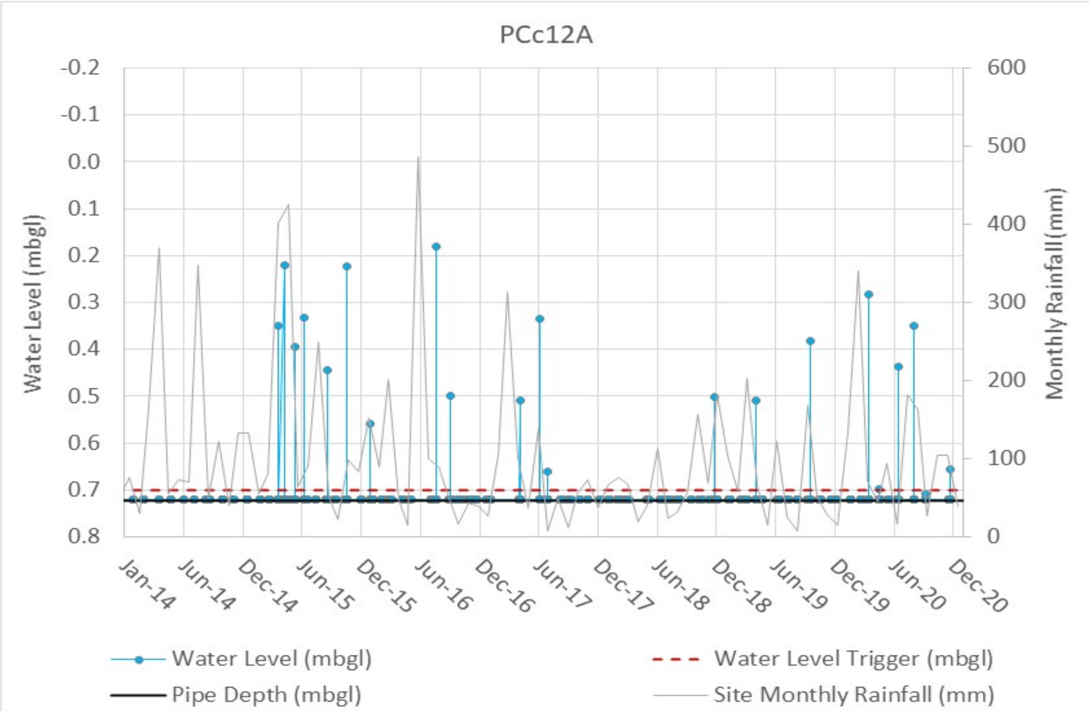
PCc10A near CCUS10



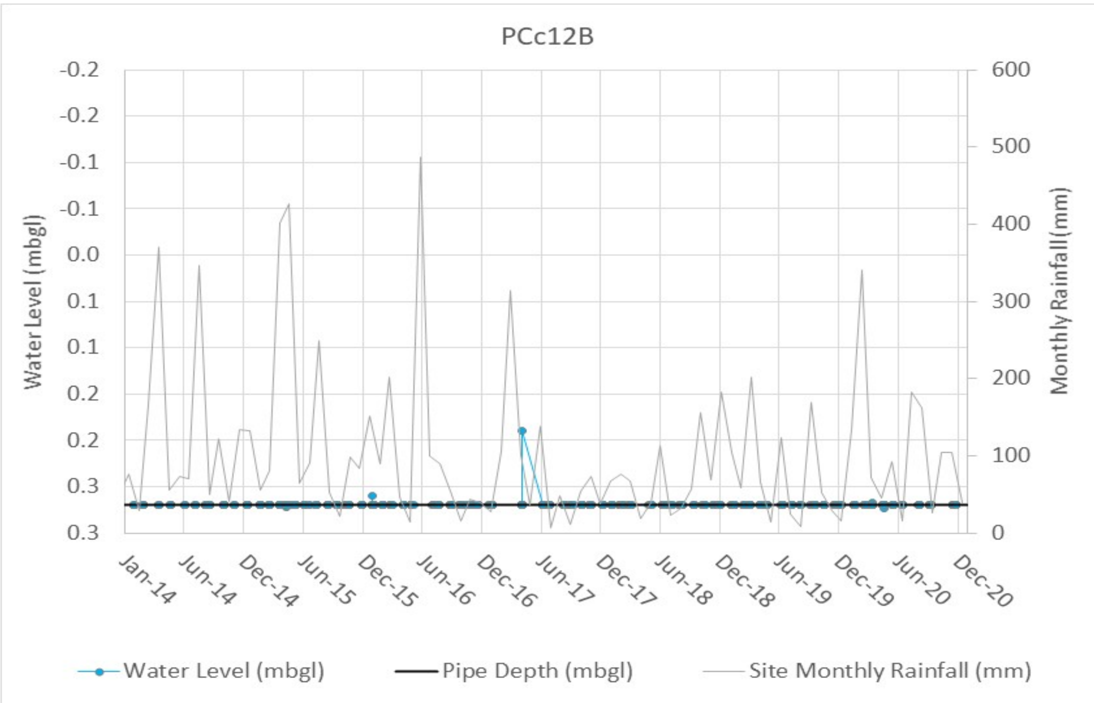
PCc10B near CCUS10



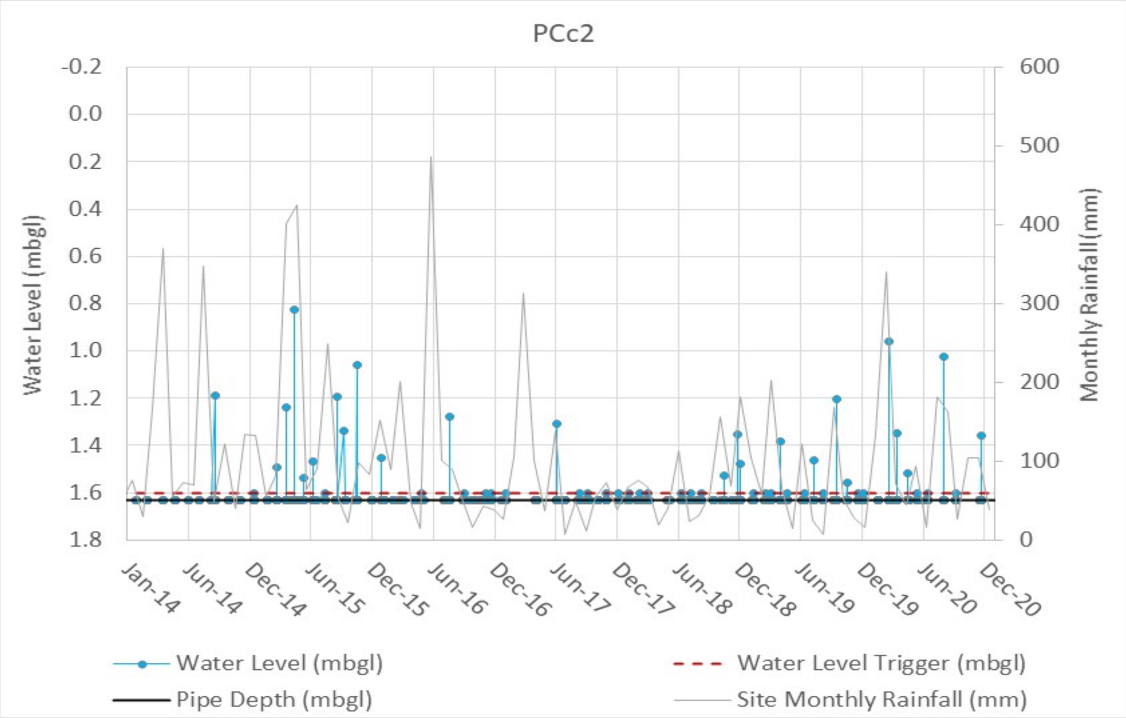
PCc12A near CCUS12



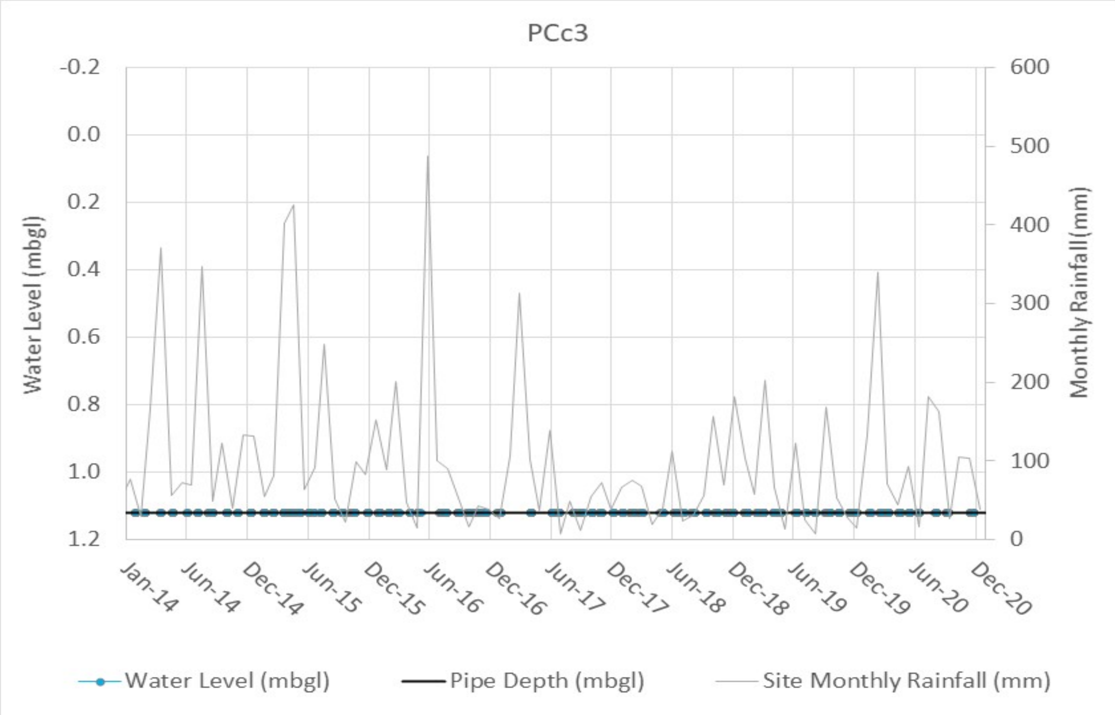
PCc12B near CCUS12



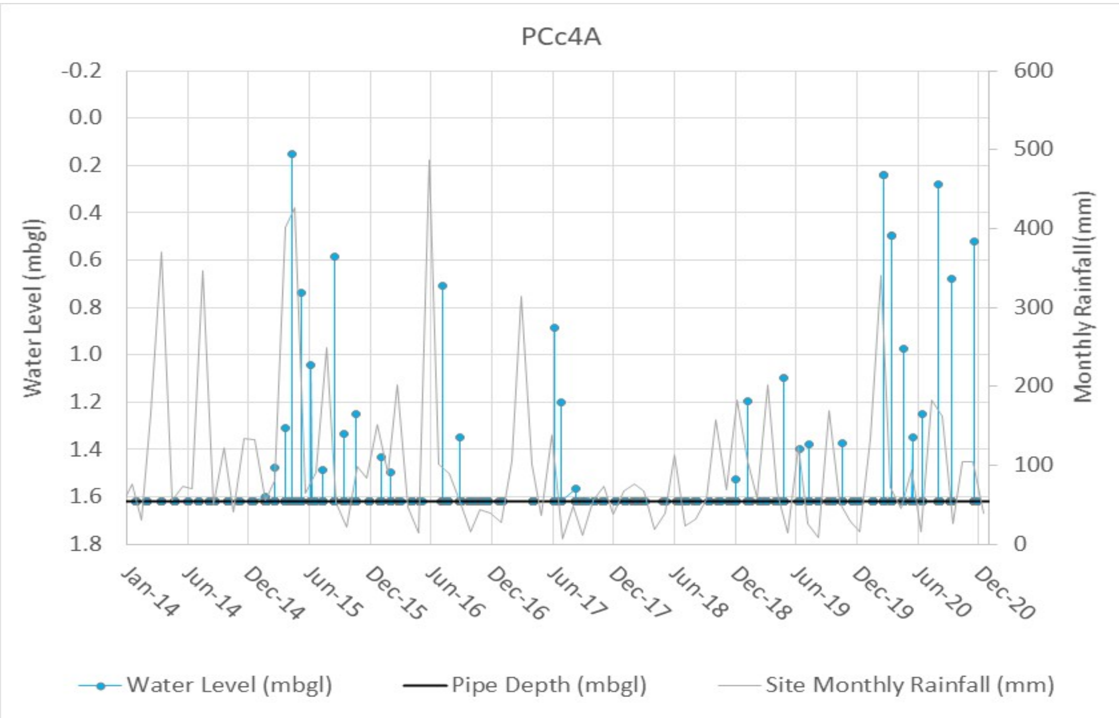
PCc2 near CCUS2



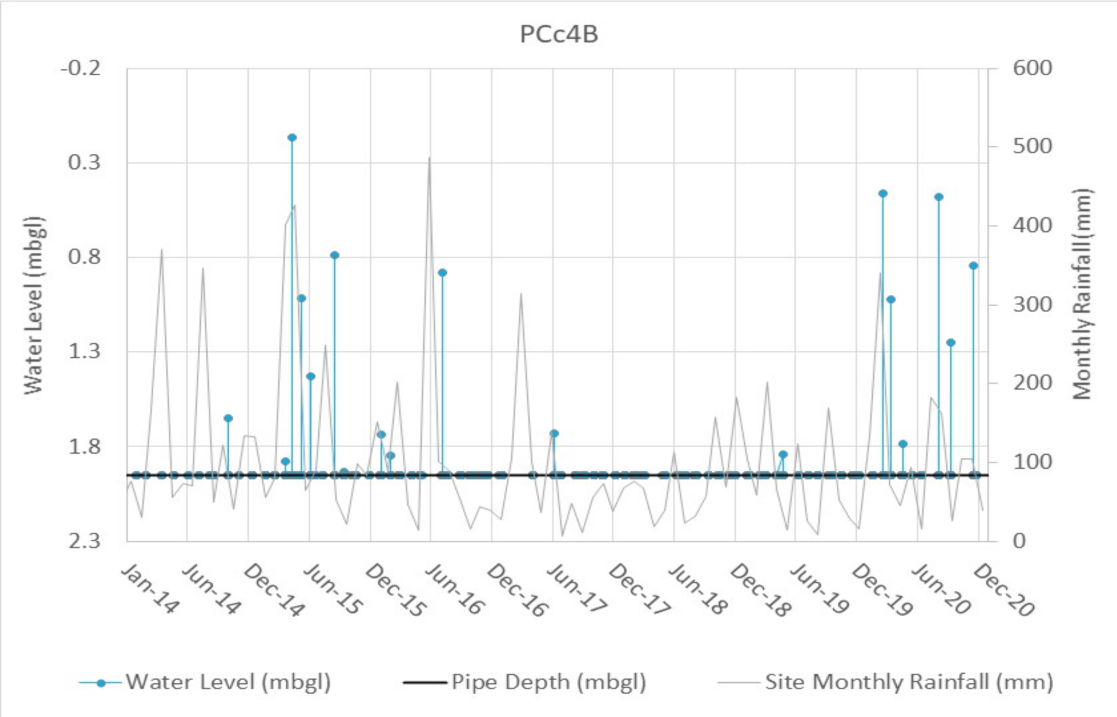
PCc3 near CCUS3



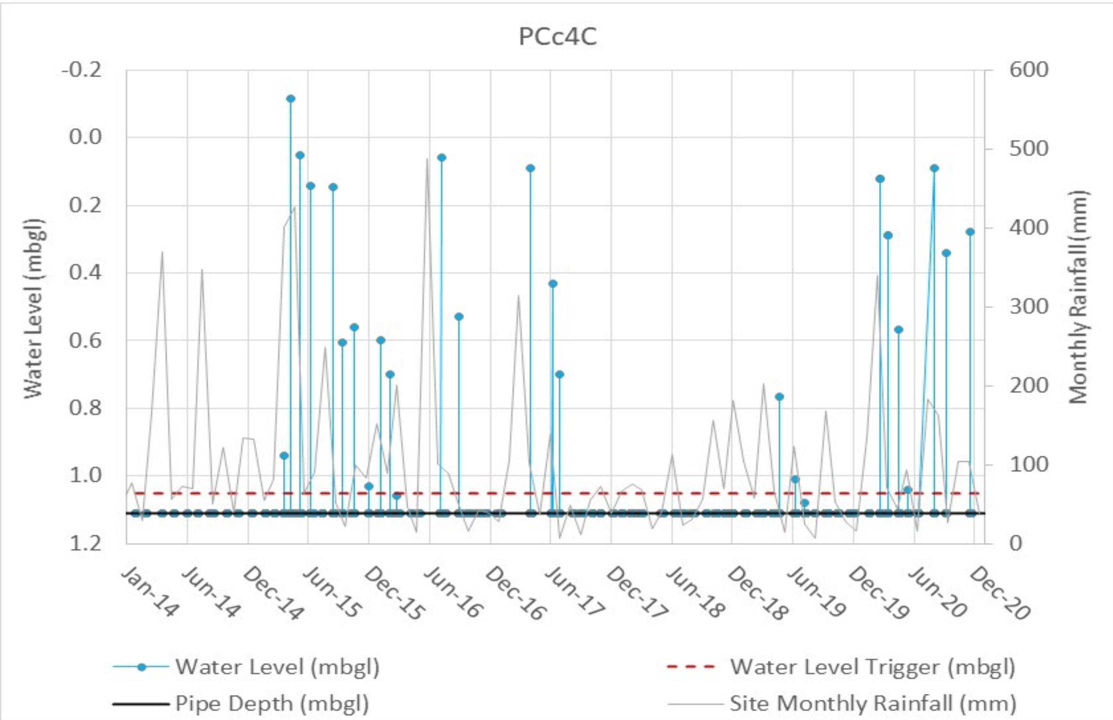
PCc4A near CCUS4



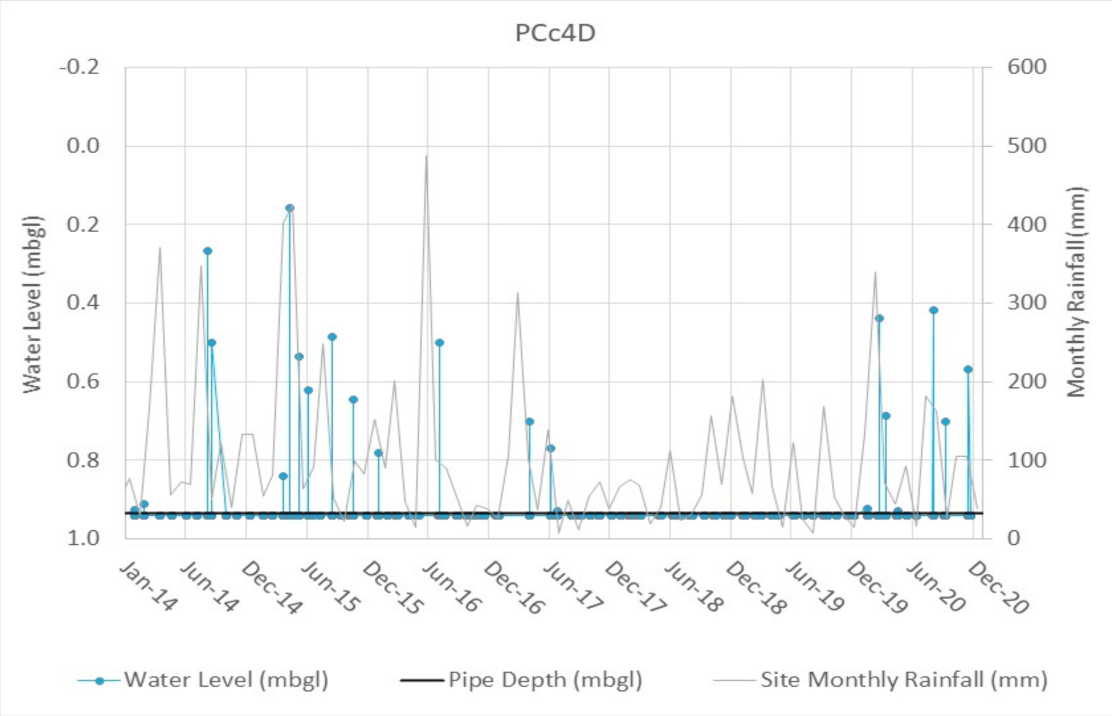
PCc4B near CCUS4



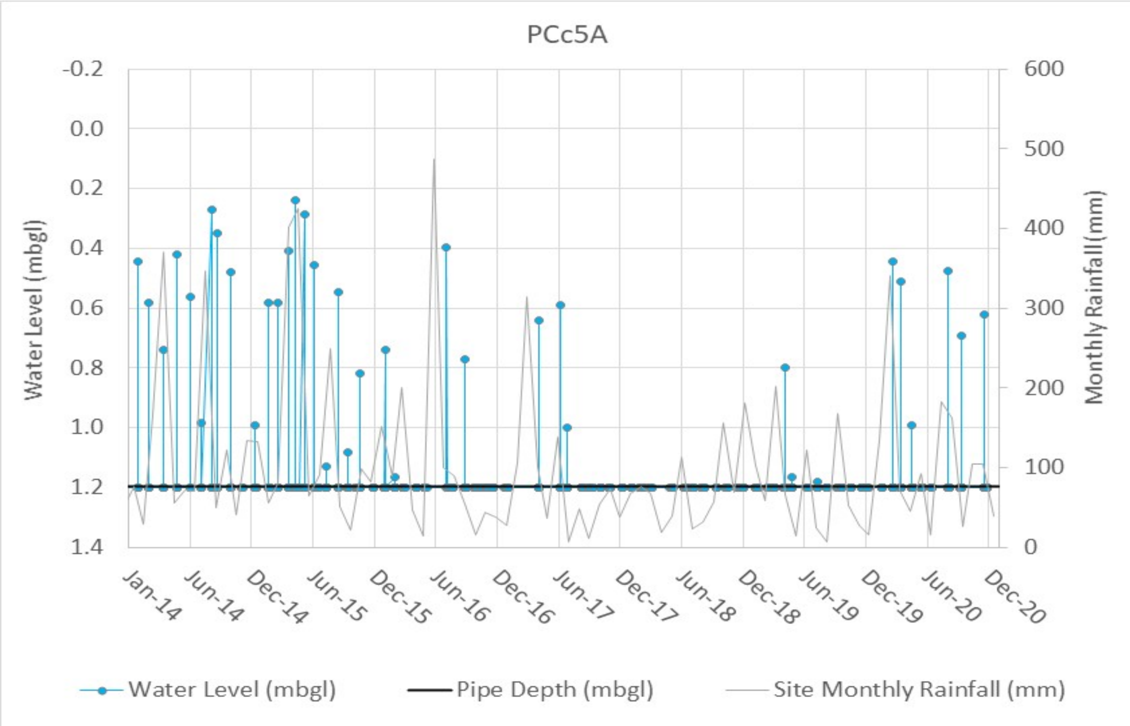
PCc4C near CCUS4



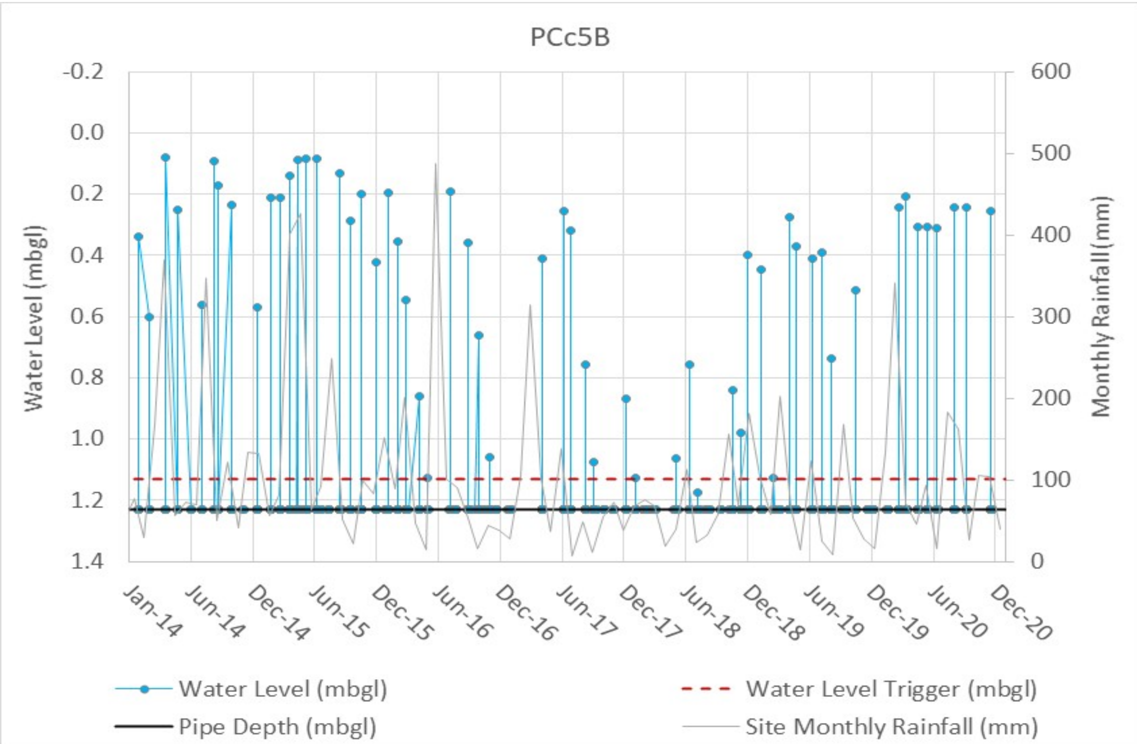
PCc4D near CCUS4



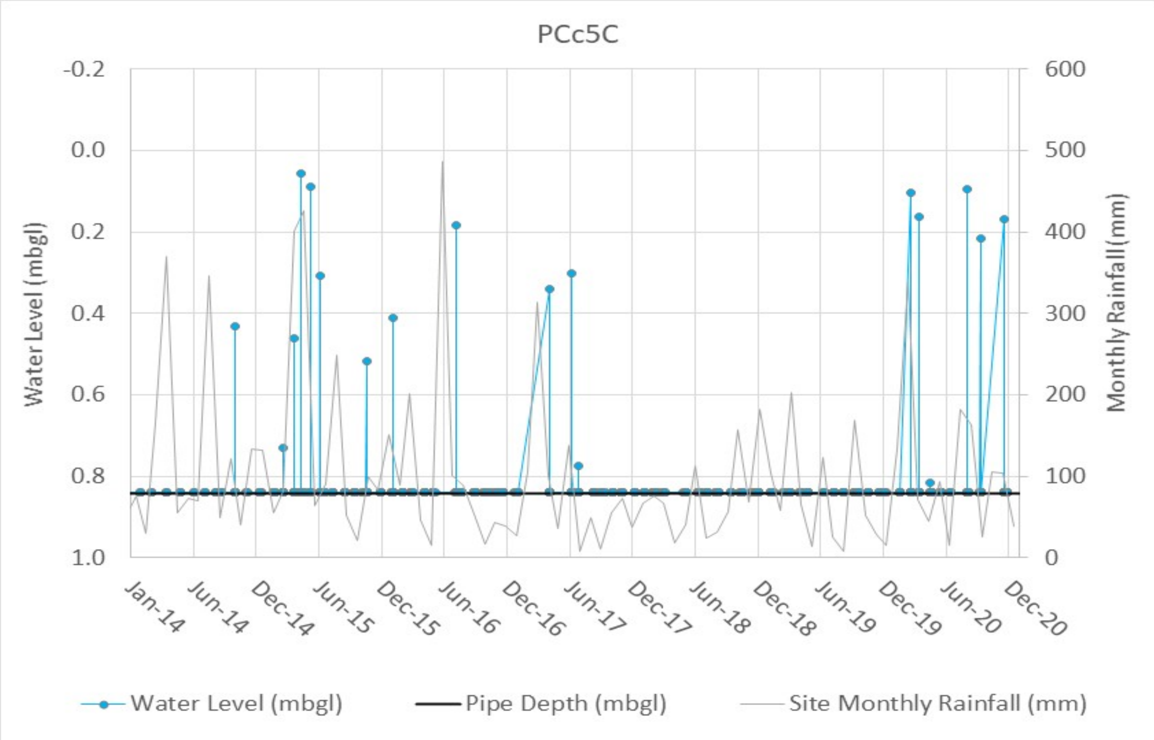
PCc5A near CCUS5



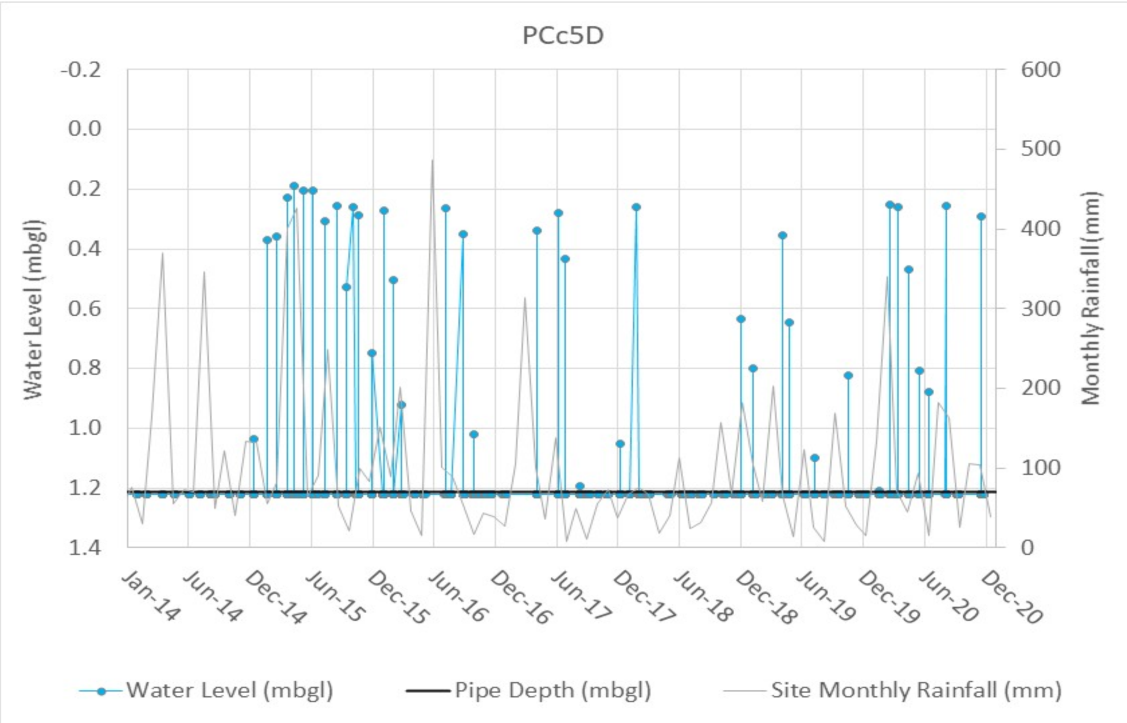
PCc5B near CCUS5



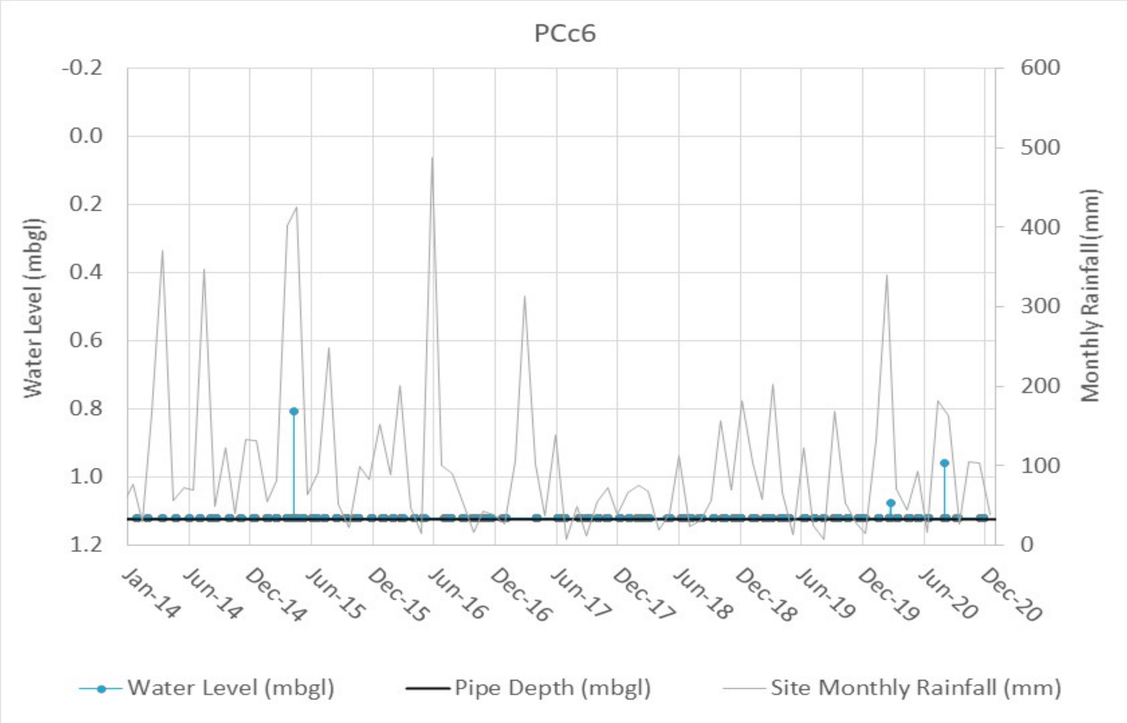
PCc5C near CCUS5



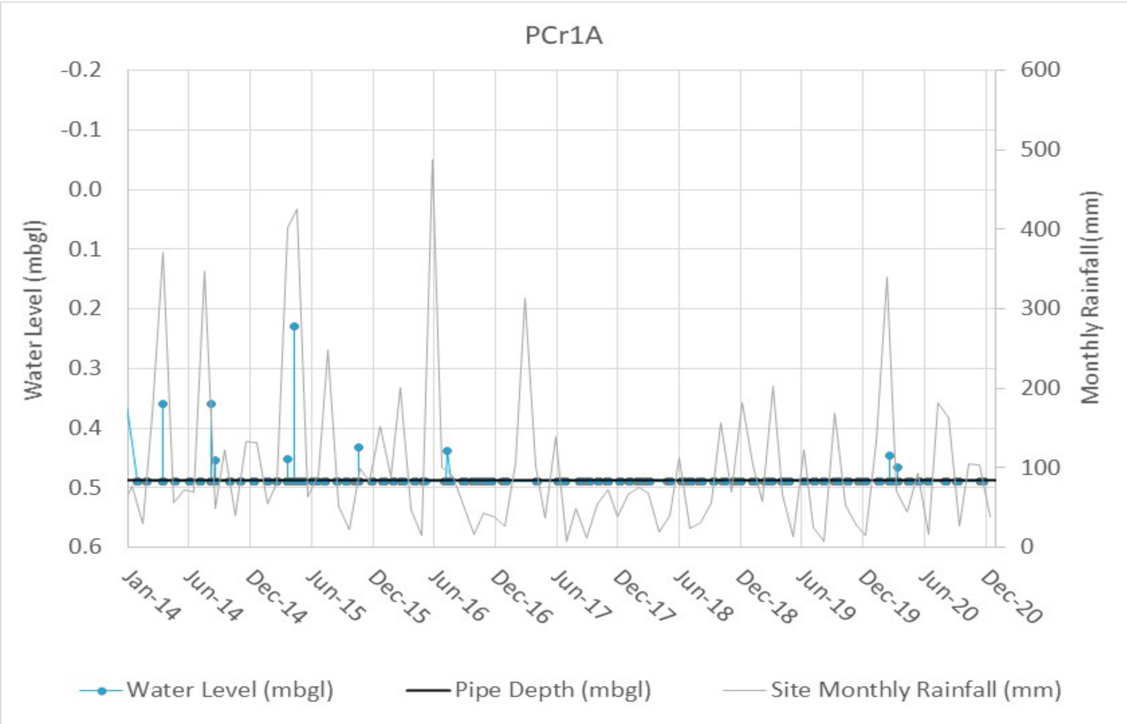
PCc5D near CCUS5



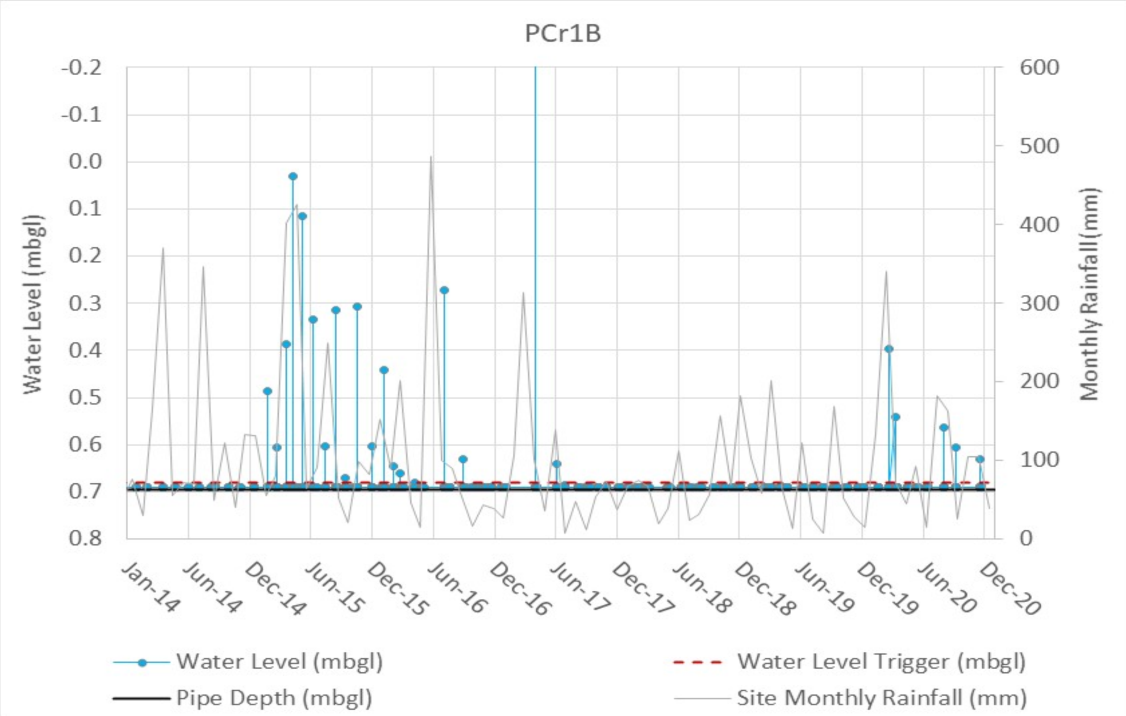
PCc6 near CCUS6



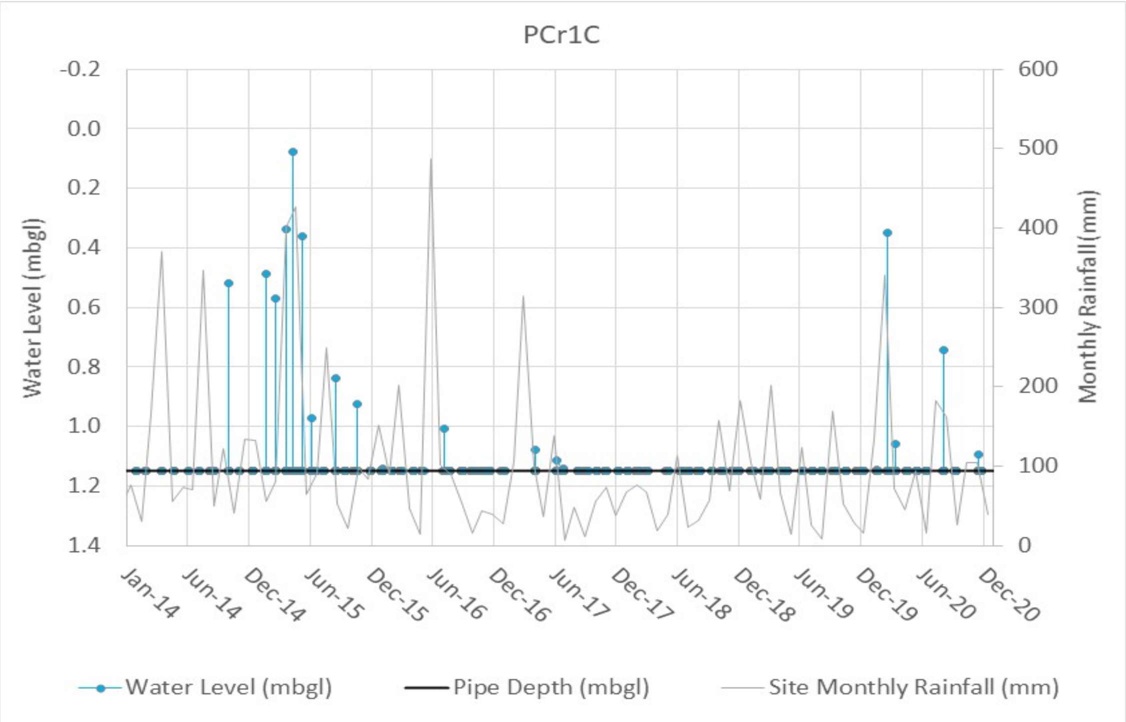
PCr1A near CRUS1



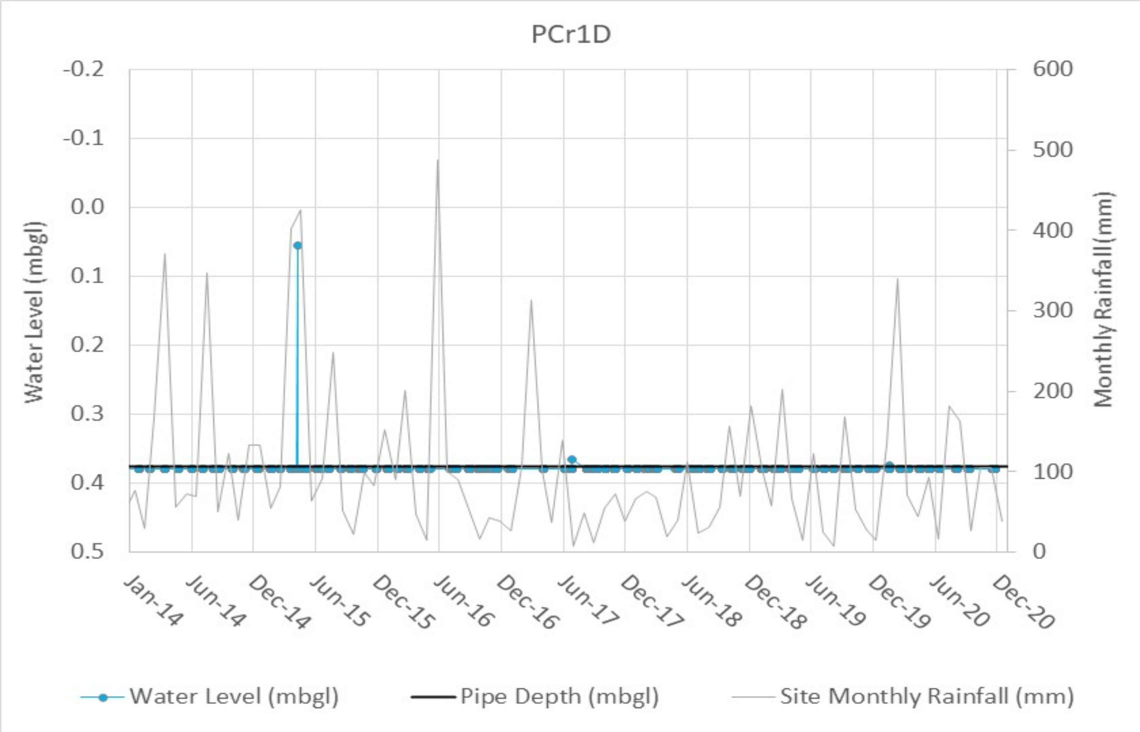
PCr1B near CRUS1



PCr1C near CRUS1



PCr1D near CRUS1



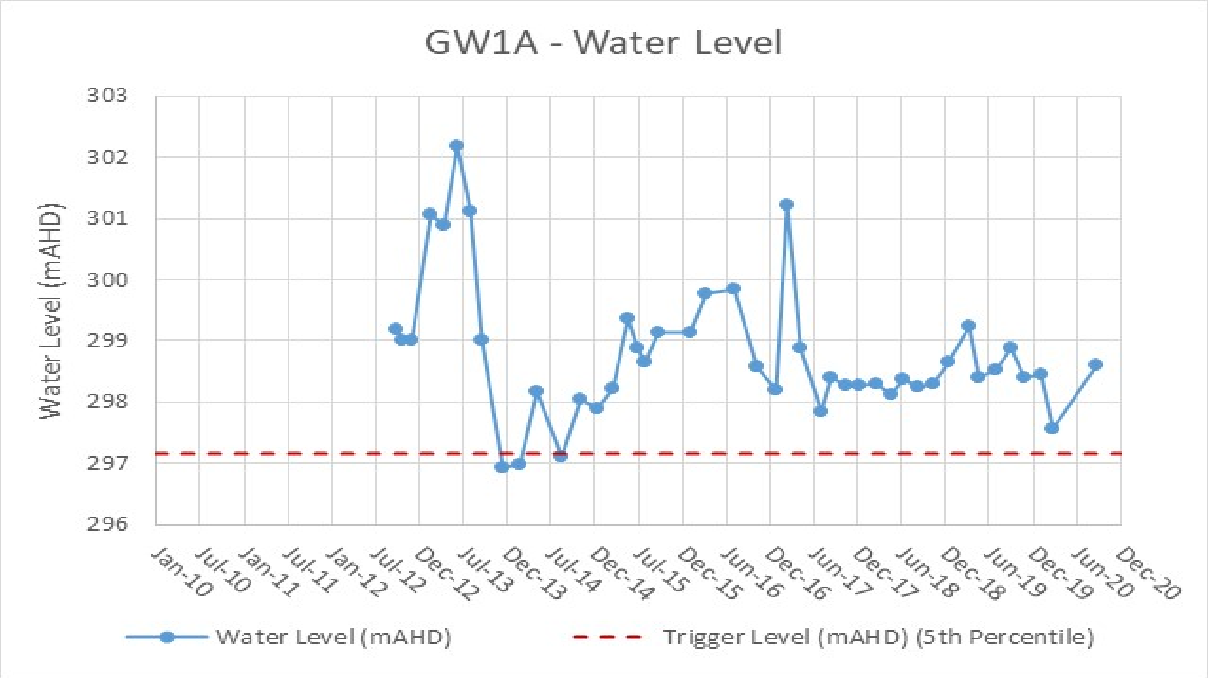
OPEN STANDPIPE GROUNDWATER TRIGGERS

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

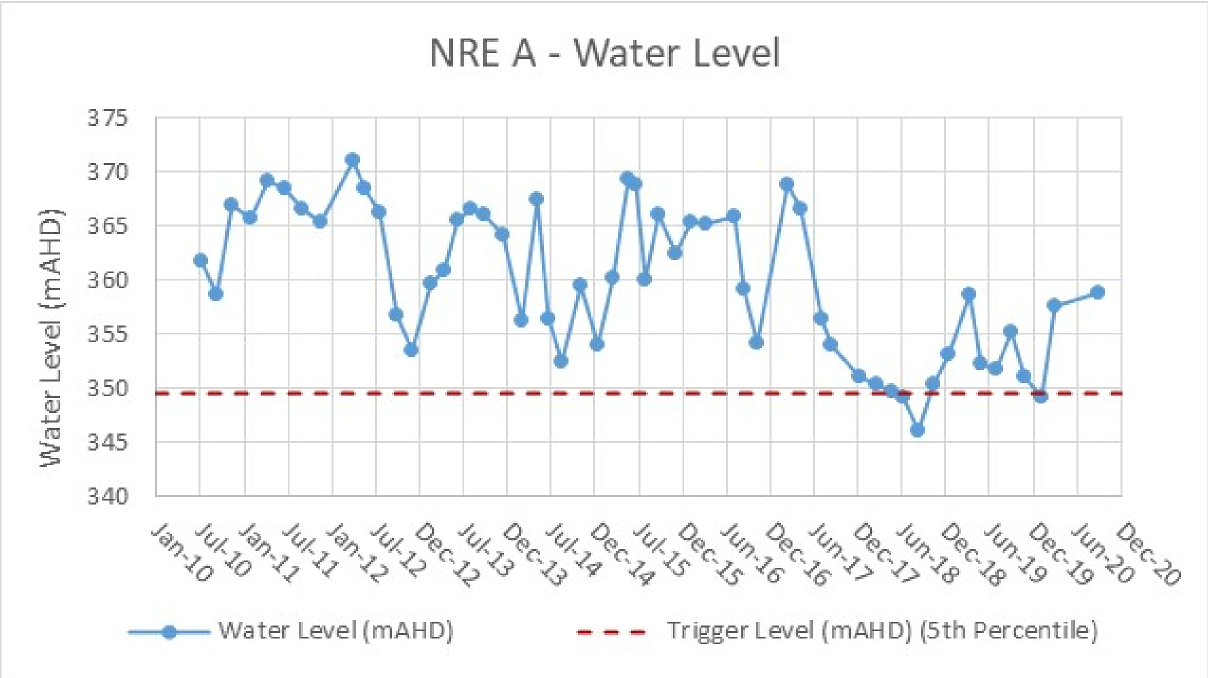
Notes:

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.

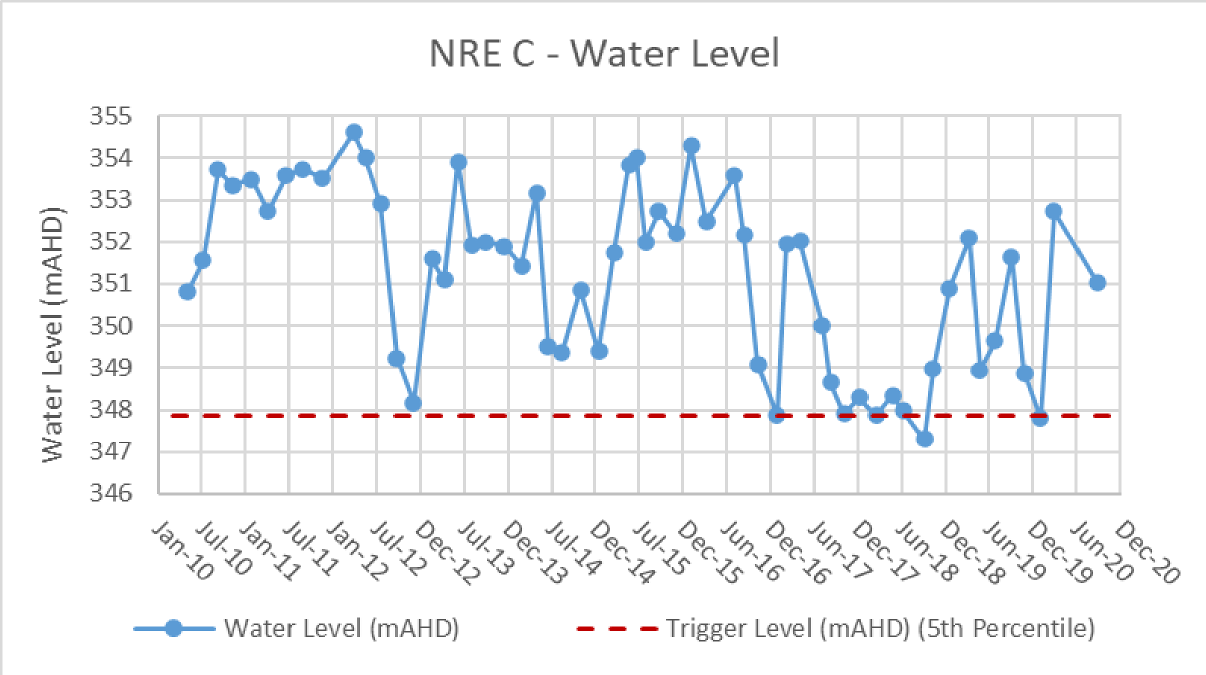
GW1A


GW1A - Water Level
Water Level (mAHD)
303
302
301
300
299
298
297
296
Jan-10 Jul-10 Jan-11 Jul-11 Jan-12 Jul-12 Dec-12 Jul-13 Dec-13 Jul-14 Dec-14 Jul-15 Dec-15 Jun-16 Dec-16 Jun-17 Dec-17 Jun-18 Dec-18 Jun-19 Dec-19 Jun-20 Dec-20
Water Level (mAHD)
Trigger Level (mAHD) (5th Percentile)

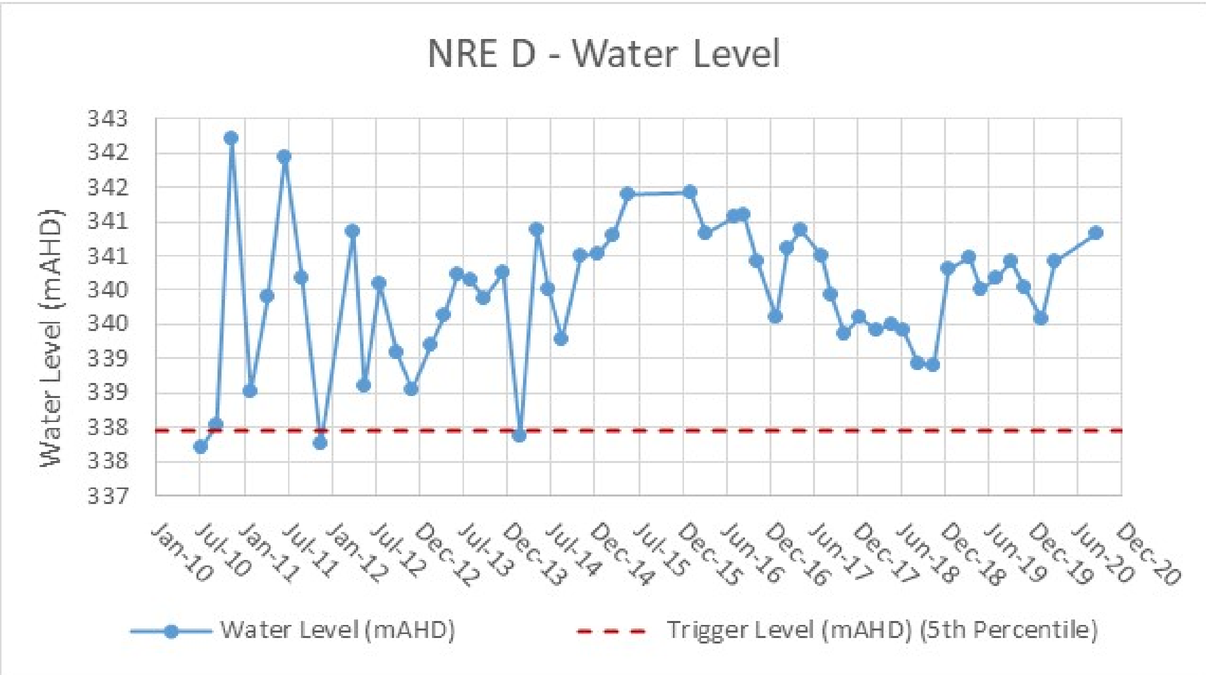
NRE A


NRE A - Water Level
Water Level (mAHD)
375
370
365
360
355
350
345
340
Jan-10 Jul-10 Jan-11 Jul-11 Jan-12 Jul-12 Dec-12 Jul-13 Dec-13 Jul-14 Dec-14 Jul-15 Dec-15 Jun-16 Dec-16 Jun-17 Dec-17 Jun-18 Dec-18 Jun-19 Dec-19 Jun-20 Dec-20
Water Level (mAHD)
Trigger Level (mAHD) (5th Percentile)

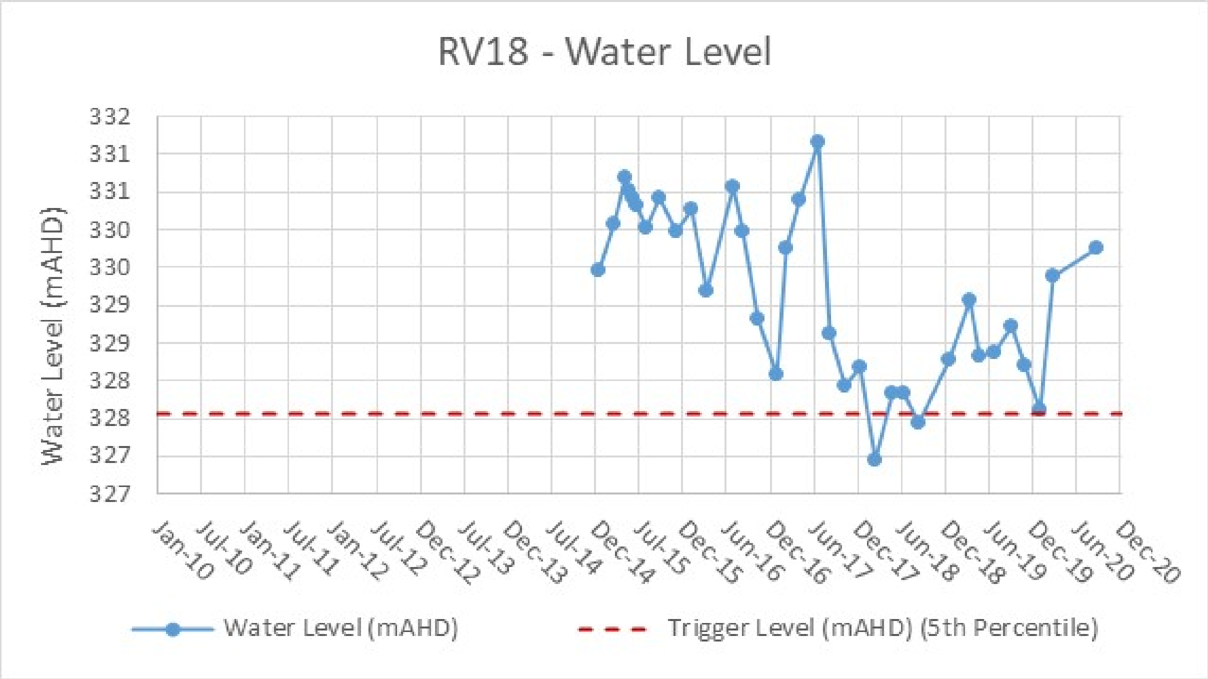
NRE C


NRE C - Water Level
Water Level (mAHD)
355
354
353
352
351
350
349
348
347
346
Jan-10 Jul-10 Jan-11 Jul-11 Jan-12 Jul-12 Dec-12 Jul-13 Dec-13 Jul-14 Dec-14 Jul-15 Dec-15 Jun-16 Dec-16 Jun-17 Dec-17 Jun-18 Dec-18 Jun-19 Dec-19 Jun-20 Dec-20
Water Level (mAHD)
Trigger Level (mAHD) (5th Percentile)

NRE D

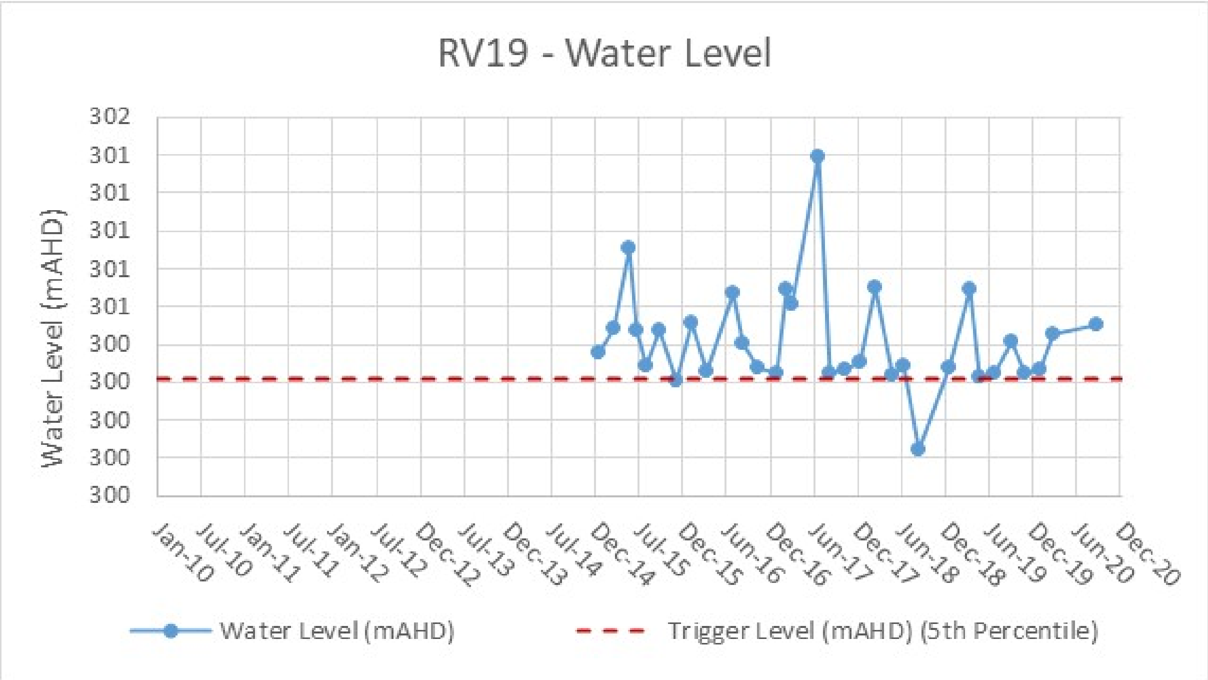

NRE D - Water Level
Water Level (mAHD)
343
342
342
341
341
340
340
339
339
338
338
337
Jan-10 Jul-10 Jan-11 Jul-11 Jan-12 Jul-12 Dec-12 Jul-13 Dec-13 Jul-14 Dec-14 Jul-15 Dec-15 Jun-16 Dec-16 Jun-17 Dec-17 Jun-18 Dec-18 Jun-19 Dec-19 Jun-20 Dec-20
Water Level (mAHD)
Trigger Level (mAHD) (5th Percentile)

RV18



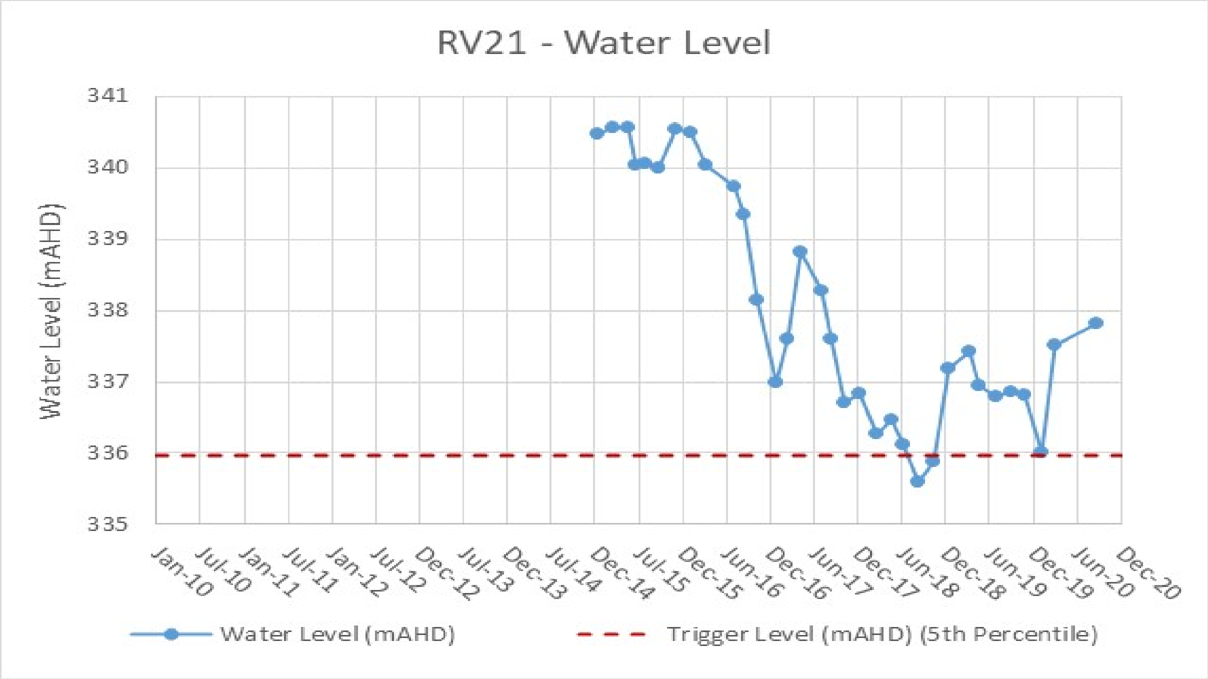
RV18 - Water Level
Water Level (mAHD)
332
331
331
330
330
329
329
328
328
327
327
Jan-10 Jul-10 Jan-11 Jul-11 Jan-12 Jul-12 Dec-12 Jul-13 Dec-13 Jul-14 Dec-14 Jul-15 Dec-15 Jun-16 Dec-16 Jun-17 Dec-17 Jun-18 Dec-18 Jun-19 Dec-19 Jun-20 Dec-20
Water Level (mAHD)
Trigger Level (mAHD) (5th Percentile)

RV19



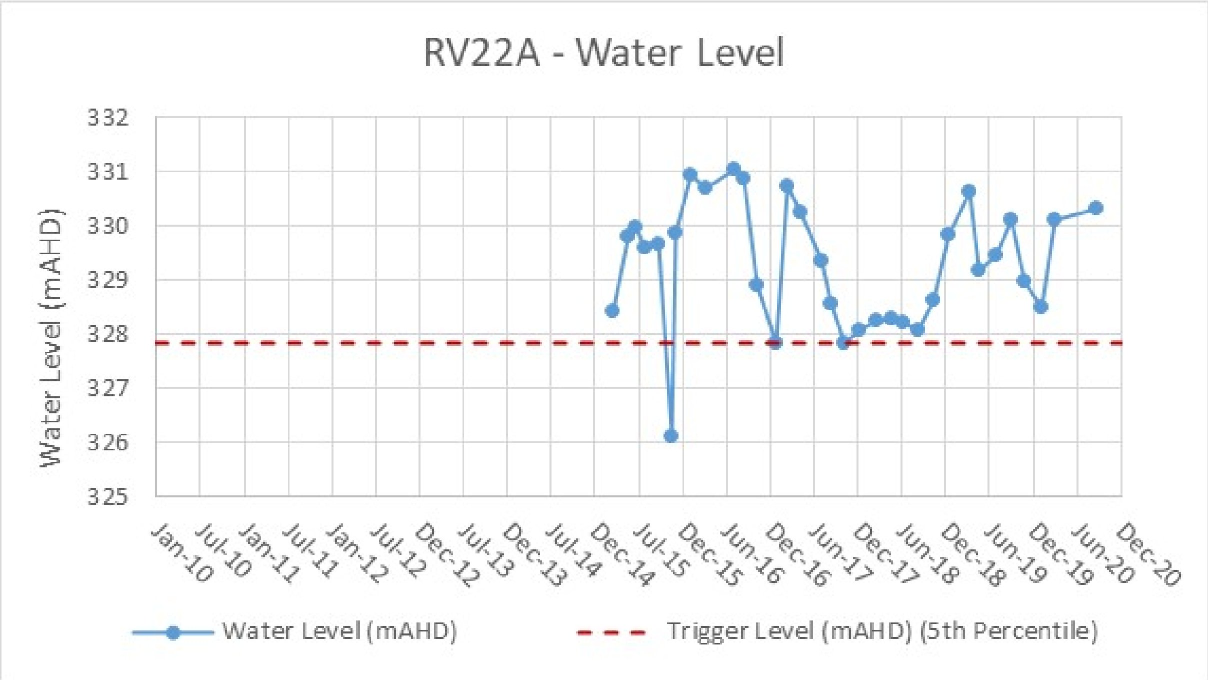
RV19 - Water Level
Water Level (mAHD)
302
301
301
301
301
301
300
300
300
300
300
Jan-10 Jul-10 Jan-11 Jul-11 Jan-12 Jul-12 Dec-12 Jul-13 Dec-13 Jul-14 Dec-14 Jul-15 Dec-15 Jun-16 Dec-16 Jun-17 Dec-17 Jun-18 Dec-18 Jun-19 Dec-19 Jun-20 Dec-20
Water Level (mAHD)
Trigger Level (mAHD) (5th Percentile)

RV21



RV21 - Water Level
341
340
339
338
337
336
335
Water Level (mAHD)
Jan-10
Jul-10
Jan-11
Jul-11
Jan-12
Jul-12
Dec-12
Jul-13
Dec-13
Jul-14
Dec-14
Jul-15
Dec-15
Jun-16
Dec-16
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Jun-20
Dec-20
Water Level (mAHD)
Trigger Level (mAHD) (5th Percentile)

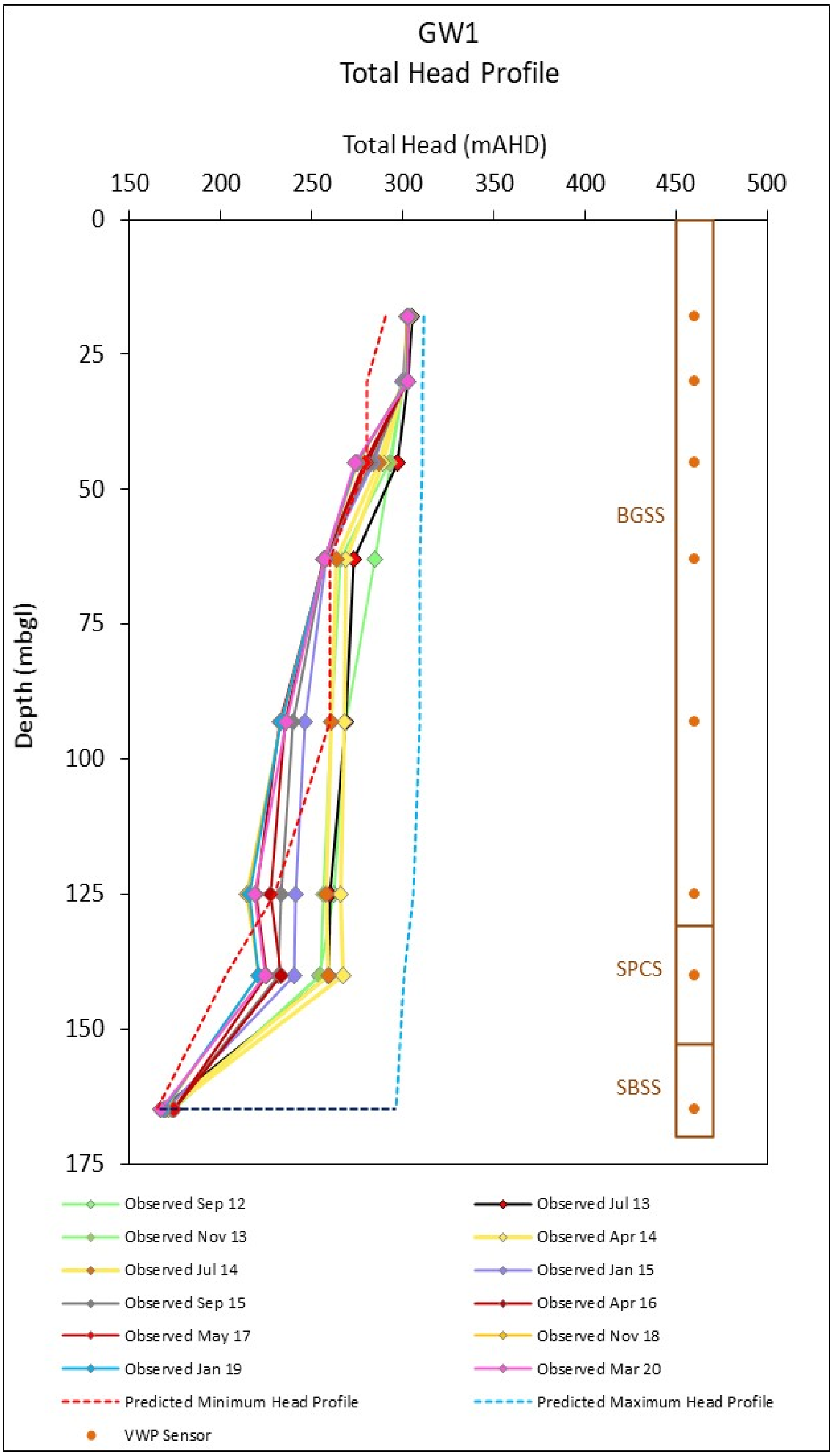
RV22A



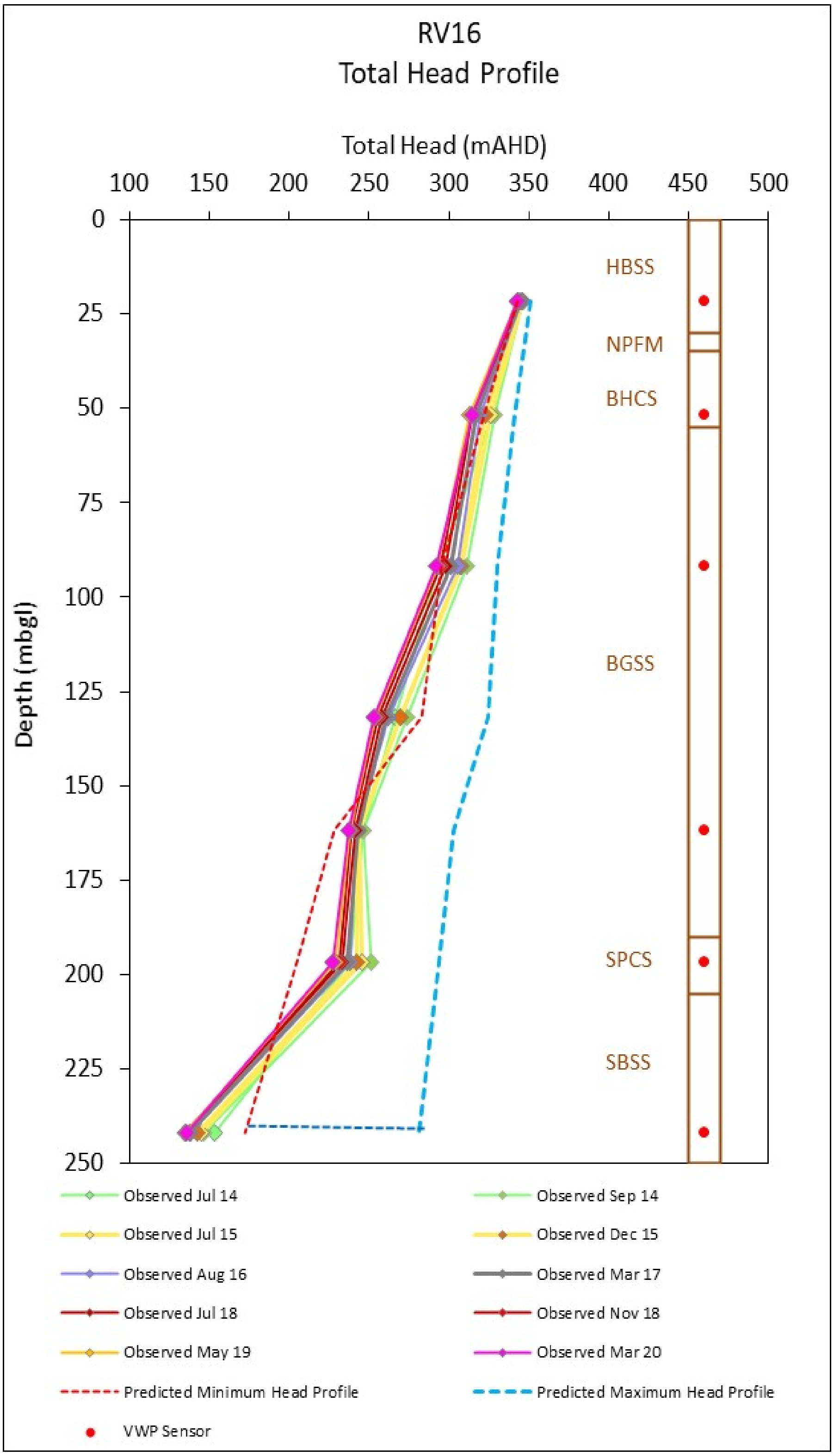
RV22A - Water Level
332
331
330
329
328
327
326
325
Water Level (mAHD)
Jan-10
Jul-10
Jan-11
Jul-11
Jan-12
Jul-12
Dec-12
Jul-13
Dec-13
Jul-14
Dec-14
Jul-15
Dec-15
Jun-16
Dec-16
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Jun-20
Dec-20
Water Level (mAHD)
Trigger Level (mAHD) (5th Percentile)

VWP GROUNDWATER LEVEL TRIGGERS

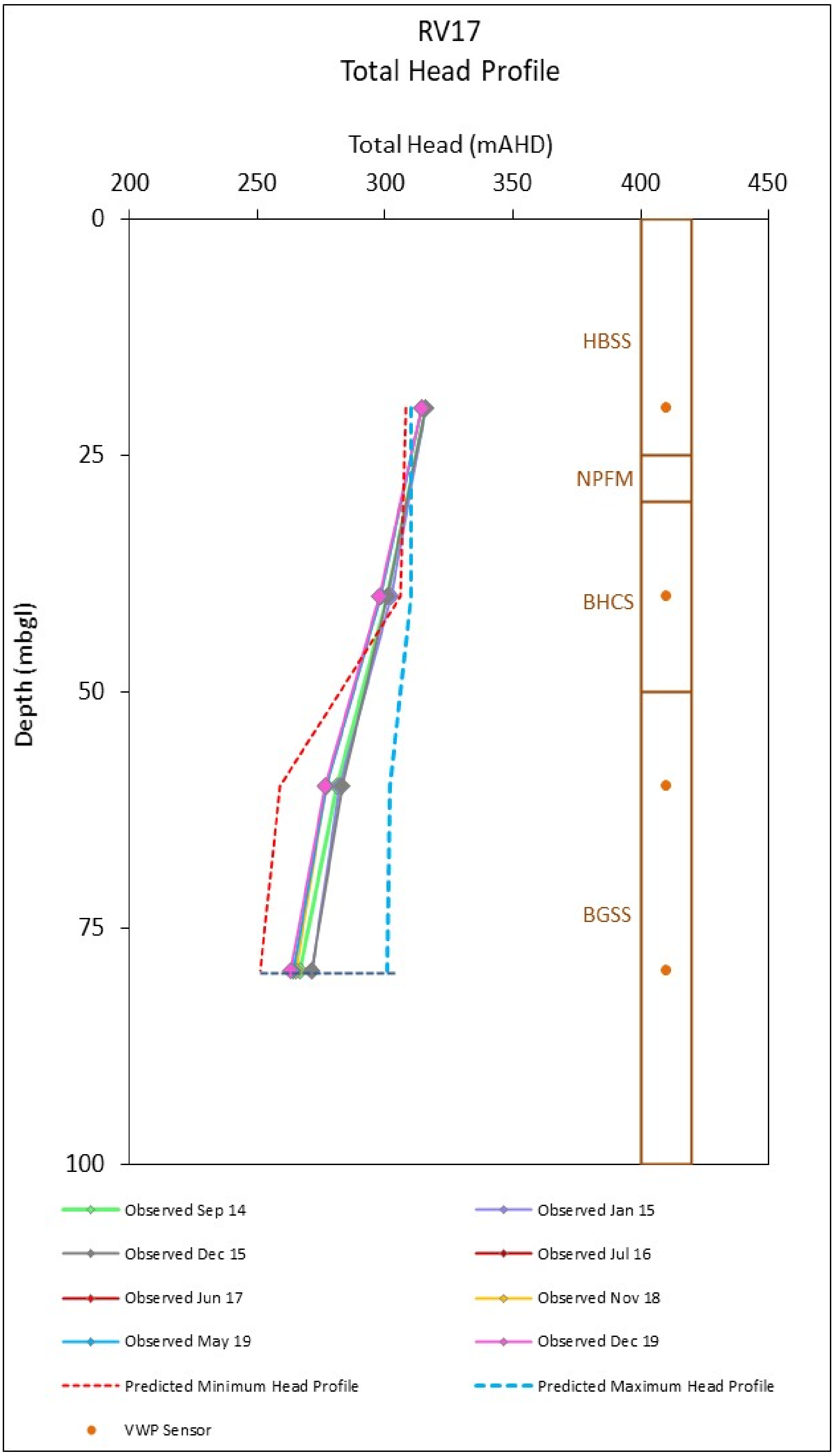
GW1 (VWP)


GW1
Total Head Profile
Total Head (mAHD)
150
200
250
300
350
400
450
500
0
25
50
75
100
125
150
175
Depth (mbgl)
BGSS
SPCS
SBSS
Observed Sep 12
Observed Jul 13
Observed Nov 13
Observed Apr 14
Observed Jul 14
Observed Jan 15
Observed Sep 15
Observed Apr 16
Observed May 17
Observed Nov 18
Observed Jan 19
Observed Mar 20
Predicted Minimum Head Profile
Predicted Maximum Head Profile
VWP Sensor

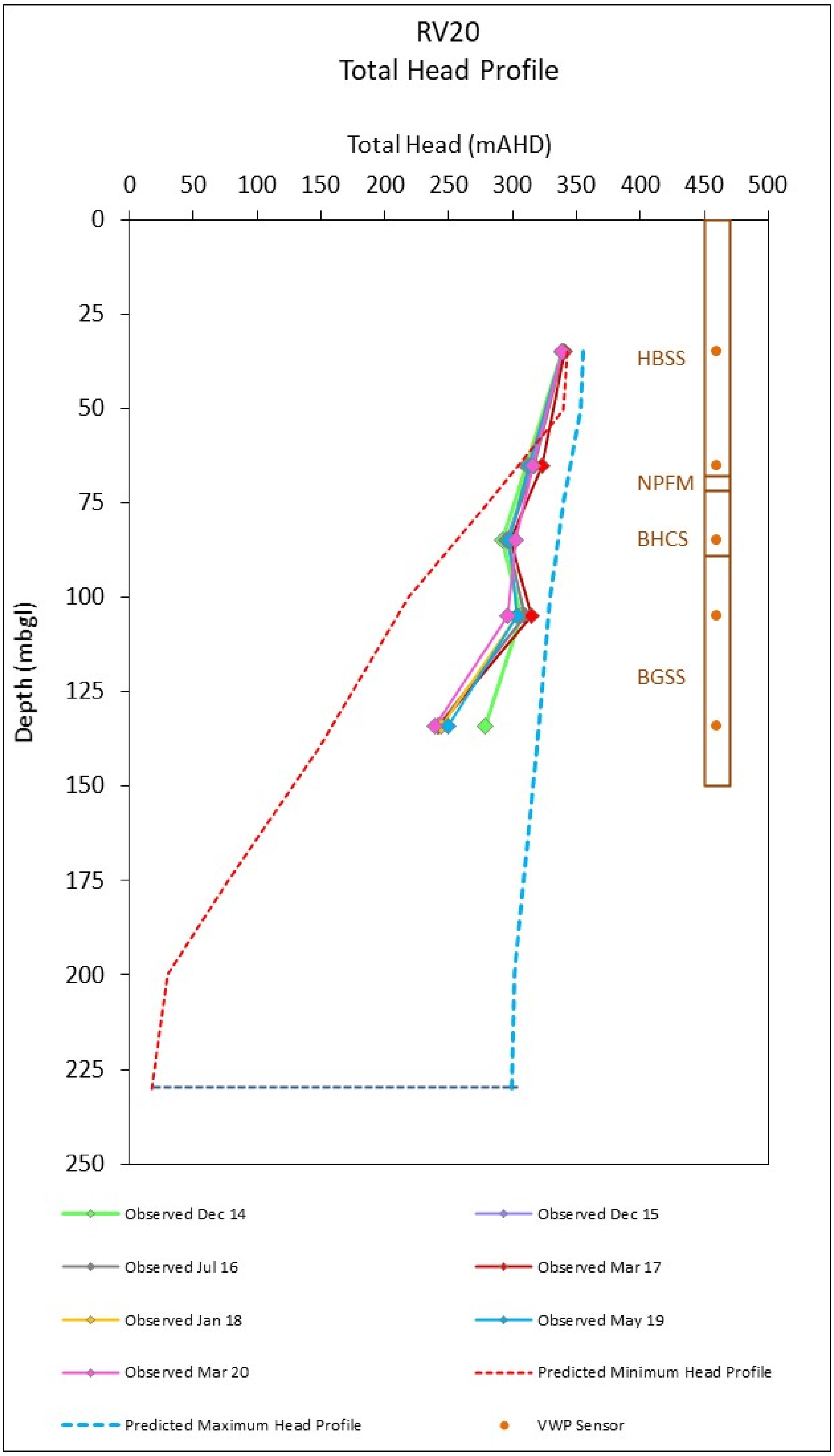
RV16 (VWP)


RV16
Total Head Profile
Total Head (mAHD)
100
150
200
250
300
350
400
450
500
Depth (mbgl)
0
25
50
75
100
125
150
175
200
225
250
HBSS
NPFM
BHCS
BGSS
SPCS
SBSS
Observed Jul 14
Observed Sep 14
Observed Jul 15
Observed Dec 15
Observed Aug 16
Observed Mar 17
Observed Jul 18
Observed Nov 18
Observed May 19
Observed Mar 20
Predicted Minimum Head Profile
Predicted Maximum Head Profile
VWP Sensor

RV17 (VWP)

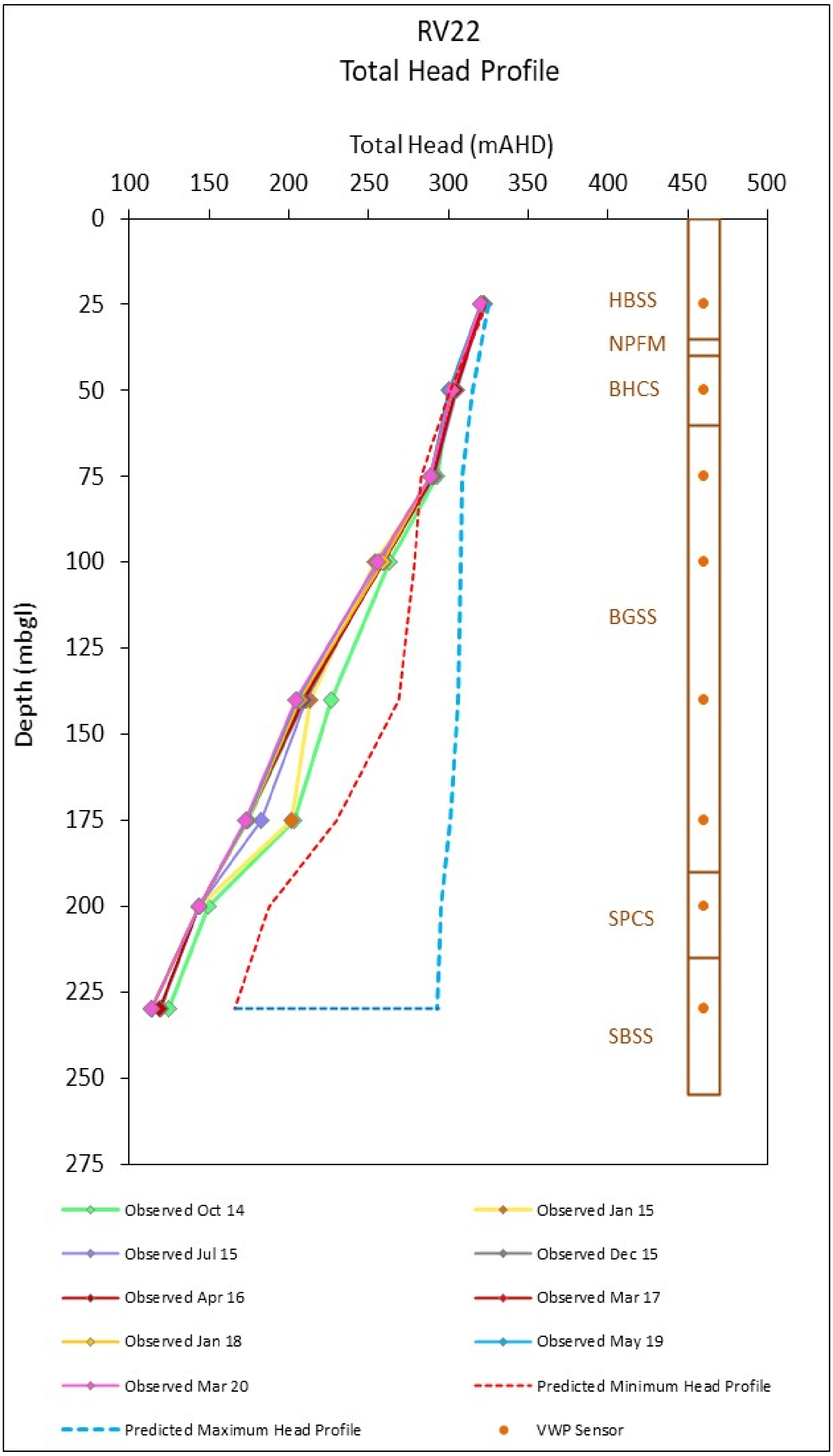

RV17
Total Head Profile
Total Head (mAHD)
200
250
300
350
400
450
0
25
50
75
100
Depth (mbgl)
HBSS
NPFM
BHCS
BGSS
Observed Sep 14
Observed Jan 15
Observed Dec 15
Observed Jul 16
Observed Jun 17
Observed Nov 18
Observed May 19
Observed Dec 19
Predicted Minimum Head Profile
Predicted Maximum Head Profile
VWP Sensor

RV20 (VWP)



RV20
Total Head Profile
Total Head (mAHD)
0 50 100 150 200 250 300 350 400 450 500
Depth (mbgl)
0 25 50 75 100 125 150 175 200 225 250
HBSS
NPFM
BHCS
BGSS
Observed Dec 14
Observed Dec 15
Observed Jul 16
Observed Mar 17
Observed Jan 18
Observed May 19
Observed Mar 20
Predicted Minimum Head Profile
Predicted Maximum Head Profile
VWP Sensor

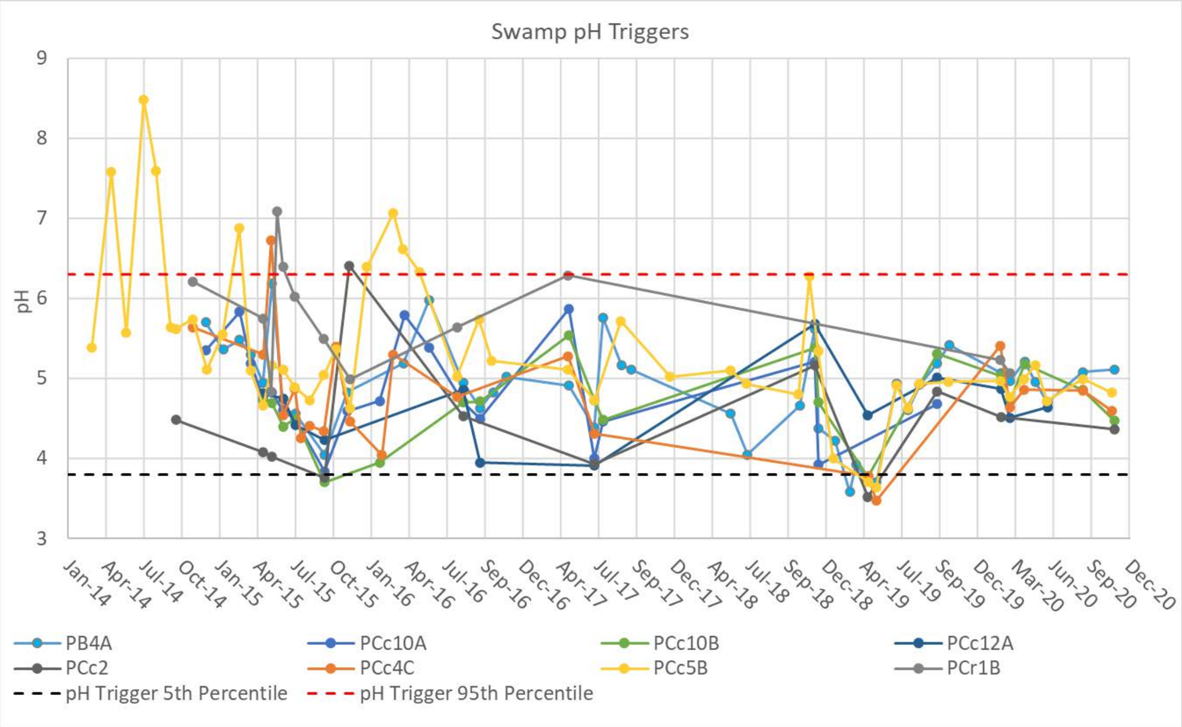
RV22 (VWP)


RV22
Total Head Profile
Total Head (mAHD)
100
150
200
250
300
350
400
450
500
Depth (mbgl)
0
25
50
75
100
125
150
175
200
225
250
275
HBSS
NPFM
BHCS
BGSS
SPCS
SBSS
Observed Oct 14
Observed Jan 15
Observed Jul 15
Observed Dec 15
Observed Apr 16
Observed Mar 17
Observed Jan 18
Observed May 19
Observed Mar 20
Predicted Minimum Head Profile
Predicted Maximum Head Profile
VWP Sensor

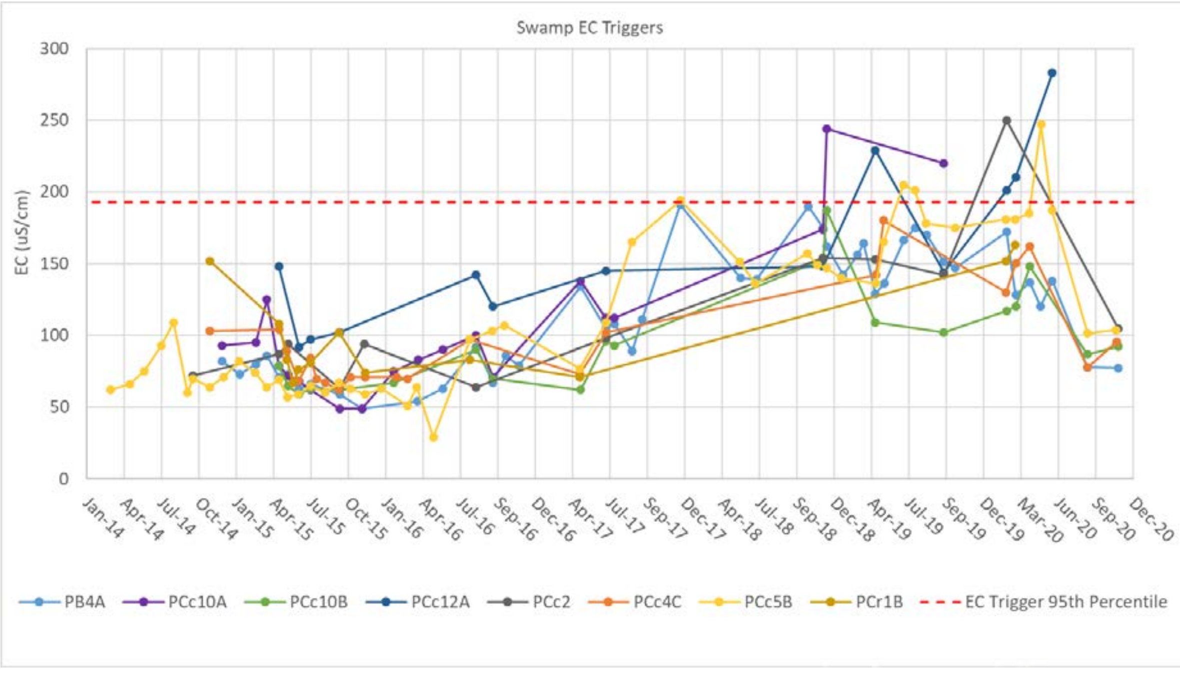
APPENDIX H – GROUNDWATER QUALITY TRIGGERS

SWAMP WATER QUALITY TRIGGERS

pH Triggers

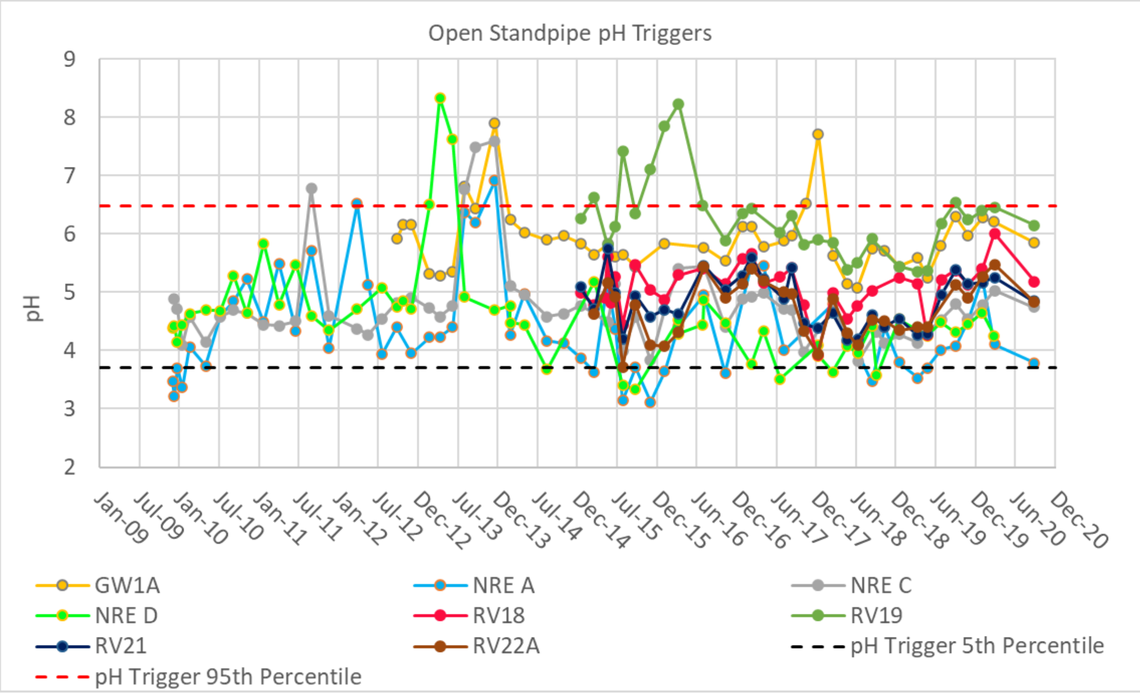


EC Triggers

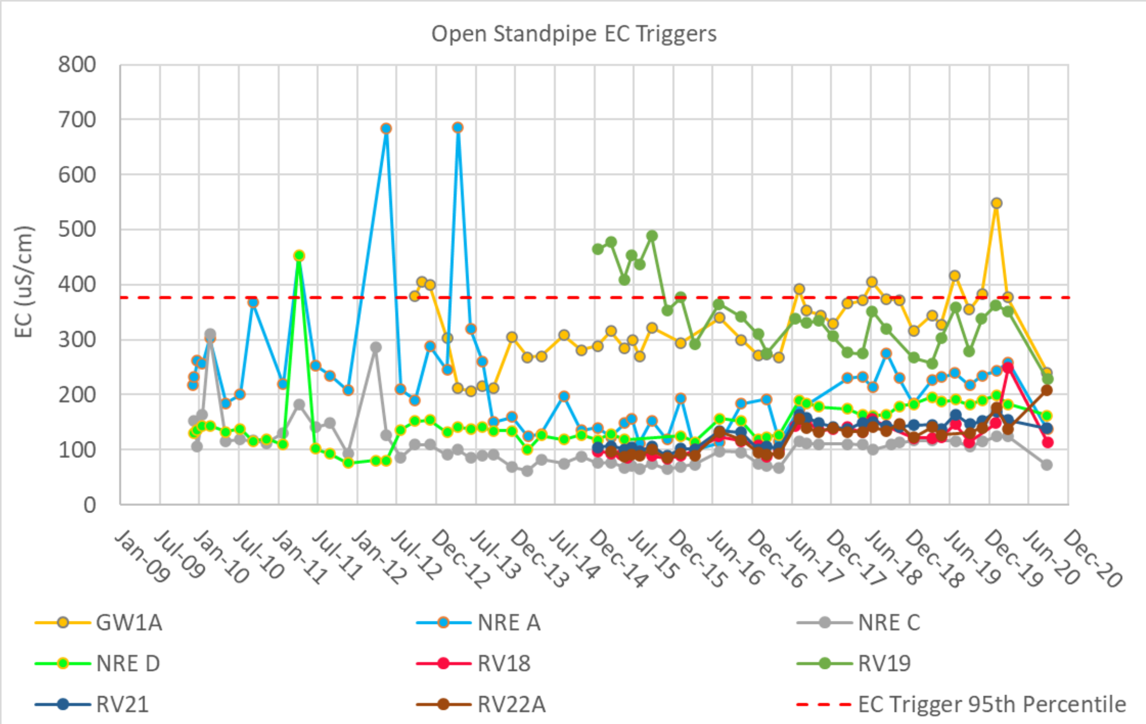


OPEN STANDPIPE WATER QUALITY TRIGGERS

pH Triggers



EC Triggers



Open Standpipe EC Triggers
EC (uS/cm)
0
100
200
300
400
500
600
700
800
Jan-09
Jul-09
Jan-10
Jul-10
Jan-11
Jul-11
Jan-12
Jul-12
Dec-12
Jul-13
Dec-13
Jul-14
Dec-14
Jul-15
Dec-15
Jun-16
Dec-16
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Jun-20
Dec-20
GW1A
NRE A
NRE C
NRE D
RV18
RV19
RV21
RV22A
EC Trigger 95th Percentile

APPENDIX E. SITE WATER BALANCE

Environmental & Social Consultants

WATER BALANCE ASSESSMENT

Russell Vale Colliery Revised Underground Expansion Project

FINAL

December 2020

WATER BALANCE ASSESSMENT

Russell Vale Colliery Revised Underground Expansion Project

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Wollongong Coal Limited

Project Director:	Barb Crossley
Project Manager:	Gabrielle Allan
Technical Director:	Chris Bonomini
Report No.	3687/R20
Date:	December 2020

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Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
Final	Chris Bonomini	15/12/2020	Gabrielle Allan	15/12/2020

Table of Contents

Figures

Tables

1.0 Introduction

The Russell Vale Colliery (RVC) is an existing underground coal mine located in Russell Vale, approximately 8 km north of Wollongong in NSW (refer to **Figure 1.1**). RVC is owned and operated by Wollongong Coal Limited (WCL) and has been on 'care and maintenance' since 2015. WCL is currently seeking approval to extend underground mining operations at RVC using long term stable first workings mining methods, a proposal referred to as the Revised Underground Expansion Project (UEP). The proposed first workings mine plan is shown on **Figure 1.2**.

This Water Balance Assessment has been prepared by Umwelt (Australia) Pty Ltd (Umwelt) on behalf of WCL to estimate the gross water balance for the UEP, the likely import water demand for the UEP and the volume and frequency of discharges from the UEP.

The key elements of the UEP are:

- Mining using first working mining techniques only, with the workings designed to be long-term stable with imperceptible subsidence impacts. No longwall mining is proposed.
- Extraction of approximately 3.7 Million tonnes (Mt) of run-of-mine (ROM) coal over a period of five years at a reduced production rate that will not exceed 1 Mt of product coal per year.
- Mining within the Wonga East area only, with no mining proposed within the Wonga West area or underneath the full supply level of Cataract Reservoir.

An overview of the layout and contents of this report is presented in **Table 1.1**.

Table 1.1 Structure of Water Balance Assessment Report

Section	Description
Section 1.0	Covers the purpose of the Water Balance Assessment, provides a description of the UEP and includes a structure of the report.
Section 2.0	Includes a description of the existing approved Pit Top water management system
Section 3.0	Includes surface water balance assumptions, operational surface water balance (including results) and post mining water balance (including results).
Section 4.0	Provides a conclusion to the Water Balance Assessment.
Section 5.0	References

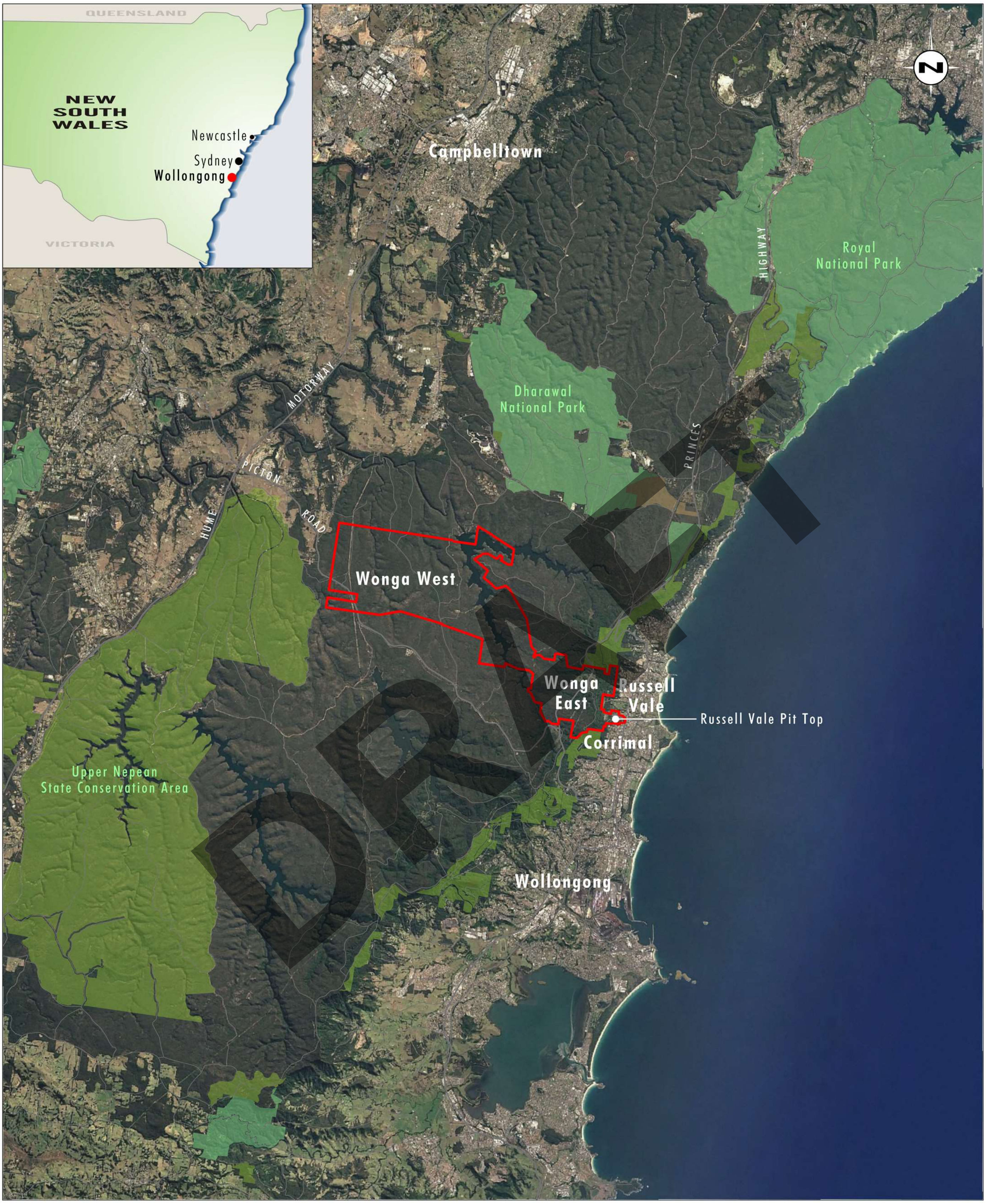

Image Source: Google Maps (2016)
Data Source: OEH (2016), Wollongong Coal (2020)

Legend
UEP Application Area

FIGURE 1.1

Locality Plan

File Name (A4): R20/3687_130.dgn
20201125 10.32

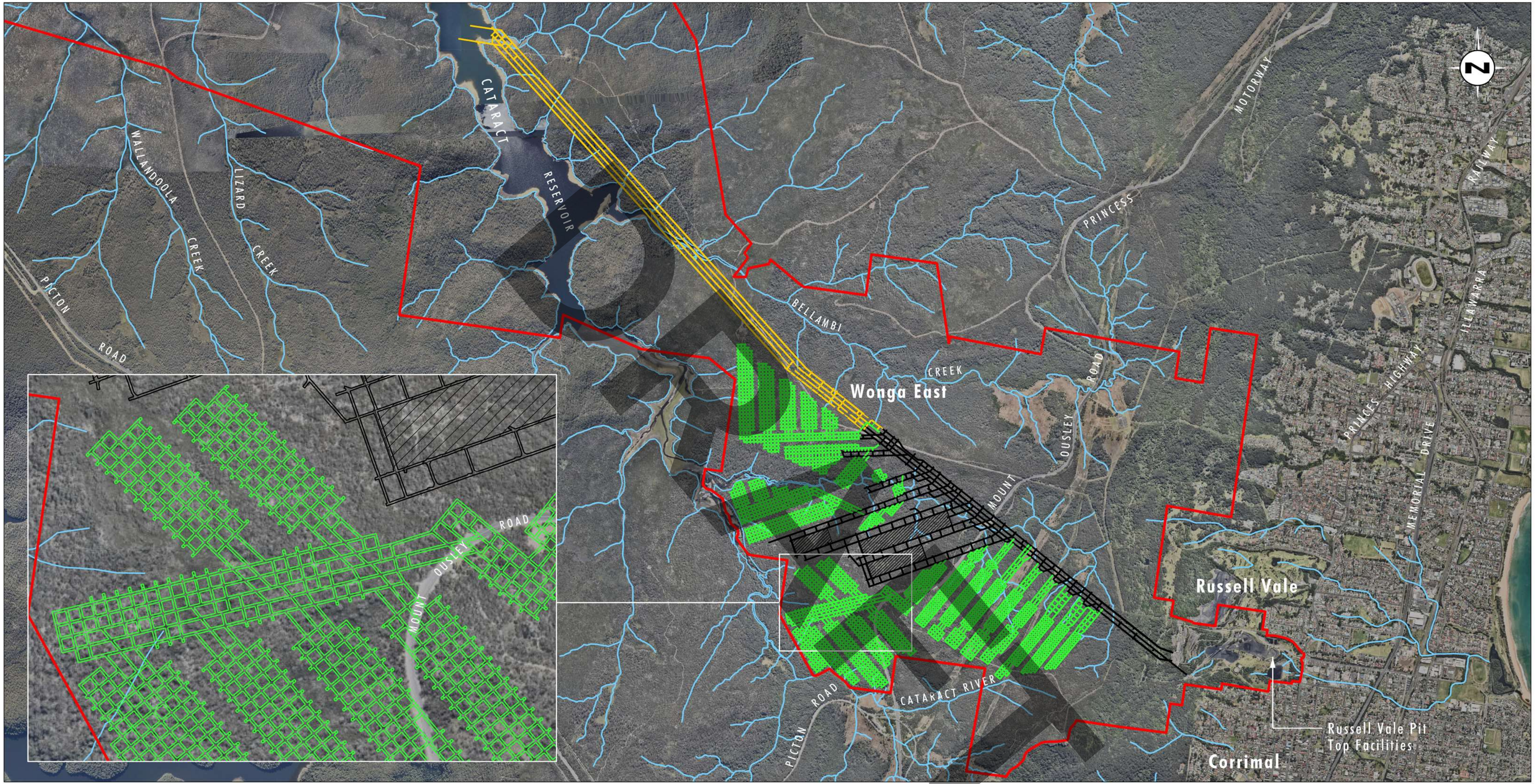

Image Source: Nearmap (Oct 2016)
Data Source: Wollongong Coal (2016)

Legend

- UEP Project Application Area
- Approved Wonga Central Development Mains
- Proposed Wongawilli Seam Workings
- Existing Wongawilli Seam Workings
- Drainage Line

FIGURE 1.2

Revised Underground Expansion Project Mine Plan

File Name (A4): R20/3687_131.dgn
20190702 16.41

2.0 Pit Top Water Management System

The existing approved RVC Pit Top Water Management System (WMS) catchment is approximately 43 ha in area and consists of the following sub catchments:

- Rehabilitated and undisturbed natural catchments.
- Disturbed catchments including the pit top area and coal handling infrastructure.
- Hardstand areas including the maintenance workshop area, administration offices, access roads and car parking.

The existing WMS allows for two categories of water:

- Clean water, comprising runoff from undisturbed and fully rehabilitated areas, and
- Dirty water, comprising runoff from any area disturbed by mining operations, runoff from areas where coal is stockpiled and handled, and groundwater extracted from the underground workings.

The WMS was designed to maximise the separation of clean and dirty water. **Figure 2.1** presents a plan of the existing WMS and **Figure 2.2** presents a process flow schematic of the WMS.

2.1 Water Sources and Demands

Inflows to the WMS include rainfall on dams, runoff from WMS catchments, groundwater extracted from the underground workings and imported water from the Sydney Water supply. Outflows include evaporation, dust suppression losses, product coal moisture, moisture bound with course rejects, licensed discharges and spills from water storages during high or prolonged rainfall events that exceed WMS infrastructure capacities. Wastewater from onsite amenities is discharged to sewer.

2.2 Clean Water

Clean water upslope of the surface facilities flows through the natural Bellambi Gully watercourse which will connect with a stormwater diversion channel currently in the final stages of detailed design prior to construction (refer to **Figure 2.5**). The diversion channel will convey stormwater around the coal handling area into an on-site detention basin (OSD) which drains to Bellambi Gully at the eastern end of the site. Clean water runoff from the north western upslope catchment is directed to the north around the Pit Top WMS (refer to **Figure 2.5**).

2.3 Dirty and Mine Water Management

The RVC Pit Top WMS includes six water management dams and a seepage sump, as shown on **Figure 2.1** and **Figure 2.2**.

Runoff from the stockpile and coal handling area, and maintenance and laydown areas, drains to a dry detention basin to settle course suspended solids prior to discharging under gravity to Dam 1. Dam 1 which functions as a flow through sediment basin and discharges draining under gravity to the SWCD. Dam 1 also receives excess water draining from the truck wash and pumped transfers from the underground mining operation (groundwater and excess process water pumped into the underground for operational purposes). The SWCD also receives pumped transfers from the Highway Dam and runoff from approximately 7.5 ha of mostly undisturbed upslope catchment which includes Dam 5. Dam 5 has minimal catchment and no water is actively sourced from Dam 6 for operational demands.

Water from the SWCD is transferred to the Water Treatment Plant (WTP) (refer to **Figure 2.2**) which incorporates a thickener tank to remove suspended solids (using a coagulant) prior to either reuse as process water or discharge to Bellambi Gully via a licenced discharge point (refer to **Table 2.1** and **Figure 2.2**). The solids stream generated by the thickener tank is released into a small drying bed adjacent to the thickener tank, which is periodically desilted. Seepage through the SWCD wall is collected in the Seepage Sump, along with any runoff from the small Seepage Sump catchment and returned to the SWCD.

Wherever possible, dirty water captured in the Pit Top WMS is reused within the mining operation as a priority to minimise the import of water from other sources such as the Sydney Water supply onsite and minimise controlled discharges to Bellambi Gully.

2.4 Licenced Discharge Points and Monitoring Locations

WCL currently holds an Environment Protection Licence (EPL) (12040) for operations at RVC, issued under Section 55 of the NSW *Protection of the Environment Operations Act 1997* (POEO Act). Treated water discharged from the RVC Pit Top WMS is currently undertaken in accordance with EPL12040, which defines four licenced discharge points (LDPs 1, 2, 3 and 9) and two ambient water quality monitoring points (EPLs 11 and 12) for the RVC site, as well as the applicable discharge limits at these locations (refer to **Table 2.1**).

Table 2.1 Environment Protection Licence Monitoring Locations

Point	Description	Monitoring Requirements	Frequency	Limit Conditions
LDP1	*Licensed Discharge Point:* Underground drainage from coal stockpile and forested area in Rath's Gully	pH Total Suspended Solids Turbidity Electrical Conductivity	Monthly during discharge	- - - -
LDP2	*Licensed Discharge Point:* Treated water outlet discharging to Bellambi Gully	pH Total Suspended Solids Turbidity Electrical Conductivity	Monthly during discharge	6.5 – 9.2 50 mg/L - -
		Volume	Continuous	2,500 kL/day
LDP3	*Licensed Discharge Point:* Seepage through the SWCD wall into Bellambi Gully	-	-	-
LDP9	*Licensed Discharge Point:* The SWCD gabion spillway discharging to Bellambi Gully	-	-	-
EPL11	*Ambient Monitoring Point:* Bellambi Gully ambient water quality west of Princes Highway	Turbidity Electrical Conductivity Volume	Continuous	- - -
EPL12	*Ambient Monitoring Point:* Bellambi Gully upstream ambient water quality	Turbidity Electrical Conductivity Volume	Continuous	- - -

Water from the WTP is discharged at LDP2. The site SCADA system is programmed to cease discharges when the total flow on any given day at LDP2 reaches 2,450 kL ensuring that the discharge volume limit (i.e. 2,500 kL/day) (refer to **Table 2.1**) is not exceeded.

WCL continuously monitors the turbidity of the supernatant discharge from the thickener, Bellambi Gully upstream (EPL point 12) of the coal handling area and, once operational, the Bellambi Gully diversion channel outlet (EPL point 10) which is downstream of LDP2. Should the discharge from the thickener exceed a turbidity of 60 NTU, discharge is ceased and the supernatant is diverted to the SWCD. In the event that the turbidity in Bellambi Gully downstream of LDP2 exceeds 100 NTU, WCL implement a Trigger Action Response Plan (TARP) to investigate the cause of the elevated turbidity and respond accordingly to mitigate any potential contributions from colliery operations.

Water seepage through the SWCD wall (LDP3) is collected in a sump and returned to the SWCD by a submersible pump. However, discharges from LDP3 to Bellambi Gully may occur when the seepage rate combined with the seepage sump catchment runoff exceeds the capacity of the submersible pump (refer to **Figure 2.2**). During periods of high rainfall, excess water draining to the SWCD may spill to Bellambi Gully via the SWCD spillway (LDP9).

It is noted that LDP 1 is outside of the UEP project area and as such has not been considered as part of the UEP Pit Top water balance assessment.

It is noted that RVC has been discharging treated water into Bellambi Gully for more than 30 years.

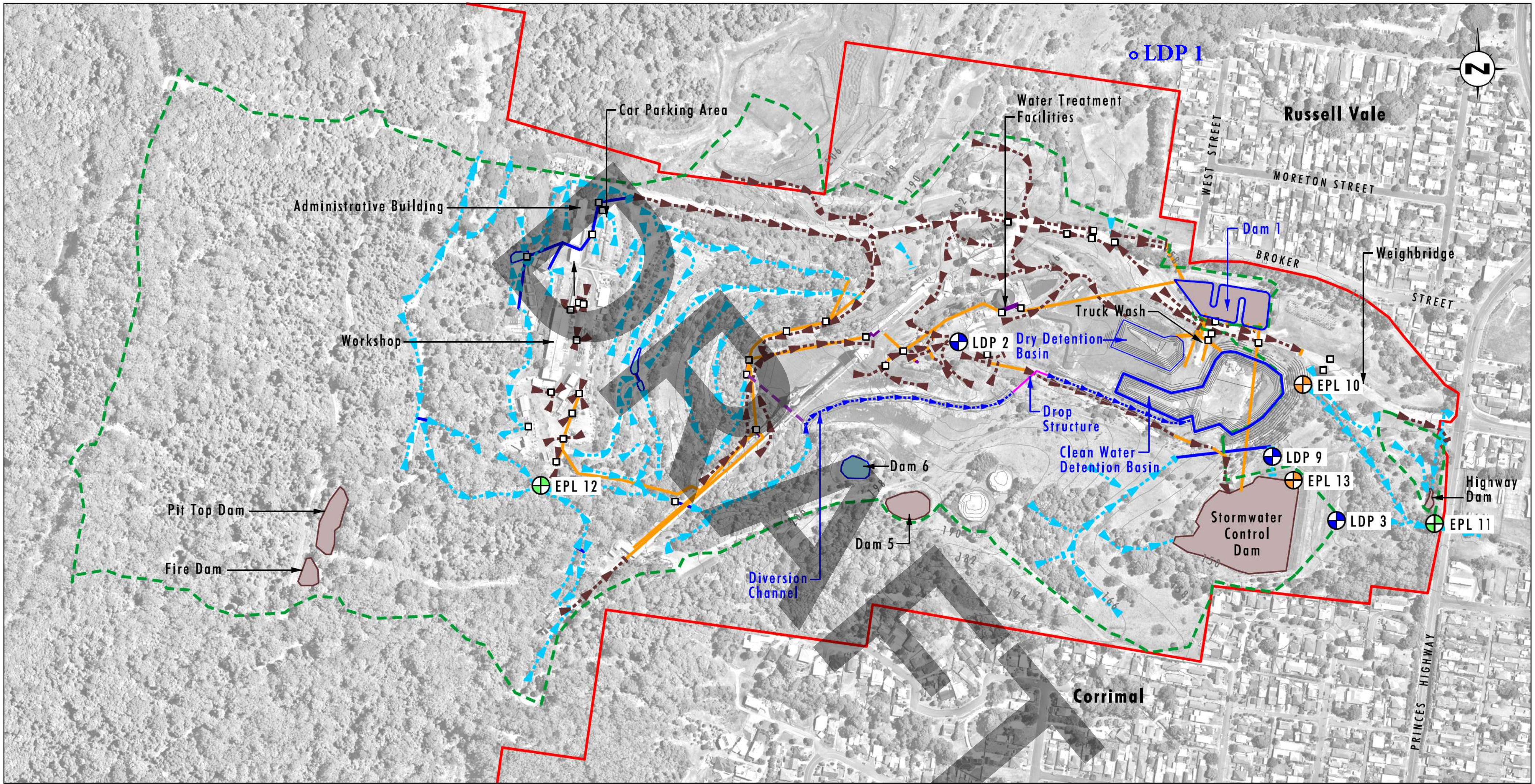

Image Source: Nearmap (Dec 2018)
Data Source: Wollongong Coal (2020)

0 100 200 400m
1:7000

Legend

- UEP Application Area
- WMS Boundary
- Pit/Sump
- Clean Water Dam
- Dirty Water Dam
- Clean Water Diversion Drain
- Dirty Water Diversion Drain
- Clean Water Pipe/Culvert
- Dirty Water Pipe/Culvert
- Clean Water Pipeline
- Thickener Discharge Pipe
- EPL Point is Ambiant Monitoring Location
- EPL Point is Licensed Discharge Point
- Former Monitoring Location
- Detention Basin/Dam
- Diversion Channel
- Drop Structure

FIGURE 2.1

Approved Water Management System Plan

File Name (A4): R20/3687_132.dgn
20201207 20.22

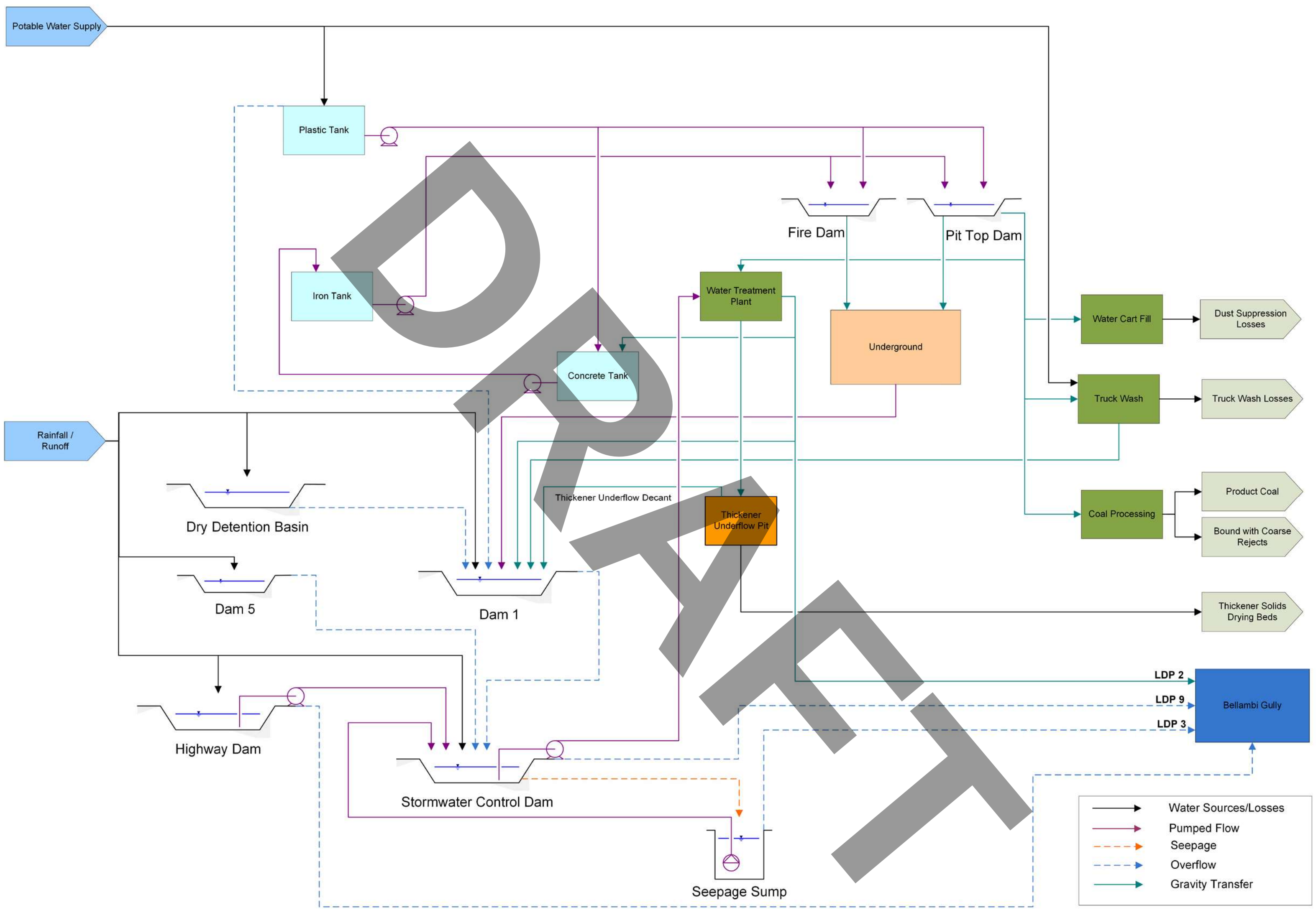

FIGURE 2.2

Approved Water Management System Schematic

3.0 Surface Water Balance

A daily time step operational water balance model was developed for the UEP using the GoldSim modelling package to estimate:

- The gross water balance for the Project (excluding water imports and controlled discharges)
- The likely import water demand for the Project
- The volume and frequency of discharges (controlled and uncontrolled) from the Project.

A separate water balance model has also been prepared to estimate runoff to Bellambi Gully for a post mining scenario which will include a water treatment facility that may discharge to Bellambi Gully (refer to **Section 3.3**).

3.1 Model Basis and Assumptions

3.1.1 Water Sources

Catchment Runoff

The water balance model uses historical rainfall records from 1930 to 2019 from the BoM Woonona monitoring station (Station ID 68018), located approximately 2.2 km from site, with infill data from the Bellambi climate monitoring station (Station ID 68228), located approximately 3.7 km from site, in periods with data gaps. Average daily evaporation data from the Sydney Airport AMO BoM (Station No. 66037), located approximately 53 km from site (the closest BoM station to the site with a daily evaporation data record), was used as the evaporation data set in the model. Catchment runoff has been calculated using the Australian Water Balance Model (AWBM) based on the daily rainfall and evaporation data detailed above. Three catchment types were defined for surface facilities WMS and the AWBM parameters used in the model for the three catchment types are presented in **Table 3.1**. The AWBM parameters were adjusted as part of the water balance model calibration process which is detailed in **Section 3.2.1**.

Runoff calculations for the calibration of the water balance model were based on Pit Top facility catchments for the 2016 to 2019 period (i.e. the calibration period). Runoff for the operational water balance model was estimated based on the surface facilities WMS catchments following construction of the approved Bellambi Gully diversion channel and on site detention basin (refer to **Figure 3.1**).

Table 3.1 Catchment Types and AWBM Parameters

Catchment	Surface Store Area Split			Surface Store Capacities			BFI[1]	Kb[2]	Ks[2]	Evap%[4]
	A1	A2	A3	C1	C2	C3				
Undisturbed	0.134	0.433	0.433	37.8	386.4	772.8	0.25	0.973	0.5	1
Disturbed/Industrial	0.134	0.433	0.433	16.4	167.7	335.3	0.05	0.985	0.0	0.85
Hardstand	1	0	0	1	0	0	0	0	0.0	0.85

Notes
1. Base flow index
2. Baseflow recession constant, day^{1}
3. Surface runoff recession constant
4. Pan factor to potential evapotranspiration

umwelt

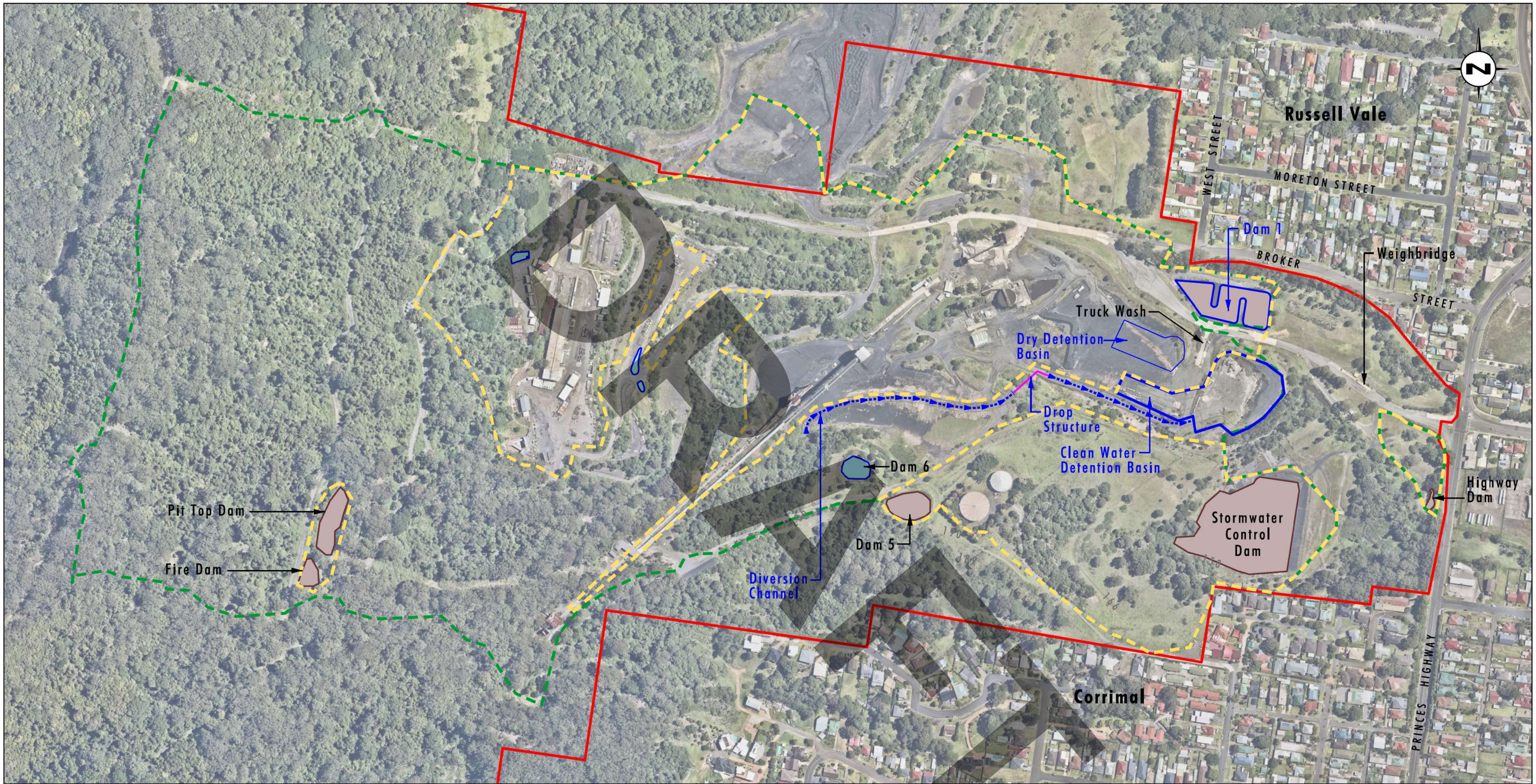

Image Source: Nearmap (Dec 2018)
Data Source: Wollongong Coal (2020)

0 100 200 400m
1:7000

Legend

- UEP Application Area
- WMS Boundary
- Dirty Water System Catchment
- Clean Water Dam
- Dirty Water Dam
- Detention Basin/Dam
- Diversion Channel
- Drop Structure

FIGURE 3.1

Operational Water Management System Catchment

File Name (A4): R20/3687_134.dgn
20201126 12.36

Groundwater

The operational water balance modelling has been undertaken based on maximum groundwater inflow to the underground of 0.79 ML/day during the first workings operation (Geoterra, 2020). All of the groundwater inflow is assumed to require dewatering to the Pit Top WMS.

3.1.2 Water Demands

Water demands considered in the operational water balance model are:

- evaporative losses from water storages
- water lost with product coal and course rejects based on the following values:
  - 1.2 Mtpa ROM production
  - in-situ coal and coarse reject – 2.4% weight by weight (w/w)
  - product coal moisture – 7.5% w/w
  - coarse reject as percentage of ROM – 17%.
- water losses associated with water pumped into the underground for dust suppression are accounted for on product coal and course reject moisture
- water cart dust suppression losses of 0.39 ML/day (BECA, 2011)
- truck wash demand of 0.3 ML/day (BECA, 2011) with an actual loss assumed to be 10% of the demand i.e. 0.03 ML/day).

Amenities potable water usage is estimated to be approximately 3.6 ML/year, however, potable water for amenities has not been included in the operational water balance as all incoming amenities water is lost directly through consumption or to sewer.

3.1.3 Assumptions

The following assumptions have also been applied for the water balance modelling:

- The first 10 mm of runoff from the maintenance/administration catchment is captured by a first flush system and directed into the WMS with all runoff in excess of 10 mm being directed to the Bellambi Gully diversion channel.
- A maximum pump discharge rate of 2.5 L/s to return seepage and Seepage Sump catchment runoff to the SWCD (based on pump performance curve and estimated total discharge head).
- Potable water are available for import to the WMS if required.
- A maximum treated water discharge from LDP 2 to Bellambi Gully of 2.5 ML/day in accordance with EPL 12040. A minimum discharge volume 0.9 ML/day from LDP 2 has been applied in the water balance model to ensure the model more accurately reflects historical discharge frequencies.
- The SWCD is operated to maintain a free storage capacity of at least 30 ML to accommodate high or prolonged rainfall events. Given the minimum discharge from LDP 2 has been set to 0.9 ML/day, the water balance model will allow SWCD freeboard to be reduced to a minimum of 29.1 ML.

3.1.4 Climate Change

Given the life of the first workings mining operation is limited to five years, climate change impacts on rainfall and evaporation have not been incorporated into the operational water balance modelling scenario. It is considered that changes in rainfall and evaporation in the short term (i.e. next five years) would have a negligible impact on water balance results when compared to the variability in the historical rainfall data set used in the model and the magnitude of groundwater inflows to the Pit Top WMS.

Climate change impacts have been considered in the post mining water balance modelling (refer to **Section 3.3**).

3.2 Operational Surface Water Balance

3.2.1 Model Calibration

The AWBM surface store capacities for undisturbed catchments were calibrated to give an average annual runoff equal to the average annual runoff of 1.30 ML/ha/year (estimated using the NSW Farm Dams Calculator (WaterNSW, 2020) for the local area.

AWBM parameters for the Disturbed/Industrial and Hardstand catchments were adjusted such that the water balance model predicted annual discharge volumes from LDP2 to closely align the recorded annual discharge volumes from LDP2 for the period that the RVC has been in care and maintenance, i.e. 2016, 2017, 2018 and 2019.

Other than rainfall and evaporation, the two key inputs to the water balance model for the calibration process were care and maintenance water demands and groundwater inflows. WCL provided an estimate of 0.2 ML/day for care and maintenance operations based on site measured water inventory data. Groundwater inflows to the surface facilities WMS for the calibration period (2016 to 2019) were based on *Russell Vale Colliery: 2018 Update of Water Balance Estimation* (SCT Operations, 2019) which provides estimates of groundwater inflows to the RVC underground workings based on recorded pumping data for the period February 2016 to June 2018.

The SCT Operations report estimates that the approximate groundwater inflows to the underground workings that were dewatered to the surface facilities (i.e. the Bulli, Balgownie and Wongawilli seam workings) over the update estimation period were 1.1 ML/day which was down from the estimate of 1.4 ML/day for the previous review period (to the end of 2016). Groundwater inflow to the underground workings declined over the update estimation period which corresponds to a prolonged period of less than average rainfall. The average annual rainfall for the 1930 to 2019 data set modelled is 1,311 mm while annual rainfall for 2016, 2017, 2018 and 2019 was 1,217 mm, 915 mm, 816 mm and 704 mm respectively.

Initially, calibration of the water balance model was attempted based on a groundwater inflow to the surface facilities WMS of 1.1 ML/day across the calibration period (2016 to 2019). However, calibration to recorded annual discharge volumes from LDP 2 could not be achieved for all years with the water balance model underpredicting discharges in 2016, closely predicting discharges in 2017 and overpredicting discharges in 2019. As such, a variable groundwater inflow rate was applied across calibration period (2016 to 2019). The groundwater inflows applied were selected on the following basis:

- The average groundwater inflows to the underground workings for the 2016 to 2018 period (the SCT estimation update period) is 1.1 ML/day
- The groundwater inflows declined linearly from 2016 to 2019

- The rate of gradient of the linear decline in groundwater inflow was approximated using the six monthly moving average groundwater inflow chart (SCT Operations, 2019) across the 2016 to 2017 period.

The water balance model was run iteratively with adjustments made to the AWBM surface storage capacities for Disturbed/Industrial and Hardstand Catchments until the model as closely predicted LDP2 discharge volumes across the calibration period. Groundwater inflows and a comparison of predicted and recorded LDP2 discharges for the calibrated model are presented in **Table 3.2**.

Table 3.2 Groundwater Inflows and LDP2 Discharge Volume Calibration Results

Year	Groundwater Inflow (ML/day)	Predicted Discharge (ML)	Recorded Discharge (ML)	Variance
2016	1.3	485	452	7%
2017	1.1	368	364	1%
2018	0.9	287	245	17%
2019	0.7	210	185	14%

The results presented in **Table 3.2** shows that the water balance model closely predicts annual discharges from LDP2 for the calibration period in 2016 and 2017 but with less accuracy in 2018 and 2019. It is noted that the SCT Operations (2019) groundwater inflow estimates for the 2016 to 2018 period are based on recorded pumping data up to June 2018. As such, the weaker calibration for the 2018 and 2019 years appears to indicate that groundwater inflows declined more rapidly across the second half of 2018 and 2019 with the ongoing period of below average rainfall. While other calibration approaches including calibration to site water inventories may be used to refine the AWBM runoff model, calibration results indicate that surface WMS performance, including discharge volumes from LDP2, is more sensitive to groundwater inflows than surface runoff and the calibrated AWBM parameters are considered appropriate for estimating future surface WMS performance. Further, the calibration results demonstrate over prediction of LDP 2 discharges and therefore the AWBM parameters used contribute to ensuring a conservative approach with respect to water discharge management.

As the period of calibration is based on a limited data set, only a high level assessment of sources of uncertainty has been undertaken. **Table 3.3** presents an accuracy statement in general accordance with the *Water Accounting Framework for the Minerals Industry* (Minerals Council of Australia, 2014) for the calibrated model inflows and outflows across the calibration period.

Based on the calibration results and consideration of the accuracy of data sources input to the water balance model, the water balance is considered to predict surface facilities WMS performance with a medium level of confidence. Further calibration of AWBM parameters based on site water inventories and site measured flows could improve the water balance model accuracy. However, the main source of uncertainty in the model is considered to be associated with error in estimation of groundwater inflows to the underground workings that are dewatered to the surface facilities WMS. SCT Operations (2019) indicated that the accuracy of groundwater inflow estimates is +/- 0.2 ML/day for short term estimates and +/- 0.1 ML/day for long term estimates. As such, refining the measurements used to estimate groundwater inflows would be considered a priority with respect to improving water balance model accuracy.

Table 3.3 Calibrated Model Results Accuracy Statement

Flow	Percentage of Total Flow	Data Type	Confidence Level	Comments
Inflows				
Rainfall Runoff	9%	Simulated	Medium	The AWBM runoff model is considered to predict runoff at a medium confidence level rather than high as parametric calibrations were limited to average annual runoff for undisturbed catchments and calibration to site discharge rather than water inventory.
Groundwater	41%	Measured	Medium	While groundwater inflows are based on measured data (i.e. pump and flow meter data) it is understood that there are various sources of error in the estimate including a leaking pipe discharging to the underground during the update estimation period (estimated by SCT Operations to be approximately 0.2 ML/day) and flow and pump run data capture frequency (SCT operations recommend hourly data capture instead of the current daily data capture) of the site Supervisory Control and Data Acquisition System (SCADA).
Outflows				
Evaporation	3%	Simulated	Medium	Evaporative losses are considered to be estimated with a medium level of confidence as stage storage relationships were not used to estimate dam water surface areas and the use of non-site specific evaporation data.
Operational Demand	8%	Measured	Medium	While the water demand for the care and maintenance operation is based on measured data, the measurements were across a relatively short time of the calibration period.
LDP2 Discharge	38%	Simulated	Medium	Predicted LDP2 discharges for the calibration period were within 10% of the recorded discharges for the 2016 and 2017 years and 20% of the recorded discharges for the 2018 and 2019 years and as such the model is considered to predict LDP2 discharge volumes with a medium level of confidence.

Flow	Percentage of Total Flow	Data Type	Confidence Level	Comments
LDP3 Discharge	0%	Simulated	Medium	Historically, seepage outflows from the SWCD (i.e. LDP3 discharges) drained directly to Bellambi Gully via a v-notch weir and as such measured seepage rates are available. However, seepage flows are now returned via pumping (known pump rate) to the SWCD and LDP3 discharges only occur when the seepage rate combined with runoff rates exceed the pump capacity. As such, the model is considered to predict LDP3 discharge volumes with a medium level of confidence.
LDP9 Discharge	0%	Simulated	Medium	The volume of the SWCD is known and the modelled inflows and outflows to the SWCD are considered to be predicted with a medium level of confidence
Highway Dam Spills	0%	Simulated	Low	As the volume of the Highway Dam has been estimated, the volume of spills from the Highway Dam is considered to be predicted with a low confidence level. The Highway Dam catchment is only 0.55 ha (less than 5% of the WMS catchment) and inflows and spills associated with the Highway Dam catchment have a minimal impact on the overall water balance results.

3.2.2 Operational Water Balance Results

The modelling predicts that the UEP will have a positive gross site water balance for all rainfall years modelled. The gross water balance does not account for controlled discharges (e.g. licensed discharges under EPL 12040) or water imports from external sources (e.g potable water imports) and provides an indication of whether the operation will have a surplus or deficit of water in the absence of discharges and imports. The water make associated with the UEP will either be used for operational demands or discharged off site in accordance will the EPL.

Gross water balance model results for the 10th percentile, 50th percentile and 90th percentile water balance years are presented in **Table 3.4**. Detailed net water balance results for the 50th percentile gross water balance year are presented in **Table 3.5**. The net water balance accounts for controlled discharges and water imports form external sources.

Table 3.4 Annual Gross Water Balance Results

Statistic	Result (ML/year)
10th %ile	115
50th %ile	165
90th %ile	309

Table 3.5 50th Percentile Year Net Water Balance Result

Parameter	Result (ML/year)
Inflows	
Rainfall on dams and runoff	112
Groundwater	288
Potable Water Import to Supplement Operational Demands	0
ROM coal moisture	29
Total Inflows	***429***
Outflows	
Evaporation	27
Product Coal	73
Coarse Rejects	10
Water Cart Dust Suppression	142
Truck Wash	11
LDP 2 (from WTP)	165
LDP 3 (SWCD seepage)	0
LDP 9 (SWCD spillway)	0
Spills from Highway Dam	0
Total Outflows	***429***
Change in Site Water Inventory	0
Net Water Balance	**0**

The water balance results indicate that the UEP will have a surplus gross water balance in all years and will be able to adequately meet operational water demands with little to no import of water from off-site sources.

Table 3.6 presents the predicted licensed discharge volumes, **Table 3.7** presents the predicted licensed discharge frequencies and **Table 3.8** presents the predicted spill volumes and frequencies from the Highway Dam.

Table 3.6 Annual Predicted Licenced Discharge Volumes (ML/year)

Statistic	LDP 2	LDP 3	LDP 9
Minimum	96	0.0	0
10th %ile	115	0.0	0
50th %ile	165	0.0	0
90th %ile	292	0.0	44
Maximum	434	0.1	144

Table 3.7 Predicted Licenced Discharge Frequencies (days/year)

Statistic	LDP 2	LDP 3	LDP 9
Minimum	82	0	0
10th %ile	95	0	0
50th %ile	116	0	0
90th %ile	160	0	7
Maximum	209	2	16

Table 3.8 Annual Predicted Highway Dam Spills

Statistic	Volume (ML/year)	Frequency (days/year)
Minimum	0.00	0.00
10th %ile	0.00	0.00
50th %ile	0.00	0.00
90th %ile	0.00	3.00
Maximum	1.10	10.00

The following observations are made with respect to the predicted licenced discharge results:

- LDP 2 discharges are likely to be required on a regular basis to manage site water inventories (i.e. maintain the SWCD with a freeboard of 30 ML) as a result of the low operational water demands relative to rainfall runoff and groundwater inflows. Discharges from LDP2 during the operation phase of the UEP are predicted to be significantly lower (an average of 181 ML/year) than discharges during the 2016 to 2019 period (an average discharge of 337.5 ML/year) when the mine was in care and maintenance. This is largely due to the higher operational water demands and the overall lower predicted groundwater inflows compared to those observed during the care and maintenance period.

- Discharge frequencies from LDP 2 should be considered indicative as the water balance model cannot account for operational decisions and situations that may present themselves into the future. For example, WCL may discharge larger daily volumes to provide additional freeboard in the SWCD to accommodate forecast wet weather or maintain larger site water inventories to cover operational demands if dry conditions are forecast. Other operational situations that could impact on discharge frequency include WTP breakdowns.

- Minimal off-site discharge volumes are predicted from LDP 3 as water is captured and returned to the SWCD. LDP 3 discharges are only likely during high rainfall events where the seepage sump overflows to Bellambi Gully.

- LDP 9 discharges are predicted to be infrequent and only occur during high or prolonged rainfall events. Water balance modelling results indicate that LDP 9 discharges occur following an average rainfall depth of over 270 mm in the five days preceding the discharge event.

- Spill volumes from the Highway Dam are predicted to be relatively small and only occur during high or prolonged rainfall events. The maximum spill volume from the Highway Dam of approximately 320 kL was predicted to occur following over 200 mm of rainfall.

3.3 Post Mining Water Balance

At the completion of mining, dewatering of the underground workings will cease. Groundwater inflows are predicted to the fill the underground workings to the escarpment adit spill level of 117.5 mAHD by approximately 2057 (Geoterra, 2020). The groundwater inflow rate to the underground workings following completion of mining is predicted to stabilise at 0.3 ML/day (Geoterra, 2020). WCL has committed to extracting groundwater from the underground workings and treating the groundwater to a standard suitable for reuse (e.g. potable water) or discharge to Bellambi Gully.

Should treated water be discharged from the water treatment facility, the discharge location is anticipated to be into Bellambi Gully just to the south of the existing ROM conveyor. The catchment upslope of the water treatment facility will consist of the existing undisturbed areas and former mine infrastructure areas which are expected to be redeveloped to be urban residential. A post mining water balance model was developed to assess the likely flows in Bellambi Gully at the potential water treatment facility discharge location for consideration with respect to dilution of discharges.

3.3.1 Climate Change Projections

The Commonwealth Government's online Climate Futures Tool provides regional projections of climate variables, including rainfall and evapotranspiration, for a range of future anthropogenic forcings (i.e. greenhouse gas emissions). The Climate Futures Tool can also be used to classify projections from the range of climate models based on a combination of two variables allowing assessment of the most appropriate climate model projections to use for a particular impact assessment. As the purpose of the post mining water balance modelling is to assess a worst case scenario with respect to clean water flows to the potential water treatment facility discharge location, the rainfall and evaporation projections were based on:

- the representative concentration pathway 8.5 (RCP8.5). The RCP8.5 scenario represents a future with little curbing of emissions, with a carbon dioxide concentration continuing to rapidly rise, reaching 940 ppm by 2100
- use of climate model projections that predict "Much Drier" conditions and a "Large Increase" in evapotranspiration.

For RCP8.5, the Climate Futures Tool indicates that four of 29 climate models predict "Much Drier" conditions and a "Large Increase" in evapotranspiration for 2050 (2040 to 2059). In 2070 (2060 to 2079), the Climate Futures Tool indicates that seven of 29 climate models predict "Much Drier" conditions and a "Large Increase" in evapotranspiration. Three climate models predicted "Much Drier" conditions and a "Large Increase" in evapotranspiration for both 2050 and 2070:

- CSIRO-Mk3-6-0
- IPSL-CM5B-LR
- GFD-ESM2M.

Gridded RCP8.5 projections of annual rainfall percentage change and annual evapotranspiration change for the above three models were sourced using the climate futures tool for 2050 and 2070 for use in the post mining water balance model. As the projection data is provided with grid spacings of more than 200 km, site specific data was estimated using bilinear interpolation. **Table 3.9** presents the site specific projections for change in annual rainfall and evapotranspiration.

Table 3.9 Rainfall and Evapotranspiration Change Projections

Model	2050 (2040 to 2059)		2070 (2060 to 2069)	
	Rainfall	Evapotranspiration	Rainfall	Evapotranspiration
CSIRO-Mk3-6-0	-8.63%	5.07%	-18.86%	10.10%
IPSL-CM5B-LR	-10.12%	4.60%	-13.21%	9.46%
GFDL-ESM2M	-10.09%	8.99%	-16.27%	10.45%

3.3.2 Post Mining Water Balance Model Basis and Assumptions

The post mining water balance model was based on the following:

- A total upslope catchment area of 31.4 ha consisting of (refer to **Figure 3.2**):
  - 26.8 ha of undisturbed catchment
  - 4.6 ha of urban residential catchment with 50% of the catchment impervious (e.g. roads, roofs, other pavement). The remaining 50% is considered to be vegetated.
- Runoff from undisturbed and vegetated areas was calculated using the AWBM parameters provided in **Table 3.1**.
- A runoff factor of 0.98 was been applied to impervious areas.
- The projected changes in annual rainfall and annual evapotranspiration (refer to **Table 3.9**) were applied on a daily basis to the historical rainfall data set used for the operational water balance model (refer to **Section 3.1.1**).
- The Fire Dam and Pit Top Dam will be removed from the upslope catchment area post mining.

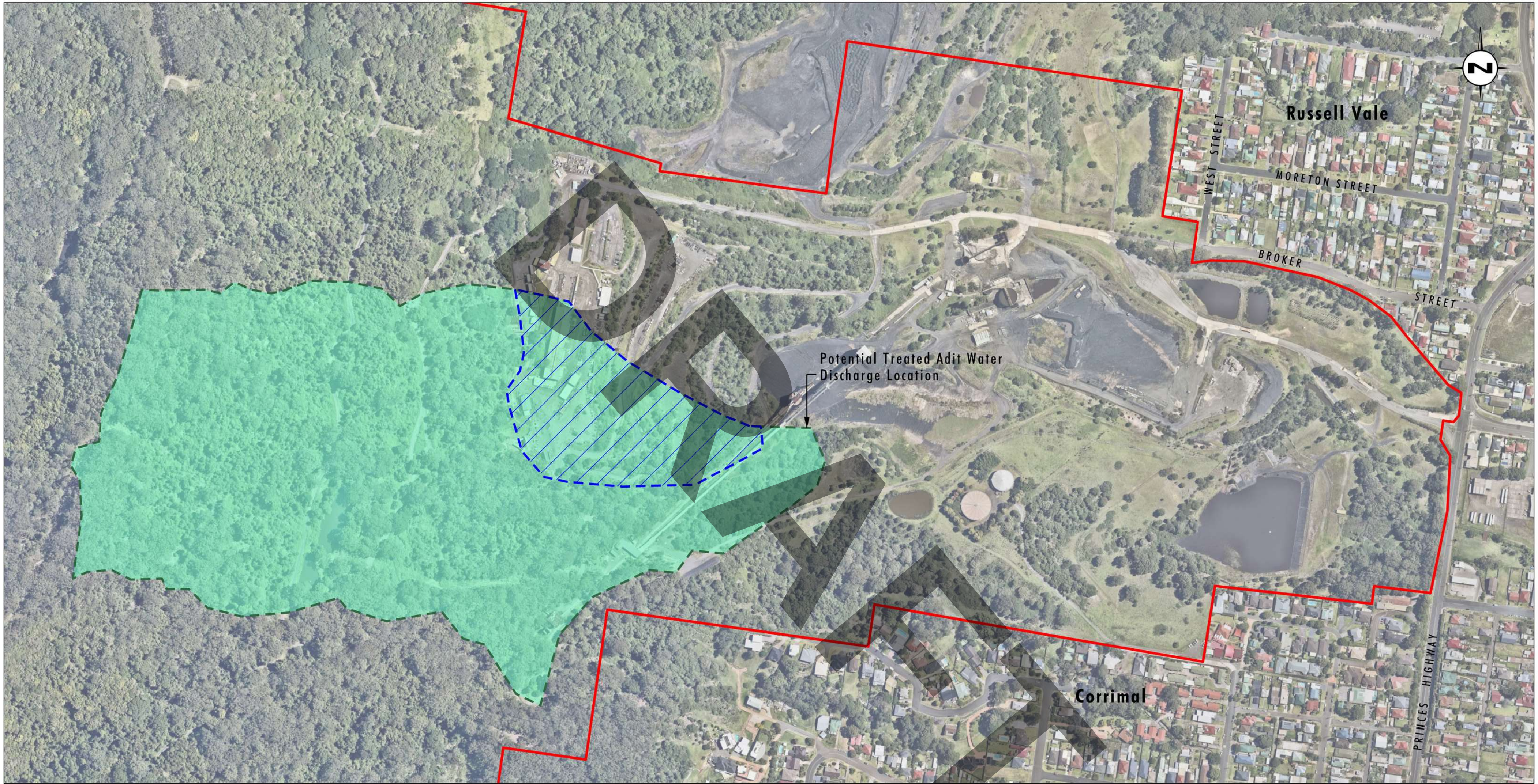

Image Source: Nearmap (Dec 2018)
Data Source: Wollongong Coal (2020)

0 100 200 400m
1:7000

Legend

- UEP Application Area
- Upslope Catchment
- Urban Catchment

FIGURE 3.2

Post Mining Catchments Upslope of Water Treatement Pant Discharge

3.3.3 Post Mining Water Balance Results

Predicted daily and annual flow volume statistics at the potential water treatment facility discharge location for the unchanged historical rainfall and evaporation data and for the historical data with 2050 and 2070 climate change projections applied are presented in **Table 3.10** and **Table 3.11** respectively.

Table 3.10 Flow Volume Predictions - 2050

Climate Data	Daily (ML/day)			Annual (ML/year)		
	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile
Unchanged	0.0007	0.0168	0.3701	22.2	42.7	137.3
CSIRO-Mk3-6-0	0.0005	0.0127	0.3076	18.9	36.9	101.5
IPSL-CM5B-LR	0.0004	0.0121	0.2990	18.4	36.1	98.7
GFDL-ESM2M	0.0004	0.0118	0.2945	18.2	35.9	97.5

Table 3.11 Flow Volume Predictions - 2070

Climate Data	Daily (ML/day)			Annual (ML/year)		
	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile
Unchanged	0.0007	0.0168	0.3701	22.2	42.7	137.3
CSIRO-Mk3-6-0	0.0002	0.0090	0.2476	15.6	31.3	75.4
IPSL-CM5B-LR	0.0003	0.0108	0.2778	17.2	34.2	88.7
GFDL-ESM2M	0.0002	0.0098	0.2609	16.3	32.5	80.1

The modelling results indicate that the contribution of daily flows to Bellambi Gully at the potential water treatment facility discharge location from the upslope catchment will be relatively low on most days when compared to possible treated water discharges (up to approximately 0.3 ML/day). This is consistent with the existing situation for Bellambi Gully, with licenced discharges from RVC consisting a high proportion of stream flows in this portion of Bellambi Gully. This is also the case for the modelled scenario that does not include climate change impacts (i.e. reduction in rainfall and increase in evapotranspiration). Daily flows would only provide a significant contribution to treated water discharge dilution on an infrequent basis. As such, any water treatment solution that requires discharge to Bellambi Gully will not rely on dilution as a water quality control strategy. That is, should discharges to Bellambi Gully from the water treatment facility be required, the discharge water quality will be of a standard that maintains or enhances the environmental values of the waterway.

4.0 Conclusions

A Water Balance Assessment of the Russell Vale Colliery Pit Top facilities was completed to estimate the gross water balance (excluding water imports and controlled discharges), the likely import water demand for the UEP and the volume and frequency of discharges (controlled and uncontrolled) from the UEP.

The operational water balance results indicate that the UEP will have a surplus gross water balance in all years and will be able to adequately meet operational water demands with little to no import of water from off-site sources (excluding potable water demands for amenities usage).

Licenced discharges from LDP 2 to Bellambi Gully are likely to be required on a regular basis to manage water inventories as a result of the low water demands relative to rainfall runoff and groundwater inflows. Minimal off-site discharge volumes are predicted from LDP 3 as water is captured and returned to the SWCD. LDP 9 discharges are predicted to be infrequent and only occur during high or prolonged rainfall events. Spill volumes from the Highway Dam are predicted to be relatively small and only occur during high or prolonged rainfall events (the maximum spill volume from the Highway Dam of approximately 320 kL was predicted to occur following over 200 mm of rainfall).

The development consent conditions for the UEP (MP09_0013) require the preparation and update of a site water balance on an annual basis. As it is considered that the main source of uncertainty in the water balance model predictions is associated with groundwater inflow estimates, refinement of the methodology and measurements associated with groundwater inflow estimation to inform future model updates is recommended.

The post mining water balance modelling results indicate that the contribution of daily flows to Bellambi Gully at the potential water treatment facility discharge location from the upslope catchment will be relatively low on most days when compared to possible treated water discharges. This is consistent with the existing situation for Bellambi Gully, with licenced discharges from RVC consisting a high proportion of stream flows in this portion of Bellambi Gully. Daily flows would only provide a significant contribution to treated water discharge dilution on an infrequent basis. As such, any water treatment solution that requires discharge to Bellambi Gully will not rely on dilution as a water quality control strategy. That is, should discharges to Bellambi Gully from the water treatment facility be required, the discharge water quality will need to be of a standard that maintains or enhances the environmental values of the waterway.

5.0 References

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APPENDIX F. SALT BALANCE

A site salt balance has been developed for the RVC Pit Top WMS as an extension of the site water balance. The salt balance model allows for the prediction of salt load and salinity of water which is exported from the RVC site.

Salt transfers were simulated within the site water balance in parallel with the water transfers. The site salt balance provides the expected salt loads (from inflows) and salt concentrations associated with each water transfer within the site water balance model.

The site salt balance will be reviewed on an annual basis and reported in the Annual Review.

Saline Material

Saline material is any material moved on site that has the potential to generate saline water. Salt has the potential to be chemically released by weathering when saline material is exposed to the surface and then has the potential to be transported by water. The sources of saline material at RVC include:

- ROM coal.

Saline Water

The sources of saline water at RVC include:

- Direct rainfall onto the surface of water storage dams, generally negligible and has been ignored from further analysis.
- Runoff – salt on the surface of soils or saline materials is dissolved by rainfall and enters the WMS dissolved in runoff.
- Groundwater inflows into the underground workings.
- Water imported from the Sydney Water Supply (very minor).

The amount of salt lost from the system via evaporation is negligible and salt will therefore typically concentrate in the water stored and used on site. This salt remains within the site WMS unless the water is discharged under the EPL release.

The representative salinity values of each source of saline water, estimated from the site water quality monitoring data or reference values from other sites, are presented in Table 20.

Table 20 Typical Salinity of Site Runoff and Salt Sources

SALT SOURCE	TYPICAL SALINITY (mg/L)
Natural Catchment Runoff	220
Disturbed Catchment Runoff	2000
Hardstand Catchment Runoff	5000
Groundwater Inflow to the Underground Workings	2170
Potable Water Imports from the Sydney Water Supply (negligible)	30

Saline Water Management

Saline material will be managed through storage and emplacement such that the saline water that is generated is contained within the mine WMS. The measures to manage saline material and minimise the discharge of saline water from site are summarised in Table 21.

Table 21 Saline Material Management Measures

SOURCE	MANAGEMENT STRATEGY
ROM Coal	Stored in stockpiles that are constructed such that runoff is contained within the mine WMS before being processed.
Discharge of treated water	Use of a WTP to reduce (via RO) the salt loads in water discharged via the LDPs.

APPENDIX G. STAGING OF THE WATER MANAGEMENT PLAN

Planning, Industry & Environment

NSW GOVERNMENT

Mr Richard Sheehan
Environmental Manager
Wollongong Coal Limited
7 Princes Highway
Corrimal, NSW, 2518

18/08/2021

Dear Mr. Sheehan

Russell Vale Underground Expansion (MP09_0013)
Request to Stage Waste and Water Management Plans

I refer to the Request to Stage Management Plans letter submitted on 20 July 2021 in accordance with Condition A21(a) of Schedule 2 of the Development Consent for the Russell Vale Underground Expansion (MP09_0013).

The Department has carefully reviewed the letter and understands that Wollongong Coal Limited intend to assess the viability of the Coal Processing Plant (CPP) during Stage 1 of operations, thereby determining if coal rejects waste will be generated by the project.

Accordingly, the Secretary has approved the staging of the Waste and Water Management Plans. Wollongong Coal Limited must update (to the satisfaction of the Secretary) the Waste and Water Management Plans with the necessary coal rejects waste management, disposal and monitoring processes prior to any coal reject being generated on site.

If you wish to discuss the matter further, please contact Wayne Jones on (02) 6575 3406.

Yours sincerely

Stephen O'Donoghue
Director
Resource Assessments
As nominee of the Secretary

Wollongong Coal Ltd

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29 July 2021

Daniel Martin
Senior Planning Officer – Post Approval
NSW Department of Planning, industry
and Environment
PO Box 3145
Singleton NSW 2330

Staging of the Russell Vale Colliery Coal Processing Plant Rejects Management

Reference:

- **Waste Management Plan**
- **Water Management Plan**

Dear Daniel,

Wollongong Coal Limited (**WCL**) have committed to undertaking the operations at the Russell Vale Colliery (**RVC**) in a staged approach under development consent MP09_0013 (**the consent**), 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:

a) *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).*

To this end WCL requests that the secretary approve the current management plans without taking into consideration the management, disposal and monitoring of coal reject material generated by the CPP, in specific reference to the waste and water management plans.

WCL will undertake the necessary steps to assess the feasibility of the CPP during stage 1 of the operations and, if the company makes the decision to proceed with the construction of the CPP, will update any relevant management plans with the necessary coal rejects waste management, disposal and monitoring processes. The relevant plans will be updated and resubmit to the secretary for approval prior to any coal rejects being generated on site.

If you have any questions or require any further information please contact Devendra Vyas, Technical Services Manager on 0423 880 227 or devendra.vyas@jindalsteel.com

Regards

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