



ASHTON COAL OPERATIONS



WATER MANAGEMENT PLAN

Ashton Mine Complex

Version 13

Date: April 2025

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1. PURPOSE

This Water Management Plan (WMP) describes the management measures to be implemented by Ashton Coal Operations Limited (ACOL) to manage and mitigate potential mine related impacts on water resources for the Ashton Coal Project (ACP).

This document has been prepared to satisfy Schedule 3, Conditions 26 and 32, and Schedule 5, Condition 2 of the ACP Development Consent Development Application (DA) 309-11-2001-i, (Ashton DA) (dated 6 July 2022), and Schedule 3, Conditions 6 and 23 of the Ravensworth Underground Mine (RUM) Development Consent DA 104/96 (RUM DA) (dated 6 July 2022). Previous iterations of this WMP has been prepared in consultation with the Environmental Protection Authority (EPA), Natural Resource Access Regulator, NSW Resources Regulator, Department of Regional NSW - Division of Resources and Geoscience (now Mining, Exploration and Geoscience, Department of Planning and Environment (DPE) (now Department of Planning, Housing and Infrastructure [DPHI]) and Singleton Council.

The DPE approved Modification 11 to the Ashton DA and Modification 10 to the RUM DA on 6 July 2022. These modifications allow for the integration of the two neighbouring underground mines and enables ACOL to access and extract approved but unmined coal resources from a portion of the RUM. For operational and management purposes, this portion of the RUM will now form an integral part of the ACP (hereafter referred to as the ACOL-operated RUM)¹. This integration is further described in **Section 2.1**.

¹ The integration is referred to as the ACOL-operated portion of the RUM in the Ashton and Ravensworth Modification Reports

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2. INTRODUCTION

ACOL, a wholly owned subsidiary of Yancoal Australia Limited (Yancoal), operates the ACP, an underground coal mine (and completed open cut mine), located approximately 14 kilometres (km) north-west of Singleton in the Upper Hunter Valley, New South Wales (NSW). **Figure 1** illustrates the locality of the ACP.

The key elements of the ACP include:

- An open cut pit (North East Open Cut [NEOC]) that has now been completed, with the final void remaining for the storage of coarse and fine reject;
- A four-seam descending underground mine with approval to extract up to 5.45 Million Tonnes Per Annum (Mtpa) of Run of Mine (ROM) coal;
- Surface mine infrastructure associated with the underground Mine, including gas drainage bores, ventilation fans, mine dewatering and water supply infrastructure;
- Coal handling and preparation facilities including rail siding and rail loading bin;
- Reject and tailings emplacements;
- Administration, bathhouse and workshop buildings; and
- Integration with the RUM to allow ACOL to access and extract approved but unmined coal resources from a portion of the RUM (refer **Section 2.1**).

The Ashton DA was initially granted for the ACP by the Minister for Planning in October 2002. The approval has been subsequently modified on several occasions.

2.1. Integration of Ashton Underground Mine with Ravensworth Underground Mine

The Ashton Underground Mine and the RUM share a common mining lease boundary and the approved underground mining areas are separated (at their closest) by approximately 45 metres (m) (**Figure 1**).

Modification 11 to the Ashton DA and Modification 10 to the RUM DA enable the integration of the Ashton Underground Mine and RUM, and for ACOL to access and extract approved but unmined coal resources from a portion of the RUM. The modifications allow for connections to be made between the two neighbouring mines via non-subsiding first workings (**Figure 2**). ACOL will utilise its existing longwall mining equipment and employees to mine the Pikes Gully and Middle Liddell coal seams at the RUM.

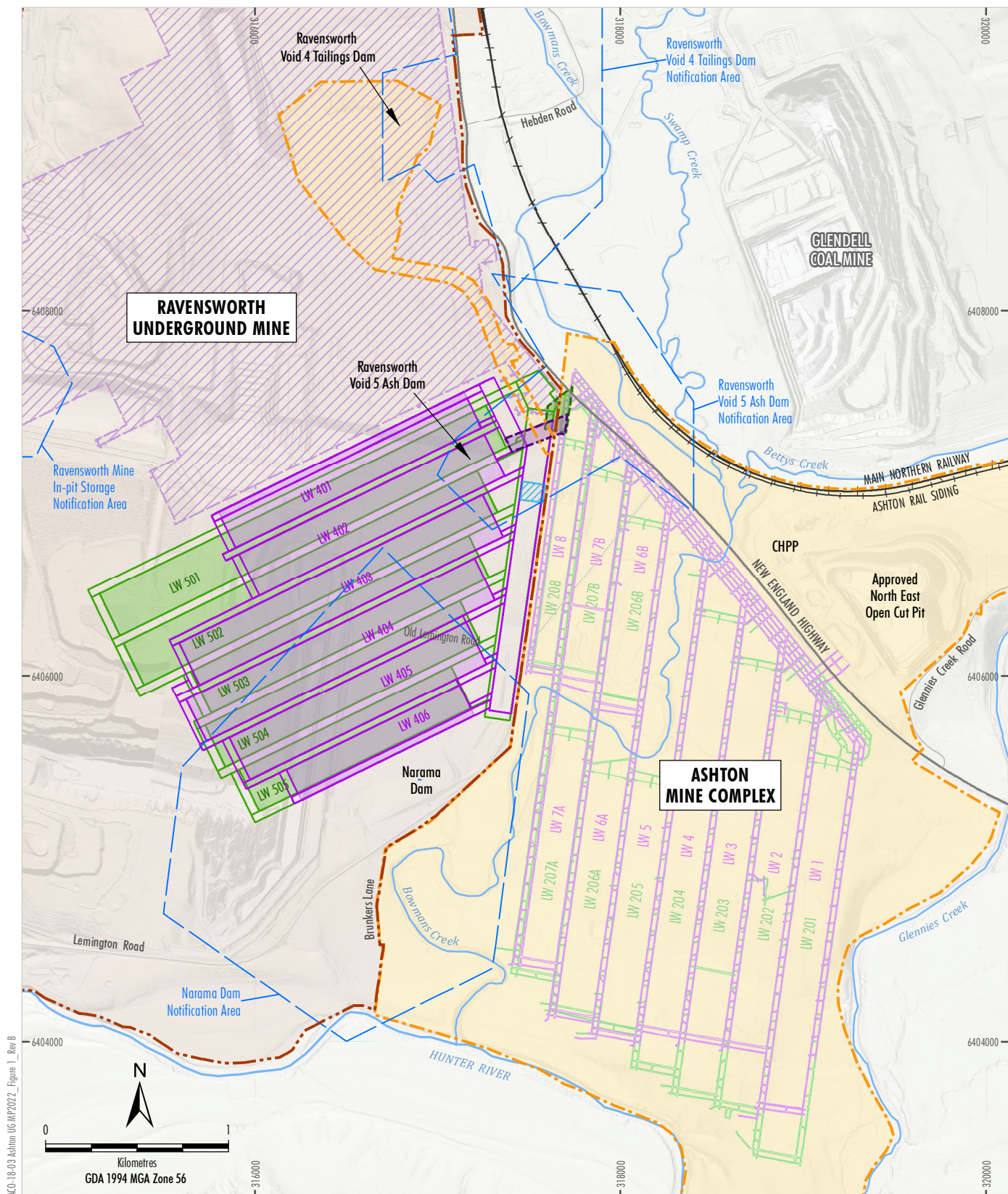
In 2022, ACOL lodged an EPBC Referral (EPBC 2022/09208) to the Commonwealth Department of Climate Change, Energy, the Environment and Water for approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Commonwealth Department of Climate Change, Energy, the Environment and Water approved EPBC 2022/09208 on 24 September 2024.

ACOL will handle, process and transport coal from the RUM in the same manner it handles coal from its Ashton Underground Mine. ROM coal will be transferred via underground conveyors to the Ashton Mine Complex and through to the Ashton pit top, via its existing coal clearance system. ROM coal will be processed at Ashton's Coal Handling and Processing Plant (CHPP) prior to being loaded onto trains for transportation to market using the existing rail infrastructure.

Rejects and tailings generated from the processing of the RUM ROM coal will be emplaced in the existing NEOC void and Ravensworth Void 4 Tailings Dam. Water and gas from the RUM will also be transferred to the ACP to be managed within the existing water and gas management system.

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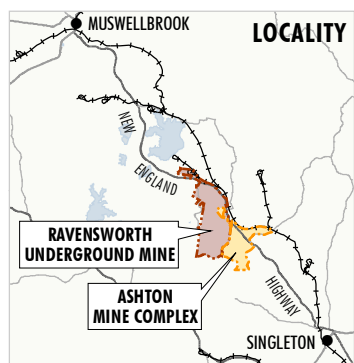
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AKO-18-03 Ashton UG MP2022_Figure 1_Rev B

Source: NSW Spatial Services (2022); Dams Safety NSW (2020)

Note: The approved Upper Liddell and Lower Barrett Seams at the Ashton Coal Project and approved Lemington and Barrett Seams at the Ravensworth Underground Mine are not shown on this figure.



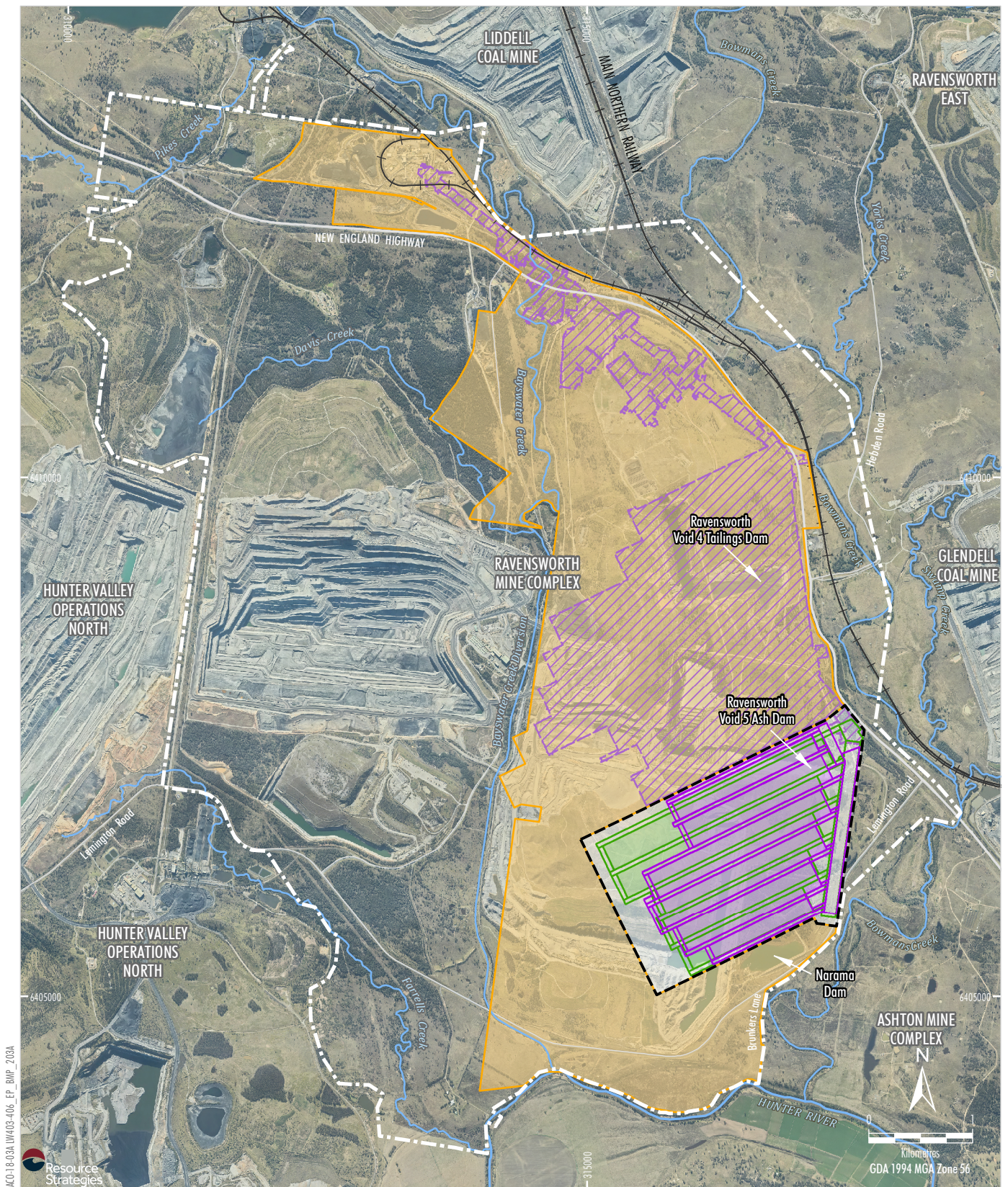
- LEGEND**
- Dam Notification Area
 - Ashton Mine Complex
 - Ashton Coal Project Development Consent Boundary
 - Pikes Gully Seam Longwall Layout
 - Upper Lower Liddell Seam Longwall Layout
 - Ravensworth Underground Mine
 - Ravensworth Underground Mine Development Consent Boundary
 - Existing Shaft 5 Location
 - Completed Pikes Gully Seam Workings
 - Indicative Pikes Gully Seam Longwall Layout
 - Indicative Modified Pikes Gully First Workings
 - Indicative Middle Liddell Seam Longwall Layout
 - Indicative Middle Liddell Seam First Workings



ASHTON UNDERGROUND MINE

Locality Plan
and General Arrangement

Figure 1



The Ravensworth Underground Mine includes ancillary infrastructure and surface disturbance associated with underground mining including, but not limited to, ventilation, gas management and water management infrastructure and subsidence monitoring, management and remediation activities.

^ This area is called the 'ACOL-operated portion of the RUM' in the Modification Report.

The area of ACOL-operated RUM will be managed under the RUM DA and is shown on **Figure 2**.

ACOL will implement the management, monitoring and reporting outlined in this WMP during mining of the ACOL-operated RUM.

The remaining areas of the approved RUM (i.e. outside of the ACOL-operated RUM) including the completed Pikes Gully seam Longwalls 1-9 as well as open cut mining activities associated with the Ravensworth Operations Project (Project Approval 09-0176) are managed in accordance with the Ravensworth Environmental Management Strategy (and associated management plans) and the RUM Rehabilitation Management Plan.

Regular meetings will be held between ACOL and Glencore to discuss the following:

- planned ACOL and Glencore activities within the ACOL-operated RUM and surrounds;
- potential interactions between the Ravensworth Operations Project and the ACOL-operated RUM, including any relevant consequences of subsidence;
- environmental monitoring results relevant to the ACOL-operated RUM; and
- data and report sharing.

In addition, the Built Features Management Plans required under Condition 6, Schedule 3 of the RUM DA will address interactions with Glencore's and AGL Macquarie's assets and operations.

2.2. Statutory Context

Schedule 5, Condition 6 of the Ashton DA and Schedule 4, Condition 3 of the RUM DA require the review (and where necessary the revision) of the Management Plans within 3 months of the submission of an incident report, Annual Review, Audit (as specified within the DA) or any modification to the conditions of the Development Consent.

This WMP is specifically required by and has been prepared in accordance with Schedule 3, Conditions 26 and 32, of the Ashton DA, Schedule 3, Conditions 6 and 23, of the RUM DA. In addition, this WMP has been updated to incorporate the ACOL-operated RUM as required by approval Conditions 2 and 5 of EPBC 2022/09208.

Table 1 provides a summary of the specific requirements of the Ashton DA and groundwater licences held by ACOL (under the *Water Management Act 2000*) and where these are addressed within the WMP. **Table 2** provides a summary of the specific requirements of the RUM DA, which are applicable to the ACOL-operated RUM.

This WMP was most recently approved by the Department of Planning, Industry and Environment (DPIE) (now the DPHI) on 15 September 2020. A copy of the correspondence is included in **Appendix A**.

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Table 1 Summary of the ACP WMP Development Consent and Aquifer Water Access Licence conditions

Condition	Requirements	Where Addressed in WMP
Schedule 3, Condition 23(d)	<p>The applicant must prepare a Bowmans Creek Diversion Management Plan for the proposed creek diversions in the underground mining area, which must:</p> <ul style="list-style-type: none"> • be submitted to the Planning Secretary for approval; • be consistent with any related requirements in future Extraction Plan(s); and • include: <ul style="list-style-type: none"> - a vision statement for the creek relocations; - an assessment of the surface water and groundwater quality, ecological, hydrological and geomorphic baseline conditions within the creek; - detailed design specifications for the creek relocations; - a construction program for the creek relocations, describing how the work would be staged, and integrated with mining operations; - a revegetation program for the relocated creeks using a range of suitable native species; - water quality, ecological, hydrological and geomorphic performance and completion criteria for the creek relocations based on the assessment of baseline conditions; and - a program to monitor and maintain surface water and groundwater quality, ecological, hydrological and geomorphic stability of the creek diversions. 	Section 4
Schedule 3, Condition 25 (Table 8)	<p>Water Management – General:</p> <ul style="list-style-type: none"> • Maximise water sharing with the other mines in the region • Minimise the use of clean water on site <p>Construction and operation of infrastructure:</p> <ul style="list-style-type: none"> • Design, install and maintain erosion and sediment controls generally in accordance with the series <i>Managing Urban Stormwater: Soils and Construction</i> including <i>Volume 1</i>, <i>Volume 2A – Installation of Services</i> and <i>Volume 2C – Unsealed Roads</i> • Design, install and maintain all new infrastructure within 40 m of watercourses generally in accordance with the <i>Guidelines for Controlled Activities on Waterfront Land</i> (DPI 2007), or its latest version • Design, install and maintain creek crossings generally in accordance with the <i>Policy and Guidelines for Fish Friendly Waterway Crossings</i> (NSW Fisheries 2003) and <i>Why Do Fish Need To Cross The Road? Fish Passage Requirements for Waterway Crossings</i> (NSW Fisheries 2003), or their latest versions 	Section 3 Section 4 and Section 5
Schedule 3, Condition 26	The Applicant must prepare a Water Management Plan for the Ashton Mine Complex to manage potential impacts of the development. This plan must:	This document
Schedule 3, Condition 26(a)	be prepared in consultation with the Resources Regulator and Council, and be endorsed by DPE Water and then submitted to the Planning Secretary for approval;	Section 1
Schedule 3, Condition 26(b)	include detailed performance criteria and describe measures to ensure that the Applicant complies with the Water Management Performance Measures (see Table 8);	This document Sections 4.5, 6.2 and 7.2
Schedule 3, Condition 26(c)	<p>include a Site Water Balance, which must:</p> <ul style="list-style-type: none"> • include details of: <ul style="list-style-type: none"> - sources and security of water supply; - water use on site; - water management on site; - any off-site water transfers, and • investigate and implement all reasonable and feasible measures to minimise water use by the Ashton Mine Complex; 	Sections 2.2, 3.2 and 3.3

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Condition	Requirements	Where Addressed in WMP
	<ul style="list-style-type: none"> - a program to monitor and report groundwater inflows to underground workings; - a program to manage and monitor impacts on groundwater bores on privately-owned land 	Section 7.3.2 Section 7
MW8295-00001 of Water Access Licence (WAL) 41501, WAL 41551, WAL 41553, and WAL 41529	A. The access licence holder must record the following information in a logbook for each period of time that water is taken: <ol style="list-style-type: none"> date, start and end time when water was taken, volume of water taken, and the water supply work approval number under which the water was taken, and the purposes for which water was taken. B. The access licence holder must record the following information in the logbook at the end of each water year: <ol style="list-style-type: none"> the volume of water taken in the water year, and the maximum volume of water permitted to be taken in that water year. C. This condition ceases to apply to this access licence on the day on which the relevant mandatory metering equipment condition applies as specified in clause 230(1) in the Water Management (General) Regulation 2018. D. This condition does not apply to this access licence if the licence nominates only water supply works that have: <ol style="list-style-type: none"> a meter that complies with Australian Standard AS 4747 - Meters for non-urban water supply, and a data logger. 	Section 2.4.1
MW6612-00001 of WAL 41501, WAL 41551, WAL 41553, and WAL 41529	A logbook used to record water take information must be retained for five (5) years from the last date recorded in the logbook.	Section 2.4.1
MW8241-00001 of WAL 41501, WAL 41551, WAL 41553, and WAL 41529	A. The water access licence holder must produce the Logbook to the Minister for inspection when requested. B. This condition does not apply to this access licence if the licence only nominates water supply works that have: <ol style="list-style-type: none"> a meter that complies with Australian Standard AS 4747 - Meters for non-urban water supply, and a data logger. 	Section 2.4.1
MW6983-00001 of WAL 41501, WAL 41551, WAL 41553, and WAL 41529	A. Once the water access licence holder becomes aware of a breach of any condition on this water access licence, the water access licence holder must notify the Minister as soon as practicable. B. If the initial notification was not in writing, written notice must be provided within seven days of becoming aware of the breach by: <ol style="list-style-type: none"> email: nrar.enquiries@nrar.nsw.gov.au, or mail: <ul style="list-style-type: none"> - DPE Water, PO Box 2213, Dangar NSW 2309, or - DPE Water, Locked Bag 10, Grafton NSW 2460. 	Section 2.4.1

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Table 2 Summary of the RUM WMP Development Consent Conditions

Condition	Requirements	Where Addressed in WMP
Schedule 3, Condition 6(i)	<p>The Applicant must prepare and implement an Extraction Plan for any second workings on site, to the satisfaction of the Planning Secretary. The plan must include a:</p> <ul style="list-style-type: none"> Water Management Plan, which has been prepared in consultation with DPE Water, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on surface water resources, groundwater resources and flooding, and which includes: <ul style="list-style-type: none"> surface and groundwater impact assessment criteria, including trigger levels for investigating any potentially adverse impacts on water resources or water quality; a program to monitor and report groundwater inflows to underground workings; a program to manage and monitor impacts on groundwater bores on privately-owned land 	<p>This document</p> <p>Sections 6 and 7</p> <p>Section 7.3.2</p> <p>Section 7</p>
Schedule 3, Condition 23	<p>The Applicant must prepare and implement a Water Management Plan for the development to the satisfaction of the Planning Secretary. This plan must be prepared in consultation with DPE Water, and be submitted to the Planning Secretary for approval by the end of October 2013. The plan must include:</p>	This document
Schedule 3, Condition 23(a)	<p>a Site Water Balance, which must:</p> <ul style="list-style-type: none"> include details of: <ul style="list-style-type: none"> sources and security of water supply; water use on site; water management on site; any off-site water transfers; and investigate and implement all reasonable and feasible measures to minimise water use by the development; 	Section 2.2, 3.2 and 3.3
Schedule 3, Condition 23(b)	<p>an Erosion and Sediment Control Plan, which must:</p> <ul style="list-style-type: none"> identify activities that could cause soil erosion, generate sediment or affect flooding; describe measures to minimise soil erosion and the potential for the transport of sediment to downstream waters, and manage flood risk; describe the location, function, and capacity of erosion and sediment control structures and flood management structures; and describe what measures would be implemented to maintain the structures over time; 	Section 5
Schedule 3, Condition 23(c)	<p>a Surface Water Management Plan, which must include:</p> <ul style="list-style-type: none"> detailed baseline data on surface water flows and quality in creeks and other waterbodies that could potentially be affected by the development; surface water and stream health impact assessment criteria including trigger levels for investigating any potentially adverse surface water impacts; a program to monitor and assess: <ul style="list-style-type: none"> surface water flows and quality; impacts on water users; stream health; and channel stability; 	Section 6

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Condition	Requirements	Where Addressed in WMP
Schedule 3, Condition 23(d)	a Groundwater Management Plan, which must include: <ul style="list-style-type: none"> • detailed baseline data of groundwater levels, yield and quality in the region, and privately owned groundwater bores, that could be affected by the development; • groundwater impact assessment criteria including trigger levels for investigating any potentially adverse groundwater impacts; • a program to monitor and assess: <ul style="list-style-type: none"> - groundwater inflows to the mining operations; - impacts on regional aquifers; - impacts on the groundwater supply of potentially affected landowners; - impacts on the Hunter River, Bayswater Creek and Bowmans Creek alluvial aquifers; and - impacts on any groundwater dependent ecosystems and riparian vegetation; 	Section 7
Schedule 3, Condition 23(e)	a Surface and Ground Water Response Plan, which must include: <ul style="list-style-type: none"> • a response protocol for any exceedances of the surface water and groundwater assessment criteria; • measures to prevent, minimise or offset groundwater leakage from alluvial aquifers caused by the development, particularly when mining within 150 metres of any such alluvials; • measures to compensate landowners of privately-owned land whose basic landholder rights is adversely affected by the development; and • measures to mitigate and/or offset any adverse impacts on groundwater dependent ecosystems or riparian vegetation. 	Section 8

2.3. Water Management System Description

Figure 3 shows the mine layout and surface facilities in relation to surface features including watercourses at the ACP and the ACOL-operated RUM. Existing and future underground operations extend southwards and are located between Bettys Creek (to the north), the Hunter River (to the south), Glennies Creek (to the east) and Bowmans Creek (to the west). Glennies Creek and Bowmans Creek are tributaries of the Hunter River while Bettys Creek is a tributary of Bowmans Creek. Glennies Creek is a heavily modified stream with a regulating storage (Glennies Creek Dam) located upstream. Glennies Creek drains southwards joining the Hunter River immediately south-east of the ACP. Bowmans Creek has a largely unmodified catchment in its middle and upper reaches and also flows southwards joining the Hunter River 3 km upstream of the confluence with Glennies Creek.

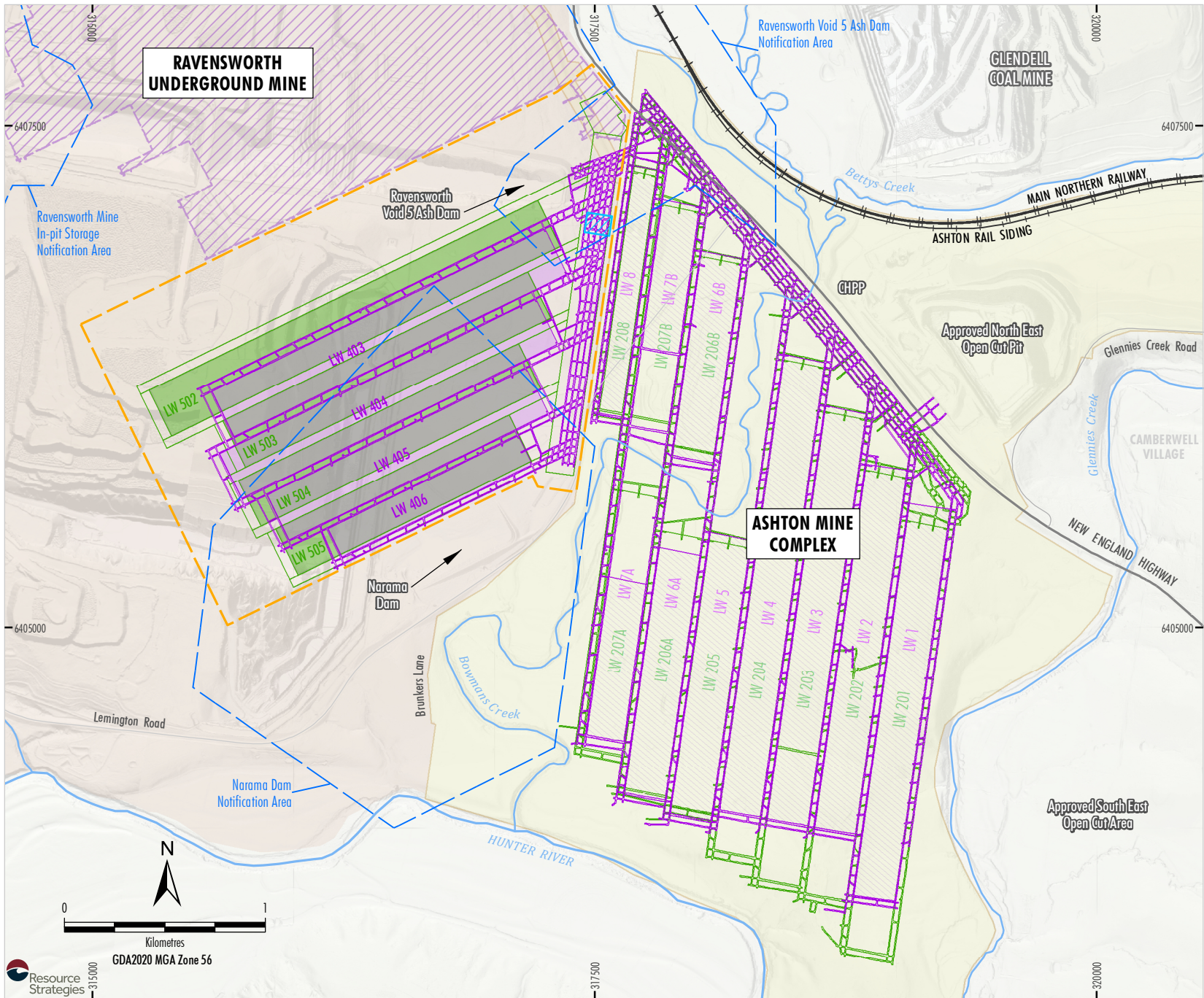
Open cut mining at the ACP ceased on September 2011. The current underground mine extracts coal using longwall mining methods, with the area of mined panels (Pikes Gully seam, Upper Liddell seam) and current/near future panels (Upper Lower Liddell seam, Lower Barrett seam) shown on **Figure 3**. Two reaches of Bowmans Creek have been diverted in order to mitigate the effects of mining subsidence resulting from direct hydraulic connection between the Bowmans Creek Alluvium (BCA) and the underground workings. The Eastern and Western reaches of the Bowmans Creek Diversion (BCD) are shown on **Figure 3**. Construction has been completed, except for permanent block banks, which will be constructed 12 months prior to mining LW 106B or as triggered by subsidence monitoring (in the ULD Seam) (refer **Section 4**).

The water management system would remain substantially unchanged by the integration of the ACP with the RUM.

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RAVENSWORTH UNDERGROUND MINE
LONGWALLS 403 TO 406 EXTRACTION PLAN

ACP and ACOL-operated
RUM Mine Area Layout

Figure 3

The key components of the mine water management system at the ACP and ACOL-operated RUM are shown in schematic form in **Figure 4**. The catchment area and capacity of each water storage is given in **Table 3**.

Table 3 ACP Mine Water Storages

Storage	Catchment Area (ha)	Capacity (ML)
North-East Open Cut	159	10,600*
Process Water Dam	14	60
Settling Dam	25	34
Dam 56	35	61
Arties Pit Sump	10	31

Note: ha = hectares, ML = Megalitres.

* Capacity slowly reducing with continued rejects placement.

The Process Water Dam (PWD) supplies water to the CHPP for road dust suppression (truckfill) and miscellaneous CHPP usage. The north-east open cut (NEOC) is the former open cut pit which is now in the process of being progressively backfilled with coarse rejects and, in terms of available capacity, it is the main water storage at the ACP and ACOL-operated RUM. Rejects disposal to the NEOC was approved under Section 100 of the *Coal Mine Health & Safety Act 2002* on 1st March 2012. The Section 100 Application Report (Cardno, 2012) states that to meet geotechnical and stability requirements, the groundwater level within the rejects emplacement must not rise to within 3 m of any coarse rejects surface.

Tailings disposal occurs to the Ravensworth Final Void No. 4 East (Ravensworth Void 4). ACOL is responsible for the management of Ravensworth Void 4 which is owned by AGL Macquarie and is a remnant of previous open cut mining operations. ACOL is responsible for the management of a defined area within the AGL Macquarie owned land for the duration of tailings emplacement and rehabilitation operations. Ravensworth Void 4 has an estimated surface catchment area of 31 ha. Water is reclaimed by pumping from Ravensworth Void 4 to the ACP Settling Dam which is pumped or overflows to the PWD for CHPP re-use (refer **Figure 4**).

Tailings generated by the processing of RUM ROM coal at the ACP CHPP would be emplaced in the existing NEOC void in accordance with existing management practices.

The NEOC void would provide capacity for the emplacement of rejects and tailings over the remainder of the mine life.

Water consumption at the ACP and ACOL-operated RUM is primarily driven by supply to the CHPP, but also includes loss from supply to the underground mining area, evaporation, supply to irrigation, truckfill and potable use (refer **Section 3.1**). Majority of inflows to the site are from groundwater inflows to the Ashton Underground Mine and runoff captured from disturbed mine landforms. Other sources of water supply are from Glennies Creek and the Hunter River (accessed with WALs), tailings water reclaim and water returned to the system from CHPP miscellaneous uses. Water held in storages on site, including surface facilities dams, which collect runoff from the catchment area of the site and groundwater as well as water returned from underground mining operations.

Supply of potable water to offices, workshops, bathhouses and underground workings is sourced from the Tank Farm. The Tank Farm receives inflows from Glennies Creek or the Hunter River accessed using WALs. Sewage treatment is provided by three Sewage Treatment Plants (STPs). Effluent from the STPs is irrigated on dedicated land located within the mine water management system and licensed through Environment Protection Licence (EPL) 11879.

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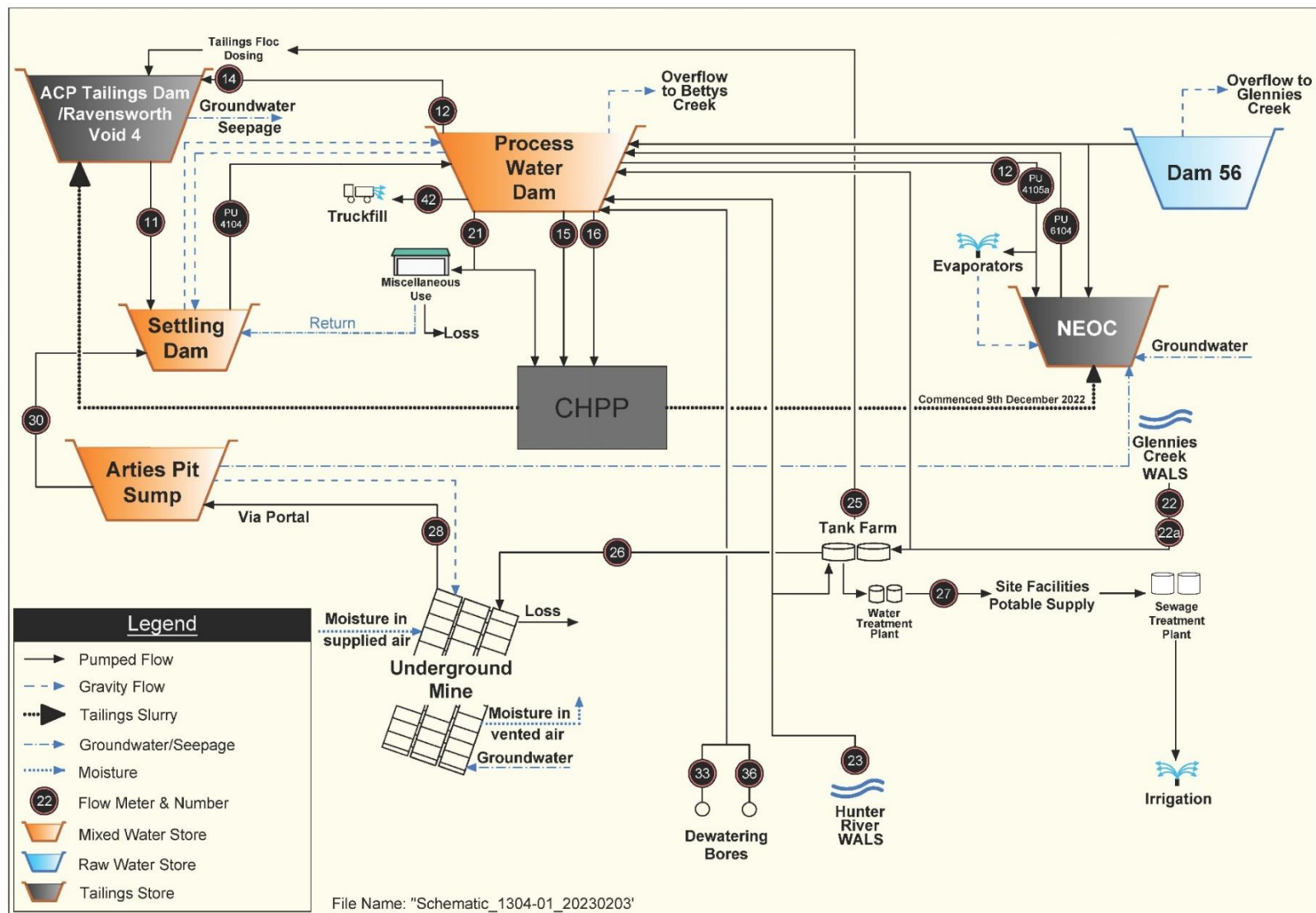


Figure 4 Water Management Schematic

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A bank of evaporator sprays was commissioned in the NEOC void in July 2014. During periods when the site water balance identifies increasing water inventory as an issue, water is pumped from the PWD to these evaporators to increase system losses and mitigate the water inventory increase. Unevaporated water from the irrigators reports to the NEOC.

No discharge of surface water occurs from the ACP and ACOL-operated RUM. All mine affected water is stored in mine water storages (refer **Table 3**) for use on site.

2.4. Water License

ACOL currently holds WALs under the *Water Management Act 2000* for groundwater extraction from the *North Coast Fractured and Porous Rock Groundwater Sources Water Sharing Plan* (WSP) and surface water extraction under the *Hunter River Regulated Water Source WSP* and the *Hunter River Unregulated and Alluvial Water Sources WSP*. The reach of the Hunter River and Glennies Creek adjacent to the ACP comprise management zones 1B and 3A of the WSP. Groundwater monitoring bores are approved under the *Water Act 1912* by bore licence 20BL173735. This licence permits up to 224 monitoring bores across the ACOL project area. A summary of WALs held by ACOL for both surface and groundwater is provided in **Table 4**.

Groundwater and rainfall runoff are extracted from the NEOC via a large diameter well ('caisson') constructed within the backfilled coarse rejects and equipped with a pump, for pumped transfer to the PWD. Groundwater and return water from the underground operations is extracted via the mine access portal and dewatering bores to the Arties Pit Sump and PWD respectively. **Figure 3** shows the location of the existing dewatering bores.

Table 4 Summary of Water Access Licences

Water Access Licence Number	Water Sharing Plan, Source, Management Zone and Reliability	Entitlement*
Surface Water		
984	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek), General Security	9
997	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek), High Security	11
8404	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek), High Security	80
15583	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek), General Security	354
Total		454
1120	Hunter Regulated Water Sharing Plan, surface water, Hunter Regulated River Water Source, High Security	3
1121	Hunter Regulated Water Sharing Plan, surface water, zone 1B (Hunter River from Goulburn River Junction to Glennies Creek Junction), General Security	335
19510	Hunter Regulated Water Sharing Plan, surface water, zone 1B (Hunter River from Goulburn River Junction to Glennies Creek Junction), High Security	130
Total		468
23912	Hunter Unregulated and Alluvial Water Sources 2009, surface water, Whole Water Source (Jerrys Water Source) (Bowmans Creek), Unregulated	14
36702	Hunter Unregulated and Alluvial Water Sources 2009, surface water, Jerrys Management Zone (Jerrys Water Source) (Bowmans Creek), Unregulated	116
36703	Hunter Unregulated and Alluvial Water Sources 2009, surface water, Jerrys Management Zone (Jerrys Water Source) (Bowmans Creek), Unregulated	150
Total		280
29566	Hunter Unregulated and Alluvial Water Sources 2009, aquifer, Jerrys Management Zone (Jerrys Water Source), Unregulated	358

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Water Access Licence Number	Water Sharing Plan, Source, Management Zone and Reliability	Entitlement*
1358	Hunter Regulated Water Sharing Plan, surface water, Hunter Regulated River Water Source, Supplementary	4
6346	Hunter Regulated Water Sharing Plan, surface water, Hunter Regulated River Water Source, Supplementary	15.5
Total		377.5
Groundwater		
41501	North Coast Fractured and Porous Rock Groundwater Sources, Sydney Basin – North Coast Groundwater Source, aquifer (NEOC)	100
41552	North Coast Fractured and Porous Rock Groundwater Sources, Sydney Basin – North Coast Groundwater Source, aquifer (U/G)	511
41553	North Coast Fractured and Porous Rock Groundwater Sources, Sydney Basin – North Coast Groundwater Source, aquifer (U/G)	81
41529	North Coast Fractured and Porous Rock Groundwater Sources, Sydney Basin - North Coast Groundwater Source, aquifer (RUM)	400
20BL173735	Monitoring bore, Water Act 1912 Groundwater Licence	Nil - Monitoring Only
Total		1092

* Note the annual water take by the ACP will be reported in the ACP Annual Reviews.

Water take predictions for the ACP are as presented in the Ashton-Ravensworth Integration Modification - Groundwater Review (AGE, 2021). ACOL holds WALs with sufficient entitlements to account for the predicted water take and will report the actual annual water take volumes associated with the ACP in its Annual Reviews.

The total harvestable right for the ACP associated landholdings is 84 ML. The capacity of existing eligible dams and subsidence areas on ACOL landholdings has an estimated combined capacity of 101.6 ML (calculated conservatively from the estimated ponding depth and surface area derived from topographic data and aerial photography for potential subsidence areas). As shown in **Table 4**, ACOL hold WALs with sufficient entitlements to account for any take above the harvestable rights allowance, should this be required during the life of the Ashton Mining Complex.

The PWD, Settling Dam and Dam 56 are solely for the capture, containment and recirculation of mine affected water consistent with best management practice to prevent the contamination of a water source. Therefore, in accordance with Schedule 1 of the *Water Management (General) Regulation 2018*, these dams are considered “excluded works” and are exempt from the requirement for water supply works or WALs.

All water captured on-site would be in accordance with the Water Management Act 2000 and the *Water Management (General) Regulation 2018*.

2.4.1 Water Access Licence Conditions

As required under WAL 41501, WAL 41552, WAL 41553, and WAL 41529, ACOL will record the following information in a logbook for each period of time that water is taken:

- date, start and end time when water was taken, volume of water taken;
- the water supply work approval number under which the water was taken; and
- the purposes for which water was taken.

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In addition, ACOL will record the following information in a logbook at the end of each water year:

- the volume of water taken in the water year; and
- the maximum volume of water permitted to be taken in that water year.

The logbook used to record water take information will be retained for five years from the last date recorded in the logbook. The logbook will be provided to the Minister for inspection when requested.

In the event of a breach of any condition within the Water Access Licence, ACOL will notify the DPHI and any other relevant department as soon as reasonably practicable.

2.5. Works Approvals

ACOL holds Works Approvals under the *Water Management Act 2000* for surface water extraction works (pump sites) on the Hunter River (20CA201626) and Glennies Creek (20CA201565), used to supply operational water for the ACP. Works approval 20CA211424 is held to allow interception of water from Bowmans Creek and associated alluvial water sources. ACOL also holds 13 works approvals associated with Camberwell properties, used for *Stock & Domestic* water use.

The levee that separates the PWD from Bettys Creek is a licenced flood control work (20FW213279) and, as a project approved under the Environmental Planning and Assessment Act 1979, the ACP and ACOL-operated RUM has been designated the miscellaneous works approval number 20MW065006, to allow linkage with associated surface and aquifer WALs.

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3. SITE WATER BALANCE

3.1. Site Water Balance Model

A life-of-mine water balance model of the ACP was initially developed by Hydro Engineering & Consulting Pty Ltd (HEC) (now ATC Williams) in 2013 with annual reviews conducted thereafter. The most recent update of the model was prepared to support the ACP Modification 11 application (HEC, 2021).

The structure of the model is generally per the schematic in **Figure 4**. The model operates on a sub-daily time-step and has most recently been setup to simulate the forward planning period from 1/07/2021 to 1/07/2035, reflecting mining at the ACP and ACOL-operated RUM through to their completion.

3.1.1 Data and Calibration

The water balance model has been linked to output from the Hunter River Integrated Quantity and Quality Model (IQQM). The IQQM is the model used by WaterNSW to make available water determinations in the Hunter Valley, in accordance and in conjunction with the WSP for the Hunter Regulated River Water Source. The IQQM was run using climatic data from 1892 to 2012 to generate predictions of the general security of available water determinations and periods of off-allocation.

The Australian Water Balance Model (Boughton, 2004) was used to simulate runoff from rainfall on the various catchments and landforms across the mine area. Model rainfall-runoff parameters have been taken from studies conducted at similar mining operations and then adjusted as part of model calibration.

Seven different sub-catchment types were modelled, namely: undisturbed (natural) areas, hardstand (e.g., roads and infrastructure areas), open cut pit, waste rock, rehabilitated waste rock, stockpile areas and tailings. Each storage catchment area was divided into these sub-catchment areas based on estimations from aerial photography and current mine contour plans.

Surface catchment areas of the mine were simulated using supplied plans.

The only simulated change to the ACP catchment areas would be as a result of the excision of the Ravensworth Void 4 tailings storage which was assumed fully rehabilitated and is forecast to be excised from the water management system by the end of November 2025. The majority of the ACP's catchment area reports to the NEOC (refer **Table 3**) and comprises most of the NEOC overburden emplacement area (refer **Figure 4**) much of which has been rehabilitated.

Annually, varying ROM coal tonnages (which affect CHPP water demand) are expected to be between 1.4-3.8 Mtpa over the simulated period. The ACP is approved to produce up to 5.45 Mtpa of ROM coal up to December 2035. Projected ROM coal tonnages, yields and moistures (feed, product, rejects and tailings) were used to calculate CHPP demand.

Underground mine groundwater inflow rates were obtained from groundwater modelling by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) (2021). The predicted inflow rates average to 1.4 megalitres per day (ML/d). Groundwater inflows to the NEOC were assumed negligible, which was estimated from the model's calibration.

Underground demand was calculated based on historical pumping records, with an average demand during mining of 0.59 ML/d, while during longwall change-outs this drops to 0.23 ML/d. For water quality reasons, this water is sourced only from WALs.

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The water balance model was calibrated by comparing model estimates of total water volume stored in all monitored water storages (NEOC, Arties Pit Sump, PWD, Settling Dam and Dam 56) against water volumes estimated from monthly monitoring records for the period December 2012 to December 2020 inclusive and adjusting model parameters (e.g. rainfall runoff model parameters) to obtain a close match between the two.

This period includes frequent monitoring of water levels in the NEOC, which comprises the majority of stored water at the ACP and therefore a specific focus was to simulate the stored water volumes in the NEOC as closely as possible for this period. The following data was used in model calibration:

- Recorded ACP daily rainfall data.
- Daily pan evaporation data sourced from the SILO Point Data.
- Open cut pit and mine water storage catchment and sub-catchment areas estimated from contour plans and aerial photography.
- Recorded storage water levels provided by ACOL, which were used along with storage volume-area-level relationships for each water storage to estimate water storage volumes for the calibration period.
- Recorded monthly CHPP feed tonnes and product yields and underground mine ROM tonnes.
- Groundwater inflow estimates to the underground from modelling undertaken by various specialist groundwater consultants. Groundwater inflow estimates for the NEOC were assessed as part of the calibration process.
- Recorded pumped volumes from flow meters shown in **Figure 4**, including water pumped from Glennies Creek and Hunter River WALs.

The model simulates 121 mine life “realizations”, derived using the climatic record from 1892 to 2012². The first realization uses climatic data starting in 1892, the second 1893 the third 1894 and so on. The results from all realizations are used to generate water storage volume estimates and other relevant water balance statistics. This method effectively includes all recorded historical climatic events in the water balance model, including high, low and median rainfall periods.

Simulation of evaporator sprays in the NEOC was included in the model. The model simulates pumping from the PWD to these evaporators at a rate of 2.81 ML/d in summer and 1.87 ML/d in winter (as advised by ACOL). Operation was simulated only on days with less than 5 millimetres (mm) rain, with 30% of the water pumped assumed lost and the balance (unevaporated water) reporting to the NEOC. Operation was undertaken only when the stored NEOC water volume rose above a low trigger volume.

3.1.2 Results

The average predicted site water balance at the ACP and ACOL-operated RUM is summarised in **Figure 5**. **Figure 5** presents the forecast inflows and outflows at the ACP and ACOL-operated RUM, and display the average rates (in megalitres per year [ML/year]) and percentages given at the conclusion of all 121 climatic realizations.

² Data was sourced from ‘Data Drill’ generated climatic data for the mine location. The Data Drill is a system which provides synthetic data sets for a specified point by interpolation between surrounding point records held by the Bureau of Meteorology (refer Queensland Government, 2014). Both rainfall and pan evaporation data were obtained from this source. Additional climate data after 2012 was generated by “wrapping” data from the beginning of the climate record to after 2012. In this way, the drought period of 2005/06 and the wet period of 2007 could be simulated as occurring at varying times through the mine life.

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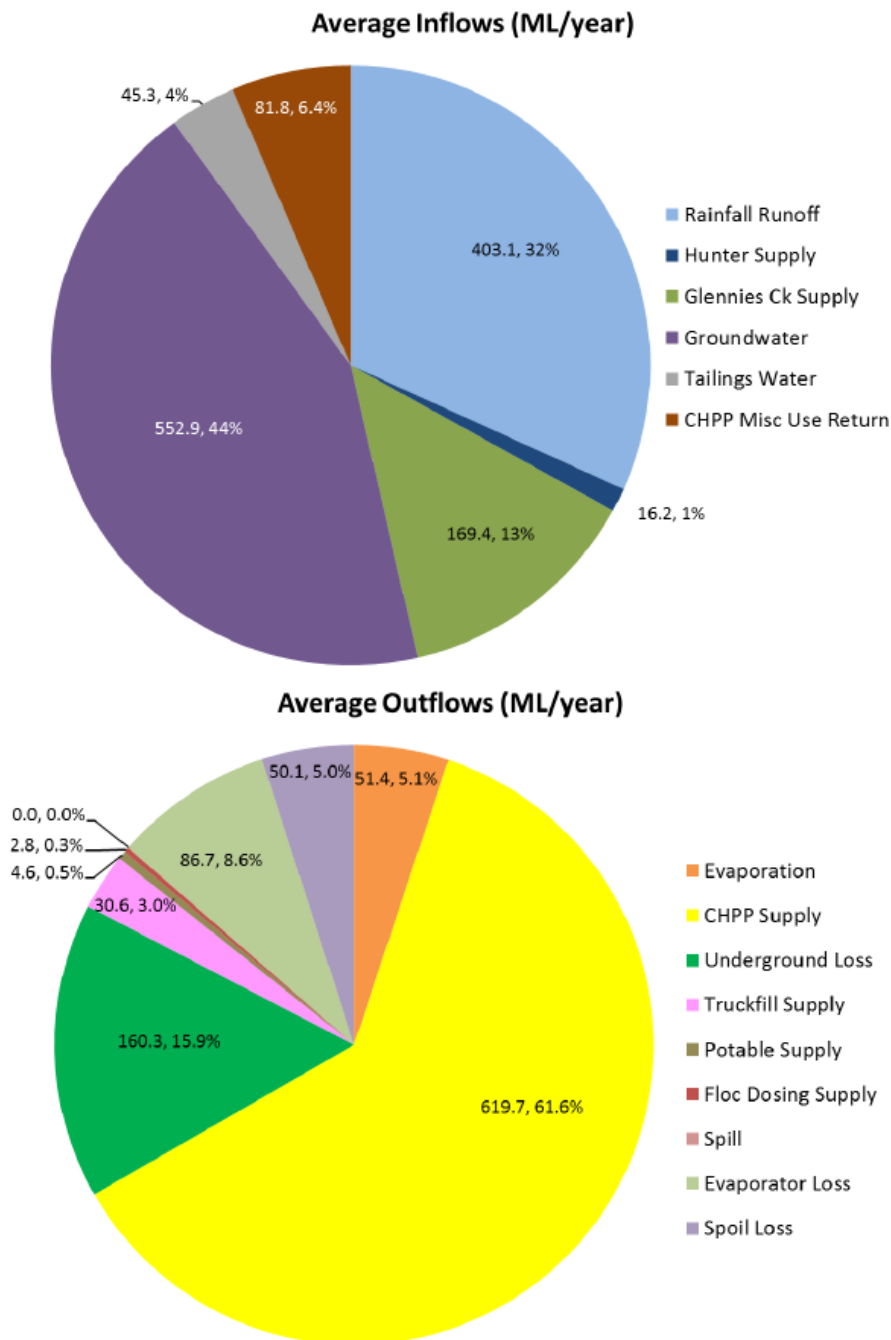


Figure 5 Modelled Average System Inflows and Outflows – Existing System

Figure 5 indicates that the majority of the forecast system inflow is from groundwater, with rainfall run-off comprising approximately one third of average inflows. The majority of system outflows are to CHPP supply.

Water supply reliability is a metric describing the adequacy of a water supply at sustaining the demand volume of an operation or activity over a period of time. Predicted average supply reliability is expressed as total water supplied over the simulation period divided by total demand (i.e. a volumetric reliability). This is calculated as an average over all forecast years and 121 realisations.

No CHPP short falls were forecast in any realizations. This result is influenced by the planned commissioning of tailings dewatering at the start of 2025, which will significantly reduce the demand for makeup water at the CHPP.

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For supply to the underground (which is sourced only from WALs due to water quality constraints), the average reliability over all realisations was 83.7%, while the lowest in an individual realisation was 43.2%. This indicates that underground supply reliability can, in drought conditions, fall significantly. This is because underground supply is reliant upon WALs, which are affected by the available volume in the regional regulating storages. This result is consistent with previous model forecasts.

The forecast total stored water volume in all storages is shown in **Figure 6** and is derived from all 121 climatic realizations. The 10th and 90th percentile plots in **Figure 6** indicate predicted total water volume ranges within which the predicted total volume could vary. The displayed forecast results in **Figure 6** indicate that total stored water volume is predicted to remain relatively stable in the short-term, with a slight increase predicted from approximately late 2022. From 2025, the total stored water volume is predicted to steadily rise, which is likely related to the reduced CHPP demand associated with the planned commissioning of tailings dewatering.

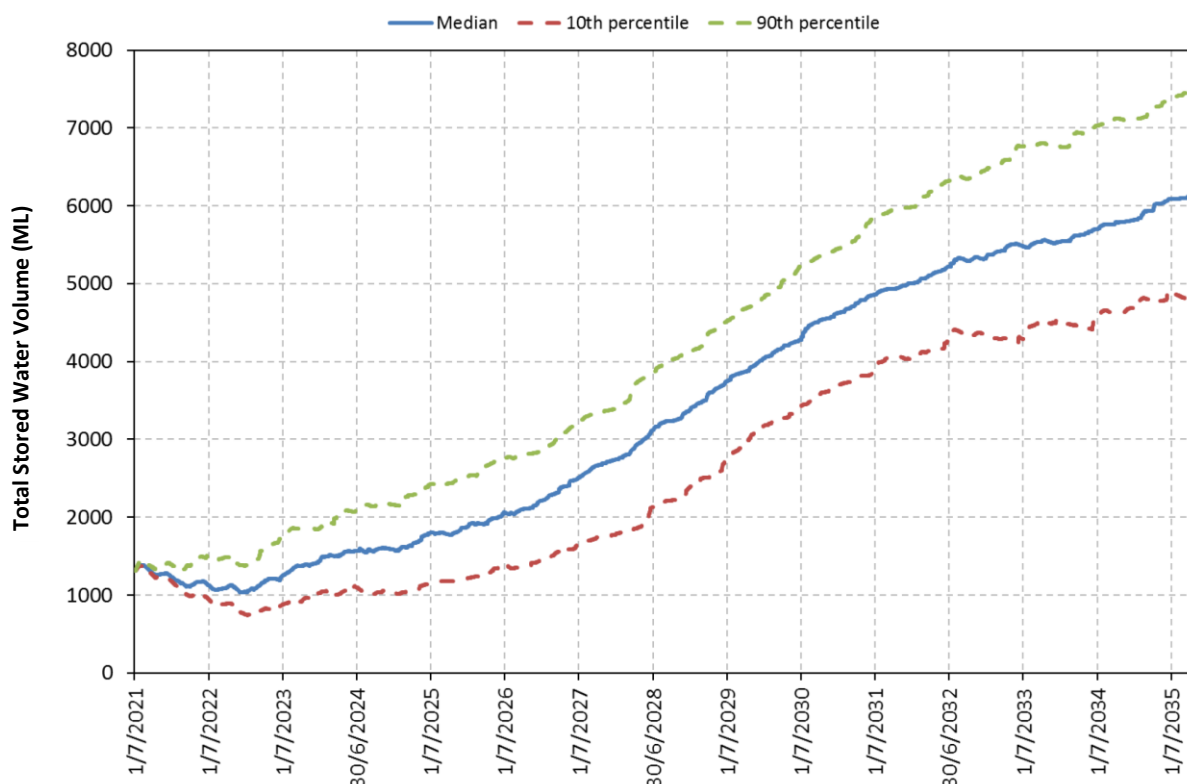


Figure 6 Simulated Total Stored Water Volume

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3.2. Reporting

An annual retrospective site water balance for the reporting period is documented in the Annual Review. Annual site water balance updates will continue to be undertaken.

3.3. Measures to Minimise Clean Water Use

Measures to minimise clean water use include:

- Recovery of tailings bleed water and use of this as a priority for CHPP and truckfill demand on site instead of WALs.
- Storage and use of runoff from disturbed areas in preference to using WALs.
- Use of water reclaimed from underground operations in preference to using WALs.
- Maintenance of water management infrastructure to ensure efficient operation and minimisation of wastage.

Although there is no current imperative to reduce water inventory, ACOL are investigating the feasibility of diverting the rehabilitated surface catchment of the NEOC overburden emplacement to adjacent non-mine catchments (once suitable water quality has been demonstrated), in order to minimise runoff captured in the water management system, should this be required in the future.

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4. BOWMANS CREEK DIVERSION MANAGEMENT PLAN

The two reaches of the BCD (Eastern and Western) have been constructed in the underground mining area as shown in **Figure 7**. Construction commenced on the Eastern diversion in March 2011 and on the Western diversion in February 2012. Both were commissioned with direction of flow through each diversion in November 2012. Temporary low level block banks have been constructed across the original channel of Bowmans Creek, directing low flows into the diversion reaches. High (flood) flows are designed to overtop the temporary block banks so that such flows do not pass through the diversion until full vegetation establishment. The construction program has been completed (engineering sign off obtained) including the permanent block banks. Remnant stockpiles of soil or alluvium may be used for re-spreading into future subsidence areas on the floodplain.

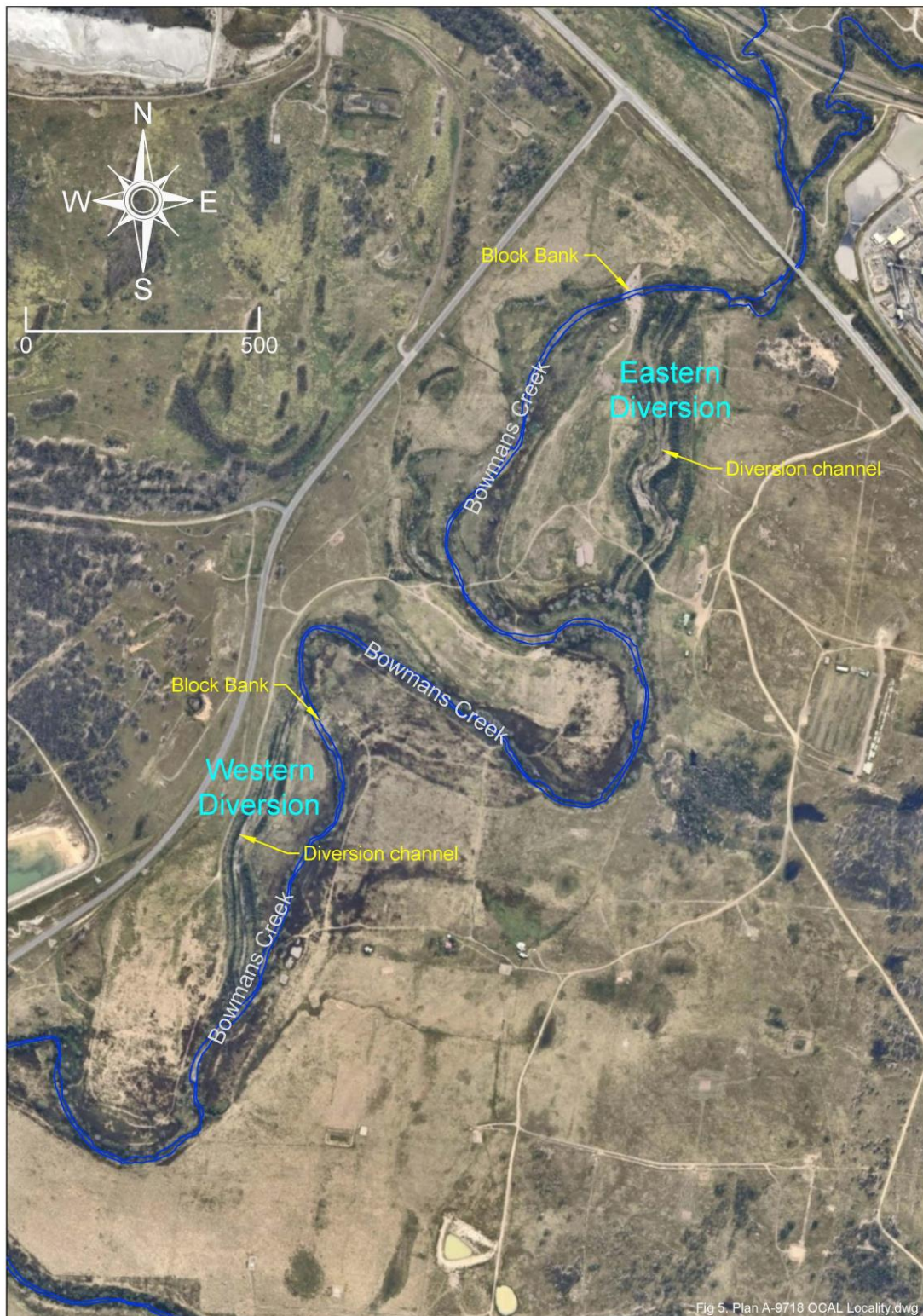
4.1. Vision Statement

The vision for the diversions is to establish an ecologically healthy riparian corridor between the New England Highway and the Hunter River, on land owned by ACOL. Fulfilment of this vision includes construction, landscaping and ongoing monitoring and management which, compared to the characteristics and conditions of the pre-diverted creek, will provide:

- flow channels that mimic the hydraulic and geomorphic characteristics and provide similar resilience;
- for fish passage and a diversity of aquatic habitat;
- an enlarged, ecologically diverse and naturally vegetated riparian corridor; and
- a free draining floodplain that is vegetated to a standard consistent with the final intended land use.

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Figure 7 Bowmans Creek Diversion Layout

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4.2. Design Specifications

The key design objectives of the BCD are summarised in **Table 5**.

Table 5 Key Design Specifications

Design Specification	Design Criterion/Strategy	Features
Conveyance		
Divert flows up to 5 year ARI	152 cubic metres per second (m ³ /s)	152 m ³ /s
Minimise seepage losses in 80 th – 100 th percentile low flow range	Seal under low flow channel (80 th percentile flow = 2 ML/d = 0.023m ³ /s)	Seal under channel to convey flow up to 10 m ³ /s (865 ML/d)
Channel Morphology and Stability		
Channel shear stress	Comparable to existing	Comparable to existing
Low flow channel cross section and longitudinal profile	Mimic existing	Channel sections copied. Longitudinal profile with similar variation.
Floods inundate low level floodplain	Inundation at least once per year	Low level floodplain inundated once per year
Channel Alignment and Geometry		
Maximise channel length with sinuosity within defined corridor	Existing E channel grade 0.17% Existing W channel grade 0.39%	E channel grade 0.24% W channel grade 0.40%
Batter slopes comparable to existing channel	1:3.5 – 1:11 (V:H)	Typical batter slopes 1:4 – 1:7
Maintain comparable lower active floodplain	Range 21 – 35 m width	Channel sections copied
Maintain comparable width of incised creek corridor	Range 50 – 100 m width	Channel sections copied
Sinuosity	Mimic existing channel sinuosity as far as possible	Comparable channel alignment
Flood Levels and Flood Storage		
100 year ARI flood level at Highway	No increase	No increase
Flow velocity at Highway	Peak 100 year ARI velocity 4.3 metres per second (m/s)	Peak 100 year ARI velocity 4.5 m/s
Floodplain storage	No significant loss of storage	Increased flood storage
Fish Passage and Aquatic Habitat		
Fish passage when creek flowing	Passage possible in moderate flows	Flow conditions similar
Provide appropriate pool and riffle sequence	Mimic existing channel	Pool and riffles mimic existing creek
Maximum bed slope of riffles	Approximately 5%	Approximately 5%
Maintain comparable pool area	0.9 ha	1.1 ha
Riparian and Low Active Floodplain Ecology		
Maintain area of lower active floodplain area inundated in 1 year ARI flood	6.7 ha	6.4 ha
Improve habitat value of lower active floodplain	Revegetate and exclude domestic stock	Establish plant communities characteristic of those present prior to European colonisation
Ecosystem resilience	Create robust, relatively self-sustaining ecosystem	

ARI = Average Recurrence Interval

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4.3. Baseline Conditions

An assessment of the surface water and groundwater quality, ecological, hydrological and geomorphic baseline conditions within Bowmans Creek was included in the Environmental Assessment (EA) prepared in support of the Ashton DA modification application (Evans & Peck, 2009). Updated surface water and groundwater quality baseline data as well as hydrological baseline conditions are detailed in **Sections 6.1** and **7.1**, respectively. Updated ecological and geomorphic baseline conditions, including baseline site pollution sensitivity indices, are detailed in the Biodiversity Management Plan (BMP) (formerly the Flora and Fauna Management Plan).

4.4. Rehabilitation

The Bowmans Creek Diversion Rehabilitation Strategy (BCDRS) (ACOL, 2010) provides a consolidated account of the overall design and rehabilitation strategy for the BCD. Progression of rehabilitation is ongoing and ahead of the schedule outlined in the BCDRS (ACOL, 2010). Phase 1 (Bank Stabilisation) is finalised with Phase 2 (Community Structure) in progress and Phase 3 (Species Diversity) commenced.

4.5. Performance and Completion Criteria

Performance and completion criteria for channel geomorphology and stability, stream health and rehabilitation are summarised in **Table 6** below (taken from and further detail provided in the BCDRS [ACOL, 2010]). Rehabilitation performance and completion criteria for the BCD rehabilitation will be included in the BMP.

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Table 6 Bowmans Creek Diversion Performance and Completion Criteria

Functional Aspect	Assessment Method	Performance Criteria	Corrective Action
Geomorphology and Channel Stability			
Absence of permanent channel scouring	Visual inspection after minor floods during first three years.	No visible scouring.	Repair any significant scour and revegetate as necessary.
Geometry of diversion channels	Establish 10 permanent survey sections in each diversion channel. Survey these cross and long section (along the channel thalweg) at the following times after completing construction of the diversion channels: <ul style="list-style-type: none"> • 6 months; • 1 year; • 2 years; • 5 years; • 10 years; • After floods with peak flow* > 150 m³/s. Compare channel sections against earlier surveys and any changes in reference sites to assess trajectory towards long-term stability (assessment by qualified fluvial geomorphologist).	Evident trend towards long-term stability (by qualified fluvial geomorphologist).	As recommended by qualified fluvial geomorphologist.
Channel geometry at existing reference sites	Re-survey cross sections in remaining active sections of channel every 5 years and after floods with peak flow* > 150 m ³ /s.	None (for comparison with diversion channel sections).	-
Bed load transport	At same time as above surveys, sample channel bed at four locations in each diversion channel (two pools and two riffles) and at eight comparable representative sites in the remaining active sections of the creek. Undertake particle size distribution analyses on samples.	Statistics of data from the diversion channels within 20% of that from the existing channel.	Review by qualified fluvial geomorphologist to assess trend and recommend corrective actions.
Stream Health			
Fish passage and aquatic ecology of diversion sections	Macro-invertebrate sampling of diversion reaches using AusRivAS protocols, fish sampling, habitat diversity assessment, water quality sampling and assigning site scores for Macroinvertebrate diversity, site SIGNAL index, site fish lists and site RCE aquatic habitat condition and comparing against baseline site mean \pm SD scores. Baseline sites comprise: <ul style="list-style-type: none"> • corresponding sites within the creek sections excised (pre-excision); and • reference sites in the existing creek. 	New site scores are consistently within or above the range (Baseline Excised Site Mean – SD) score and consistent with trend in reference sites.	Review by aquatic ecologist to assess trend, whether change is natural expected change or otherwise and recommend corrective actions.
Rehabilitation			
Community Structure (Phase 2** – vegetation elements that provide habitat niches)	Annual surveys to record growth rates, species abundance as well as percentage cover to determine a final structural complexity index.	Quantitative data compared with data sets from reference sites to assess success of this phase.	Feedback to planting program and modification thereof

* Flow measured at the WaterNSW gauging station on Bowmans Creek – GS 210130.

** Current rehabilitation phase

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Water quality and hydrological completion criteria are defined based on the impact assessment criteria detailed in **Section 6.2**. For the criteria to be achieved, the impact assessment criteria for the Bowmans Creek monitoring locations must not be triggered over a 12-month period due to causes attributable to the BCD.

4.6. Monitoring Program

Surface water quality and groundwater quality monitoring for the BCD are carried out in accordance with the Surface Water Monitoring Program (refer **Section 6.3**) and Groundwater Monitoring Program respectively (refer **Section 7.3**). In addition, ACOL will undertake monthly review of streamflow data in Bowmans Creek at the streamflow gauging station on Bowmans Creek (refer **Section 6.1.1** and **Section 6.2** for relevant surface water impact assessment criteria).

Subsidence monitoring of Bowmans Creek (including BCD and creek section excised by BCD) is completed by ACOL surveyors in accordance with the program outlined in the current approved Extraction Plan(s). At the time of writing, the Extraction Plan for LW205-208 was in effect.

Ecological monitoring is carried out in accordance with procedures outlined in the BMP.

Monitoring of the geomorphic stability of the BCD is detailed in the BCDRS (ACOL, 2010) and summarised in **Table 6** above.

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5. EROSION AND SEDIMENT CONTROL PLAN

The objective of this Erosion and Sediment Control Plan (ESCP) is to set out strategies to control soil erosion and sediment generation close to the source and thereby minimise the potential for mine activities to adversely affect downstream water quality. Minimal surface disturbance occurs at the ACP and ACOL-operated RUM, with most of the site rehabilitated. The main areas of disturbance are:

- the remnant NEOC void which is used for coarse reject emplacement and will ultimately be self-draining and integrated into the final landform;
- the Ravensworth Void 4 area which is also self-draining, used for fine reject emplacement and will ultimately be integrated into the final landform;
- Ravensworth Operations' Narama pit and overburden emplacement area (overlying the ACOL-operated RUM area); and
- AGL Macquarie's overburden emplacement area (overlying the ACOL-operated RUM area).

Activities that could cause soil erosion and generate sediment have been identified as:

- mine-induced subsidence and cracking (and crack repair works);
- NEOC overburden emplacement, much of which is completed and rehabilitated;
- contained reject emplacement in the NEOC void;
- stockpiling in the CHPP area;
- gas drainage, exploration, de-watering and service bores (drill pad, bore construction);
- surface disturbance at the gas drainage plant area;
- failure of the BCD; and
- rehabilitation of the BCD.

The following principles, which have been taken from the Landcom guidelines (2004), underpin the approach to erosion and sediment control for the mine site:

- minimising surface disturbance and restricting access to undisturbed areas;
- progressive rehabilitation/stabilisation of mine infrastructure areas;
- separation of runoff from disturbed and undisturbed areas where practicable;
- construction of surface drains to control and manage surface runoff; and
- construction of sediment dams or use of existing/modified water storages to contain runoff up to a specified design criterion.

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Figure 8 NEOC and CHPP Area Drainage and Water Storages

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These principles have been implemented to minimise soil erosion and the potential for transport of sediment off site. Specific measures used at the ACP and ACOL-operated RUM include:

- inclusion of disturbance management and rehabilitation conditions on Ground Disturbance Permits;
- contour drains and rock-armoured drop structures on the NEOC overburden emplacement (refer to **Figure 8**);
- collection drains at the toe of the NEOC overburden emplacement and around the perimeter of the NEOC and administration areas (refer to **Figure 8**);
- direction of runoff from disturbed areas to mine water storages (refer **Section 2.1**);
- a levee bank constructed between the Settling Dam/PWD and Bettys Creek;
- repair of subsidence induced surface cracking or instability implemented in a timely fashion following occurrence by regrading, ripping or infilling followed by revegetation, using equipment suitably sized for the task;
- coal stockpiling on prepared/stabilised pads;
- drill sumps and surface tanks are contained on site and not allowed to spill;
- drill pads will have a silt fence established around the downslope perimeter, with the pads themselves sheeted with road base material (low fines fill);
- sealing high-traffic roads;
- maintenance of unsealed roads to avoid erosion, with table drain outlets directed to well grassed areas;
- use of downslope/downstream silt fences hay bale filters or natural grass filters (Landcom, 2004) associated with loose material stockpiles and new surface excavation or disturbance;
- upslope diversions and downslope sediment dam used to divert and collect runoff around the gas drainage plant (refer **Figure 8**); and
- shaping and revegetation of stockpiles at the BCD.

No additional broadscale surface disturbance (other than mining induced subsidence) is planned in the near future at the ACP and ACOL-operated RUM. Erosion and sediment control is therefore focussed on maintenance of existing controls, managing surface water drainage and controlling minor disturbance associated with surface infrastructure projects.

The design criteria for sediment control structures are summarised in **Table 7**.

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Table 7 Design Criteria for Sediment Control Structures

Sediment Control Structure	Function	Design Capacity
Upslope diversion drains	Reduce runoff from undisturbed areas onto disturbed areas	Peak flow calculated for 1 in 20 year* critical duration rainfall event (Table 6.1, Department of Environment and Climate Change [DECC], 2008)
Downslope collection drains	Intercept and convey disturbed area runoff water to sediment dams/sumps	Peak flow calculated for 1 in 20 year* critical duration rainfall event (Table 6.1 DECC, 2008)
Sediment dams	Containment of sediment-laden runoff from disturbed areas with more than 150 m ³ /yr estimated soil loss (Section 6.3.2(d), Landcom 2004)	Settling Zone: Capacity to store the runoff produced from the 90 th percentile*, 5-day rainfall event (Table 6.1, DECC 2008)
		Sediment Storage Zone: <u>Either:</u> Two months calculated soil loss estimated using RUSLE** (Landcom (2004), Section 6.3.4 (i)) <u>Or:</u> Half the Settling Zone Capacity [†]
Sediment fences and/or straw bale filters	Retention/filtration of suspended sediments	Peak flow limited to less than 50 litres per second in the design 1 in 10 year critical duration rainfall event (Section 6.3.7(e) ^{††} , Landcom 2004)

* Assuming a duration of disturbance greater than 3 years with a standard, not sensitive, receiving environment.

** Revised Universal Soil Loss Equation (RUSLE)

[†] Only on land of low erosion hazard (Section 4.4.1, Landcom, 2004).

^{††} Assuming a duration of disturbance between 1 and 3 years with a standard sensitivity receiving environment.

The 90th percentile 5-day rainfall event, used in determining the sediment dam settling zone capacity, was calculated to be 39.4 mm from the average of values for Scone and Cessnock³ as given in Table 6.3a in Landcom (2004).

Based on the methodology and parameters contained in Landcom (2004) and DECC (2008), the settling zone capacity and sediment storage zone capacity and hence required dam capacity are calculated using Equations 1, 2 and 3 below respectively:

$$\text{Settling Zone Capacity (m}^3\text{)} = V_{\text{settling}} = 251.8 \times A \quad (1)$$

$$\text{Sediment Zone Capacity (m}^3\text{)} = V_{\text{sediment}} = 0.5 \times V_{\text{settling}} \quad (2)$$

$$\text{Required Dam Capacity (m}^3\text{)} = V_{\text{total}} = V_{\text{settling}} + V_{\text{sediment}} \quad (3)$$

Where;

V_{settling} = settling volume

V_{sediment} = sediment volume

V_{total} = total volume

A = catchment area of the sediment dam (ha)

³ Table 6.3a of Landcom (2004) gives 90th percentile 5-day rainfall depths for Cessnock and Scone of 42.8 mm and 35.9 mm respectively

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Mine water storages (refer **Table 3**) at the ACP serve both as water management structures and sediment dams. The locations of these storages are shown in **Figure 8**.

Table 8 summarises the minimum sediment dam capacity requirements in comparison to existing surveyed capacities.

Table 8 Comparison of Sediment Dam Requirements to Existing Dam Capacities

Storage	Capacity (ML)	Required Settling Zone Volume (ML)	Required Sediment Zone Volume (ML)	Minimum Required Total Volume (ML)
NEOC	10,600*	40	20	60
Process Water Dam	60	3.5	1.8	5.3
Settling Dam	34	6.3	3.1	9.4
Dam 56	61	8.8	4.4	13.2
Arties Pit Sump	31	2.5	1.3	3.8

* Prior to rejects placement, gradually reducing with time.

Monthly inspections of sediment control structures, as well as inspections following significant rainfall events (more than 25 mm in 24 hours), are conducted by ACOL personnel. During these inspections, sediment control structures are inspected for capacity, structural integrity and effectiveness.

Where inspections indicate substantial accumulation of sediment in a storage, clean-out is undertaken so as to reinstate the minimum required volumes given in **Table 8**. Silt fences and straw bale filters are inspected and trapped sediment removed or straw bales replaced as necessary. Removed sediment is placed in areas upslope of existing sediment control structures, mine water storages or tailings storages.

Monthly inspections of the NEOC overburden emplacement are undertaken to identify areas of erosion of water management infrastructure (i.e. dams, drains, contour banks) degradation / failure that will require remediation.

Block banks, stabilised areas and vehicle creek crossings at the BCD are routinely inspected and monitored to ensure that the risk of erosion has been effectively reduced. Any repairs or remedial measures are implemented as required.

5.1. Flooding

Schedule 3, Condition 26(d) of the Ashton DA and Condition 23(b) of Schedule 3 of the RUM DA require the ESCP to consider potential flooding which could affect infrastructure or properties external to the mine, or the environment. Flood assessments were completed as part of the ACP Environmental Impact Statement (EIS) (2001) and BCD (MOD 6) EA. Activities that could affect flooding have been identified as:

- Mine-induced subsidence;
- Stockpiling in the CHPP area;
- Failure of the BCD;
- Failure of the drainage infrastructure on the NEOC; and
- Any construction works in flow paths.

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The following principles underpin the approach to management of flood risk for the mine site:

- Construction, monitoring and maintenance of a licenced flood works levee (20FW213279) to separate natural flows in Bettys Creek and the mine water management footprint;
- Stockpiling and construction works are not carried out in flow paths or potential flood-prone areas unless detailed assessment has been completed; and
- The BCD and NEOC drainage infrastructure have been constructed to be stable up to the required flood design criteria and regular monitoring and maintenance is carried out.

5.2. Creek Crossings

Schedule 3, Condition 25 of the Ashton DA requires creek crossings at the ACP and ACOL-operated RUM to be designed, installed and maintained in accordance with the following two documents:

- *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management* (2013 update) (NSW Department of Primary Industries 2013); and
- *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull & Witheridge, 2003).

Seven existing creek crossings have been identified at the ACP and ACOL-operated RUM as shown on **Figure 9** and summarised in **Table 9**. As no new crossings are proposed, recommendations regarding design and installation are not applicable to the ACP and ACOL-operated RUM, and only maintenance recommendations in the guideline documents above have been considered.

Table 9 Summary of Creek Crossings

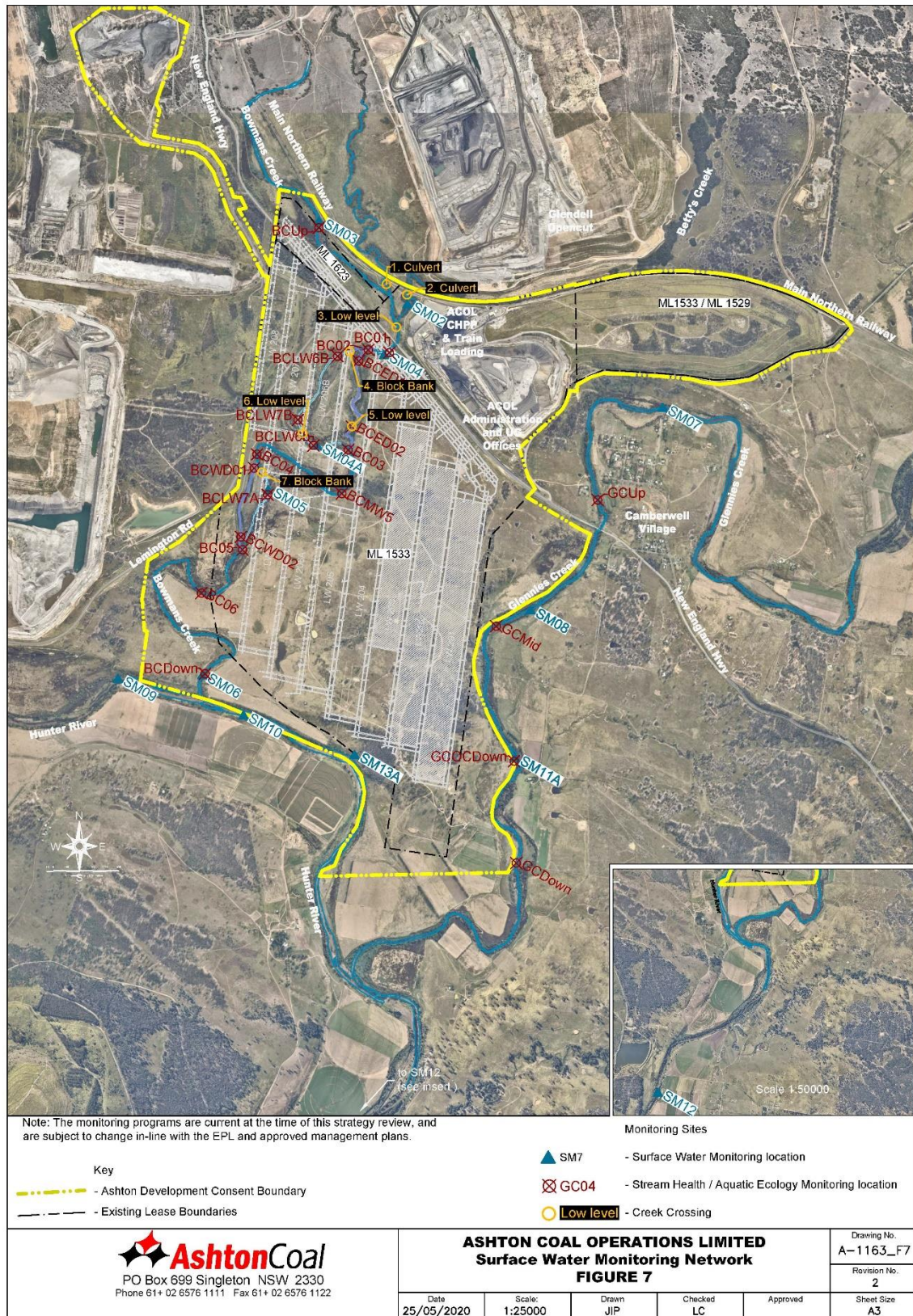
Number	Creek	Location	Description
1	Bettys Creek	Downstream of railway, upstream of confluence with Glennies Creek	Pipe culvert under road, no flow observed in the creek
2	Swamp Creek	Downstream of railway, upstream of confluence with Glennies Creek	Pipe culvert under road, no flow observed in the creek
3	Bowmans Creek	Downstream of confluence with Bettys Creek, upstream of New England Highway crossing	Concrete causeway
4	Bowmans Creek	Block bank for Eastern Diversion of BCD	Complete blockage of low flows, redirected to BCD
5	Bowmans Creek	Eastern Diversion of BCD	No structure, drowned gravel track crossing
6 [^]	Bowmans Creek	Excised section (Eastern) of Bowmans Creek	No structure, drowned gravel track crossing
7	Bowmans Creek	Block bank for Western Diversion of BCD	Complete blockage of low flows, redirected to BCD

[^] To be closed permanently

All seven of these crossings are inspected during the erosion and sediment control inspection following heavy rainfall events (>25 mm in 24 hours) to assess their hydraulic capacity and utility for fish passage, as well as to assess the need to remove debris and sediment deposits or repair bed and bank erosion as needed. As recommended in the above documents, wherever possible, in-stream maintenance activities will be programmed for those times of the year that minimise overall environmental harm (e.g. low or no flow periods) with appropriate consideration to anticipated critical periods of fish passage and seasonal high flows (Fairfull & Witheridge, 2003).

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Figure 9 ACP Surface Water Monitoring Network

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6. SURFACE WATER MANAGEMENT PLAN

The objective of the Surface Water Management Plan (SWMP) is to provide baseline data for creeks potentially affected by the ACP and ACOL-operated RUM, nominate surface water impact assessment criteria for investigating any potentially adverse impacts and provide details of the monitoring program used to monitor the effects of the ACP and ACOL-operated RUM on existing surface water bodies, in order to assist in the detection of any significant off-site impacts that occur as a result of ACP or ACOL-operated RUM operations and to trigger response plans to any adverse impacts.

6.1. Baseline Data

Glennies Creek has been modified by the construction of the Glennies Creek Dam in its upper reaches. Bettys Creek has been modified with its upper reaches diverted around the Mt Owen Complex operations. Bowmans Creek has been modified in its lower reaches by the construction of the BCD and overlies the underground mining operations of the ACP. Flows in the Hunter River are affected by releases from Glenbawn Dam and by controlled releases from mining operations in accordance with the Hunter River Salinity Trading Scheme.

Historical data relating to water quality and flows in the above watercourses are summarised in the sections to follow. This data is used as a baseline for on-going monitoring of the impacts of mining activities on surface water in these watercourses. For the purposes of developing impact assessment criteria, the water quality baseline data end date has been assumed as December 2011.

6.1.1 Streamflow

Streamflow monitoring is focussed on Bowmans Creek which has the greatest potential to be impacted by the ACP and ACOL-operated RUM. Additional gauging stations exist on the Hunter River in the vicinity of the ACP and ACOL-operated RUM, however given the large catchment area of the Hunter River (13,590 square kilometres [km²] at Bowmans Creek), the effect of releases from Glenbawn Dam and licensed extraction from and releases to the river by others, any effects on streamflow by the ACP and ACOL-operated RUM are likely to be indiscernible. Similarly, direct monitoring of flow in Glennies Creek is obviated by the effects of regulated flow releases from Glennies Creek Dam and licensed extraction by others.

Streamflow gauging station GS 210130 on Bowmans Creek is maintained by WaterNSW. This station is located between the Eastern and Western reaches of the BCD. Therefore, the data from this station forms a valuable baseline in any future assessment of the impact of the ACP and ACOL-operated RUM on streamflow. Available streamflow data is summarised in **Table 10**. Data indicates that (except during drought periods) Bowmans Creek at GS 210130 has been persistent, with zero flow recorded on 8.4% of days (and 99% of those no-flow days being recorded since March 2018).

Table 10 Summary of Recorded Baseline Bowmans Creek Streamflow Monitoring Data

Catchment Area:	240 km ²
Period of Record:	28/10/1993 to present
No. Missing Days:	791
No. Zero Flow Days:	805 (784 post-March-2018)
Max. Daily Flow (ML/d):	23,045 (June 2007 flood)
Mean Annual Flow (ML/year):	14,181

* Data source: WaterNSW (<https://realtime.data.watarnsw.com.au/>)

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6.1.2 Water Quality

Water quality monitoring has been carried out since 2003 at the sites shown in **Figure 9**. Routine monitoring occurs for pH, electrical conductivity (EC), total dissolved solids (TDS) and total suspended solids (TSS). Baseline water quality data are summarised in **Table 11** to **Table 14** for the four watercourses (Bowmans Creek, Bettys Creek, Glennies Creek and the Hunter River).

In addition, quarterly sampling of the site STPs commenced in 2019, with testing for pH and faecal coliforms in accordance with Condition M2.3 of EPL 11879.

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Table 11 Summary of Baseline Surface Water Quality Monitoring Data – Bowmans Creek

Site Name		SM3	SM4	SM4a	SM5	SM6
Description		Upstream Bettys Creek	Upstream Eastern Diversion	Former Channel (Eastern Diversion)	Former Channel (Western Diversion)	Upstream Hunter River
Baseline Period		12/9/03 – 16/12/11	12/9/03 – 16/12/11	5/12/06 – 16/12/11	22/9/03 - 16/12/11	22/9/03 - 10/11/11
pH	No.	406	422	249	100	99
	Min	6.79	6.66	6.79	6.90	6.84
	Max.	8.94	9.16	8.54	8.28	8.46
	Mean	7.66	7.91	7.83	7.80	8.01
	Median	7.66	7.90	7.84	7.79	8.05
	5 th %ile	7.20	7.40	7.40	7.50	7.60
	20 th %ile	7.42	7.71	7.67	7.66	7.84
	80 th %ile	7.88	8.09	8.01	7.97	8.23
	95 th %ile	8.10	8.40	8.30	8.10	8.40
EC (µS/cm)	No.	406	422	249	100	99
	Min	283	82	289	381	367
	Max.	3720	14700	4620	2040	2000
	Mean	1147	2797	1030	1223	970
	Median	1115	1795	981	1190	958
	5 th %ile	598	589	543	610	605
	20 th %ile	879	909	824	927	764
	80 th %ile	1440	3656	1140	1542	1108
	95 th %ile	1620	10790	1796	1831	1424
TSS (mg/L)	No.	406	421	247	100	99
	Min	1	1	1	1	2
	Max.	996	592	140	98	163
	Mean	21	32	15	14	21
	Median	10	19	10	10	14
	5 th %ile	5	8	5	6	8
	20 th %ile	5	8	5	6	8
	80 th %ile	20	37	19	20	26
	95 th %ile	62	104	44	31	60
TDS (mg/L)	No.	406	422	248	100	99
	Min	194	212	227	294	294
	Max.	2150	9070	2530	1160	1080
	Mean	678	1673	597	707	540
	Median	653	1030	562	681	514
	5 th %ile	361	364	339	360	334
	20 th %ile	500	514	474	513	397
	80 th %ile	878	2270	653	891	642
	95 th %ile	965	6331	1067	1031	810

µS/cm = microsiemens per centimetre, mg/L = milligrams per litre

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Table 12 Summary of Baseline Surface Water Quality Monitoring Data – Bettys Creek

Site Name		SM1	SM2
Description		Upstream ACP	Upstream Bowmans Creek
Baseline Period		24/11/03 – 8/12/11	24/11/03 – 8/12/11
pH	No.	40	47
	Min	6.42	6.15
	Max.	8.12	8.14
	Mean	7.34	7.23
	Median	7.28	7.16
	5 th %ile	6.60	6.60
	20 th %ile	6.97	6.87
	80 th %ile	7.70	7.63
	95 th %ile	8.00	7.90
EC (µS/cm)	No.	40	47
	Min	113	119
	Max.	2490	2100
	Mean	656	651
	Median	338	405
	5 th %ile	148	142
	20 th %ile	202	222
	80 th %ile	1198	1144
	95 th %ile	1811	1803
TSS (mg/L)	No.	40	47
	Min	7	5
	Max.	504	330
	Mean	83	71
	Median	41	46
	5 th %ile	7	6
	20 th %ile	14	16
	80 th %ile	122	116
	95 th %ile	273	213
TDS (mg/L)	No.	40	47
	Min	198	184
	Max.	1670	1180
	Mean	591	541
	Median	548	500
	5 th %ile	246	222
	20 th %ile	326	302
	80 th %ile	794	732
	95 th %ile	1193	1105

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Table 13 Summary of Baseline Surface Water Quality Monitoring Data – Glennies Creek

Site Name		SM7	SM8	SM11A
Description		Upstream ACP	Adjacent LW Panels	Upstream Hunter R.
Baseline Period		22/9/03 – 16/12/11	22/9/03 – 16/12/11	22/9/03 – 16/12/11
pH	No.	100	100	100
	Min	7.15	7.18	7.10
	Max.	8.40	8.28	8.45
	Mean	7.83	7.78	7.88
	Median	7.82	7.77	7.88
	20 th %ile	7.66	7.62	7.74
	80 th %ile	8.03	7.96	8.02
EC (µS/cm)	No.	100	100	100
	Min	207	219	208
	Max.	903	887	888
	Mean	415	413	417
	Median	352	347	353
	20 th %ile	270	265	269
	80 th %ile	577	562	564
TSS (mg/L)	No.	100	100	100
	Min	2	1	2
	Max.	226	120	86
	Mean	17	18	16
	Median	12	14	13
	20 th %ile	6	8	8
	80 th %ile	19	22	20
TDS (mg/L)	No.	100	100	100
	Min	131	125	126
	Max.	460	474	466
	Mean	243	241	242
	Median	206	201	204
	20 th %ile	163	160	160
	80 th %ile	342	334	332

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Table 14 Summary of Baseline Surface Water Quality Monitoring Data – Hunter River

Site Name		SM9	SM10	SM13A	SM12
Description		Upstream Bowmans Creek	Downstream Bowmans Creek	Down-stream LW Panels	Downstream Glennies Creek
Baseline Period		22/9/03 – 10/11/11	22/9/03 – 6/12/11	22/9/03 – 6/12/11	22/9/03 – 10/11/11
pH	No.	99	100	100	97
	Min	7.54	7.66	7.69	7.62
	Max.	8.52	8.52	8.68	8.39
	Mean	8.16	8.18	8.17	8.03
	Median	8.20	8.21	8.20	8.06
	20 th %ile	8.00	8.00	8.02	7.84
	80 th %ile	8.32	8.32	8.32	8.24
EC (µS/cm)	No.	99	100	100	97
	Min	304	319	293	239
	Max.	1270	1290	1260	982
	Mean	775	772	760	565
	Median	744	742	713	552
	20 th %ile	619	629	605	375
	80 th %ile	942	942	927	728
TSS (mg/L)	No.	99	100	100	97
	Min	1	2	1	2
	Max.	204	160	226	184
	Mean	27	30	33	26
	Median	22	25	24	16
	20 th %ile	10	12	12	10
	80 th %ile	34	42	41	36
TDS (mg/L)	No.	99	100	100	97
	Min	236	255	142	150
	Max.	722	672	750	640
	Mean	426	426	420	320
	Median	400	406	390	314
	20 th %ile	330	332	329	214
	80 th %ile	541	526	516	415

6.2. Surface Water Impact Assessment Criteria

Impact assessment criteria can be described as trigger levels, which, if triggered, would lead to a response in terms of more intensive monitoring, investigation and ultimately, if required, remedial action. The Surface and Groundwater Response Plan (SGRP – **Section 8**) contains details of responses. Surface water impact assessment criteria are related to water quality in local watercourses. **Table 15** shows a summary of the impact assessment criteria.

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Table 15 Surface Water Quality Impact Assessment Criteria

Parameter	Trigger
pH	<i>Either</i> If recorded value at a monitoring site is greater than the x th percentile of baseline data* for 3 consecutive readings or, for pH, less than the y th percentile of baseline data for 3 consecutive readings, where: x = 80 during periods of flow x = 95 during periods of no, trickle or low flow [†] y = 20 during periods of flow y = 5 during periods of no, trickle or low flow [†] <i>Or</i> If a recorded value at a monitoring site differs extremely from the preceding 3 readings at that location and there are no unusual events that could have caused the difference
EC	
TSS	
TDS	

* Refer **Table 11** to **Table 14**

[†] Only occurs Bowmans and Bettys Creeks. Refer **Table 16**

The above triggers will be revised in future revisions of the WMP, if analysis of additional data (including other monitoring sites) demonstrates that improvement(s) to triggers and their associated assessment methods would result from such a revision.

Table 16 shows predicted average yearly reductions in baseflow obtained from the most recent revision of the groundwater model (AGE, 2021).

Table 16 Predicted Average Annual Creek Baseflow Reduction

Year	Baseflow Reduction in:					
	Glennies Creek		Bowmans Creek		Hunter River	
	Avg. m ³ /d	ML	Avg. m ³ /d	ML	Avg. m ³ /d	ML
2023-2024	62.2	22.7	43.6	15.9	3.3	1.2
2024-2025	62.5	22.8	44.7	16.3	3.6	1.3
2025-2026	62.7	22.9	47.7	17.4	3.8	1.4
2026-2027	62.7	22.9	50.1	18.3	3.8	1.4
2027-2028	63	23	51.5	18.8	4.1	1.5
2028-2029	63	23	52.6	19.2	4.1	1.5
2029-2030	63.8	23.3	53.4	19.5	4.4	1.6
2030-2031	65.5	23.9	54.2	19.8	4.4	1.6
2031-2032	66.6	24.3	54.8	20	4.7	1.7
2032-2033	67.7	24.5	55.3	20.2	4.9	1.7
2033-2034	67.9	24.7	55.9	20.4	4.9	1.8
2034-2035	67.9	24.8	57.5	21	4.9	1.8
2035-2036	67.9	24.8	59.2	21.6	4.9	1.8

m³/d = metres cubed per day

Baseflow impacts cannot be measured directly from seepages underground. Instead, a sudden drawdown in the alluvium that is greater than the predicted drawdown may indicate a baseflow impact that is greater than predicted. The impact assessment criteria for monitoring baseflow impacts as a result of groundwater drawdown is provided in **Section 7.2**.

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The predicted average annual baseflow reductions given in **Table 16** are used by ACOL each year to 'reserve' a volume of water from their WALs (**Table 4**) – i.e. the effective annual WAL volume is reduced by the predicted baseflow reduction.

6.3. Monitoring Program

The SWMP for the ACP and ACOL-operated RUM involves the monitoring of all data relevant to surface water impact assessment criteria (refer **Table 15**). A summary of the monitoring locations and parameters monitored is provided in **Table 17** and **Figure 9**.

Table 17 Summary of Surface Water Monitoring Program

Watercourse / Location	Site	Parameters	Frequency
Bowmans Creek	SM3, SM4, SM4A, SM5, SM6	pH, EC, TSS, TDS, flow (qualitative) [†] .	Monthly
		Tot. Hardness, Oil & Grease, turbidity, Ca, Mg, Na, K, Cl, sulphate (SO ₄), bicarbonate (HCO ₃), carbonate (CO ₃), Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Se, Zn, ammonia (NH ₃), nitrate (NO ₃), F.	Annual
	BCUp, BC1, BC2, BCED1, BCLW6b, BCLW6B, BCLW7B, BCED2, BC3, BCMW5, BC4, BCWD1, BCLW7A, BCWD2, BC5, BC6, BCDown*	Aquatic ecology sampling and stream health assessment: field observations of aquatic habitat, macroinvertebrate sampling, macrophyte sampling, fish trapping, selective 'edge' and riffle habitat sampling, field water quality, taxonomic identifications and diversity assessment, SIGNAL index calculations, site condition index (RCE).	Annual
	BCED1, BCED2, BCWD1, BCWD2	Photo point assessment and comparison or erosion and deposition features	Annual
Bettys Creek	SM1, SM2	pH, EC, TSS, TDS, flow (qualitative) [†] .	Monthly
		Tot. Hardness, Oil & Grease, turbidity, Ca, Mg, Na, K, Cl, SO ₄ , HCO ₃ , CO ₃ , Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Se, Zn, NH ₃ , NO ₃ , F.	Annual
Glennies Creek	SM7, SM8, SM11A	pH, EC, TSS, TDS, flow (qualitative) [†] .	Monthly
Hunter River	SM9, SM10, SM12, SM13A	pH, EC, TSS, TDS, flow (qualitative) [†] .	Monthly
		Tot. Hardness, Oil & Grease, turbidity, Ca, Mg, Na, K, Cl, SO ₄ , HCO ₃ , CO ₃ , Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Se, Zn, NH ₃ , NO ₃ , F.	Annual
Narama Dam	ND1	pH, EC, TSS, TDS, flow (qualitative) [†] .	Monthly
Sewage Treatment Plants	Admin / Underground (EPL Site 17) CHPP (EPL Site 18) Open cut / Workshop (EPL Site 19)	pH, Faecal Coliforms	Quarterly

[†] Data logged every 10 minutes.

[†] Qualitative flow assessment at the time and location of sampling involves the designation of either zero flow (i.e. a stagnant pool), trickle, low, moderate or high flow.

* A number of these sites were brought into the monitoring program sequentially as the staged diversion works proceeded and other sites are to be brought in sequentially as mining proceeds. These latter sites will be introduced into the aquatic ecology monitoring program on a staged basis, that is, relative to the progression of the respective longwall mining. Sampling of each of these short-term longwall sites will be scheduled into the regular sampling program to incorporate a before, and at least two after samples from each site, according to the scheduled mining program. Not all sites are to be sampled for the full stream health monitoring program but will be sampled for fish passage and/or field water quality as appropriate.

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In accordance with Schedule 3 Condition 26(e) of the Ashton DA 3 and Schedule 3 Condition 23(c) of the RUM DA, the impacts of the operation on private water users will be monitored, assessed and responded to in accordance with the SGRP (**Section 8**). There are 10 private water users on Bowmans Creek with 13 extraction licenses (Industry & Investment NSW, 2012), with 4 users located downstream of the confluence with Bettys Creek. The surface water monitoring network shown in **Figure 9** will be used to monitor and assess any impacts on these users.

The results of surface water quality monitoring are reported in the Annual Review. This includes an assessment of results in terms of off-site impacts as a result of mining.

ACOL undertake routine monitoring of water usage, water imported to and extracted from the mine and volumes of water stored on site, as part of a program of monitoring to verify the mine site water balance. The data is used to:

- monitor trends in water use and efficiency;
- assess mine water inflows;
- check stored water inventory;
- validate or re-calibrate the mine water balance; and
- assist in future mine water supply and management planning.

Flow meters are shown on **Figure 4** and are typically recorded on a monthly basis. Flow metering at the ACP and ACOL-operated RUM is conducted to ensure accurate accounting and water balance data. Flow meters are installed on all water extraction devices that are used to take water from water sources. Records are kept onsite of flow meter readings to account for water take.

Water levels in all mine water storages (**Table 3**) are also typically recorded on a monthly basis. Site water balance reviews are undertaken on at least an annual basis as part of the Annual Review.

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7. GROUNDWATER MANAGEMENT PLAN

The objective of the Groundwater Management Plan (GMP) is to provide baseline data for the area that could possibly be affected by the ACP and ACOL-operated RUM, nominate groundwater impact assessment criteria for investigating any potentially adverse impacts and provide details of the monitoring program used to monitor the effects of the ACP and ACOL-operated RUM on surrounding groundwater aquifers. This will assist in the detection of any significant off-site impacts that occur as a result of ACP and ACOL-operated RUM operations and to trigger response plans to any adverse impacts.

Two distinct main aquifer systems occur within the ACP and ACOL-operated RUM area:

- a semi-confined, porous fractured rock aquifer system in the consolidated Permian age sedimentary strata (Permian coal measures); and
- a shallow, unconfined, granular aquifer system in the unconsolidated sediments of the alluvium associated with Bowmans Creek, Glennies Creek and Hunter River.

The alluvium is hydraulically connected with a layer of weathered rock / regolith and colluvium (colluvium is defined as sediment/detritus accumulated in drainage lines at the surface). Whilst these units are not constantly saturated, they can contribute to the recharge of the alluvium and fractured rock aquifer.

The main aquifers are the alluvial deposits, which extend along the low-lying areas of the watercourses. Except during periods of high flow in the watercourses, water discharges from the alluvium into the watercourses, providing baseflow. Mining activities that reduce the water table have the potential to reduce the contribution of baseflow from the alluvial aquifers and to affect licensed bores in the alluvium.

7.1. Baseline Data

7.1.1 Groundwater Levels

The baseline groundwater level range for selected monitoring bores in the BCA, Glennies Creek Alluvium (GCA) and Hunter River Alluvium (HRA) are summarised in **Table 18** and the bore locations are shown in **Figure 10**. The baseline data spans the period from November 2000 to August 2011. It is important to note that baseline levels fluctuate according to seasonal and longer-term cyclical climatic variations.

Baseline monitoring location co-ordinates are included in **Appendix B**.

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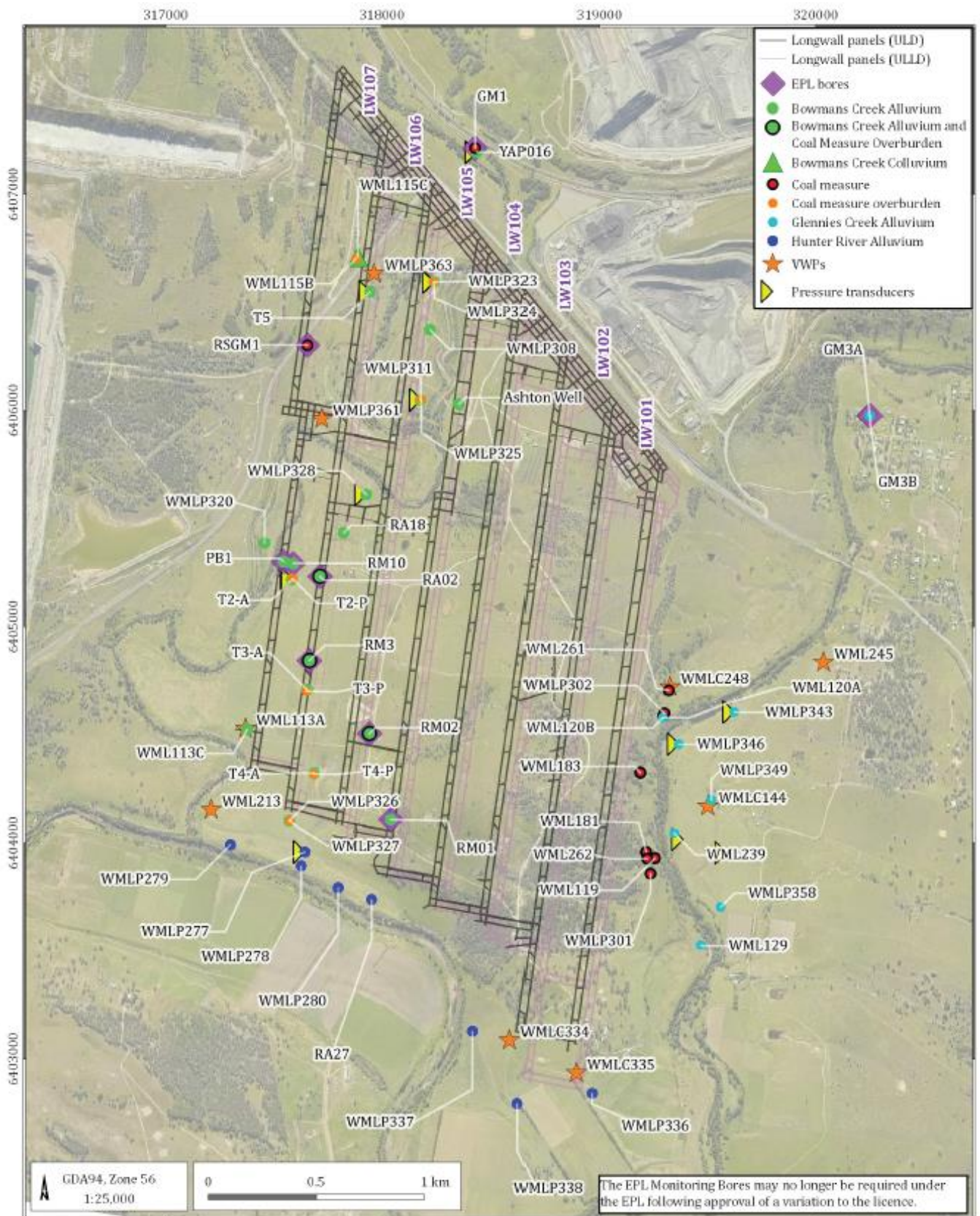


Figure 10 Groundwater Level Baseline and Trigger Level Monitoring Bores

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Table 18 Alluvium Monitoring Bore Baseline Water Levels

Alluvial Area	Bore	Highest Recorded Level (m AHD)	Mean Level (m AHD)	Lowest Recorded Level (m AHD)
Bowmans Creek	RM6	56.8	55.7	55.11
	RM7	57.2	56.08	55.33
	RM9	57.26	56.74	55.3
	RA30	62.59	61.01	59.95
	RA18	56.84	56.41	55.98
	T2-A	56.02	55.43	55.12
	T3-A	60.37	50.98	50.35
	T4-A	50.57	49.92	49.26
Glennies Creek	WML129	51.95	50.79	43.14
Hunter River	RA27	50.51	49.48	48.89

AHD = Australian Height Datum

7.1.2 Groundwater Quality

Groundwater quality varies in different aquifers. Alluvial groundwater in the floodplains of Bowmans Creek, Glennies Creek and the Hunter River is generally of a quality suitable for stock and, in some areas, suitable for domestic use. The colluvial groundwater and some of the alluvial groundwater was characterised as brackish to saline in quality and is not for consumptive use. Groundwater in coal measures is saline and is not suitable for consumption, nor is it used for consumptive purposes apart from mining demands. A summary of the baseline groundwater quality, from representative bores over the available period of data prior to longwall mining (2007 to 2011) is given in **Table 19**.

Table 19 Summary Baseline Groundwater Quality

Aquifer	pH		EC (µS/cm)	
	Mean	Range	Mean	Range
BCA	7.23	6.44 – 10.04	1,622	722 – 9,920
HRA	6.97	6.76 – 7.14	2,091	1,375 – 2,540
GCA	7.05	6.53 – 7.79	3,202	300 – 16,300
Colluvium	6.91	6.52 – 7.87	6,682	1,300 – 13,860
Coal measures (Pikes Gully Seam)	6.87	5.29 – 7.78	2,088	86 – 8,820

7.1.3 Groundwater Users

There are no non-ACOL registered bores in surrounding areas that will be impacted by the underground mine. The reason for this is that most of the drawdown due to the underground mine occurs in close proximity to the mined area. There are no privately-owned groundwater bores in close proximity to the Proposed Action as the land north of the Hunter River is owned by ACOL, Glencore and AGL (AGE, 2024a). Therefore, no privately-owned bores are predicted to experience more than 0.1 m of drawdown from the Proposed Action (AGE, 2024a).

Based on groundwater model predictions (AGE, 2024a) and monitoring observations during longwall mining to date, drawdown impacts due to the underground operation are not expected to propagate over long distances towards private registered bores in surrounding regions.

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7.1.4 Groundwater Dependent Ecosystems

Two small stands of River Red Gums (RRGs) are commonly identified as a groundwater dependent ecosystem (GDE) located in the vicinity of the ACP (refer to **Figure 9**). These stands of RRGs are located on the lower reaches of Bowmans Creek, within 1 km of the Hunter River confluence, and the lower reaches of Glennies Creek. However, these RRG were determined not to be completely dependent on groundwater, drawing water opportunistically from multiple sources (Marine Pollution Research, 2009). Nor are these RRG stands mapped on the High Priority Groundwater Dependent Ecosystem Map (NSW Department of Water and Energy, 2009). Nonetheless, the RRG are not predicted to be significantly impacted by approved underground mining at the ACP and ACOL-operated RUM (AGE, 2024b).

7.2. Groundwater Impact Assessment Criteria

Impact assessment criteria can be described as trigger levels, which, if triggered, will lead to a response in terms of further, more intensive monitoring, investigation and ultimately, if required, remedial action. The SGRP (**Section 8**) contains details of all responses relating to each impact assessment criterion. Groundwater impact assessment criteria focus on particular areas and each area may contain more than one criterion.

Impact assessment criteria have been defined based on a statistical analysis of the baseline and operational groundwater data collected across all hydrogeological units at the ACP and ACOL-operated RUM and consideration of guideline water quality values for slightly to moderately disturbed ecosystems as given in ANZECC/ARMCANZ (2000).

7.2.1 Groundwater Levels

Groundwater levels within the alluvium can provide an indication of the potential for impacts on watercourse baseflow. Groundwater levels can also indicate induced leakage from alluvial aquifers to underlying hydrogeological units in response to subsidence impacts. Triggers have been developed based on observed natural variations in monitored bores and predicted mining-induced drawdowns at alluvium monitored bores (AGE, 2016). Predicted drawdown in alluvium (AGE, 2016), by the end of mining in LW204 (Upper Lower Liddell seam), ranges from 0.02 m to 1.12 m in BCA monitoring bores, from 0.08 m to 1.1 m in GCA monitoring bores and from 0.01 m to 0.13 m in HRA monitoring bores. A summary of the observed and modelled drawdown (AGE, 2016) compared to the approved impacts is included in **Table 20**. Both the observed and modelled impacts are within the limits of the approved impacts.

The maximum predicted drawdown from the mining of the RUM Longwalls 403 to 406 in the alluvium is less than 0.1 m (AGE, 2024b). This maximum predicted drawdown is less extensive than previously approved for the RUM (AGE, 2024b). This reduction is attributed to the scaled back longwall mining in the PG seam, with Longwalls 401 and 402 not due to be mined at this time.

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Table 20 Comparison of 2021 modelled drawdown to 2001 EIS and 2009 EA modelled drawdown (AGE 2016)

Location	Observed	2021 AGE model	2009 EA	2001 EIS
	<i>Impact to September 2021</i>	<i>Completed mine impact (end of 2035))</i>	<i>Completed mine modelled impact</i>	<i>Completed mine modelled impact</i>
BCA	No mining-related drawdown observed in WMP bores (WMLP311, WMLP323, WMLP328, T2A)	≤ 1 m	< 3 m	No significant drawdown
GCA	No drawdown observed in WMP bores (WML120B, WML129, WML239)	< 1 m	< 2 m	2.5 m
HRA	No drawdown observed in WMP bores (WMLP279, WMLP280, WMLP337)	< 1 m	< 1 m	No significant drawdown

To account for natural variation, trigger levels are derived by interpreting the variation observed in recent years (2011 to 2021), the approved impacts (Aquaterra 2009) and the predicted drawdown (AGE, 2021) – refer to **Table 20**. The result is a practical trigger level that accounts for both model predictions and natural influences (**Table 21**).

The compliance bores water level trigger values have been derived by subtracting the model predicted drawdown (AGE, 2016) from the minimum water level observed in recent and measured natural variation. A contingency of 0.2 m has also been applied to allow for the conservative nature of the updated model relative to the approved impacts as detailed in Aquaterra (2009). Trigger levels are given for bore locations shown in **Figure 10**. A recorded water level below the defined trigger level at a monitoring bore at any time between now and the end of mining of LW204 in the ULLD, sustained for three consecutive months, will trigger a response (refer **Section 8**).

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Table 21 Trigger Levels for Alluvial Piezometers

Aquifer and Monitoring Piezometer	Ground Elevation (m AHD)	Base of Bore Elevation (m AHD)	Base of Alluvium Elevation (m AHD)	Lowest Recorded Water Level (m AHD)	Modelled Drawdown (m) [#]	Assigned Groundwater Level Trigger Value at End of Mining of in ACOL-operated RUM (Pikes Gully Seam) (m AHD)
BCA[*]						
WMLP311	63.64	56.04	55.64	56.94	0.25	56.49
WMLP323	64.47	56.59	59.47	58.39	0.25	57.94
WMLP328	61.52	49.47	49.42	50.73	0.14	50.39
T2A	59.69	50.79	49.69	53.51	0.55	52.76
GCA						
WML129	54.94	45.94	45.44	50.63	0.53	49.90
WML239	58.82	45.32	50.82	51.03	0.84	49.99
WMLP343	61.0	49.14	50.00	52.10	0.47	51.43
WMLP349	58.34	48.34	48.84	51.91	0.77	50.94
WMLP358	59.66	48.46	50.16	51.61 [§]	0.62	50.79[§]
HRA						
WMLP279	61.6	44.2	45.10	48.90	0.48	48.22
WMLP280	59.92	43.92	44.92	48.67	0.62	48.75
WMLP337	59.85	46.35	48.05	47.85	0.00	47.65
WMLP336	60.37	44.94	47.87	48.41	0.11	48.10

[#] The drawdown modelled for each monitoring is based on the cumulative mining impact after extraction of the Pikes Gully seam at the ACOL-operated RUM. The modelled drawdown and groundwater trigger levels will be revised prior to the mining of the Middle Liddell Seam to incorporate the drawdown associated with mining of this seam.

^{*} BCA is approved to be dewatered in areas above the mine plan by end of mining of the Upper Liddell seam (Aquaterra 2009). Trigger values are therefore intended as a guide representing updated, more conservative, impact predictions from the updated groundwater model (AGE, 2016).

[§] This water level trigger is based on the second lowest water level measured, as the lowest measured water level is an outlier in the dataset.

It is noted that, in accordance with the approved groundwater impact predictions (Aquaterra, 2009), the sections of BCA that overlie the mine plan were anticipated to be dewatered by the end of mining in the Upper Liddell seam. The updated predictions (AGE, 2016) and subsequently assigned trigger values for water level in the BCA piezometers show a level of saturation remaining.

This indicates that the approved ACP and ACOL-operated RUM impacts are conservative in nature, in that observed mining-related impacts are within the limits of the approved impacts. Trigger levels have been assigned to the BCA using updated predictions however, these should be considered in the context that the ACP and ACOL-operated RUM is approved to induce dewatering in these areas (Aquaterra, 2009).

Baseline, trigger and monitoring bore location co-ordinates are included in **Appendix B**.

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7.2.2 Groundwater Quality

In a similar fashion to observed water levels, groundwater quality exhibits a degree of natural variation. Based on the baseline and recently recorded water quality data, water quality impact assessment criteria have been refined for the alluvial aquifers. The following trigger values for specific monitoring bores represent an observed value outside of expected natural variation for those bores. Natural variation has been determined using the 5th and 95th percentile of the historical data. The pH and EC trigger levels for alluvial piezometers are given in **Table 22** and **Table 23**.

A maintained 'trend', regarded as three consecutive measurements outside of these percentiles (trigger values), will trigger a response (refer **Section 8**). In addition, if a recorded value at a monitoring bore differs extremely from the preceding three readings at that location and there are no unusual events that could have caused the difference, a response will be triggered.

Table 22 Trigger Levels for Alluvial Piezometers

Aquifer and Monitoring Piezometer	pH								
	No. of records*	Min	Max	Mean	Median	Standard Deviation	Range	Groundwater pH Trigger - Lower (5 th Percentile)	Groundwater pH Trigger - Upper (95 th Percentile)
BCA									
WMLP311	51	6.3	8.2	7.1	7.0	0.40	1.9	6.5	8.0
WMLP323	50	6.5	8.1	7.2	7.1	0.39	1.7	6.5	8.1
WMLP328	50	6.6	8.4	7.2	7.1	0.44	1.8	6.6	8.2
T2A	37	6.6	7.8	7.1	7.1	0.24	1.2	6.7	7.7
WML113C	12	6.6	7.4	7.1	7.0	0.28	0.9	6.6	7.4
WMLP326	14	6.6	7.5	7.1	7.1	0.27	0.9	6.6	7.5
GCA									
WML120B	118	6.1	8.8	6.9	6.8	0.41	2.7	6.4	7.7
WML129	114	6.5	8.5	7.2	7.1	0.42	2.0	6.7	8.0
WML239	61	6.2	7.7	6.9	6.8	0.32	1.5	6.3	7.4
WMLP343	2	7.0	7.6	7.3	7.3	0.28	0.6	6.7	7.2
WMLP346	2	6.9	7.3	7.1	7.1	0.18	0.4	6.5	7.1
WMLP349	2	7.0	7.7	7.4	7.4	0.37	0.7	6.5	6.8
WMLP358	2	6.7	7.4	7.1	7.1	0.36	0.7	6.2	6.9
HRA									
WMLP279	27	6.3	7.5	6.8	6.8	0.28	1.2	6.3	7.5
WMLP280	73	6.5	8.9	7.2	7.1	0.41	2.4	6.6	7.9
WMLP337	88	6.7	8.5	7.2	7.1	0.31	1.8	6.8	7.8
WMLP336	29	6.1	8.9	6.9	6.8	0.51	2.9	6.2	8.2

* Data reviewed includes historical data to June 2017.

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Table 23 Trigger Levels for Alluvial Piezometers

Aquifer and Monitoring Piezometer	EC ($\mu\text{S}/\text{cm}$)							
	No. of records*	Min	Max	Mean	Median	Standard Deviation	Range	Groundwater EC Trigger (95 th Percentile)
BCA								
WMLP311	51	790	1400	1090	1080	117	610	1289
WMLP323	50	796	1481	1060	1072	137	685	1241
WMLP328	50	844	1298	1030	1029	83	454	1175
T2A	40	346	1680	1046	1036	193	1334	1422
WML113C	13	902	1450	1111	1120	162	548	1445
WMLP326	15	1420	2080	1735	1720	196	660	2078
GCA								
WML120B	121	438	1930	775	676	275	1492	1387
WML129	121	227	1080	459	428	142	853	740
WML239	63	637	1000	812	800	79	363	984
WMLP343	3	651	859	731	684	91	208	994
WMLP346	3	684	805	734	713	52	121	750
WMLP349	3	1150	2700	1780	1490	665	1550	983
WMLP358	2	294	400	347	347	53	106	401
HRA								
WMLP279	27	906	1375	1014	1014	94	469	1276
WMLP280	73	1130	2250	1723	1751	185	1120	2034
WMLP337	88	1840	5690	2791	2819	447	3850	3254
WMLP336	29	627	1747	1007	892	305	1120	1708

* Data reviewed includes historical data to June 2017.

7.2.3 Groundwater Inflows

Groundwater inflows to the underground mining operations have been forecast by AGE (2024b). Monitoring of water supplied to and extracted from the underground operations is undertaken using portal and de-watering bore flow meters, with volumes recorded typically monthly.

Monitored groundwater inflows across the entire water year will be compared to the predicted groundwater inflows levels specified in **Table 24** and reported in the Annual Review.

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Table 24 Predicted Groundwater inflows

Water Year	Maximum Predicted Groundwater Inflows (ML/Year)
2025-2026	73
2026-2027	130
2027-2028	109
2028-2029	48

7.3. Monitoring Program

7.3.1 Bores and Piezometers

The groundwater monitoring program is tailored to current operations and some sites will be monitored more or less frequently depending on where mining is taking place at the time. Bores and Vibrating Wire Piezometer (VWP) installations can be damaged through planned subsidence and may be deleted from the monitoring network if no longer necessary or functional.

The current groundwater monitoring network consists of 64 monitoring bores and VWP installations that monitor the alluvial and fractured rock aquifers on site. ACOL will seek a data sharing agreement with Glencore to utilise data from groundwater bores located south and west of the ACOL-operated RUM to expand its currently monitoring network. Where available, this data would be considered in the ACP Annual Reviews.

The groundwater monitoring program includes the monitoring of:

- water levels;
- piezometric pressure;
- field water quality parameters – pH and EC;
- groundwater sampling for a minor chemical analysis suite, comprising Lab pH, Lab EC and cation/anions;
- groundwater sampling for comprehensive chemical analysis, comprising Lab pH, Lab EC, temperature, TDS, Turbidity, Na, K, Ca, Mg, F, Cl, SO₄ HCO₃, NO₃, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr, Total Alkalinity, Total Cyanide;
- monitoring of water level and EC required by EPL 11879; and
- dewatering bore / portal pumped volumes.

Monitoring frequency/parameters are as follows:

- Monthly campaign:
 - Water levels at all WMP monitoring bores are measured at monthly intervals. Bores equipped with pressure transducers are downloaded monthly.
 - Monthly monitoring at selected alluvium and fractured rock aquifer piezometers (refer **Table 25**) is undertaken of water level and field water quality.
 - Monthly monitoring of piezometric pressure occurs at selected VWP installations.

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- Quarterly campaign

In addition to the monthly monitoring campaign, the quarterly campaign also includes:

- Quarterly monitoring at selected monitoring bores (refer **Table 25**) is undertaken of water level and field water quality (EC and pH).
- Quarterly sampling at selected monitoring bores (refer **Table 25**) is undertaken for minor suite of chemical analysis (laboratory analysis of pH, EC and cation/anions).

- Six-monthly monitoring at EPL 11879 monitoring bores for water level and field EC only.

- Annual campaign

In addition to the quarterly monitoring campaign, the annual campaign also includes:

- Annual sampling at selected monitoring bores (refer **Table 25**) for minor suite of chemical analysis (laboratory analysis of pH, EC and cation/anions).
- Annual sampling at selected monitoring bores (refer **Table 25**) for comprehensive chemical analysis (laboratory analysis of pH, EC, temperature, TDS, Turbidity, Na, K, Ca, Mg, F, Cl, SO₄ HCO₃, NO₃, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr, Total Alkalinity, Total Cyanide).

A summary of the monitoring locations and parameters monitored is provided in **Table 25** and **Figure 10**. Monitoring location co-ordinates are included in **Appendix B**.

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Table 25 Summary of Groundwater Monitoring Program (Monthly, Quarterly and Annual Campaigns)

ID	Type	Data Recording Method	Targets	Monthly	Quarterly	Annually
Ashton Well	Monitoring bore	-	BCA	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis
GM1	EPL Monitoring bore	-	197-203m deep (BAR seam)	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus field parameters and comprehensive analysis
GM3A	Monitoring bore	-	GCA	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis
GM3B	Monitoring bore	-	GCA	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis
PB1	Monitoring bore	-	BCA	Water level only	Monthly plus field EC only	Quarterly plus minor lab analysis
RA02	Monitoring bore	-	BCA + Coal Mine Overburden (CMOB)	Water level only	Monthly plus field EC only	Quarterly plus field parameters and comprehensive analysis
RA18	Monitoring bore	-	BCA	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis
RA27	Monitoring bore	-	HRA	Water level only	Monthly plus field parameters	Quarterly plus comprehensive analysis
RM01	Monitoring bore	-	BCA	Water level only	Monthly plus field EC only	Quarterly plus minor lab analysis
RM02	Monitoring bore	-	BCA + CMOB	Water level only	Monthly plus field EC only	Water level and field EC only
RM03	Monitoring bore	-	BCA + CMOB	Water level only	Monthly plus field EC only	Quarterly plus minor lab analysis
RM10	Monitoring bore	-	BCA + CMOB	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus minor lab analysis
RSGM1	Monitoring bore	-	Coal measure (BWS)	Water level only	Monthly plus field EC only	Quarterly plus field parameters and comprehensive analysis

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ID	Type	Data Recording Method	Targets	Monthly	Quarterly	Annually
T2-A	Monitoring bore	Pressure transducer	BCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus comprehensive analysis
T2-P	Monitoring bore	Pressure transducer	CMOB	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
T3-A	Monitoring bore	-	BCA	Water level only	Monthly plus field parameters	Quarterly plus comprehensive analysis
T3-P	Monitoring bore	-	CMOB	Water level only	Monthly plus field parameters	Quarterly plus comprehensive analysis
T4-A	Monitoring bore	-	BCA + BWS	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
T4-P	Monitoring bore	-	CMOB	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
T5	Monitoring bore	Pressure transducer	BCA	Water level only	Monthly plus field parameters	Quarterly plus comprehensive analysis
WML113C	Monitoring bore	-	BCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus comprehensive analysis
WML115B	Monitoring bore	-	CMOB & Lem3-4	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis
WML115C	Monitoring bore	-	BCA	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis
WML119	Monitoring bore	-	PG	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
WML120A	EPL Monitoring bore	-	PG	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
WML120B	EPL Monitoring bore	-	GCA	Water level and field parameters	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis

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ID	Type	Data Recording Method	Targets	Monthly	Quarterly	Annually
WML129	EPL Monitoring bore	-	GCA	Water level and field parameters	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
EPL WML181	Monitoring bore	-	PG	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
EPL WML183	Monitoring bore	-	PG	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
WML213	VWP	-	BWS, Lem 8-9, Lem 15, Lem 19, PG, ULD, ULLD, LB	Pressure head	Pressure head	Pressure head
WML239	Monitoring bore	-	GCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus comprehensive analysis
WML245	VWP	-	ULD, MLD, LB, LB-HEB int	Pressure head	Pressure head	Pressure head
WML261	Monitoring bore	-	ULD	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
WML262	EPL Monitoring bore	-	ULD	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
WML269	VWP	-	Lem 5, Lem 7, Lem 8-9, Lem 11-12, Lem 15, Lem 19	Pressure head	Pressure head	Pressure head
WMLC144	VWP	-	ULD, MLD1, MLD2, ULLD, LLLD, UBS, LB	Pressure head	Pressure head	Pressure head
WMLC248	VWP	-	ULLD, ULLL, LB, HEB	Pressure head	Pressure head	Pressure head
WMLP334	VWP	-	Lem 13, Lem 15, Lem 18/19, Art, ULD, ULLD, UB, LB	Pressure head	Pressure head	Pressure head
WMLP335	VWP	-	Lem 15B, Lem 17, PG Upper, Art, ULDB, LLLD, UB, LB	Pressure head	Pressure head	Pressure head

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ID	Type	Data Recording Method	Targets	Monthly	Quarterly	Annually
WMLP277	Monitoring bore	Pressure transducer	HRA	Water level only	Monthly plus field parameters	Quarterly plus comprehensive analysis
WMLP278	Monitoring bore	-	HRA	Water level only	Monthly plus field parameters	Quarterly plus comprehensive analysis
WMLP279	EPL Monitoring bore	-	HRA	Water level and field parameters	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
WMLP280	EPL Monitoring bore	-	HRA	Water level and field parameters	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
WMLP301	Monitoring bore	-	Arties Seam	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
WMLP302	Monitoring bore	-	Arties Seam	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
WMLP308	Monitoring bore	-	BCA	Water level only	Monthly plus field parameters	Quarterly plus comprehensive analysis
WMLP311	Monitoring bore	Pressure transducer	BCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus comprehensive analysis
WMLP320	EPL Monitoring bore	-	BCA	Water level only	Monthly plus field parameters	Quarterly plus comprehensive analysis
WMLP323	Monitoring bore	Pressure transducer	BCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus comprehensive analysis
WMLP324	Monitoring bore	Pressure transducer	CMOB	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
WMLP325	Monitoring bore	Pressure transducer	CMOB	Water level only	Monthly plus field parameters	Quarterly plus comprehensive analysis
WMLP326	Monitoring bore	-	BCA	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis

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ID	Type	Data Recording Method	Targets	Monthly	Quarterly	Annually
WMLP327	Monitoring bore	-	CMOB	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis
WMLP328	Monitoring bore	Pressure transducer	BCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus comprehensive analysis
WMLP336	EPL Monitoring bore	-	HRA + CMOB	Water level and field parameters	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis
WMLP337	Monitoring bore	-	HRA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus comprehensive analysis
WMLP338	Monitoring bore	-	HRA	Water level only	Monthly plus field parameters	Quarterly plus comprehensive analysis
WMLP343	Monitoring bore	Pressure transducer	GCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus comprehensive analysis
WMLP346	Monitoring bore	-	GCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus comprehensive analysis
WMLP349	Monitoring bore	-	GCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus comprehensive analysis
WMLP358	Monitoring bore	-	GCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus comprehensive analysis
WMLP361	VWP	VWP datalogger	Lem 5, Lem 8, Lem 15A, Art, ULD	Pressure head	Pressure head	Pressure head
WMLP363	VWP	VWP datalogger	CMOB, Lem 8, Lem 9-10 int, Lem 12, Lem 14, Lem 15, PG roof, ULD	Pressure head	Pressure head	Pressure head
YAP016	EPL Monitoring bore	Pressure transducer	BCA	Water level and field parameters	Monthly plus field parameters and minor lab analysis	Quarterly plus comprehensive analysis

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Selected alluvial piezometers are located in the alluvial aquifers between the watercourses and the underground mine and provide detailed spatial coverage. Additional site bores may be maintained and monitored by ACOL for internal purposes.

A comprehensive review of groundwater quality and water level monitoring results are reported in the Annual Review. Results are compared to relevant statutory requirements, previous year's results and relevant predictions in relevant EAs and updates to the Groundwater Model.

The following quality assurance/quality control measures form part of the GMP:

- Groundwater quality monitoring and sample collection, storage and transportation are undertaken in accordance with the procedures outlined in the relevant sections of the Australian Standard for Water Quality Sampling AS/NZS5667.1-1998 and by a suitably qualified and experienced contractor. This includes the use of proforma field sheets and chain of custody records.
- Laboratory analysis is undertaken by a laboratory which has relevant accreditation by the National Association of Testing Authorities, Australia or equivalent.
- Results of all water quality monitoring that is required under EPL 11879 is reviewed internally each month by ACOL prior to the data being uploaded to the Ashton Coal website.

7.3.2 Underground Mine Inflows

Routine (typically monthly) monitoring of pumped transfer of mine water and water imported to the ACP and ACOL-operated RUM is undertaken using a network of flow meters (refer **Figure 3**). Undertaking a calculated balance on inflows to and outflows from the underground and the volume stored in the underground provides an estimate of total groundwater inflows each month. These are then partitioned into inflows from the three alluvial sources and the coal measures using the relative proportions of inflows rates predicted by the groundwater model (AGE, 2024a). This inflow partitioning may be adjusted if there is an obvious disparity between monitored data and model predictions – e.g. if the majority of monitored inflow is monitored from dewatering bore #3, which is located close to GCA and HRA, whereas the model may be predicting the majority of inflow from BCA.

During longwall extraction, ACOL will:

- Maintain a register of mine groundwater inflows.
- Record all water pumped into and out of the mine. This would include monitoring of water being pumped out of the mine (via the portal and boreholes) using flow meters, and calculation of water entrained in coal and water vapour associated with venting.
- Monitor the pH, EC and cations/anions of water extracted from the underground mining area on a quarterly basis.

A summary of the mine inflows, outflows and quality of the water extracted from the underground mining area will be reported on in the annual review.

Water balance calculations undertaken as part of the annual water balance review (**Section 6.2**) for the NEOC use monitored flow rates, water levels and modelled estimates of rainfall runoff, to estimate groundwater inflows to the open cut void.

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8. SURFACE AND GROUNDWATER RESPONSE PLAN

8.1. Objective

The objective of this SGRP is to present a set of protocols to be followed and actions for implementation should the surface or groundwater impact assessment criteria be exceeded.

8.2. Protocol for Exceedance of Surface Water Trigger Values

In the event of a surface water assessment criterion (**Table 15**) being exceeded, the following protocol will be followed:

1. Check and validate the data which indicates an exceedance of the criterion, including whether the exceedance is ongoing.
2. A preliminary investigation will be undertaken to establish the cause(s) and determine whether changes to the water management system or operations are required. This will involve the consideration of the monitoring results in conjunction with:
 - a) site activities being undertaken at the time;
 - b) baseline monitoring results;
 - c) predictive modelling;
 - d) surface water monitoring at nearby locations and upstream (including WaterNSW stations);
 - e) the prevailing and preceding meteorological and streamflow conditions;
 - f) available data indicating releases from upstream regulating storages or other sites;
 - g) changes to the land use/activities being undertaken in the contributing catchment area; and
 - h) hydrological conditions.
3. If the preliminary investigation shows that the impact is linked to activities undertaken by ACOL, a report will be emailed to the DPHI and any other relevant department. Causal factors will be addressed and rectified if possible. Contingency measures will be developed in consultation with the DPHI and any other relevant department and implemented in response to the outcomes of the investigation.
4. Remedial/compensatory measures will be developed in consultation with DPHI and any other relevant department and implemented in response to the outcomes of the investigations.
5. Monitoring will be implemented as required to confirm the effectiveness of remedial measures.
6. Where required, an independent hydrologist will be engaged to conduct investigations. ACOL will seek the Planning Secretary's approval in selecting a hydrologist.

Any loss of baseflow in excess of predictions will be further offset against ACOL's WALs. ACOL could purchase additional WALs if required.

Any exceedances and responses taken to ameliorate these exceedances will be reported in the Annual Review.

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8.4. Protocol for Exceedance of Groundwater Trigger Values

In the event of a groundwater assessment criterion (**Table 21** and **Section 7.2**) being exceeded, the following protocol will be followed:

1. Check and validate the data which indicates an exceedance of the criterion, including whether the exceedance is ongoing.
2. A preliminary investigation will be undertaken to establish the cause(s) and determine whether changes to the water management system or operations are required. This will involve the consideration of the monitoring results in conjunction with:
 - a) site activities being undertaken at the time;
 - b) activities at nearby operations (cumulative affects);
 - c) groundwater extraction by others;
 - d) baseline monitoring results and natural fluctuations;
 - e) predictive modelling;
 - f) groundwater monitoring at nearby locations;
 - g) the prevailing and preceding meteorological and streamflow conditions; and
 - h) changes to the land use/activities being undertaken nearby.
3. If the preliminary investigation shows that the impact is linked to activities undertaken by ACOL, a report will be emailed to the DPHI and any other relevant department. Causal factors will be addressed and rectified if possible. Contingency measures will be developed in consultation with the DPHI and any other relevant department and implemented in response to the outcomes of the investigation.
4. Remedial/compensatory measures will be developed in consultation with DPHI and any other relevant department and implemented in response to the outcomes of the investigations.
5. Monitoring will be implemented as required to confirm the effectiveness of remedial measures.
6. Where required, an independent hydrogeologist will be engaged to conduct investigations. ACOL will seek the Secretary of DPHI's approval in selecting a hydrogeologist.

Where a groundwater performance trigger continues to be exceeded for six sampling events, ACOL will:

- Notify DCCEEW-Water that the groundwater performance trigger has been exceeded for six sampling events; and
- Conduct further analysis to understand the cause of the continued exceedance.

Any exceedances and responses taken to ameliorate these exceedances will be reported in the Annual Review.

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8.5. Protocol for Impacts on the Water Supply of Private Landowners

No privately owned groundwater bores exist in surrounding areas that are expected to be impacted by the underground mine (refer **Section 7.1.3**), hence an impact on the groundwater supply of private landowners is not expected. There are no privately-owned surface water storages within the ACP and ACOL-operated RUM colliery holding boundary and hence impacts on the surface water supply of private landowners are not expected. If a complaint is received, this will be handled in accordance with ACOL procedures, which includes recording the details of the complaint, providing feedback to the complainant (including corrective actions) and reporting investigation outcomes and corrective actions. Compensation will be developed in consultation with the private landowner where it can be demonstrated that the ACP or ACOL-operated RUM has adversely affected the water supply. To date, no complaints have been received in relation to groundwater or surface water supply of private landowners.

If it was established that ACOL's activities have adversely affected flows in Bowmans Creek, thereby affecting licensed private water users in the lower reaches of the creek (refer **Section 6.2**), ACOL will negotiate provision of an alternative water resource with the affected users.

8.6. Protocol for Impacts on Riparian Vegetation

Whilst not considered GDEs (refer to **Section 7.1.4**), the stands of RRGs on the downstream reaches of Bowmans Creek and Glennies Creek are identified as high importance remnant vegetation communities, and RRG monitoring and response requirements are described in the BMP (ACOL, 2016).

The potential for impact on riparian vegetation has been identified in Bowmans Creek and **Section 4.4** outlines vegetation rehabilitation assessment, performance criteria and corrective actions. In addition, the BMP (ACOL, 2016) contains further details of riparian vegetation monitoring, triggers and response.

Any impacts on the RRG will be investigated, with corrective actions implemented where the impact is determined as attributable to the ACP and ACOL-operated RUM.

8.7. Roles and Responsibilities

The roles and responsibilities assigned to water management on site under this WMP are outlined in **Table 26**.

Table 26 Roles and Responsibilities for Site Water Management

Water Management Component	Responsible Person
Provide resources required to implement the WMP	Mine Engineering Manager
Review and update of WMP	Environment and Community Relations Superintendent
Management and maintenance of water management infrastructure	CHPP Manager and Technical Services Manager
Environmental Monitoring	Environment and Community Relations Superintendent
Investigation of water-related incidents	Environment and Community Relations Superintendent
Reporting (including Annual Review and incident reporting)	Environment and Community Relations Superintendent

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10. REVISION HISTORY

Water Management Plan Version History

Version	Issue Date	Section/s Modified	Reason for Modification (including whether review or minor amendment)	Modified By
1	25/9/2014	Revised from existing WMP	Document revised and submitted to DPE for review	Gilbert & Associates, J Barben
2	7/11/2014	1-6	Following DPE review	A.Marszalek (G&A), J Barben
3	22/4/2015	6	Following DPE second review	J Barben
4	1/5/2015	1	DPE Approval granted 27.4.2015	J Barben
5	14/5/2015	1.2, 6	Revised in accordance with DA309-11-2001i (Condition 1.21), 20BL173716 (Condition 6), 20BL169508 (Condition 7) and updates made to the Groundwater Section	J Barben, C Conte (Australasian Groundwater and Environment)
6	1/4/2016	1, 5.3, 6	Revised for Extraction Plan for LW 105-107 in the Upper Liddell Seam (updated in Nov 2015)	A Marszalek, C Conte, J Barben
7	9/5/2016	6.3	Following DPE comments	C Conte, J Barben
8	11/5/2016	-	Review and approval by DPE	J Barben, C Knight
9	18/7/2017	Revised from existing WMP	Update for DA Mod 5, submission of Annual Review and approval of LW201-204 Extraction Plan	A Marszalek, C Conte, J Barben
10	01/03/2018	-	Review and approval by DPE	L.Crawford
11	15/09/2020	Revised from existing WMP	Update for Independent External Audit	P Brown
12	06/07/2022	Revised after MOD 11	Following integration of Ashton Underground Mine with Ravensworth Underground Mine	P Brown
13	04/2025	All Sections	To incorporate the Ravensworth Underground Mine Longwalls 403 to 406 Extraction Plan	P. Brown

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11. APPENDICES

APPENDIX A CONSULTATION AND APPROVAL RECORDS

Organisation	Date	Format	Topic
Ashton Community Consultative Committee (ACCC)	9.07.2020	ACCC meeting - https://www.yancoal.com.au/wp-content/uploads/2024/12/200713-Ashton-CCC-JUL2020-Minutes_accepted_combined.docx-1.pdf	WMP
EPA	19.05.2022	Site Visit and Meeting	Proposed EPL variation to incorporate RUM
CCC	2.12.2021 24.02.2022 23.06.2022	ACCC Meeting - December 2021 CCC meeting minutes. https://www.yancoal.com.au/wp-content/uploads/2024/11/20211202-ACCC-December-Minutes_FINAL-combined.pdf - February 2022 CCC meeting minutes. https://www.yancoal.com.au/wp-content/uploads/2024/11/20220224-ACCC-February-Minutes.pdf - June 2022 CCC meeting minutes. https://www.yancoal.com.au/wp-content/uploads/2024/11/16-June-2022-CCC-Presentation-w-Minutes.pdf	Ashton-RUM Integration Project

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APPENDIX B BASELINE, TRIGGER AND MONITORING BORE LOCATION COORDINATES

Table B-1 Summary of Baseline and Trigger Level Monitoring Bore Locations

Bore ID	Easting (GDA94 Z56)	Northing (GDA94 Z56)	Top of Casing (mAHD)	Depth (m)
RA18	317821.7	6405434.4	62.61	8.50
RA27	317952.1	6403738.0	62.71	15.50
RA30	317810.6	6406500.9	65.19	9.00
RM6	317871	6405888	63.95	10.20
RM7	318073	6405761	63.70	9.80
RM9	318166	6406380	65.55	8.80
T2-A	317583.3	6405217.4	60.80	8.90
T3-A	317654.2	6404708.0	59.85	10.80
T4-A	317685.8	6404323.1	58.58	10.70
WML129	319468.4	6403527.8	55.34	7.00

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Table B-2 Summary of Monitoring Bore Locations

ID	Type	Easting (GDA94 Z56)	Northing (GDA94 Z56)	Top of Casing (mAHD)	Depth (m)
Ashton Well	Monitoring bore	318355.0	6406029.0	62.0	-
GM1	EPL Monitoring bore^	318431.0	6407214.0	67.0	203.0
GM3A	EPL Monitoring bore^	320246.5	6405976.9	59.0	16.2
GM3B	EPL Monitoring bore^	320250.9	6405976.7	59.0	7.5
PB1	EPL Monitoring bore^	317545.0	6405301.0	61.1	7.8
RA02	EPL Monitoring bore^	317712.8	6405233.0	55.2	11.3
RA18	Monitoring bore	317821.8	6405434.2	62.6	8.5
RA27	Monitoring bore	317952.1	6403738.0	61.6	15.5
RM01	EPL Monitoring bore^	318041.0	6404109.5	69.4	10.8
RM02	EPL Monitoring bore^	317942.0	6404506.0	61.1	12.9
RM03	EPL Monitoring bore^	317667.0	6404844.5	62.1	11.0
RM10	Monitoring bore	317589.0	6405292.0	61.6	10.8
RSGM1	EPL Monitoring bore^	317655.0	6406302.0	65.6	8.5
T2-A	Monitoring bore	317583.3	6405217.4	60.8	8.9
T2-P	Monitoring bore	317587.0	6405222.0	60.7	14.9
T3-A	Monitoring bore	317654.2	6404708.0	59.9	10.8
T3-P	Monitoring bore	317650.0	6404702.0	59.8	30.5
T4-A	Monitoring bore	317685.8	6404323.1	58.6	10.7
T4-P	Monitoring bore	317683.0	6404319.0	58.5	31.9
T5	Monitoring bore	317946.1	6406549.4	65.3	8.8
WML113C	Monitoring bore	317377.0	6404526.0	60.2	50.0
WML115B	Monitoring bore	317881.0	6406704.0	66.4	40.0
WML115C	Monitoring bore	317888.0	6406710.0	66.2	6.2
WML119	Monitoring bore	319255.3	6403930.1	61.5	35.0
WML120A	Monitoring bore	319292.0	6404579.6	60.4	20.0
WML120B	Monitoring bore	319293.6	6404587.5	60.1	9.0
WML129	Monitoring bore	319468.4	6403527.8	55.3	7.0
WML181	Monitoring bore	319215.0	6403958.3	64.3	32.0
WML183	Monitoring bore	319188.2	6404325.2	76.7	45.5
WML213	VWP	317210.0	6404154.0	61.5	316.0
WML239	Monitoring bore	319345.0	6404044.8	58.8	13.5
WML245	VWP	320035.0	6404835.0	64.9	101.0
WML261	Monitoring bore	319320.2	6404705.9	58.7	39.0
WML262	Monitoring bore	319220.1	6403927.7	63.2	60.3
WML269	VWP	317850.0	6404073.0	65.5	65.5
WMLC144	VWP	319500.0	6404170.0	59.3	132.0
WMLC248	VWP	319326.0	6404721.0	58.5	144.6
WMLP334	VWP	318589.0	6403088.0	75.9	218.5
WMLP335	VWP	318892.0	6402936.0	64.5	200.5

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ID	Type	Easting (GDA94 Z56)	Northing (GDA94 Z56)	Top of Casing (mAHD)	Depth (m)
WMLP277	Monitoring bore	317643.2	6403958.5	59.0	13.0
WMLP278	Monitoring bore	317626.3	6403894.2	62.3	12.5
WMLP279	Monitoring bore	317298.9	6403991.8	62.7	17.4
WMLP280	Monitoring bore	317797.6	6403793.4	62.5	16.0
WMLP301	Monitoring bore	319235.0	6403858.0	60.2	10.0
WMLP302	Monitoring bore	319299.6	6404600.2	59.7	10.5
WMLP308	Monitoring bore	318222.7	6406373.0	65.7	9.1
WMLP311	Monitoring bore	318178.9	6406047.9	63.6	7.6
WMLP320	Monitoring bore	317457.2	6405388.0	61.5	8.0
WMLP323	Monitoring bore	318242.2	6406594.7	64.5	7.3
WMLP324	Monitoring bore	318240.0	6406594.0	64.5	14.1
WMLP325	Monitoring bore	318181.0	6406050.0	63.7	14.6
WMLP326	Monitoring bore	317571.0	6404103.2	59.3	11.2
WMLP327	Monitoring bore	317573.0	6404103.0	59.4	18.0
WMLP328	Monitoring bore	317927.3	6405611.6	62.8	12.1
WMLP336	VWP	318965.4	6402841.9	60.6	15.5
WMLP337	VWP	318418.0	6403129.0	59.9	13.5
WMLP338	Monitoring bore	318624.7	6402794.0	58.8	12.9
WMLP343	Monitoring bore	319623.0	6404606.0	61.0	11.9
WMLP346	Monitoring bore	319366.5	6404457.23	60.68	12.5
WMLP349	Monitoring bore	319516.0	6404198.0	58.3	10.0
WMLP360	Monitoring bore	319560.0	6403704.0	59.66	11.2
WMLP361	Monitoring bore	317722.0	6405962.0	62.9	191.0
WMLP363	Monitoring bore	317963.0	6406634.0	66.0	164.0
YAP016	VWP	318438.0	6407195.0	66.8	7.3

^ EPL monitoring requirements will be removed after discussion with the EPA in the coming months. Some of the EPL bores may continue to be monitored as part of the WMP.

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APPENDIX C GROUNDWATER LEVEL TRIGGER LEVEL BORES HYDROGRAPHS

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