Rix's Creek Mine

Water Management Plan

Rix’s Creek Pty Ltd

Document Status

Version	Purpose of Document	Authored by	Reviewed by	Review Date
1.1	Draft for client review	Matt Thompson	Damien Janssen	18/1/2018

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Version	Purpose of Document	Authored by	Reviewed by	Review Date
2.0	Final	Matt Thompson	Damien Janssen	16/4/2018
2.1	Final with minor revisions	Matt Thompson	Damien Janssen	18/4/2018
2.2	Minor revisions and updated plans	Chris Quinn	Chris Knight	18/4/2018
2.3	Addressing NRAR comments	Damien Janssen	Chris Quinn	2/11/2018
2.4	Greater Ravensworth Area Water Transfer Scheme	Chris Knight	Chris Quinn	17/5/2019

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1 Introduction

1.1 Background

The current Rix's Creek Mine previously operated under two separate Water Management Plans that outlined surface water and ground water management practices including monitoring requirements, performance indicators and response plans. Rix's Creek North Water Management Plan was previously approved by the DPE on the 16th February 2016 covering conditions of Schedule 3, Condition 36 of Project Approval 08_0102. The Rix's Creek South Water Management Plan was developed during the year (2010) as part of the development consent (DA 49/94) modification approval requirements for the cut and cover tunnel.

This revision of the Water Management Plan (WMP) seeks to integrate and supersede those two previously separate plans.

1.1.1 Rix's Creek North Area

The entire Integra Operations Complex was previously owned by Vale. These facilities were subsequently purchased by Glencore and Bloomfield on the 18th of December 2015. After the purchase Bloomfield have ownership of the Open Cut operations and surface infrastructure including the Coal Handling and Preparation Plant (CHPP) and Train Loader (and refer to them as the Rix's Creek North operations); and HV Coking Coal Pty Ltd (a subsidiary of Glencore Coal Pty Ltd) have ownership of the Underground operations.

The Integra Open Cut operation is now operated and managed by Bloomfield as Rix's Creek North (RCN), as an integrated part of the overall Rix's Creek Mine.

Prior to the purchase, the open cut operation was in care and maintenance, with no mining operations taking place on the site. Bloomfield has submitted (to the Department of Planning and Environment- Resources Regulator) a Mining Operation Plans (MOP) that would allow for a maximum yearly production of 1 million saleable tonnes from the open cut mine operation in the northern area. This production will be in the Western Extension to the Camberwell Pit (previously known as South Pit). The Falbrook Pit (previously known as North Open Cut) will be utilised for temporary water storage in the near term. Production will utilise the existing Integra open cut machinery with Rix's Creek employing up to 70 additional employees to achieve these production targets.

Current and approved operations within the Rix's Creek North area include the Falbrook Pit, Camberwell Pit and the Western Extension (previously known as the Extended South Pit). Relevant supporting infrastructure associated with the area includes the Northern Coal Handling and Preparation Plant (CHPP), associated tailings storage facilities, along with various clean and dirty water storage facilities.

1.1.2 Rix's Creek South Area

Bloomfield Collieries Pty Ltd continues to operate the Rix's Creek South (RCS) area which commenced operations in 1990 and is comprised of three open cut pits, a CHPP and other infrastructure such as a rail siding. Historically, underground mining activities have occurred to the south east of the existing Arties Pit. The RCS mining was expanded to the northwest of West Pit (previously known as Pit 3) within the lease boundary in 2014. Currently the RCS complex consists of three open pit areas - Arties Pit, West Pit and South Pit (previously known as Pit 2). The Southern CHPP is located on the eastern side of the site adjacent to the administration and workshop area. The train loading facilities are located centrally to both the RCN and RCS areas, on the eastern side of the lease.

1.1.3 Rix's Creek Mine (combining RCN and RCS)

With the recent acquisition of the Rix's Creek North open cut mines and associated infrastructure, including all dirty and clean water management infrastructure, there is the opportunity to integrate water management across both the RCN and RCS areas – the combined operations being referred to as the Rix's Creek Mine. This revised WMP seeks to ensure statutory compliance to particular approvals for relevant areas, while also enabling flexibility in water management outcomes by enabling the movement of water between the northern and southern areas to better utilise water resources and optimise operational activities.

1.2 Statutory Requirements

The Rix's Creek Mine has a Water Management System (WMS), which includes mine dewatering systems, water storages, sediment dams, tailings storage facilities, pumps and pipeline infrastructure, drains and earthen bunding around stockpiles, hardstand areas, haul roads and refuelling areas. The way in which this

WMS is operated is guided by the approved WMP, which integrates both statutory and operational requirements of water management.

The following comprises a summary of statutory requirements and functions relevant to this WMP:

- Satisfy regulatory requirements, including meeting required performance criteria;
- Divert clean water around mining operations to minimise capture of upslope runoff and separate clean water runoff from mining activities;
- Segregate mine impacted water and runoff from undisturbed and revegetated areas with better water quality to minimise the volume of mine impacted water that requires reuse;
- Reuse mine impacted water within the WMS to reduce reliance on raw/clean water; and
- Avoid adverse effects on downstream waterways (including hydraulic and water quality impacts).

1.2.1 Modifications related to Project Approvals

For the Rix's Creek North area - Condition 36, Schedule 3 of the Approval 08_0102 (Modification 7, September 2017), requires that a WMP be prepared.

For the Rix's Creek South area – Condition 15, Schedule 2 of the DA 49/94 N90/00356 (Modification 9) similarly requires a WMP to be prepared.

In both cases, the required WMP is to be inclusive of the following:

- Site Water Balance;
- Erosion and Sediment Control Plan;
- Surface Water Management Plan;
- Groundwater Management Plan; and
- Surface Water and a Groundwater Response Plan.

All related requirements are addressed within this WMP, as detailed in Appendix A.

1.2.2 Environmental Protection Licence

Environmental Protection Licence (EPL) 3391 has been issued by the Environment Protection Authority (EPA) which covers the Rix's Creek North (previously Integra Open Cut) and Rix's Creek Mine site, and appropriate scheduled activities. The EPL contains conditions related to water management which this WMP aims to meet. The EPL has an annual anniversary date of 3rd April.

1.2.3 Water Licencing

Rix's Creek holds licences under the *Water Act 1912* for the operation of extraction and monitoring bores relevant to the site. Water licences applicable to mine dewatering of the open cut operations, surface water extraction and groundwater monitoring are summarised in Table 1 and Table 2.

Rix's Creek will ensure that relevant licences are obtained, renewed or upgraded as required throughout the life of the site. Mine footprints, as required, will be licenced under the *Water Management Act 2000* Aquifer Interference Provisions.

Table 1 Rix's Creek Mine – Surface Water Licence Details

Water Licence	Water Sharing Plan	Annual Entitlement
	Rix's Creek North Area	
20AL201231	Hunter Regulated River - Zone 3A Glennies Ck – High Security	230 ML
20AL200940	Hunter Regulated River – Zone 3A Glennies Ck - General Security	54 ML
20AL200530	Hunter Regulated River – Zone 3A Glennies Ck - General Security	102 ML
20AL200818	Hunter Regulated River – Zone 3A Glennies Ck - General Security	23 ML
20CA200847	Hunter Regulated River – Zone 3A Glennies Ck - General Security	14 ML
20AL201041	Hunter Regulated River – Zone 3A Glennies Ck - General Security	240 ML
20AL200846	Hunter Regulated River – Zone 3A Glennies Ck - Supplementary Water	1.2 ML
20WA207397	Hunter Unregulated and Alluvial Water Sources - Unregulated River	6 ML
20CA207373	Hunter Unregulated and Alluvial Water Sources - Aquifer	5 ML
20CA200041	Hunter Regulated River Water Source	--
20CA200041	Hunter Regulated River – Zone 3A Glennies Ck - General Security	51 ML
20BL169513	Irrigation	5 ML
	Rix's Creek South Area	
20AL203407	Regulated River (General Security)	159 Units
20AL203406	Regulated River (General Security)	49.5 Units
20AL203405	Regulated River (General Security)	49.5 Units
20AL203405	Domestic & Stock	24 Units
20AL209899	Water sharing plan – Hunter unregulated and alluvial water sources 2009	150 Units
20AL207389	Water sharing plan – Hunter unregulated and alluvial water sources 2009	5 Units
20WA209901	Water sharing plan – Hunter unregulated and alluvial water sources 2009	300 Units

Water Licence	Water Sharing Plan	Annual Entitlement
20AL209919	Water sharing plan – Hunter unregulated and alluvial water sources 2009	91 Units
20WA201499	Water sharing plan – Hunter unregulated and alluvial water sources 2009	1 Units

Table 2 Rix's Creek Mine – Groundwater Licence Details

Water Licence	Water Sharing Plan	Annual Entitlement
	Rix's Creek North Area	
20BL169513	Mining	100 ML
20BL172249	Mining	100 ML
	Rix's Creek South Area	
20BL170863	Open Cut (dewatering groundwater) Hard Rock	100 ML
20BL170864	1 x Bore (dewatering groundwater)	100 ML
20BL168734	1 x Bore (monitoring bore)	1 ML

1.3 Plan Objectives & Performance Criteria

The primary objective of the WMP and their associated performance criteria are presented in Table 2.

Table 3 Rix's Creek Mine – Planned Objectives & Performance Criteria

WMP Objectives	Performance Criteria
Compliance with legislative requirements	• No unlicensed discharges from the Mine • Compliance with all conditions of the Water Licences • Compliance with the EPA Licence discharge conditions
Support procedures to manage and monitor surface and groundwater associated with the site	• All relevant surface and groundwater quality criteria are achieved • Disturbed areas are rehabilitated and revegetated as soon as practicable and become a source of clean runoff • Surface and groundwater monitoring program undertaken to meet EPL requirements • Monitoring program results comply with EPL limits • Minimise unlicensed discharges from the Mine

WMP Objectives	Performance Criteria
	• All water management facilities are in locations that minimise impacts to the natural ecosystems • Management measures, including regular inspections, are implemented to prevent the accidental discharge of process water, disturbed area runoff or contaminated water. • Monitoring is conducted to confirm the WMP is operating as designed and meets target criteria, licence conditions and commitments made during the approval process
Encourage water reuse and recycling on site	• Maximum use is made of process water for dust suppression and other mining-related purposes • Process water is preferentially sourced from the poorest water sources within the project area. Saline water will be used preferentially to sediment-laden water • The reliability of the water supply for coal processing and other site mine-related purposes is maximised • Process water can be transferred between key process water storages
Provide management mechanisms to minimise the potential for surface water on the site to cause offsite impacts and ensure clean water is diverted about active mining areas where possible	• Clean water within the mine site is diverted away from disturbed land or is directed to flow to Glennie's Creek, wherever practicable • A facility is provided to export excess water, when available, to other mining operations • Any impacts on the availability of surface water or groundwater to surrounding residents, landholders or the environment are minimised
Provide management mechanisms to minimise the potential for the Rix's Creek Mine operations to impact upon the hydraulic and chemical properties of the groundwater in the coal measures and alluvium in the vicinity of the operational pits	• Any impacts on the availability of surface water or groundwater to surrounding residents, landholders or the environment are minimised
Ensure clean water is diverted away from the mining area wherever possible	• Erosion and sedimentation from all active and rehabilitated areas of the site is minimised • Areas producing potentially contaminated water such as hardstand, refuelling, lubricating or workshop areas are to be separated from other catchments, resultant drainage collected and treated, if required, before re-use on site
Ensure sediment-laden water is captured and transferred back within the mine water system or if it exceeds the capacity of the system, is treated to meet the required criteria prior to releasing	• Total on site containment of process water is sufficient to contain an average recurrence interval (ARI) rainfall event of 1 in 100 years (ARI100)
Ensure that water captured within the mine water management system (stormwater runoff and groundwater) or water transferred into this system is managed efficiently and appropriately	• Water conveyance infrastructure (such as diversion drains for disturbed area runoff) designed to accommodate a 20-year ARI rainfall event

2 Operational Water Management

2.1 Mine Water Management System

The Rix's Creek Water Management System (WMS) is a network of infrastructure (i.e. dams, pipelines, contours) to control the movement of water around the site and prevent unscheduled release off site. The elements of the water management system (as of 2017) are depicted geographically in Figures 1 to 5. Future changes to the site water management system will be updated (if required) in the WMP following each Annual Review and as required by project modification or other. Water is managed according to type. Water type is determined by catchment area, quality and use. Figure 4 is a conceptual diagrammatic representation of the Rix's Creek water management system.

The main types of water managed at Rix's Creek Mine include:

- Runoff water;
- Saline water;
- Licensed water extraction; and
- Imported Fresh Water (when required).

2.1.1 Runoff Water

Runoff water varies in quality depending on the characteristics of the catchment area. Runoff water is captured or diverted away from the mine water system dependent on quality, climatic conditions and production requirements. Current catchments at Rix's Creek are detailed in Table 5. Runoff water can be split into four types based of catchments:

- Undisturbed Catchment;
- Unconsolidated/ Disturbed Mine spoil;
- Rehabilitated Mine Spoil; and
- Active & Saline Mining Catchment Areas.

2.1.2 Saline Water

Water used in production on site is predominantly saline due to interaction with high salinity components within coal seams, saline mine spoils and during coal preparation. Saline water cannot be released from site and must be used during processing or stored. The Department of Planning and Environment requires saline water to be stored in facilities which have the capacity to contain runoff from rainfall events up to 1:100 ARI 24-hour duration storm.

There are three main sources of saline water managed on the Rix's Creek site:

- Mine Water (a combination of rainfall runoff, groundwater, spoils and tailings dam seepage)
- CHPP Water Supply
- Tailings Water

2.1.3 Licenced Water Extraction

At times additional water may be extracted from one of the Rix's Creek licence extraction bores if adequate local supply is not available onsite.

2.1.4 Imported Fresh Water

Currently town water is supplied for bath house and shower /toilet facilities at Rix's Creek Mine.

2.2 The Rix's Creek Mine Infrastructure

2.2.1 Rix's Creek North Infrastructure

The Rix's Creek North area comprises the following major areas and infrastructure:

- Falbrook Pit, the northern mining area located between the RCN tailings storage facilities and a major mine water storage dam (Possum Skin Dam);
- Camberwell Pit, which forms a significant part of the overburden emplacement area for the Western Extension;
- Western Extension (of Camberwell Pit), the planned primary area of open cut mining activities in the RCN area;
- The Northern CHPP, which receives, stockpiles and washes coal from Integra underground mine. The Northern CHPP can also be used to wash coal from Rix's Creek Mine. Coal is loaded via the rail load out facility into trains for transport to the port of Newcastle;
- Possum Skin Dam, a key water storage and evaporation facility; and
- Tailings Storage Facilities.
  - Tailings Dam 2 is a prescribed emplacement facility to store tailings
  - Tailings Dam 3 has reached its functional supply limit and is currently not an active tailings storage facility

2.2.2 Rix's Creek South Infrastructure

The Rix's Creek South area comprises the following major areas and infrastructure:

- Three open cut pit areas; Arties Pit, West Pit and South Pit;
- The Southern CHPP;
- A Tailings Storage Facility for tailings disposal (partially located in an old pit void); and
- The train loading facilities are located central to the Rix's Creek Mine, on the eastern side of the operational footprint.

2.3 Surface Water Management

2.3.1 Water Categories

Rix's Creek categorises water into four types to effectively manage water across the mine and to mitigate any potential for environmental harm to occur. Each type of water requires different management measures to minimise the risk of contamination of downstream drainage systems. A description of the water quality and potential sources for the four (4) categories of water are summarised in Table 3.

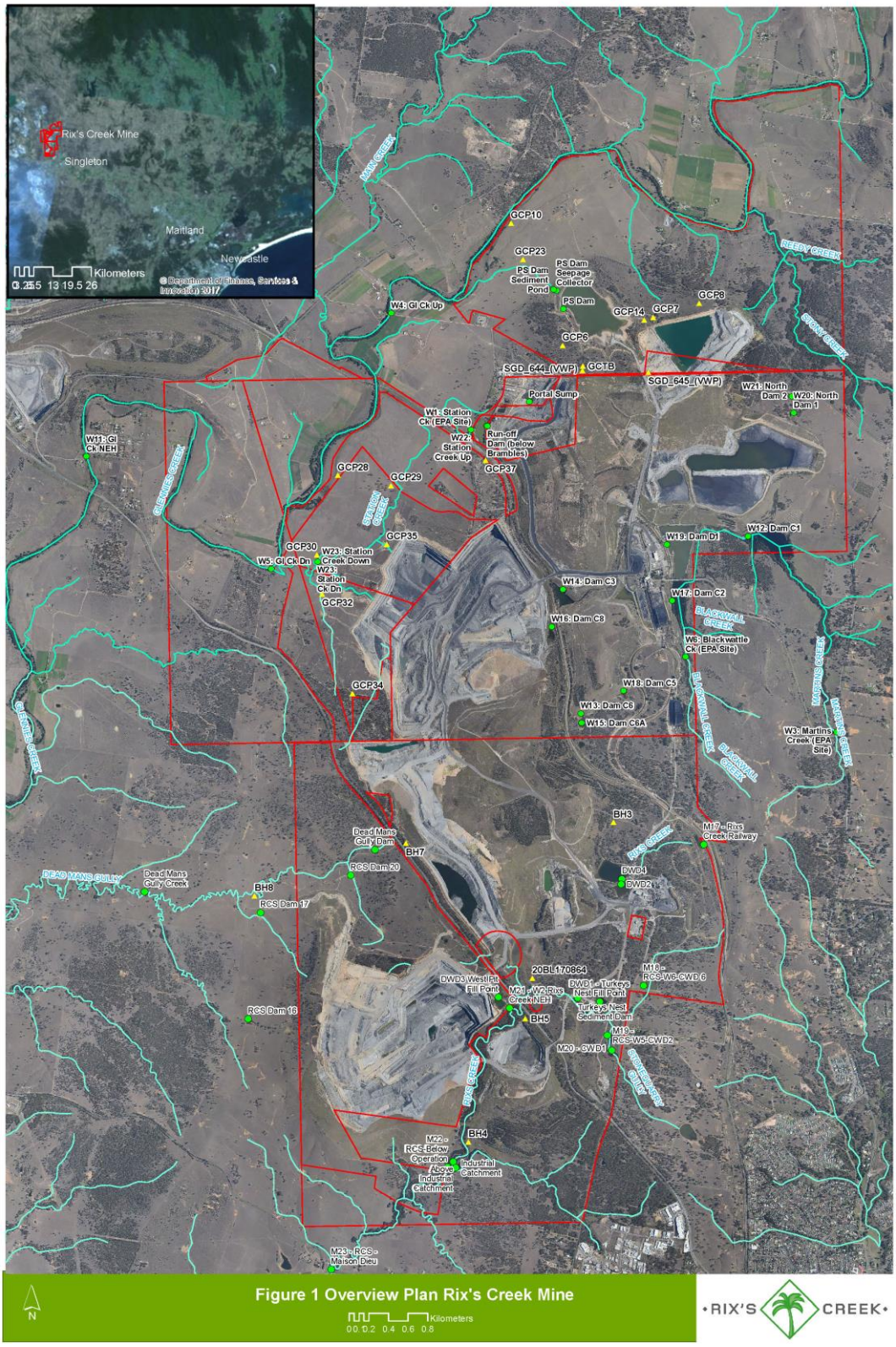

Figure 1: Overview Plan of the Rix's Creek Mine

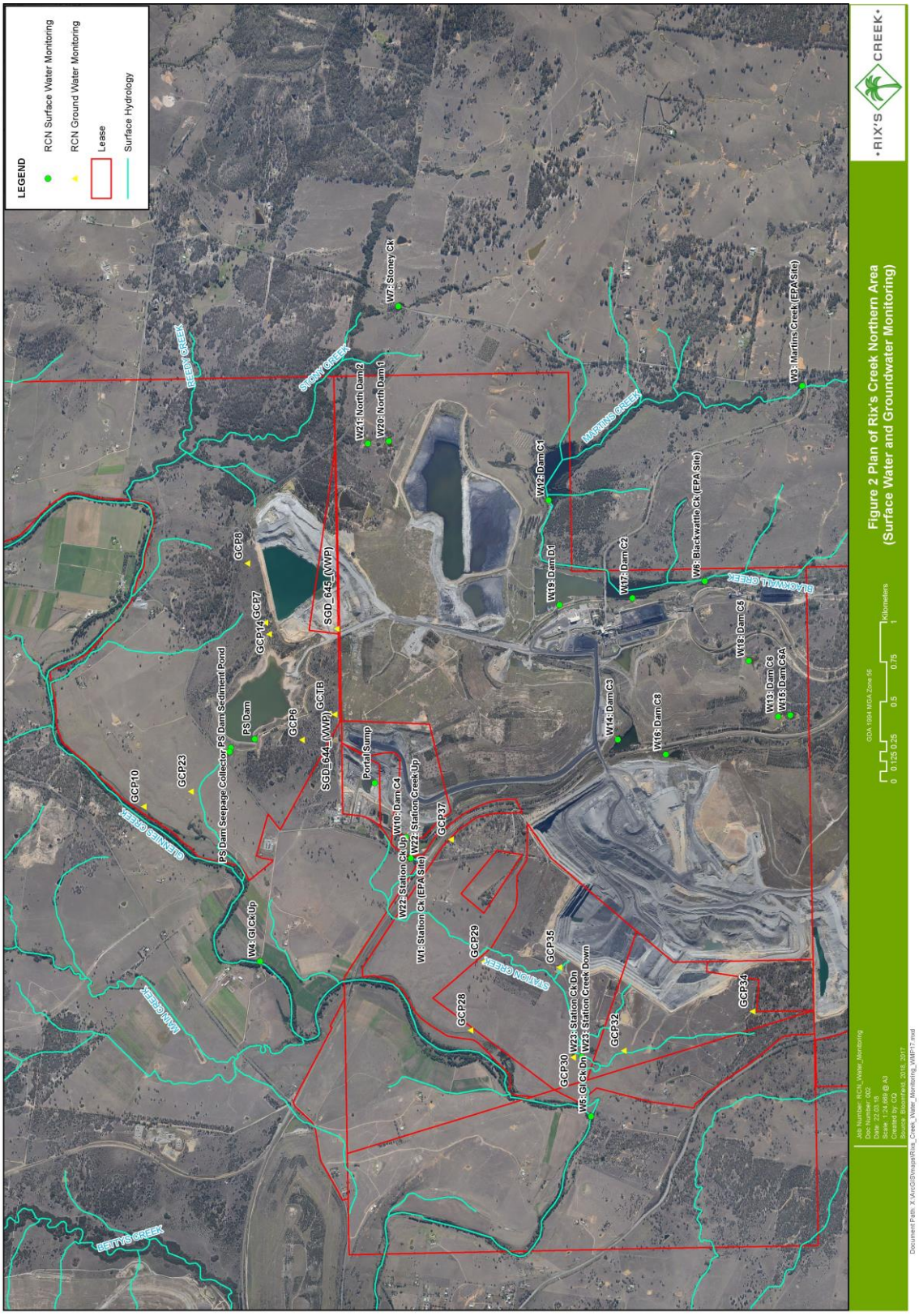

Figure 2: Plan of the Rix's Creek Northern Area (Surface Water and Groundwater)

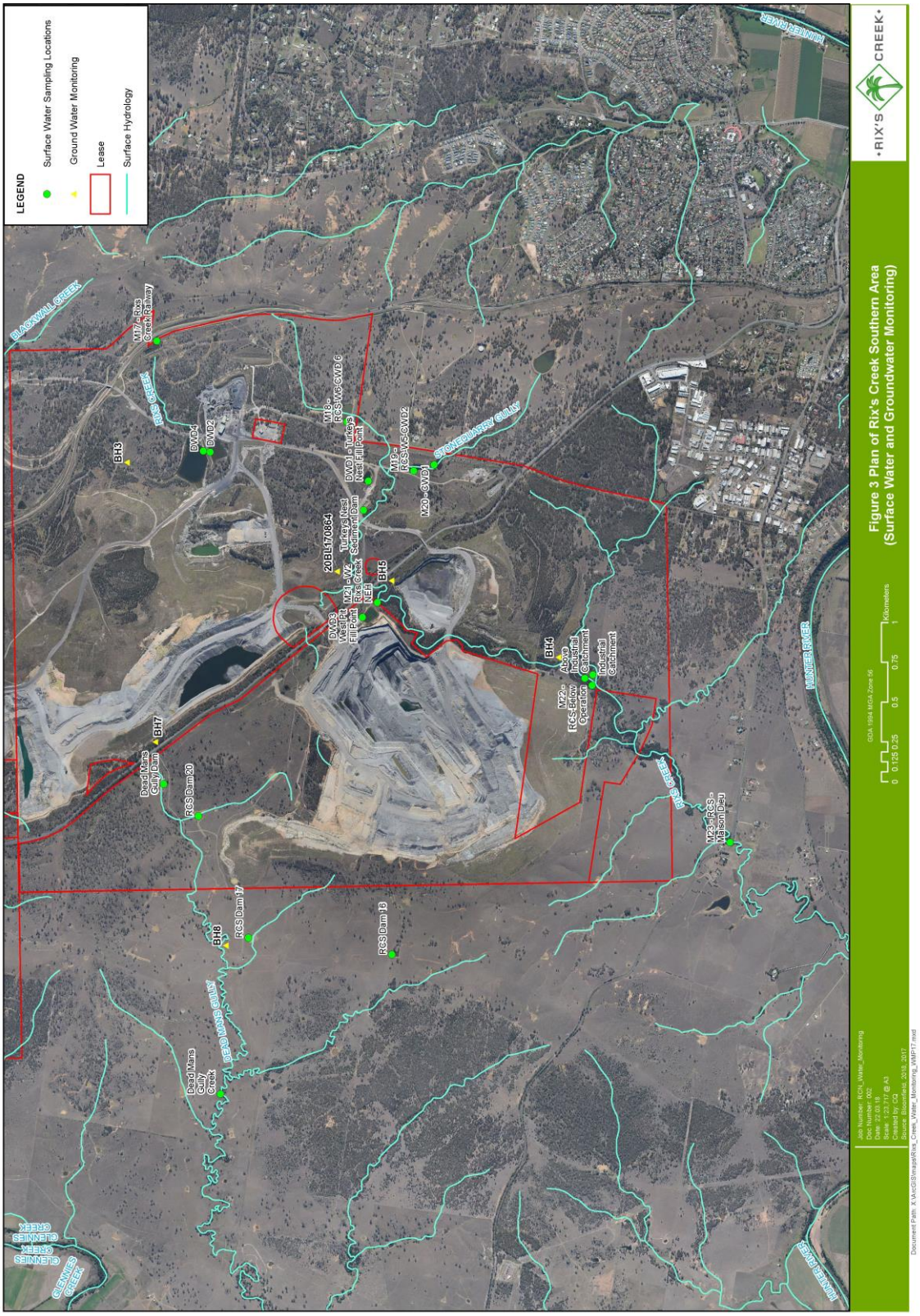

Figure 3: Plan of the Rix's Creek Southern Area (Surface Water &Groundwater)

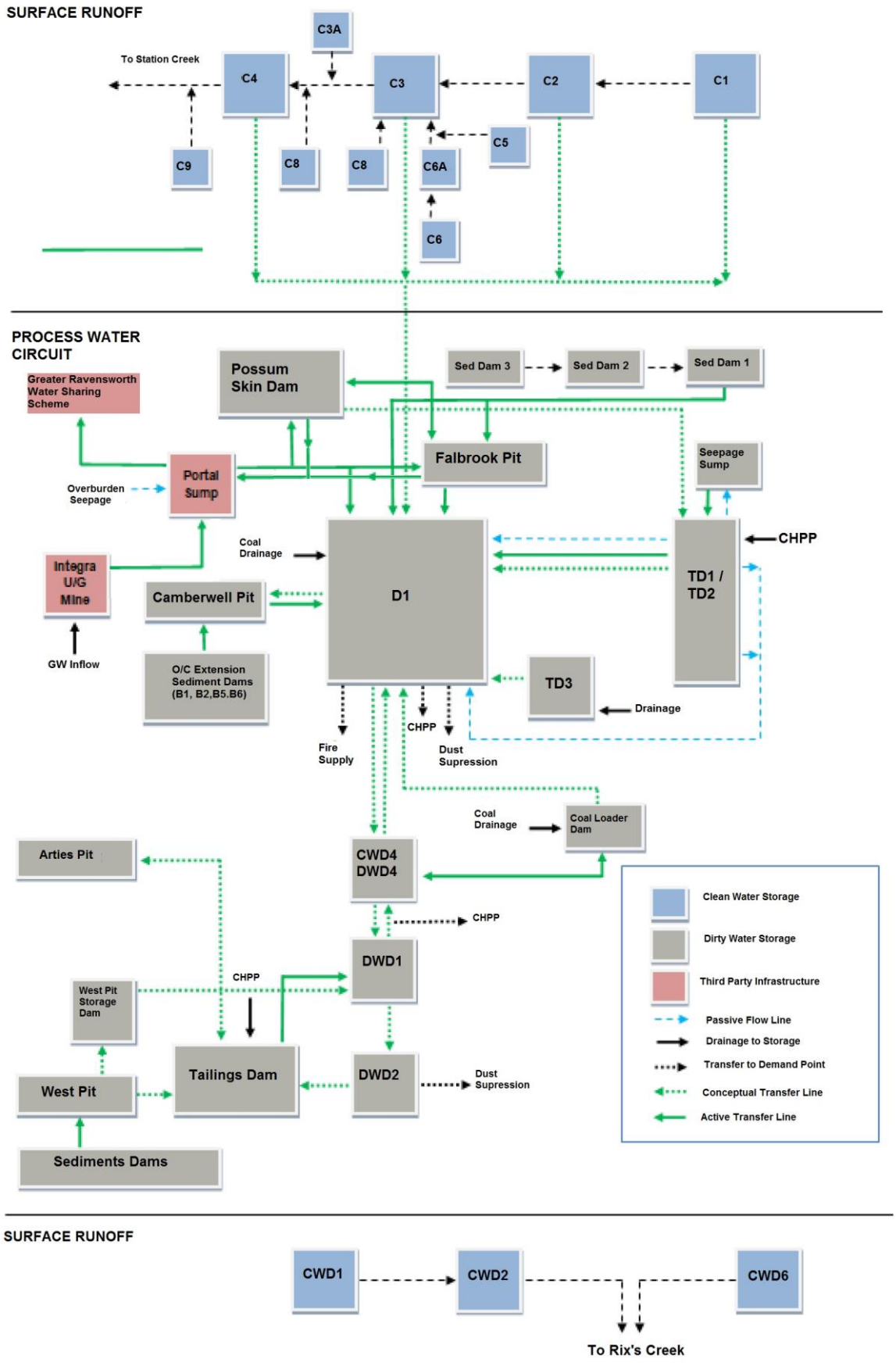

Figure 4: Conceptual Schematic of the Rix's Creek Mine Water Management Network

Table 4 Water Categories & Target Criteria

Water Category	Description	Target Criteria
Clean Water	Runoff from undisturbed or rehabilitated areas where vegetation is fully established and where the water quality is suitable for release/discharge. Also - raw water imported under licence.	Release, where practicable, to downstream environment, in accordance with the Protection of the Environment Operations (POEO) Act 1997.
Dirty Water	Runoff from disturbed areas, such as active overburden emplacement areas or overburden emplacement areas where vegetation is not fully established. These areas have the potential for elevated suspended solids (sediment-laden water) but typically have lower salinity.	Managed in line with the Blue Book (Managing Urban Stormwater: Soils and Construction Volume 1 and Volume 2E), and in accordance with the POEO Act 1997
Saline/Mine Water	Runoff from disturbed areas such as mining pits and haul roads, as well as groundwater pumped from the Integra Underground and the associated Portal Sump. As a result, mine water is typically of higher salinity levels (due to existing resident groundwater quality) than other surface water; these combined ie. Sediment-laden water and saline water are collectively known as mine water.	Contained and used during coal processing. Kept separate of clean and dirty water.
Contaminated Water	Water exposed to coal or used in coal processing and runoff within Mining Infrastructure Areas. Mine water includes water associated with groundwater inflows into open cut pits. This water may be highly saline and/or contain pollutants such as hydrocarbons.	Contained for all events. Nil discharge.

2.3.2 Clean Water Management & Drainage

The WMS for clean water includes a series of diversion and catch drains and clean water dams around the perimeter of the operation to capture and maximise diversion of upstream catchment runoff away from active mining areas, the local drainage network is shown in Figures 4 and 5. All of the creeks monitoring locations associated with the Rix's Creek Mine monitoring regime as part of the water quality monitoring program are also displayed on these Figures.

2.3.3 Dirty Water Management

Dirty water will be managed using a series of catch drains and sediment basins located to capture and manage runoff from disturbed areas. This will store dirty water separately and limit the potential for sediment laden and contaminated water to mix with other water sources. This will continue to adapt as mining progresses and the disturbed landform develops.

2.3.4 Mine Site Surface Water Catchments

Figure 1 shows the approximate extent of the surface water catchments draining to the various storages within the Rix's Creek sites. In the RCN area, the eastern portion of the Falbrook Pit area intercepts runoff from the

Reedy Creek catchment. Several diversion banks with excavated channels are used to divert clean catchment runoff around or through areas disturbed by mining operations.

In the RCS area, the Arties Pit, West & South Pit are surrounded by natural landforms that slope inwards towards the active mining area which directs any runoff over disturbed areas to flow back towards the pits. Clean water diversion structures have been installed to divert clean water away from active pits in average rainfall conditions.

The catchment areas and diversion structures are progressively changing with the ongoing excavation of approved mining areas – and are adapted and maintained to enable the outcomes described above.

The mine site surface water catchments are categorised as:

- **Undisturbed** – areas unaffected by mining operations;
- **Disturbed/Compacted** – these areas include haul roads, hardstand, surface facilities, maintenance and active mining areas within open cut pits and hence will generate much larger volumes of runoff relative to undisturbed catchments;
- **Rehabilitated** – areas covered by overburden material which has been regraded, topsoiled and revegetated; and
- **Spoil** – areas covered by active overburden emplacements.

2.3.5 Surface Water Storages

Providing sufficient storage capacity for water provides a buffer against drought and flood interruptions to the business and mitigates unlicensed discharge of polluted water offsite.

Surplus mine water at Rix's Creek Mine is stored primarily within the various major dams, sumps, and available pit voids across the mining operations. In addition to the main water storages for mine water there are also smaller dams across the operations that provide buffer storage for production and ancillary demands, as well as acting as sedimentation control.

Clean runoff water is collected across the Rix's Creek Mine and is stored separate from any dirty water, where sediment is collected prior to creek discharge.

The locations, type and functions of the main water storages in the site are given in Table 4, whilst Table 5 provides details about the entire site's water storages in terms of the type of water stored, the catchment area served by the storage, the maximum surface area and the storage's spill capacity.

Table 5 Main Surface Water Storage Facilities

Name	Location	Description	Function
Rix's Creek North			
Possum Skin Dam	To the northwest of the Falbrook Pit	• Large dam (evaporative)	• Store mine water for evaporation or use • Provide water for dust suppression • Receive pump out water from dewatering locations
D1	just east of the northern CHPP	• Primary storage dam for mine water	• Supplies northern CHPP • Used for dust suppression

Name	Location	Description	Function
			• Future water transfer connection point with the RCS area
Sediment Dams 1, 2 and 3	Eastern end of the Falbrook Pit	• Small sediment dams	• Collect disturbed area surface runoff
B1, B2, B5 and B6	West of the Extended Camberwell Pit (Western Extension)	• Small sediment dams	• Collect sediment runoff from stripped areas and topsoil stockpiles
Small-medium Farm Dams	Throughout RCN area	• Small earthen wall dams on minor drainage lines	• Collect surface runoff • Independent – not part of Mine Water Management System
Possum Skin Dam Seepage Pond	North of Possum Skin Dam	• Concrete tank	• Return seepage water back to mine when required.
Tailings Storage Facilities	North of D1 Dam	• 3 cells of a tailings storage facility	• Receive and store tailings • Return decant water into water circuit • Store small volumes of water when tailings dust control required
Rix's Creek South			
North Pit Storage/Old North	West of CWD4	• Primary storage dam for mine water	• Central repository for mine water • Supplies CHPP • Used for dust suppression
West Pit Storage	North of the RCS area Tailings Dam	• Primary storage dam for mine water	• Central repository for mine water • Supplies CHPP • Used for dust suppression
Tailings Storage Facility	just south of the New England Highway	• Primary storage facility for all tailing runoff from southern CHPP	• Receive and store tailings • Return decant water into water circuit • Store small volumes of water when tailings dust control required
DWD1	East of the southern CHPP	• Dirty water dam 1	• Overflow collection point for excess water from the tailings storage facility • Supplies southern CHPP • Used for dust suppression

Name	Location	Description	Function
DWD2	between the southern CHPP and southern Tailings Storage Facility	• Dirty water dam 2	• Used for dust suppression • Excess flows into tailing storage facility
DWD4	Northwest of the southern CHPP	• Dirty water dam 4	• Collection point for coal loader seepage dam excess • Supplies southern CHPP • Future water transfer connection point with the RCN area • Overflow directed to DWD1
Rail Loader	Central to the Rix's Creek Mine, on the eastern side of the operations	• Rail loader tunnel water runoff	• Excess water is collected and divided between CWD4 and DWD4 based on water quality
CWD1	East of the southern Tailings Dam	• Site 4 - Clean water dam 1	• Water storage dam • Spills into to Rix's Creek
CWD2	East of the southern Tailings Dam and north of CWD1	• Site 5 – Clean Water Dam 2	• Water storage dam • Spills into to Rix's Creek
CWD6	South of the southern CHPP	• Site 7 – Clean Water Dam 6	• Water storage dam • Spills into to Rix's Creek
Small to-medium Farm Dams	Throughout RCS Area	• Small earthen dams	• Collect surface runoff • Independent – not part of Mine Water Management System
Out Of Pit Dump Sediment Dam	Located to the North of the Out Of Pit Dump in West Pit	• Earthen dams	• Pumped back to mine water system when required.

Table 6 Water Storages & Associated Catchment Areas

Storage	Type of Water Stored	Total Catchment Area (ha)	Max. Surface Area (ha)	Capacity of Spill Level (ML)
Rix's Creek North				
C1	Clean	624	6.0	243
C2	Clean	215	2.3	173
C3	Clean	180	2.0	97

Storage	Type of Water Stored	Total Catchment Area (ha)	Max. Surface Area (ha)	Capacity of Spill Level (ML)
C3A	Clean	58	1.0	25a
C4	Clean	25	2.2	90
C5	Clean	69	0.7	16
C6	Clean	50	0.3	4
C6A	Clean	9	0.3	4
C7	Clean	3	0.1	2
C8	Clean	4	0.4	18
C9	Clean	2	0.2	2
C11	Clean	4	0.08	0.8
TD1	Saline	31	23.9	205
TD2	Saline	53	28.9	1,000
D1	Saline	89	11.0	440
TD3	Saline	16	6.0	600 (a)
D3	Saline	36	0.9	39
D4	Saline	3	0.7	2.5
Possum Skin Dam	Saline	138	32.7	1560 (b)
Sediment Dam 1	Sediment-laden	9	1.3	15.6
Sediment Dam 2	Sediment-laden	5	1.5	26.8
Sediment Dam 3	Sediment-laden	5	1.5	9.7
Sediment Dam B1	Sediment-laden	41	0.59	>10.5
Sediment Dam B2	Sediment-laden	3.5	0.19	>1.2
Sediment Dam B5	Sediment-laden	19	0.29	>6.1
Sediment Dam B6	Sediment-laden	22	0.43	>7.0
Rix's Creek South				
North Pit Catchment	Saline	255.56	N/A	648
West Pit Catchment	Saline	129.79	N/A	384
Old North Pit Catchment	Saline	74.48	N/A	229
Tailings Dam Catchment	Saline	31.84	N/A	138
Administration/Workshop/CHPP Catchment	Saline	25.03	N/A	74
Rail Loader Tunnel	Saline	-	N/A	55

Storage	Type of Water Stored	Total Catchment Area (ha)	Max. Surface Area (ha)	Capacity of Spill Level (ML)
DWD4 Catchment	Saline	137.54	N/A	272
North Pit Storage/Old North Cut (in-pit)	Saline	330.04	N/A	1000
West Pit Storage Dam N/A 33.5	Saline	129.79	N/A	N/A
Tailings Dam 2500 N/A	Saline	31.84	N/A	2500
DWD1 N/A 28	Saline	-	N/A	28 (d)
DWD2 N/A 16	Saline	-	N/A	16 (d)
DWD4 (was CWD4) N/A 335	Saline	137.54	N/A	335 (d)
Rail Loader N/A 38	Saline	-	N/A	38 (d)
CWD1 N/A 10	Clean	-	N/A	10 (d)
CWD2 N/A 10	Clean	-	N/A	10 (d)
CWD6 N/A 75	Clean	-	N/A	75 (d)
Sediment Dam Pit 3 - East N/A 10	Sediment-laden	-	N/A	10 (d)
Sediment Dam Pit 3 - West N/A 10	Sediment-laden	-	N/A	10 (d)

(a) Estimate only

(b) Existing conditions, Capacity to Maximum Operating Level (MOL) = 1090 ML, Expansion of North Open Cut will reduce capacity to MOL = 710 ML

(c) Portal Sump storage at RL 41m AHD in the open sump / backfill with a 10% assumed porosity

(d) Storage capacity

2.4 Groundwater

Two main aquifer systems are present within the Rix's Creek Mine footprint:

- The unconsolidated alluvium is associated with drainage lines and creeks and the regolith comprises clay-bound and silt-bound sands and gravels. Within the project area only minor alluvium, associated with Rix's Creek exists to the south of the mine lease, these deposits generally consist of low permeability clay underlain by marginally higher permeability clayey gravel and clayey sand. At Rix's Creek, alluvial aquifers are typically thin and poorly developed, while being more extensively developed in the north around Glennie's Creek; and along the Hunter River to the south.
- The Permian Coal Measures consist of a variable sequence of aquitards (predominantly siltstone and sandstone) and low permeability aquifers (coal seams). The permeability of the coal seams is typically 1 to 2 orders of magnitude greater than that of the associated interburden and overburden units, with groundwater flow within the Coal Measures predominantly confined to the cleat fractures in the coal seams. This means the coal seams themselves form the main aquifer within the hard rock system.
- Neither the coal measures nor creek alluvium are listed as vulnerable aquifers under the Aquifer Risk Assessment Report (DLWC, 1998). However, they are covered, as appropriate, by the generic State Groundwater Policy (DLWC, 1997), Groundwater Quality Protection Policy (DLWC, 1998), the

Groundwater Dependent Ecosystem Policy (DLWC, 2002) and the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources (2009).

2.4.1 Conceptual Hydrogeological Setting

The hydrogeology of the Upper Hunter Valley is dominated by two aquifer groups; alluvial deposits of quaternary age and consolidated sedimentary rocks of Permian age (Coal Measures and interburden).

2.4.1.1 Alluvial Aquifer

The unconsolidated alluvium is associated with drainage lines and creeks and the regolith comprises clay-bound and silt-bound sands and gravels. Within the project area only minor alluvium, associated with Rix's Creek exists to the south of the mine lease, these deposits generally consist of low permeability clay underlain by marginally higher permeability clayey gravel and clayey sand. At Rix's Creek, alluvial aquifers are typically thin and poorly developed, while being more extensively developed in the north around Glennie's Creek; and along the Hunter River to the south.

2.4.1.2 Permian Coal Measures Aquifer

The Permian Coal Measures consist of a variable sequence of aquitards (predominantly siltstone and sandstone) and low permeability aquifers (coal seams). The permeability of the coal seams is typically 1 to 2 orders of magnitude greater than that of the associated interburden and overburden units, with groundwater flow within the Coal Measures predominantly confined to the cleat fractures in the coal seams. This means the coal seams themselves form the main aquifer within the hard rock system.

Within the Coal Measures, the higher permeability coal seams are the main influence the bulk horizontal hydraulic conductivity, while the lower permeability interburden sandstones, siltstones and shales influence the overall vertical hydraulic conductivity – meaning groundwater prefers to flow along the coal seam beds rather than moving vertically through the lower permeability siltstone/shale units.

Increased permeability can be associated the crests and limbs of the major folds like the Camberwell anticline and Rix's Creek Syncline, and areas of localised bedding flexure. Such deformation may result in enhanced cleating within the coal seams or enhanced fracturing and jointing within adjacent strata. Although it is noted from mining to date at Rix's Creek Mine, enhanced permeability and associated groundwater inflows have not been encountered in the operational areas.

The hydrogeological basement lithologies on site are comprised of low permeability siltstones of the basal Saltwater Creek Formation of the Whittingham Coal Measures, and the underlying Mulbring Siltstone of the Maitland Group.

2.4.1.3 Regional Groundwater Flow

Regional groundwater flow within the Coal Measures is sustained by rainfall recharge to generally elevated areas of regolith and outcropping strata on the fringes of the basin structure. Downward recharge to deeper strata is aided in areas of enhanced jointing and fracturing, particularly dilated joints and bedding planes in the upper weathered horizons. Downwards recharge will typically be limited by reduced fracture connectivity with depth.

Mackie (2009) compiled a regional piezometric surface from reports submitted in support of mining approvals over the period 1993 to 2004. The map typically shows groundwater flow from areas of high ground towards the Hunter River and associated alluvium, and towards major tributary drainages such as Glennie's Creek and Wollombi Brook. In the vicinity of Rix's Creek this flow is generally to the west in the vicinity of Deadman's Gully and south to southwest in the vicinity of Rix's Creek. The regional flow regimes are altered around major below water table mining operations where drawdown influences prevail.

It is noted that in areas where mining has not impacted upon the Coal Measures strata, the deep pore pressure regime is observed to be generally stable in time with seasonal movements being commonly less than one

metre, even during periods of sustained drought – suggesting that the shallow groundwater and basement groundwater systems are hydraulically isolated from each other for the most part.

Groundwater discharge is typically to the regional drainage and overlying alluvial aquifers of the Hunter River and its tributaries with upwards leakage associated with the sub-cropping of Coal Measures in specific areas. In areas not influenced by mining operations, upwards hydraulic gradients are often identified, and reduced water quality is often associated with areas of leakage of more saline groundwater from the Coal Measures into the overlying alluvial system.

Groundwater levels within the Rix's Creek Syncline are dominated by the groundwater sinks presented by the current Rix's Creek open cut mining operation at West Pit and the neighbouring Camberwell Pit to the north, along with the Glencore Integra underground operations further to the northwest. This means that the basement groundwater levels are depressurised compared to original pre-mining conditions and are significantly deeper than the water levels observed with the alluvial aquifer system. Therefore, in this area, the basement groundwater system is not contributing baseflow to the alluvial aquifer and creek system.

2.4.1.4 Conceptual Hydrogeological Model

The conceptual hydrogeological model for Rix's Creek is relatively simple in that the basin-like structure of the Rix's Creek Syncline acts to isolate the Coal Measures from the broader regional hydrogeological regime, with little groundwater interaction through the bounding low permeability siltstones.

The basin-like structure as defined by the base of the Hebden Seam (and upper surface of the underlying siltstone basement rock of the Saltwater Creek Formation) is depicted on Figure 5 (below).

The limbs of the anticline have a relatively shallow dip on the eastern limb with the western limb dipping at a much steeper angle. The syncline axis also plunges from the north and south. The lowest point the Coal Measures in the synclinal basin is approximately -130mAHD.

Although geologically more complicated on the local scale due to the splitting and merging of multiple minor seams, the aquifer system at Rix's Creek has been simplified and represented by a layer cake style system, with the layer geometry reflecting the synclinal basin structure. Within the layer cake, the major coal seams represent the main aquifers, with the interburden units acting as low permeability aquitards between the aquifers. Within the coal seam aquifers, preferential groundwater flow is along the bedding. Large scale groundwater flow vertically between bedded units is impeded by the low permeability interburden units.

2.4.1.5 Aquifer Recharge

Rainfall recharge and infiltration will occur on remnant regolith areas, as well as rehabilitated mine areas, and direct rainfall to open cut areas. A degree of enhanced recharge and infiltration will also occur from the Old North Pit water to storage and the deposition of tailings slurry in South Pit (although tailings seepage is anticipated to be a minor contributor to the overall water balance).

The lack of water level response observed at shallow monitoring bores in the creek alluvial system, located within the limit of Coal Measures outcrop, demonstrates the disconnection of the shallow regolith and alluvial aquifers from the deeper groundwater regime. It also shows that the shallow aquifers in these locations are locally reliant on direct rainfall recharge, and that this has not been diminished by the ongoing mining operations.

2.4.1.6 Mine Site Catchment Hydrology

Run-off from undisturbed areas is directed away from mining operations through diversion banks, which direct run-off into natural watercourses or into a number clean water dams. Clean water dams overflow into the natural drainage system.

Within the RCS project area Rix's Creek is a losing (influent) stream, and within the RCN project area Reedy Creek, Station Creek and Glennie's Creek are losing streams. The elevation of the bottom of the Creek is above groundwater level and therefore the creek does not receive a base flow from the basement aquifer system – that is, there is no direct hydraulic connection between the alluvial system and the Permian Coal

Measures aquifer. This is an important concept for the Rix's Creek Mine, as it limits the potential for basement dewatering operations to impact upon creek alluvial groundwater levels

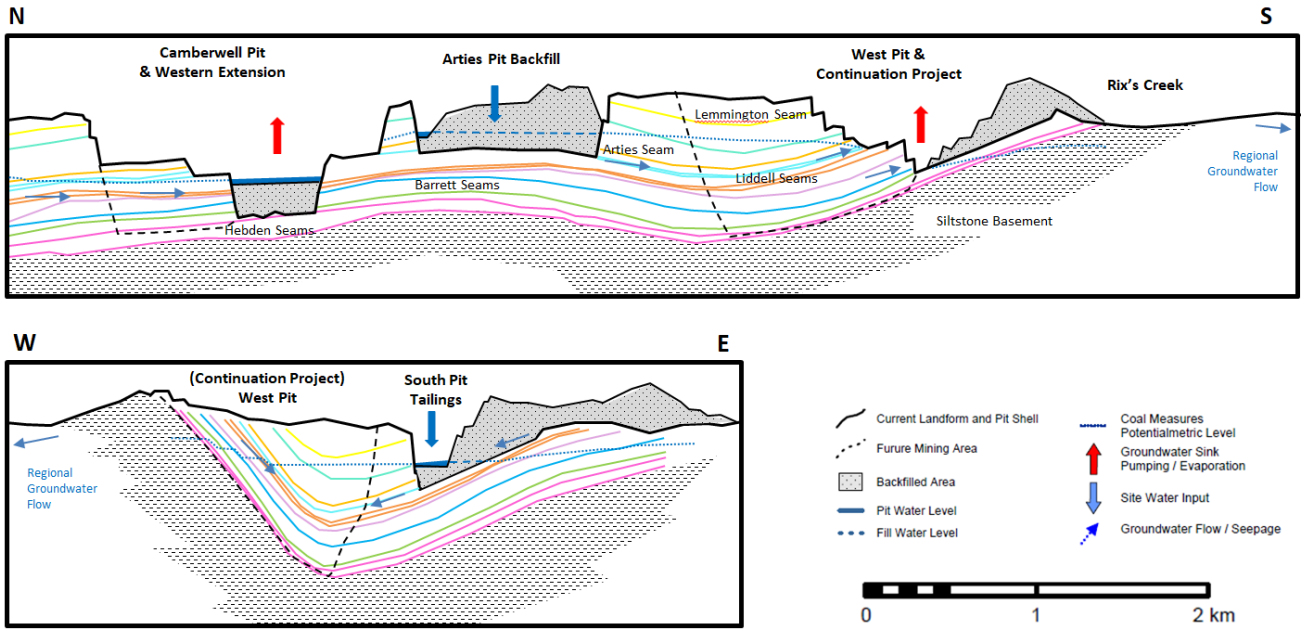

Figure 5: Conceptual Hydrogeological Model of the Rix's Creek Mine Area

2.4.2 Numerical Groundwater Model

The current version of the numerical groundwater model (2017) is an update to the previous version of the model adopted initially for the Rix's Creek South operations, and then utilised for impact assessment for the Rix's Creek Continuation Project (the expansion of West Pit). Since the Bloomfield Group acquired the open cut operations formerly associated with the Integra mining operations, there was a need to integrate these pits further into the latest version of the groundwater model – for calibration and prediction purposes.

In terms of upgrades to the model for calibration, the following is noted:

- Extended the calibration period to September 2017, including the addition of all available new observation data and four new observation bores;
- Mining sequences during the intervening period (June 2014 to September 2017) for RCN and RCS mining areas was updated based on actual mining progression; and
- Further work was undertaken to improve calibration through variation of aquifer parameters. Some limited improvement to the calibration was achieved; however the fit to the observed data is still good.

For the Prediction stage, the following adaptions are noted:

- Modification of the mining sequence predictive model to start in October 2017;
- It is noted that there were significant developments in mining since the 2014 iteration:
  - Arties Pit and South Pit are no longer present in the prediction period, as mining is completed. Aquifer parameters representing infill were added to the prediction model to represent Arties Pit and South Pit.

- West Pit mining has been modified in the model according to updated plans provided by Bloomfield.
- Camberwell Pit and Falbrook Pit mining is implemented in the model according to plans provided by Bloomfield.
- Third party mining activity was updated with the latest publically available information – including changes to Ashton Underground, Integra Underground, and Glendell Open Cut. Ashton SEOC was removed from the model as no future mining plans were found.

For the Recovery model stage, the following changes are noted:

- The recovery model was updated to reflect the newly provided final landform surface across the Mine area. Four remnant pit voids (and associated backfill) are now simulated in the recovery model – the West Pit and Arties Pit voids which were present in the original recovery model, a void in the Western Extension, and one at the Integra Underground Portal. Evapotranspiration and recharge were updated to simulate pit lakes at these voids
- The salt mass balance for the West Pit void was upgraded with groundwater fluxes from the updated model runs

For the Calibration, Prediction and Recovery models, null cases (without Rix's Creek Mine) models were developed to evaluate cumulative mining impacts (i.e. third parties only, versus all operators).

2.5 Water Balance at Rix's Creek Mine

2.5.1 Operational Mode

The main source of water supply for the Rix's Creek Mine (CHPP and dust suppression) is surface water. This is also the primary source of mine water utilised for process purposes, and is sourced from the pumped inflows from the Open Cut pits and the Portal Sump.

The Rix's Creek Mine has three other potential sources of water supply:

- Pumped inflows from various sediment dams;
- Pumped flows from the clean water diversion system; and
- Licensed extraction from Glennie's Creek (RCN) and production bore 20BL170864 (RCS).

A static water balance was calculated in review of the 2016 calendar year, providing information on inputs and outputs for both the Northern and Southern areas. The results are shown in Table 6 and Table 7 below.

Clean water use is minimised by reusing water stored onsite as the priority water source. The history of operation of the mines over recent years has shown that sufficient water is normally available within the mine water system without the need to access clean water supplies.

Most water demand on site is used for dust suppression and processing coal at the northern and southern CHPPs. In annual average terms, the estimated net CHPP demand is approximately 4.1 megalitres per day (ML/d) at RCS, or 1505 ML/a for RCN and approximately 4.8 megalitres per day (ML/d), or 1744 ML/a for RCS. The estimated dust suppression water demand for the Open Cut operations is approximately 145 ML/a for RCN and 611 ML/a for RCS.

Tables 6 and 7 provide estimates of the annualised inflows to and outflows from the mine water management system based on the site data, (including daily rainfall runoff data).

The overall site water balance will vary from year to year depending on coal production rates and climatic conditions.

2.5.1.1 Water Balance for Rix's Creek North Area

In 2016, evaporation losses from at the various water storage facilities across the Rix's Creek North area total to 1,355 ML. The major evaporative losses occurred at:

- The tailings storage facilities, approximately 441 ML;
- The Possum Skin Dam, approximately 487 ML;
- The in-pit voids, approximately 213 ML; and
- Dirty Water Dams 1 & 3; approximately 209 ML.

There was an estimated 100 ML of groundwater inflow into the open cut voids during the reporting period.

Seepage from rehabilitated emplacements and spoil dumps into the Underground Portal Storage was estimated at 511 ML. The volume pumped from the Integra Portal Sump is a combination of runoff and groundwater seepage from RCN, and runoff and underground dewatering volumes associated with Glencore's footprint and operations. Glencore have finalised the construction of a pipeline to transfer its water to the neighbouring Mt Owen Operations into Glencore's Greater Ravensworth Area Water Sharing Scheme (GRAWSS). (Mod 7 of Project Approval 08_0101), Bloomfield previously agreed to store all underground and seepage water volumes which Glencore will re-draw and transfer this water from Rix's Creek Mine into the GRAWSS.

The Rix's Creek North CHPP was not operational during 2016 and has undergone repairs to be operational in 2017. All the coal extracted from Rix's creek North operations during 2016 was washed at the Rix's Creek South CHPP with fine reject being stored in Tailings Dam 4 at Rix's Creek South operations – on that basis, the water usage and entrainment losses were lower than a "typical" year within the RCN area. The result of this operational hiatus is an above average accumulation of water - ~1,200 ML over the year.

The 2017 period coincided with rainfall significantly below the long term average rainfall in the Hunter Valley. The Rix's Creek Mine rain gauge recorded an annual rain fall of 560mm, compared to 698mm long term average rainfall in the Hunter Valley. In 2017, evaporation from site process water dams at Rix's Creek North totalled 1,450 ML. The major evaporation occurred at the Tailings Dam facilities and Possum Skin Dam, with the in-pit voids and Dirty Water Dams also contributing based on their surface area.

There was an estimated 100 ML of groundwater inflow into the open cut voids during the reporting period.

The groundwater inflow and seepage from rehabilitated emplacements and spoil dumps into the Underground Portal Storage was estimated at 805 ML. The estimate is based on water balance assessment work undertaken jointly by Rix's Creek and Integra throughout 2017 is resolving key water balance drivers and contributions.

The Rix's Creek North CHPP returned to operational mode in May 2017 and has been processing coal since that time.

Approximately 17 ML of potable water was sourced from the Singleton town water supply in 2017 for Rix's Creek South and Rix's Creek North operations.

Overall, the RCN area accumulated 832 ML, mostly in the Falbrook pit, through a combination of water directed from the Portal and the Camberwell Pit.

Table 7 2016 Static Water Balance – Rix's Creek North Area

Water Balance Component	2016 (ML)
Inputs	
Imported Fresh Water	0
Imported Potable	10
Groundwater & Spoil Seepage to Portal	511
Groundwater Seepage to Open Cuts	100
Underground Dewatering	0
Rainfall Runoff – Into Dirty Water System	2,165
Recycled to CHPP from Tails & Storage (not included in total)	0
Water from ROM Coal	0
Total Inputs	**2,783**
Outputs	
Groundwater Seepage Out	0
Dust Suppression – Water Carts	145
Exported to Other Mines – Dirty Water	0
Evaporation Fans & Sprays	0
Evaporation - Mine Water & Tailings Dams	1,350
Entrained in Process Waste	0
Water in Product Coal	0
Potable Usage	10
Total Outputs	**1,505**
Estimated Change in Pit Storage (increased)	**1,278**

Table 8 2017 Static Water Balance – Rix's Creek North Area

Water Balance Component	2017 (ML)
Inputs	
Imported Fresh Water	0
Imported Potable	7
Groundwater & Spoil Seepage to Portal	805
Groundwater Seepage to Open Cuts	100
Underground Dewatering	0
Rainfall Runoff – Into Dirty Water System	1,963
Recycled to CHPP from Tails & Storage (not included in total)	(220)
Water from ROM Coal	92
Total Inputs	**2,967**
Outputs	
Groundwater Seepage Out	0
Dust Suppression – Water Carts	198
Exported to Other Mines – Dirty Water	0
Evaporation Fans & Sprays	0
Evaporation - Mine Water & Tailings Dams	1,450
Entrained in Process Waste	389
Water in Product Coal	91
Potable Usage	7
Total Outputs	**2,035**
Estimated Change in Pit Storage (increased)	**832**

In terms of groundwater contributions in RCN against total allocations, the Table 9 (below) outlines the current forecast. These values will be scrutinised and validated as part of the annual water balance review. Within the RCN operations, in is anticipated that the underlying and deeper dewatering operations associated with the Integra Underground will continue to intercept and depressurise much of the regional basement groundwater, with RCN dewatering of Camberwell and Falbrook Pits being contributed from a more local zone of influence (upper coal seams not being intercepted by the underground workings).

In terms of key water balance components, it is noted that groundwater seepage to open cuts is only a few percent of the overall contribution, with rainfall (and associated runoff) contributions being the key water balance driver for the RCN site.

The forecast annual groundwater extraction volumes outlined in Table 9 below are based on a projection of currently intercepted groundwater seepage combined with an assessment of the planned mining sequence and mining advance rate below water table to inform the likely flows to be encountered throughout the life of mine.

Given the groundwater inflow volumes are in the order of 2-3% of total pit water inflows, with rainfall runoff being the dominating influence, the groundwater inflow is not considered to be a significant volume of water and is below the accuracy of the current water balance.

Table 9 Forecast Groundwater Extraction (versus Annual Licence Allocations)

Year	RCN Allocation (ML/a)	RCN Forecast (ML/a)	RCS Allocation (ML/a)	RCS Forecast (ML/a)
2018	200	100	100	100
2019	200	100	100	100
2020	200	150	100	80
2021	200	150	100	80
2022	200	200	100	80
2023	200	200	100	60
2024	200	250	100	60
2025	200	250	100	
2026	200	200	100	Pending Continuation Project
2027	200	200	100	
2028	200	150	100	
2029	200	150	100	
2030	200	100	100	
2031	200	100	100	
2032	200	100	100	
2033	200	80	100	
2034	200	80	100	
2035	200	80	100	

2.5.1.2 Water Balance for Rix's Creek South Area

Evaporation from Rix's Creek South process water dams totalled 430 ML in 2016. The major evaporation occurred at:

- The Process Water Dams, approximately 236 ML;

- The Arties Pit Void, approximately 32 ML;
- The southern Tailings Storage Facility 162 ML.

There was an estimated 47 ML of groundwater inflow into the open cut voids at Rix's Creek South during the reporting period.

In addition, approximately 20 megalitres (ML) of potable water was sourced from the Singleton town water supply in 2016 for the entire Rix's Creek Mine.

In 2016 the strategy was to manage water levels in the open cut at Rix's Creek South operations by pumping water to the southern CHPP for re-use, to surface water storage dams and disused pit voids to maximise evaporation. Water is pumped to the CHPP water supply dams and to the Arties Pit void from West Pit open cut operations. The RCS area ended the year with a minor accumulation of ~250 ML of water.

Table 10 2016 Static Water Balance – Rix's Creek South Area

Water Balance Component	2016 (ML)
Inputs	
Imported Fresh Water	-
Imported Potable	10
Groundwater Seepage To Open Cuts	47
Underground Dewatering	0
Rainfall Runoff – Into Dirty Water System	1,749
Recycled to CHPP from Tails & Storage (not included in total)	(646)
Water from ROM Coal	187
Total Inputs	**1,919**
Outputs	
Groundwater Seepage Out	0
Dust Suppression – Water Carts	611
Exported to Other Mines – Dirty Water	0
Evaporation Fans & Sprays	0
Evaporation - Mine Water & Tailings Dams	427
Entrained in Process Waste	572
Water in Product Coal	124
Potable Usage	10
Total Outputs	**1,744**
Estimated Change in Pit Storage (increased)	**249**

Table 11 2017 Static Water Balance – Rix's Creek South Area

Water Balance Component	2017 (ML)
Inputs	
Imported Fresh Water	0
Imported Potable	10
Groundwater Seepage To Open Cuts	50
Underground Dewatering	0
Rainfall Runoff – Into Dirty Water System	1,586
Recycled to CHPP from Tails & Storage (not included in total)	(470)
Water from ROM Coal	292
Total Inputs	**1,938**
Outputs	
Groundwater Seepage Out	0
Dust Suppression – Water Carts	410
Exported to Other Mines – Dirty Water	0
Evaporation Fans & Sprays	0
Evaporation - Mine Water & Tailings Dams	427
Entrained in Process Waste	928
Water in Product Coal	147
Potable Usage	10
Total Outputs	**1,922**
Estimated Change in Pit Storage (increased)	**16**

In terms of groundwater contributions in RCS against total allocations, Table 9 (above) outlines the current forecast. These values will be scrutinised and validated as part of the annual water balance review. Within the RCS operations, in is anticipated that ongoing dewatering of West Pit will continue to contribute only minor groundwater seepage volumes, with mining in this pit already well progressed to target depths.

In terms of key water balance components, it is noted that groundwater seepage to open cut is only a few percent of the overall contribution, with rainfall (and associated runoff) contributions being the key water balance driver for the RCS site.

2.5.2 Other Water Balance Considerations

The above water balance assessments have been undertaken independently to meet licensing and reporting requirements – however, this WMP seeks to enable flexibility to move water between the northern and southern mining areas to enable optimised water management across the whole mining complex.

In accordance with Schedule 3 Condition 35 Table 13 of PA 08_0102, Rix's Creek have investigated the opportunity to *"maximise water sharing with other mines in the region"* by providing water into the Greater Ravensworth Water Sharing Scheme (GRAWSS). Rix's Creek has finalised discussions with Glencore and have contractually agreed to provide water into the GRAWSS to export surplus water to other users in the area. Input into the scheme will reduce regional water abstraction, and improve local storage capacity at Rix's Creek Mine. This will involve water volumes greater than the currently stored Integra water as noted in section 2.5.1.1.

As at May 2019, Rix's Creek Mine are installing the required infrastructure to record all water transfers into the Scheme which will form part of the Water Accounting Framework reporting and Annual Review reporting requirements. Monthly sampling of water transferred into the scheme will be analysed for pH, ec and TSS.

3 Roles & Responsibilities

The roles and responsibilities of staff at the Rix's Creek Mine in respect of this WMP are presented in Table 8.

Table 12 Roles & Responsibilities

Role	Responsibilities
Mining Engineering Manager	• Ensure adequate resources are available to enable to implementation of this WMP; and • Provide the requisite personnel and equipment to enable this WMP to be implemented effectively. • Maintain accountability for the overall environmental performance of the Rix's Creek North operations, including the procedures and outcomes of this WMP; • Respond to any unplanned events that may potentially result in, or cause, negative environmental impacts as required. • Ensure reportable incidents are investigated and reported to the Environment Officer; • Ensure inspections are undertaken in accordance with the WMP; and • Check that persons conducting the inspection are appropriately trained, understand their obligations and the specific requirements of this WMP.
Environment Manager	• Authorise the WMP and future amendments; and • Ensure inductions and training relevant to the WMP is implemented. • Act as the interface for environmental matters between government authorities, private industry, contractors, community groups and the wider community; • Promptly notify the relevant regulatory agencies of any incidences or non-compliances; • Check that persons conducting the inspection are appropriately trained, understand their obligations and the specific requirements of this WMP;
Environment Advisor/ Officer and/or Pumping Coordinator	• Maintain a high level of understanding of the WMP; • Review and ensure implementation of the WMP; • Inform the relevant, Mining Engineering Manager and Environmental Officer of unexpected or serious environmental impact issues; • Ensure training relevant to the WMP is implemented; • Ensure reportable incidents are reported to relevant authorities; • Maintain an environmental monitoring program to gauge the effects of RCM mining operations on surface water and groundwater systems; • Conduct required monitoring to the standard and frequency outlined in this WMP and as per requirements of the EPL, Project Approval and associated water licence requirements • Develop an Annual Review report detailing the results of key performance indicators developed for each monitoring location; • Respond to any unplanned events that may potentially result in, or cause, negative environmental impacts. • Ensure inspections are undertaken in accordance with the WMP; • Review and assess the monitoring results and inspection checklists; • Carry out all required notifications; • Commission specialist input as required under this WMP; and

Role	Responsibilities
	• As required, seek the assistance of a consultant to undertake specialised monitoring, interpretation and reporting functions.
All Personnel	• Adhere to the requirements of the WMP; and • Report any events that may potentially result in, or cause, negative environmental impacts immediately to your Supervisor.

4 Surface Water Management Plan

4.1 Overview

To ensure that surface water management is occurring consistently with the objectives of this WMP, a monitoring program has been developed for Rix's Creek. The Surface Water Monitoring Program has been set up to provide parameters, sampling frequency, monitoring period and reporting requirements.

The Water Management System at Rix's Creek Mine has been designed with the primary objectives of:

- Performance of the Rix's Creek WMP;
- Minimising impacts (if any) on the surface water catchments;
- Segregation of uncontaminated, clean water runoff, from contaminated-mine water on site; and
- Priority use of and safe disposal on site of contaminated water.

A comprehensive monitoring program has been in place for the duration of the project to manage and monitor surface water during active mining operations and is detailed in Section 4.1.

4.2 Surface Water Monitoring Program

Surface water monitoring is conducted during normal mining operations at the locations identified in Figures 4 and 5. The surface water sites included in the monitoring program are:

- Streams and rivers near the site that have the potential to be impacted by the Rix's Creek Mine;
- Locations along the site's clean water diversion channel which runs through the Open Cut operations at RCN;
- Significant site water storages and areas that pose potential environmental and operational risks; and
- Pipelines, flows and levels of storages to enable water transfers and water balances to be completed.

For Rix's Creek operations, the Environmental Protection Licence (EPL 3391) revised on 30th of August 2017 requires the monitoring of selected surface waters and water storage dams for pH, EC, TSS and TDS. Grab samples are collected at the following sites once a month (minimum of four weeks).

Within the Rix's Creek North Area, the following surface water sampling locations have been identified:

- W3 - Martins Creek, where it enters the site;
- W6 - Blackwattle Creek, where it enters the site; and
- W1 - Station Creek, where it leaves the mine site.

Within the Rix's Creek South Area, the following surface water sampling locations have been identified:

- Site 1 - Railway Underpass, as the Creek enters the site;
- Site 2 - New England Highway Bridge, at the mid-point through the mine site;
- Site 10 – Below Operation, on Rix's Creek below the operation;
- Site 3 - Maison Dieu Road Bridge, after the Creek has left the site;
- Site 4-Clean Water Dam 1 - (CWD 1);
- Site 5-Clean Water Dam 2 - (CWD 2); and

- Site 7-Clean Water Dam 6 - (CWD 6).

The following sites require faecal coliforms and pH, on a quarterly basis during discharge:

- Northern CHPP STP to Discharge area; and
- Southern CHPP STP to Discharge area.

Grab samples are analysed for water quality parameters of pH, electrical conductivity, Total Dissolved Solids (TDS) and Total Suspended Solids (TSS). The water samples are analysed by laboratories that are accredited through the National Association of Testing Authorities, Australia (NATA).

The surface water monitoring locations shown on Figures 4 and 5 and details of the monitoring locations and water quality parameters to be monitored are presented in Table 9 and 10

The volumes of water inflow, storage, transfer and use within the water management system will be monitored using a series of flow meters and water level gauges at strategic locations, as shown in Table 11.

Table 13 Water Monitoring Suites

Suite	Analytes
1	Field Meter or laboratory analysis for electrical conductivity and pH
2	(Suite 1) + TDS, Alkalinity, $CaCO_3$ Sat. Index, Ca, Cl, Mg, Na, K, SiO_2, Fe, Sodium Adsorption Ratio, Total N, Total P
3	(Suite 1) + TDS, Na, K, Ca, Mg, F, Cl, SO_4, HCO_3, NO_3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr (Totals)
4	(Suite 2) + TPH
5	(Suite 1) + BOD, E Coli, Streptococci, Faecal Coliforms
6	(Suite 1) + E Coli
7	(Suite 1) + TSS, TDS
8	(Suite 1) + Comprehensive suite: Al, As, B, Ba, Be, Ca, $CaCO^3$, Total Cl, Cd, Co, CO^3, Cu, F, Fe (Soluble), HCO^3, Hg, K, Li, Mg, Mn, Na, NH^3, Ni, NO^2, NO^3, OH, P, Rb, Sb, Se, Si, SO4 (or S), Sr, Zn

Note:
TDS = Total Dissolved Solids
TPH = Total Petroleum Hydrocarbons
TSS = Total Suspended Solids
BOD = Biological Oxygen Demand

Table 14 Mine Water & Dam Monitoring – Frequency, Analytes and Method

Site	Site ID	Monitoring Suite (see **Table 9**)	Monitoring Frequency	Method
Rix's Creek North				
Dam C4	W10	Suite 7	Monthly	Grab sample
Dam C1	W12	Suite 7	Monthly	Grab sample
Dam C6	W13	Suite 7	Monthly	Grab sample
Dam C3	W14	Suite 7	Monthly	Grab sample
Dam C6A	W15	Suite 7	Monthly	Grab sample
Dam C8	W16	Suite 7	Monthly	Grab sample
Dam C2	W17	Suite 7	Monthly	Grab sample
Dam C5	W18	Suite 7	Monthly	Grab sample
Dam D1	W19	Suite 7	Monthly	Grab sample
North Dam 1 (seepage catch dam)	W20	Suite 7	Monthly	Grab sample
North Dam 2	W21	Suite 7	Monthly	Grab sample
Possum Skin Dam	GCSW03	Water level + Suite 3	Monthly	Staff gauge + grab sample
Possum Skin Dam Seepage Collector	GCSW04	Water level + Suite 3	Monthly	Visual level check for pump out + grab sample
Possum Skin Dam Sediment Pond	GCSW05	Water level + Suite 3	Monthly	Staff gauge + grab sample
Sediment Dam 1	SD1	Water level + Suite 7	Monthly	Staff gauge + grab sample
Sediment Dam 2	SD2	Water level + Suite 7	Monthly	Staff gauge + grab sample
Sediment Dam 3	SD3	Water level + Suite 7	Monthly	Staff gauge + grab sample
Sediment Dam B1	SD4	Water level + Suite 7	Monthly	Staff gauge + grab sample
Sediment Dam B2	SD5	Water level + Suite 7	Monthly	Staff gauge + grab sample
Sediment Dam B5	SD6	Water level + Suite 7	Monthly	Staff gauge + grab sample
Sediment Dam B6	SD7	Water level + Suite 7	Monthly	Staff gauge + grab sample
Pumped discharge from Extended South Pit	-	Water Volume	Monthly	Flow meter reading

Site	Site ID	Monitoring Suite (see **Table 9**)	Monitoring Frequency	Method
Pumped discharge from North Pit	-	Water Volume	Monthly	Flow meter reading
Offsite supply to other mines	-	Water Volume	Monthly (when pumped)	Flow meter reading
Rix's Creek South				
Site 1 – Rail Underpass	Site 1	Suite 1 Monthly, Suite 8 Annually	Monthly	Grab sample
Site 2 – New England Hwy	Site 2	Suite 1 Monthly, Suite 8 Annually	Monthly	Grab sample
Site 3 – Maison Dieu Bridge	Site 3	Suite 1 Monthly, Suite 8 Annually	Monthly	Grab sample
Site 10 – Below Operation	Site 10	Suite 1 Monthly, Suite 8 Annually	Monthly	Grab sample
Maison Dieu Industrial Estate Catchment Branch	-	Suite 8	Annual	Grab sample
Above Junction with Industrial Estate Catchment	-	Suite 8	Annual	Grab sample
Site 4 – Clean Water Dam 1 (CWD1)	Site 4	Suite 1 Monthly, Suite 8 Annually	Monthly	Grab sample
Site 5 – Clean Water Dam 2 (CWD2)	Site 5	Suite 1 Monthly, Suite 8 Annually	Monthly	Grab sample
Site 6 – Clean Water Dam 6 (CWD6)	Site 6	Suite 1 Monthly, Suite 8 Annually	Monthly	Grab sample
Dirty Water Dam 1	-	Suite 8	Annual	Grab sample
Dirty Water Dam 2	-	Suite 8	Annual	Grab sample
Dirty Water Dam 4 (DWD4)	-	Suite 8	Annual	Grab sample
West Pit Catchment	-	Suite 8	Annual	Grab sample
Sediment Dam Pit 3 – East	-	Suite 8	Annual	Grab sample
Sediment Dam Pit 3 – West	-	Suite 8	Annual	Grab sample
Rail Loader Tunnel Water	-	Suite 8	Annual	Grab sample

Table 15 Stream Monitoring – Frequency, Analytes and Method

Site	Type of Monitoring	Sampling Method	Frequency	Site Description
Rix's Creek North				
DWE Stn 210044 (GC1)	Electrical Conductivity and Flow	Water level logger / EC meter from NSW Office of Water website	Daily	Middle Falbrook Rd Bridge
GC1	Suite 7	Grab sample	Quarterly	Glennie's Creek
GC1	Suite 1	Grab sample	Monthly	Middle Falbrook Rd Bridge
GC1	Suite 3	Grab sample	Six Monthly	Middle Falbrook Rd Bridge
GC2	Suite 7	Grab sample	Quarterly	Glennie's Creek
GC2 / GCSW08	Suite 1	Grab sample	Monthly	Nobles Crossing
SC1 (W1)	Suite 7	Grab sample	Quarterly	Station Creek
SC2	Suite 7	Grab sample	Quarterly	Station Creek
SC3 (W23)	Suite 7	Grab sample	Quarterly	Station Creek
W3	Suite 7	Grab sample	Monthly	Martins Creek
W5	Suite 7	Grab sample	Monthly	Glennie's Creek
W6	Suite 7	Grab sample	Monthly	Blackwattle Creek
W7	Suite 7	Grab sample	Monthly	Stony Creek
Rix's Creek South				
Site 1 – Rail Underpass	Suite 1 Monthly, Suite 8 Annually	Grab sample	Monthly	Rix's Creek
Site 2 – New England Hwy	Suite 1 Monthly, Suite 8 Annually	Grab sample	Monthly	Rix's Creek
Site 3 – Maison Dieu Bridge	Suite 1 Monthly, Suite 8 Annually	Grab sample	Monthly	Rix's Creek
Site 10 – Below Operation	Suite 1 Monthly, Suite 8 Annually	Grab sample	Monthly	Rix's Creek
Maison Dieu Industrial Estate Catchment Branch	Suite 8	Grab sample	Annual	Rix's Creek
Above Junction with Industrial Estate Catchment	Suite 8	Grab sample	Annual	Rix's Creek

4.2.1 Rix's Creek Surface Water Performance

Surface water results and trends are analysed annually by specialist consultants. Recent results have shown no issues, breached trigger levels or reportable events. The water performance is summarised in the Annual reviews.

5 Surface Water Management Measures

The measures to manage surface water at Rix's Creek have been divided into those measures which aim to prevent water management incidents in the first place (i.e. Preventative Measures); and those measures which aim to minimise environmental damage in the event of a trigger or incident occurring (i.e. Corrective Measures).

5.1 Preventative Measures

5.1.1 Design & Operational Safeguards

The integrated surface water management system incorporates the design and operational safeguards set out in Table 13.

Table 16 Surface Water – Preventative Measures

Timing / Trigger	Measure	Responsibility

These design and operational safeguards are already in place.	**Rix's Creek North**
	• Retention and evaporation of mine water in the following dams:
	  • Dam D1
	  • Tailings Storage Facilities TD1, TD2 (now combined into a large single storage) and TD3
	  • Possum Skin Dam
	  • Falbrook Open Cut pit as temporary water storage
	• Use of mine water for:
	  • Processing coal at the northern CHPP, dust suppression and other mine-related activities at the Open Cut mining areas
	• Where practicable, maintenance of the water within Portal Sump at a target RL agreed with Integra (Glencore) to provide adequate storage and thereby prevent flooding of the Integra underground operations in the event of a major rainfall event.
	
	Rix's Creek South
	• Retention and evaporation of mine water in the following dams:
	  • Tailings Storage Facilities
	  • Dirty Water Dams 1 & 2 (DWD1 & DWD2)
	  • West Pit Storage Dam
	  • Arties Pit Storage Dam
	• Use of mine water for:
	  • Processing coal at the southern CHPP, dust suppression and other mine-related activities at the Open Cut mining areas
		Mining Engineering Manager

Timing / Trigger	Measure	Responsibility
These design and operational safeguards are already in place.	**Rix's Creek North** • Diversion of clean water from the upper reaches of Martin's and Blackwattle Creeks to Station Creek and then Glennie's Creek via a clean water channel through the site • Use of mine water for: • Export to other nearby mines, as demand and arrangements allow (eg. Ashton) • When possible, maintenance of Possum Skin Dam near the maximum operating level of 88.8m RL to maximise evaporation. **Rix's Creek South** • Retention and evaporation of mine water in the following dams: DWD1, DWD2, Tailings Storage Facility, West Pit Storage Dam, Arties Pit Storage Dam. • Runoff from undisturbed areas is directed away from mining operations through diversion banks and channels. • The construction and management of suitable dams and diversion banks to divert clean runoff water from entering mine workings (and associated mine water management). • Priority is given to the use of contaminated water in mine operations. Contaminated water is used in the coal beneficiation process and for dust suppression via water carts for haul road watering and spraying coal stockpiles. • Tailings from the coal beneficiation process are directed to the emplacement area and water decanted off the tailing's dam surface is recycled through the coal handling and preparation plant.	Environmental Advisor/Officer
Additional design and operational safeguards to be implemented across all sites.	**Rix's Creek North and South** • Utilise mining voids as temporary storage voids if water storage dams nearing or at capacity. • Ensure adequate pumping capacity (i.e. pumps, polypipe) available to meet site requirements. • Implement duty roster to ensure coverage of monitoring program, inspections and general management of surface water infrastructure.	Pumping Coordinator

See Figure 4 for the schematic representation of the integrated water management system for the Rix's Creek Mine.

5.1.2 Erosion & Sediment Control Plan

Erosion and sedimentation control is an integral part of the water management across the entire site. Erosion control on reshaped and rehabilitation areas is achieved by having the minimum delay in time and area between the active mining operation and establishing rehabilitation. Revegetation of rehabilitation areas is undertaken as soon as an area becomes available with the aim to establishing a minimum of 70% ground cover, the level required to adequately control soil erosion and sediment mobilisation. Accompanied with this

is the use of sediment detention basins in front of the operation, along haulage roads and on drainage lines flowing from establishing rehabilitation areas.

Clean water diversions were also constructed at RCN and RCS operational areas as required to enable mining progression in line with the requirements of the WMP. Shortly after the drains were constructed using a D6 dozer, the drains were cross ripped, and application of pasture mix was sown to promote grass cover to reduce sediment and erosion issues. In West Pit operations, the out of pit dump was rehabilitated using the Rix's Creek pasture species, with the aim of improving the water quality entering the sediment dams.

Prior to any disturbance activities being undertaken by the site, the Bloomfield Group Permit to Disturb is required to be completed. The purpose of the Permit to Disturb is to identify and address any potential environmental, community, infrastructure or safety hazards associated with the proposed works. As part of completing the Permit to Disturb, an Erosion and Sediment Control Plan (ESCP) is required to be developed. The ESCP should be implemented in conjunction with the Rix's Creek Mine Water Management Plan to ensure that the objectives of the ESCP are met. Surface water quality monitoring is included in the Water Management Plan. The erosion and sediment control inspections are conducted on a monthly basis. Actions from these inspections are recorded and remediation or improvements works undertaken as required.

Erosion and sediment control activities are to be undertaken in accordance with the guidelines from:

- Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Volumes 2A - Installation of Services, 2C- Unsealed Roads, and 2E - Mines and Quarries (DECC, 2008) (the Blue Book).

5.2 Corrective Measures

The corrective measures outlined here effectively the "Surface Water Response Plan" prepared as a condition of the Project Approval. The steps are presented in Table 13, indicating the measurements required, who is responsible for documentation and data collection and when it is to be implemented. Each category is described in further details in Sections 5.2.1 - 5.2.6.

Table 17 Surface Water – Corrective Measures

Timing / Trigger	Measure	Responsibility	Reference
Surface water quality trigger activated	• Sample and analyse discharge water and assess against relevant guidelines	Environmental Officer	5.2.1
Storm water flow exceeds drain or dam design capacity	• Increase the capacity of the drain or dam to accommodate the observed flow in accordance with the Blue Book.	Mining Engineering Manager / CHPP Manager (or delegate) or Environmental Officer	5.2.2
A discharge of sediment laden water occurs	• Assess the cause(s) of the discharge and take appropriate measures to correct any deficiencies in the design or operation of the system	Environmental Officer	5.2.3
A discharge of saline water occurs	• Assess the cause(s) of the discharge and take appropriate measures to correct any deficiencies in the design or operation of the system	Environmental Officer	5.2.3

Timing / Trigger	Measure	Responsibility	Reference
Inflows to sediment containment dam exceed design capacity	• Allow the dams to passive flow via their spillways in accordance with the design requirements in the Blue Book.	Mining Engineering Manager / CHPP Manager (or delegate) or Environmental Officer	5.2.5
Disturbed catchments have been observed that require rehabilitation	• Restore the affected areas following preparation of a post mining rehabilitation plan	Mining Engineering Manager (or delegate) or Environmental Officer	5.2.6
Changes to the catchment areas/yields occur in comparison with the pre-mining regime	• Restore pre-mining runoff characteristics in the natural water courses	Environmental Officer	-
Surface cracking and injury to people, stock or native animals occur	• Remediate the affected areas	Mining Engineering Manager (or delegate) or Environmental Officer	-
There are observed adverse effects on overland surface drainage and ponding	• Carry out additional work if required	Mining Engineering Manager (or delegate) or Environmental Officer	-
Adverse impacts on stream bed and bank stability / erosion are observed	• Remediate, as follows, if required: • Grade back unstable unconsolidated banks to their angle of repose and revegetate • Apply the appropriate revegetation technique to subsidence cracks • Revegetate denuded areas • Rectify subsidence effects on fencing and deny cattle access	Environmental Officer	-

5.2.1 Surface Water Quality Trigger Activated

In the event of a mine water storage area reaching its Blue Book Dam Design capacities, the target criteria for water leaving site would be based on the EPA guidelines and 100th percentile limit stipulated in the ANZECC (2000) limit for irrigation guidelines.

If a discharge event occurs, water sampling and analysis will be undertaken at affected locations, including downstream monitoring points. All samples will undergo water analysis for a range of parameters. These parameters will be plotted against past events, EPA guidelines and the ANZECC (2000) limit for irrigation guidelines.

The same samples will also undergo analysis to establish the concentration and frequency of pollutants. This analysis will be assessed to ensure compliance with DPI Water / EPA requirements.

5.2.2 Stormwater Flow and Dam Design Capacity

Following rainfall events, data will be reviewed to determine the magnitude of the rainfall event if the flow associated with a drain, or out of a dam, exceeds its design capacity. If the magnitude of the event is less than the design capacity (i.e. the drain or dam should have contained the event), the capacity of the drain or dam will be increased to accommodate the observed flow.

5.2.3 Discharge Events

Rix's Creek Mine is a non-discharge site meaning that mine water or sediment laden water must be retained within the Rix's Creek Mine water storage system, other than discharge through the Greater Ravensworth Area Waste Sharing Scheme (GRAWSS). Events outside the normal operation of the water storage system that exceed the design capacity of dams constructed in accordance with the Blue Book will be addressed as per the detail in sections 5.2.3.1, 5.2.3.2 and 5.3.2.3.

5.2.3.1 Discharge with High Total Suspended Solids

If water with a high Total Suspended Solids (TSS) level is discharged from site, (other than through the GRAWSS), the effect of the discharge on Glennie's or Rix's Creek will be assessed to determine the magnitude/volume of the event and the likely significance of the discharge in terms of pollutant load. Sampling and analysis will be undertaken at affected locations and downstream monitoring points to determine any potential environmental impact. The assessment will make recommendations as to appropriate measures to correct any deficiencies in the design or operation of the system.

These incidents will be reported to the Environment Protection Agency (EPA), Department of Planning and Environment (DPE), and Resources Regulator (RR) as per the Bloomfield Groups Environmental Incident and Emergency Response Plan.

5.2.3.2 Discharge of Saline Water

If saline water is discharged from site, (other than through the GRAWSS), the effect of the discharge on Glennie's and Rix's Creek will be assessed to determine the magnitude of the event and the likely significance of the discharge in terms of pollutant load. The assessment will make recommendations on appropriate measures to correct any deficiencies in the design or operation of the system.

These incidents will be reported to the Environment Protection Agency (EPA), Department of Planning and Environment (DPE), and Resources Regulator (RR) as per the Bloomfield Groups Environmental Incident and Emergency Response Plan.

5.2.3.3 Sediment Dam Inflows Exceed Design Capacity

If storm runoff exceeds the design operating capacity of sediment dams, the dams will discharge via their spillways into Reedy Creek (Falbrook Open Cut) or Station Creek (Camberwell Pit and Western Extension at RCN; or into Rix's Creek in the RCS area.

The spillways are designed to minimise the risk of scouring embankments and loss of the storage. In addition, silt fencing has been installed and should be maintained downstream of these spillways to help reduce any potential environmental impacts should an overflow event occur.

These incidents will be reported to the Environment Protection Agency (EPA), Department of Planning and Environment (DPE), and Resources Regulator (RR) as per the Bloomfield Groups Environmental Incident and Emergency Response Plan.

5.2.4 Restoration of Disturbed Catchments

Mine operational impacts which necessitate the need to rehabilitate any land surface, stream bed or bank, modify stream flow or improve water, will be undertaken following preparation of a post mining rehabilitation plan that addresses the relevant issues.

Following the completion of mining, site rehabilitation will entail re-shaping, soil application and vegetation, with the completed mining areas in the pit and associated catchments being revegetated primarily with endemic local species to restore the run-off and water quality characteristics of these areas or water sources. Waste rock emplacement areas will be rehabilitated progressively to minimise mine footprint, and the associated volumes of mine water run-off, and to restore the flow and quality of run-off from these catchments.

In accordance with Rix's Creek North Project Approval (PA08_0102) Rix's Creek Mine have committed to undertake riparian rehabilitation along Glennies Creek and will include

- Erosion control, rubbish removal, complimentary planting, weed control, habitat enhancement and exclusion of grazing of stock from riparian areas; and
- A monitoring and management programme to identify and manage noxious weed infestations.

6 Groundwater Monitoring Management Plan

6.1 Overview

The groundwater monitoring program has been implemented to monitor for potential groundwater impacts and to provide data that enables comparison of the actual impacts of the Rix's Creek Mine with those predicted in the current groundwater model. Monitoring locations for potential impacts were selected to facilitate the observation of any significant changes in the groundwater regime across the project area – the Permian basement and the creek alluvial system.

The monitoring network was designed to comply with the DPI Water guidelines to:

- Permit the collecting of a sufficient and reliable level of data such that any interpretation based on that data should accurately represent the condition of the natural resource at the time of sampling;
- Provide a mechanism for monitoring the impact of mining developments on the groundwater system and to relate it to the predictions made during the environmental impact assessment process; such as:
  - Tailings emplacement area - groundwater pollution;
  - Spoils and emplacement – contribution of salt to surface water and groundwater;
  - Surface water bodies – these may locally control groundwater levels in surrounding spoil and Permian strata; and
  - Waste dumps & CHPPs – surface water runoff and associated water quality issues.
- Initiate any required remediation and restoration program where there is degradation of the groundwater regime beyond the trigger levels identified in the approvals as part of the development application.

The overall aim of the monitoring program is to develop and expand a baseline set of water level and quality data for the Rix's Creek Mine against which any future perceived, or actual groundwater impacts of the mine can be independently assessed. The currently implemented groundwater monitoring program consists of the following:

- Groundwater levels monitored via a network of VWPs, open standpipe piezometers and production bores;
- Piezometers monitor water levels in both the regolith, alluvium and coal seams;
- Hydrogeological conditions in the shallow and deep groundwater systems adjacent to the working seam are monitored by multi-level piezometers (nested installations);
- The Singleton STP weather station provides climatic data;
- Field water chemistry is recorded (EC, pH, TDS and Temperature);
- Piezometer water levels and field chemistry are recorded on a bi-monthly basis; and
- All piezometers are sampled annually for a standard chemistry suite undertaken by a laboratory.

The monitoring network currently includes a combination of standpipe piezometers (monitoring bores), production bores and vibrating wire piezometers. The bore details are summarized in Table 14 and the objectives of the monitoring program are outlined in Table 15.

Table 18 Groundwater Monitoring Program Network

Bore ID	License	Easting	Northing	Screened Interval (mbgl)	Stick Up (m)	Surface Elevation (mAHD)	Total Depth (mbgl)
Rix's Creek North							
Creek Alluvium							
GCP10	(20BL171708)	324414	6408030	Unknown	0.7	74.891	11.5
GCP23	(20BL171721)	324535	6407659	4.6 - 8	1.01	75	8
GCP28	(20BL171722)	322651	6405459	6.7 to 12.0	0.8	69.5	12
GCP29	(20BL171722)	323191	6405356	4.5 to 10.0	0.9	71	10
GCP30	(20BL171720)	322438	6404649	5.5 to 12.0	0.94	67.5	12
Coal Measures							
GCP6	(20BL169631)	324941	6406784	Unknown	0.38	102.931	126
GCP7	(20BL169628)	325864	6407071	60 – 72 & 96 - 102	0.1	93.034	120
GCP8	(20BL169630)	326332	6407214	Unknown	0.44	105.095	120
GCP14	(20BL169628)	325774	6407042	Unknown	0.66	90.99	123
GCTB	(20BL169631)	325149	6406572	Unknown	0.2	102.564	90
GCP27	(20BL171881)	323197	6406037	36.5 to 37.5	1.11	70	27.5
GCP32	(20BL171880)	322491	6404250	49.0 to 55.0	0.66	70.5	55.55
GCP34	(20BL171879)	322800	6403235	47.0 to 56.25	0.61	101	56.25
GCP35 (VWP)	VWP	323149	6404757	72 / 147 / 195	n/a	71	197
GCP36	(20BL171722)	322915	6405320	14.5 to 16.0	0.85	70.5	16
GCP37 (VWP)	VWP	324156	6405612	70 / 125	n/a	80	127.5
SGD 644 (VWP)	VWP	325143	6406526	77.6 / 83.6 / 94.4	n/a	104.6	104
SGD 645 (VWP)	VWP	325815	6406509	57.6 / 66.6 / 75.2	n/a	96.6	96
Rix's Creek South							
Creek Alluvium							
BH-8	-	321803	6401175	5 to 14	0.8	85.446	20

Bore ID	License	Easting	Northing	Screened Interval (mbgl)	Stick Up (m)	Surface Elevation (mAHD)	Total Depth (mbgl)
BH-4	-	323982	6398666	7 to 10	0.74	N/A	10
Coal Measures							
BH-3	-	325457	6401923	5 to 8	0.97	N/A	11
BH-5	-	324562	6399924	63 to 66	1.04	76.469	66.5
BH-7	-	323345	6401709	150.5 to 198.5	0.72	100.86	200.5
20BL170864	-	324633	6400335	N/A	0.3	N/A	~70
DDH223	VWP	321684	6409694	N/A	N/A	N/A	N/A
DDH224	VWP	323034	6407439	N/A	N/A	N/A	N/A

Table 19 Groundwater Monitoring Plan

Timing / Trigger	Measure	Responsibility
Monitoring activities will be undertaken in accordance with the frequency / timing indicated in this WMP.	The groundwater monitoring program specifically provides for the collection of information relating to: • Provide detailed baseline data of groundwater levels, yield and water quality in the region • Impacts on groundwater levels on neighbouring properties and any beneficial groundwater users • Impacts on the groundwater dependent ecosystems associated with the alluvial aquifers of Glennie's Creek, Station Creek, and Rix's Creek. • Groundwater impact assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts The current operational groundwater monitoring programs will continue with ongoing review and possible modification of the program as further data are obtained and interpreted	Environmental Advisor / Officer

6.2 Groundwater Monitoring Program

6.2.1 Monitoring Water Levels

As part of the Water Management Plan for Rix's Creek Mine, an extensive monitoring program has been implemented to detect any impacts from mining (and associated dewatering) on the groundwater regime, and from any nearby groundwater users (including third party mining operators). The broad monitoring program incorporates both shallow and deep groundwater monitoring locations monitoring the water levels in the Creek Alluvial deposits and the Permian Coal Measures around both the RCN and RCS areas. The monitoring

locations are shown in Figures 1 to 3, and listed in Table 16. Table 17 outlines the method and frequency of water level measurement requirements based on the water management plan.

The monitoring site selection was based on:

- Previous assessments of the local environment;
- The current and proposed mining operations;
- Mine rehabilitation plans; and
- The existing groundwater users in the area.

Piezometers, production bores and VWPs included in the operational groundwater monitoring program include the Foybrook Formation basement coal measures as well as the Glennie's Creek, Station Creek, and Rix's Creek alluvium groups. As the Rix's Creek Mine continues to develop and evolve, there may be requirements from time to time to replace, remove or add piezometers to enable the monitoring network to achieve its stated objectives – such alterations would be documented in future revisions to the WMP over time.

Table 20 Groundwater Level Monitoring – Method and Frequency

Monitoring Site	Sampling Method	Frequency	Units
Rix's Creek North			
GCP6, 8, 10, 21	Dip meter	Bi-monthly	mbgl
GCP7, 14, 23, TB	Dip meter	Bi-monthly	mbgl
GCP29, 30, 32, 34,	Dip meter	Bi-monthly	mbgl
GCP27,28, 32	Dip meter	Bi-monthly	mbgl
GCP35, GCP37, SGD644, SGD645	Vibrating wire piezometer array	Twice daily / annual download	Pressure (m head)
Rix's Creek South			
BH3 – BH5, BH7 - BH8	Dip meter	Bi-monthly	mbgl
DDH223, DDH224	Vibrating wire piezometer array	Twice daily / annual download	Pressure (m head)
20BL170864	Dip meter	Bi-monthly	mbgl

Note:

*mbgl = metres below ground level

*Missing bore numbers are either not drilled or not used (GCP03, 4, 17, 33, 40) or have been removed / destroyed

*Where they are now required, any new bores will be installed by suitably licenced drillers after obtaining the relevant licence from DPI Water

*Bi-monthly is every two months

6.2.2 Rix's Creek Mine Water Level Performance

Groundwater results and trends are analysed annually by specialist consultants. Recent results have shown no exceedances of groundwater trigger levels or reportable events. Water level performance is summarised in the Annual reviews.

6.2.3 Monitoring Groundwater Quality

Table 14 presents the combined monitoring bore network for Rix's Creek North and Rix's Creek South which make up the Rix's Creek Mine. The bores and parameters are to be monitored while mining operations are occurring. The units and frequency of monitoring for the groundwater quality monitoring program for all open standpipe piezometers is to be bi-monthly for EC, pH, TDS and Temperature and annually for a full suite as noted in Table 17.

Groundwater samples will be collected annually from selected piezometers and analysed at a NATA accredited laboratory for major ions and selected metals. Monitoring will continue for 3 years following cessation of mining or longer if required by EPA, DP&E and DPI Water.

The frequency of monitoring will be reassessed after mining of specific areas is complete as it may be viable, depending on results, to reduce the sampling frequency.

6.2.3.1 Rix's Creek North Area

Groundwater monitoring sites have been identified ranging from piezometers, production / regional bores and VWP installations to provide adequate monitoring coverage to produce a viable Groundwater Monitoring and Response Plan.

Baseline monitoring data has been reviewed back to September 2009, with monthly monitoring of field water quality parameters including: Electrical conductivity (EC), TDS and pH. Quarterly sampling has been undertaken regularly since 2012. The historical comprehensive laboratory analysis suite of parameters including:

- Physical properties (EC and pH);
- Major cations, anions and selected Total Metals (Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr)

6.2.3.2 Rix's Creek South Area

Groundwater monitoring sites have been identified ranging from piezometers, production bores and VWP installations to enable the development of a suitable Groundwater Monitoring and Response Plan. In May 2010, five standpipe piezometer monitoring bores were installed (BH-1 to BH-5) and along with an existing production bore (20BL170864), with a further two bores BH-7 and BH-8 installed in 2015.

Baseline monitoring commenced in May 2010, with regular monthly monitoring of field water quality parameters including: Electrical conductivity (EC), Total dissolved solids (TDS) and pH. Quarterly sampling was undertaken for historical comprehensive laboratory analysis of a broader suite of parameters including:

- Physical properties (EC, TDS, and pH);
- Major cations and anions (Ca, Mg, Na, K, Cl, SO4, HCO^3 and CO^3); and
- Selected Total Metals.

Table 21 Groundwater Quality Monitoring – Method and Frequency

Monitoring Site	Water Quality Parameters	Sampling Method	Frequency
GCP6, 8, 10, 21, 22, GCP7, 14, 19, 20, 23, TB, GCP29, 30, 34,GCP27, 28, 32, BH3 – BH5, BH7 - BH8, 20BL170864,	EC, pH, TDS, Temperature	Pumped or bailed sample	Bi-monthly
GCP6, 8, 10, 21, 22, GCP7, 14, 23, TB, GCP29, 30, 32, 34, GCP27, 28, 32, BH3 – BH5, BH7 - BH8, 20BL170864	(EC, pH) + TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, hardness, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd (Totals)	Pumped or bailed sample	Annually

6.2.4 Rix's Creek Mine Water Quality Performance

6.2.4.1 Rix's Creek North Area

Results from 2016 reporting period showed pH remained at relatively constant levels throughout the reporting period at all GC series piezometers (neutral to slightly alkaline range). EC was consistently low at the Glennie's Creek alluvial bore GC09 (307-445 μS/cm).

The pH and salinity in the Glennie's Creek alluvial open standpipe piezometers has not shown any significant trends since they were installed in 2007, except for a reducing salinity profile in GCP29 and GCP30 between mid-2009 and early 2011.

The pH and salinity in the basement open standpipe piezometers in the vicinity of the Camberwell Pit has not shown any significant trends since they were installed after mid-2007.

The pH and salinity in the alluvial open standpipe piezometers in the vicinity of the Falbrook Open Cut Pit has not shown any significant trends since they were installed in 2012. Likewise, the pH and salinity in the Falbrook Open Cut basement open standpipe piezometers have not shown any significant trends since they were installed in 2012, excepting a rise then fall in salinity in GCP14 and a reduction in salinity at GCP02.

6.2.4.2 Rix's Creek South Area

Results from 2016 annual water review showed pH remained at relatively constant levels throughout the reporting period at all BH series piezometers (neutral to slightly alkaline range). Groundwater EC (mS) throughout the period of monitoring have also returned stable results. This is all consistent with the historical groundwater EC ranges.

The average salinity values of the groundwater sampled from the screened bore in the coal seam (BH5) ranged between 4,680 to 6,140 mg/L showing high levels of salinity. BH7 was also sampled and recorded 7,250 mg/L in May 2016, although the bore appeared to be dry during other sampling events during 2016. The salinity values within the regolith (BH3 and BH4) are also high ranging from 5,720 to 20,400 mg/, but are consistent with field water quality parameters observed in the region over time.

Since monitoring commenced in 2012, salinity levels are shown to remain consistent (yet distinct) in the coal seams and the regolith/alluvium. This indicates limited connectivity (and mixing) between the two aquifer zones, and no negative water quality trends are being driven from mining operations in the area. This is consistent with the hydrogeological conceptualisation which underpins the groundwater baseline study and impact assessment work, and continues to be validated by the ongoing monitoring analysis.

7 Groundwater Management Measures

As with surface water management, measures to manage groundwater at Rix's Creek Mine have been divided into those measures which aim to prevent groundwater management incidents in the first place (i.e. Preventative Measures); and those measures which aim to minimise environmental damage in the event of a trigger or incident occurring (i.e. Corrective Measures).

7.1 Preventative Measures

7.1.1 Open Cut Groundwater Inflows

The approach to the management of groundwater inflows into open cuts is outlined in Table 19.

Table 22 Groundwater – Preventative Measures

Timing / Trigger	Measure	Responsibility
Ongoing	• Groundwater seepage will be estimated by measuring the total volume of water pumped into and out of each pit using flow meters • The annual groundwater seepage volume for each pit will be determined from the measured pit inflow and outflow volumes, after allowing for annual rainfall within each pits' catchment area and for evaporation • The estimated groundwater inflow in the open cut pits will be reported annually in the Annual Review Report • Impacts on the groundwater supply of nearby landowners. • Impacts on nearby creeks and any groundwater dependent ecosystems and riparian vegetation will be reported	Environmental Advisor / Officer

7.2 Corrective Measures

The corrective measures which follow effectively constitute the "Groundwater Monitoring and Response Plan" required as a condition of Project Approval. The measures are presented in Table 20, indicating the measures required, who is responsible for implementing the measure and when it is to be implemented. Explanatory notes for each action follow the table.

Table 23 Groundwater – Corrective Measures

Timing / Trigger	Measure	Responsibility	Reference
Groundwater level trigger activated	• Investigate the causes for the unpredicted changes to groundwater levels and take appropriate actions	Environmental Officer	7.2.1
Groundwater quality trigger activated	• Investigate the causes for the unpredicted changes to groundwater quality and take appropriate actions	Environmental Officer	7.2.2

Timing / Trigger	Measure	Responsibility	Reference
Departures from groundwater model validation and calibration experienced	• A suitably qualified and experienced hydrogeologist assess the cause(s) of departures and take appropriate actions (if required)	Environmental Advisor/Officer	7.2.3
Adverse impacts on yield of well GW67291 or other private bores/wells	• A suitably qualified and experienced hydrogeologist assess the cause(s) of departures and take appropriate actions	Environmental Advisor/Officer	7.2.4
A reduction in the standing water level within a private bore/well which exceeds the identified trigger because of mining	• Bloomfield to enter negotiations with affected landowner(s) to explore options (including to provide compensatory water supply)	Environmental Advisor/Officer	7.2.5
A loss of flow in Glennie's, Station or Main Creeks	• A suitably qualified and experienced hydrogeologist investigate the cause(s) of loss of flow and develop a strategy to minimise any adverse impacts if loss of flow due to open cut operations at Rix's Creek Mine	Environmental Advisor/Officer	7.2.6
Stream flow monitoring within Glennies, Station, or Main Creeks indicates significant adverse departure from previously monitored stream flows	• Determine if equivalent offset to the stream flow loss is required	Environmental Advisor/Officer	7.2.7

7.2.1 Groundwater Level Trigger Activated

A groundwater level trigger will be activated if the groundwater level in a piezometer or well within the Quaternary alluvium falls by greater than 15% of the saturated aquifer thickness. Where the historic water level exceeds the 15% alluvium thickness level, the actual measured variation range will take precedent, as shown in Table 21. To activate the trigger, the reduction in water level will also need to be at a level that is deeper than the historical ranges of natural variability measured in the overall monitoring data set.

Ongoing monitoring will continue to identify whether increasing and declining trends in the data are associated with climatic/streamflow trends, or the more local influences of drawdown. Appendix B shows the historical data and associated hydrographs which inform and track this level trigger. To date, the trends in the alluvium hydrographs shows a correlation with rainfall events (and associated streamflow influences), and not with dewatering drawdown.

The trigger level will undergo adaptive management, if necessary, against updated benchmark data as the monitoring program continues.

It should be noted that historically, no groundwater level triggers have been set for the Coal Measures piezometers. Based on the groundwater modelling undertaken in 2017, and at the request of NRAR, it is now proposed that the piezometers identified in Table 22 (inserted below) and associated groundwater level reduction be reviewed and discussed annually as part of the water reporting to assess basement drawdown trends. The development of specific trigger levels has not been explored in detail, for a number of reasons:

- There is a lack of pre-mining / unimpacted water level data in the basement units to enable calibration to these hydraulic conditions across the catchment and model domain;

- There are numerous mining operations undertaking dewatering operations, with the finer detail of such operations unavailable to integrate into Rix's Creek groundwater modelling, meaning divergences in individual hydrograph responses and model calibration are likely;
- The groundwater model is developed with a focus on regional impact assessment, and does not seek to replicate hydraulic processes relating to water storage and seepage mechanisms local to the operational footprint (and such processes can influence individual hydrographs); and
- Overall, the water levels measured in more recent times (since 2012), show that there is a vertical separation between the basement water levels (deeper) and the alluvial water levels (shallower) that mean that from an impact/risk point of view – that further changes in basement water levels are unable to influence upon the alluvial aquifer performance.

On this basis, we recommend the adoption of a basement water level review and discussion as part of annual reporting, rather than the development of specific hard trigger levels on a bore-by-bore basis

In the event of trigger activation, the causes will be investigated, and appropriate actions determined and undertaken.

If the monitoring results show an exceedance of the adopted water level trigger values, the response actions listed below will be initiated. An action plan will be prepared to reflect these actions:

- Once an exceedance is detected the circumstances of the event will be immediately investigated including a review of relevant monitoring data, meteorological conditions, etc;
- An assessment will be made to determine the reason for the exceedance, the potential magnitude of the impact, and inform the level of future risk;
- If assessed as being caused by the mining operation, and it is further assessed to be likely to cause an adverse impact on an existing use for surface water, then an appropriate preventative and/or remedial strategy will be prepared for discussion with relevant authorities which may comprise:
  - Additional monitoring including assessment of ecological aspects;
  - Modification of mine water management procedures;
  - Modification of mine water management facilities; or
  - (If appropriate) change to Operations.
- A response / mitigation plan will be implemented to the satisfaction of the relevant authorities
- If it is found that downstream water users have been adversely impacted, the landholder(s) will be consulted regarding the provision of an alternative water supply or some other appropriate agreement negotiated between the parties

Table 24 Groundwater Level Reduction – Saturated Alluvium Thickness Trigger

Bore ID	Screened Interval (mbgl)	Total Depth (m)	15% of Alluvial Thickness	Historical Water Level Variability (m)	Trigger Value
Rix's Creek North					
GCP10	Unknown	11.5	1.73	0.4	1.73

Bore ID	Screened Interval (mbgl)	Total Depth (m)	15% of Alluvial Thickness	Historical Water Level Variability (m)	Trigger Value
GCP21	6 to 11	11	1.65	1.04	1.04
GCP23	4.6 - 8	8	1.20	0.62	1.20
GCP26	7.0 - 11.0	11	1.65	0.88	1.65
GCP28	6.7 -12.0	12	1.80	0.4	1.80
GCP29	4.5 - 10.0	10	1.50	0.4	1.50
GCP30	5.5 -12.0	12	1.80	2.03	2.03
Rix's Creek South					
BH4	7-10	10	1.5	2.33	2.33
BH8	5-14	20	3	0.14	3

7.2.2 Groundwater Quality Trigger Activated

Groundwater monitoring has shown that the groundwater quality in both the coal measures and alluvial aquifers, except for groundwater immediately adjacent to Glennie's Creek (i.e. GCP9 and GCP10), exceeds the criteria shown in Table 21 and Table 22.

Trigger levels (Table 23) are set so that a variation of greater than 15% from the average 2002 to 2016 baseline EC value or 0.5 pH deviation from baseline range conditions will trigger further investigation. In the event of a trigger activation, the causes will be investigated, and appropriate actions determined and undertaken.

Table 25 Groundwater Quality Criteria – Major Ions & Nutrients

Type	pH	TDS	EC	F	SO_4	NO_3	Hardness as $CaCO_3$
	Unit	mg/L	uS/cm	mg/L	mg/L	Mg N/L	mg/L
Irrigation	6 - 8.5	-	-	2	-	25 – 125 (N)	>60 - 350
Livestock	-	<4000 / 5000	6100 / 7700	2	-	-	-

Table 26 Groundwater Quality Criteria – Metals (mg/L)

Type	Cu	Pb	Zn	Ni	Fe	Mn	As	Se	Cd	Cr
Irrigation	5	5	5	2	10	10	2.0	0.05	0.05	1

Type	Cu	Pb	Zn	Ni	Fe	Mn	As	Se	Cd	Cr
Livestock	1 / 0.4	0.1	20	1	-	-	0.5	0.02	0.01	1

Table 27 Groundwater Quality Trigger Levels

Parameter	Trigger Level
Electrical Conductivity (EC)	>15% variation from the average 2003-2016 baseline data
pH	>pH 0.5 variation from the average 2003-2016 baseline data

7.2.3 Groundwater Model Validation and Calibration Departures

The current version of the numerical groundwater model (2017) is an update to the previous version of the model adopted initially for the Rix's Creek South operations, and then utilised for impact assessment for the Rix's Creek Continuation Project (the expansion of West Pit). Since the Bloomfield Group acquired the open cut operations formerly associated with the Integra mining operations, there was a need to integrate these pits further into the latest version of the groundwater model – for calibration and prediction purposes.

If groundwater level monitoring data within the Rix's Creek Mine alluvial and basement piezometers suite indicates a significant adverse departure from the anticipated drawdowns, and these departures may be directly related to dewatering of the Falbrook Pit, the Western Extension of the Camberwell Pit, then a suitably qualified and experienced hydrogeologist will be required to assess the cause of the departure.

If the departure from the groundwater prediction can be directly related to the unanticipated adverse drawdowns in the Glennie's Creek, Station Creek, or Main Creek alluvium or the Permian Coal Measures basement lithologies (Foybrook Formation) due to dewatering of the open cut pits, then a groundwater model validation and calibration program to site specific conditions may be required, after discussion and agreement with DPI Water.

7.2.4 Adverse Impact on Groundwater Users

At present there is one active registered groundwater extraction point (well GW67291) within the potential drawdown area for the Falbrook Open Cut pit (modelled by AGE Pty Ltd, 2006 on behalf of Integra Operations); and the Western Extension of the Camberwell Pit (modelled by Geoterra, 2009 on behalf of Integra Operations).

In the event of any reported adverse impacts on the yield of the subject water supply well or any private bores or wells that may be developed in the future within the Rix's Creek Mine water footprint, the cause will be investigated by a suitably qualified and experienced hydrogeologist. If the impacts can be directly related to the mine following assessment of the available monitoring data, either the affected bore or well will be deepened or an alternative water source will be provided.

7.2.5 Compensatory Groundwater Supply

If monitoring identifies a reduction in the standing water level within a private bore or well which exceeds the identified trigger and it is established to be a consequence of mining, Bloomfield will enter into negotiations

with the affected landowner(s) with the intent of formulating an agreement which provides for one or a combination of:

- Re-establishment of saturated thickness (alluvial aquifer) or standing water level (basement aquifer) in the affected bore(s) through bore deepening;
- Establishment of additional bores to provide the yield at least equivalent to the effected bore prior to being affected by mining;
- Provision of access to alternative sources of water; and/or
- Compensation to reflect increased water extraction costs – e.g. due to lowering pumps or installation of additional or alternative pumping equipment.

The compensatory water supply measures will provide an alternative long-term supply of water that is equivalent to the loss attributed to the Rix's Creek Mine.

If Bloomfield and the landowner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer to the Secretary for resolution. If Bloomfield is unable to provide an alternative long-term supply of water, then Bloomfield shall provide alternative compensation to the satisfaction of the Secretary.

7.2.6 Loss of Flow in Glennie's, Station or Main Creeks

The surface water assessment conducted for the Environmental Assessment (PSM, 2007) and for the Western Extension of the Camberwell Pit (WRM Water and Environment, 2009) did not anticipate any observable loss of flow in Glennie's Creek, Station Creek, and no ameliorative actions are currently proposed. In the southern area, Rix's Creek is likewise not anticipated to be influenced by mine water management operations.

If any observable loss of flow in Glennie's Creek is identified, then a qualified hydrologist will be commissioned to assess whether the loss of flow is due to operations at Rix's Creek Mine.

If the loss of flow is due to Rix's Creek Mine operations, then the hydrologist will develop a strategy to minimise any adverse impacts.

7.2.7 Stream Baseflow Offsets

If stream flow monitoring at nominated locations within the Rix's Creek Mine indicates a significant adverse departure from previously monitored stream flows, and those departures may potentially be related to Rix's Creek Mine influences, then an independent, qualified hydrologist will be requested to assess the causes of the departure.

If the effect can be directly related to unanticipated adverse drawdown in the Quaternary stream alluvium or basement lithologies due to mining operations within the Rix's Creek Mine dewatering operations, then an equivalent offset to the stream flow loss may be required, after discussion and agreement with DPI Water.

Stream baseflow offsets may be provided via the retirement of adequate water entitlements to account for the loss attributable to the project.

Rix's Creek Mine is not required to provide additional baseflow offsets where such offsets have already been provided under previous consents or approvals for the operation.

Groundwater modelling indicates no impact to the Glennies Creek alluvium as a result of continued mining operations. Nevertheless, to provide early warning of any potential losses from the Glennies Creek alluvium, Rix's Creek Mine will use the two OEH streamflow gauging stations located upstream and downstream of the operation and will assess the changes in baseflow contribution based on the long term historical data available

for those two stations. In addition, groundwater monitoring bores installed in the alluvium will provide early warning of any potential changes in groundwater levels and therefore changes to flow. The review of groundwater monitoring data will occur quarterly and reported in the Annual Review.

7.2.8 Groundwater Dependent Ecosystem Impacted

Mining operations are not predicted to impact on the Groundwater Dependent Ecosystem (GDE) located at some reaches of Glennies Creek and hence there is no monitoring program proposed for the GDE's during mining operations as Rix's Creek Mine is a nil discharge site. Shallow monitoring bores are installed in the Glennies Creek alluvium and will provide data, allowing for early detection of altered baseflow contribution to the creek and provide information on any potential impact from seepage from water storages on the alluvium.

8 Complaints Handling

Any complaint received relating to any surface water or groundwater issues will be managed in accordance with the Environmental Management Strategy, which is based on the requirements of the site's Project Approval and EPL. As a minimum, records of the complaint will include:

- Date and time the complaint was logged;
- Personal details provided by the complainant;
- Nature of the complaint;
- Action taken regarding the complaint, or if no action was taken, the reason why; and
- Follow up contact with the complainant.

9 Reporting & Review

9.1 Reporting

Water monitoring results and interpretations will be reported internally monthly and annually in the Annual Review (AR), which will outline trends in surface water and groundwater quantity and quality and standing groundwater levels and quality in both alluvial and basement aquifers.

The assessment of trends will not only consider the trigger levels identified in this report, but also any natural variations that occur. The report will include:

- Raw water monitoring data and groundwater extraction data;
- A basic statistical analysis (mean, minimum, maximum and. standard deviation) of the results for the parameters measured in creeks, dams, bores, piezometers or wells;
- An interpretation of the water quality results and trends in water quality and water levels at surface and groundwater monitoring points supported by graphs and plots (versus ANZECC Guidelines as appropriate);
- An interpretation and review of the results in relation to trigger criteria and predictions made in the original Environmental Assessments;
- A review of Rix's Creek water balance assumptions in the light of the actual measured inflows and outflows and provide an interpretation of Rix's Creek area water balances compared to Mine Water Access Licences
- The water monitoring and review detail will be prepared by a qualified hydrogeologist.

The AR will provide a summary of complaints, incidents and non-compliances and the required action undertaken. A copy of the AR will be forwarded to relevant stakeholders including, but not limited to, NSW Department Planning and Environment, Department Primary Industry Water and Crown Land and Water, Environment Protection Agency and Resource Regulator Division of Resources and Geosciences in accordance with the relevant DPE and DPI Water guidelines.

External audits of this management plan will be undertaken by specialists periodically as determined by the Environment Manager, or in response to significant environmental incidents for which a systems failure has been determined as a contributor to the incident. An Independent Environmental Audit will be undertaken every three years (or as otherwise required by the DPE) by an audit team whose appointment has been endorsed by the Secretary of the DPE.

9.2 Plan Reviews

The review of this document will be in line with the Environmental Management Strategy for Rix's Creek. That is, reviews will be conducted every three (3) years, after independent environmental audits, and as required by relevant Project Approval requirements. The purpose of the review is to ensure that the WMP remains suitable, adequate and effective. The monitoring data will be reviewed as it is collected and at strategic milestones in the mine life, including AR reporting periods. The WMP will be modified as required to reflect changes to the mine plans, monitoring results or in response to stakeholder comments. Any significant modifications will be made only after consultation with DPI Water and CL&W, RR DRG, EPA and the DPE.

10 References

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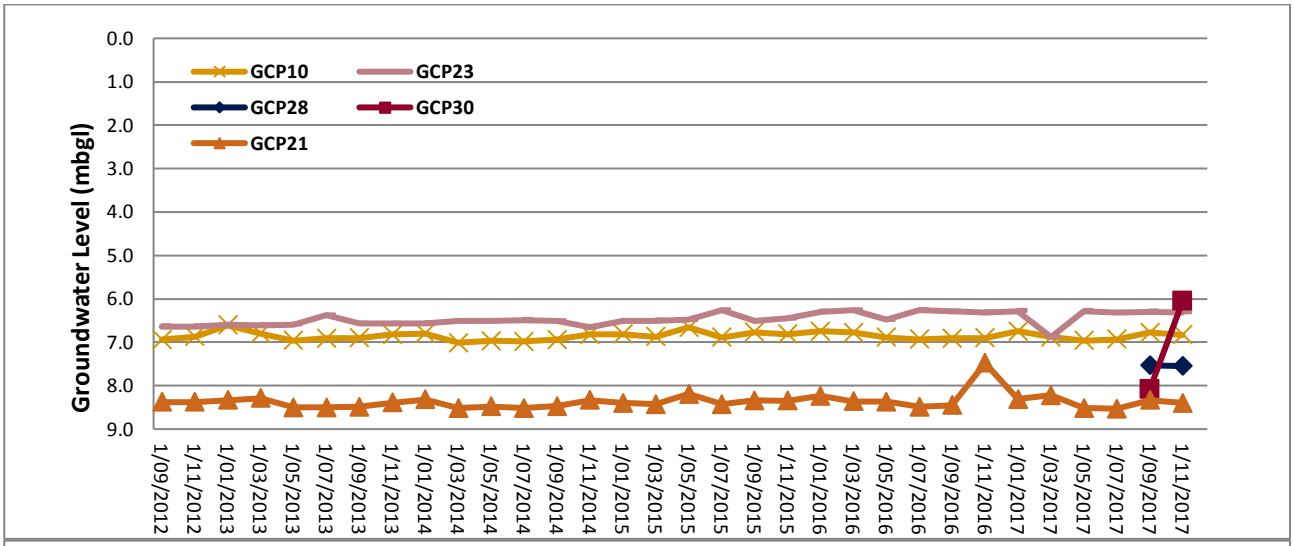
Appendix A

Approval Conditions & EA Commitments

	Water Management Plan (RCN) - Notice of Modification 6	Water Management Plan Section
36a	**Preparation Process**	
	Prepared in consultation with OEH, EPA, DRE and Council, and be endorsed by DPI Water and then submitted to the Secretary for approval;	Section 1.2 - Statutory Requirements
36b	**Performance Criteria (Table 13)**	
	Include detailed performance criteria and describe measures to ensure that the Proponent complies with the Water Management Performance Measures.	Section 1.3 - Plan Objectives & Performance Criteria; Table 3
36c	**Site Water Balance**	
	Include a site water balance (source/security of water supply; use on site; management on site; off-site transfers); describe measures to minimise clean water use	Section 2.5 - Mine Water Balance; Table 6
36d	**Erosion and Sediment Control Plan**	
	Identify activities that could cause soil erosion and generate sediment; 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 2.1 - Mine Water Management Section 2.3 Surface Water Management Section 5.1 - Preventative Measures Section 5.2 Corrective Measures
36e	**Surface Water Management Plan, which must include:**	
	Detailed baseline data on flow and quality in creeks that could be potentially affected by the project	Section 5.1.1 - Design & Operational Safeguards
	Surface water and stream health impact assessment criteria including trigger levels for investigating potential adverse impacts	Section 5.2.1 - Surface Water Trigger Levels; Table 11
	Monitor and assess (SW flows and quality; impacts on users; stream health; channel stability)	Section 4.2 - Surface water Monitoring Programme
36f	**Groundwater Management plan, which must include:**	
	Detailed baseline data on GW levels, yield and quality in the region, particularly privately owned bores that could be affected by the project	Section 6 - Groundwater Monitoring, Table 14
	GW impact assessment criteria including trigger levels for investigating and potential impacts	Sections 7.2.1 - 7.2.2 - Groundwater Level & Quality Triggers; Table 23
	Program to monitor and assess (GW inflows to mining ops; impacts on regional aquifers; impacts of third party supply; impacts on Glennies ck and Station ck; impacts on GDEs and riparian veg)	Section 7.1.1 - Open Cut Groundwater Inflows Section 7.2.6 - Loss of Flow in Glennie's and Station Creek
36g	**SW and GW Response Plan, which must include:**	
	Protocol for any exceedances of the SW and GW assessment criteria, including provision for independent investigation by a suitbaly qualified hydrogeologist whose apppointment has been approved by the Secretary	Section 7.2 - Corrective Measures
	Measures to offset the loss of any baseflow to watercourses caused by the project	Section 5.2.6 - Restoration of Disturbed Catchments
	Measures to compensate landowners whose water supply is adversely affected by the project	Section 7.2.4 - Adverse Impact on Groundwater Users
	Measures to mitigate and/or offset any adverse impacts on GDEs or riparian veg	Section 7.2.8 - Groundwater Dependent Ecosystem Impacted
	Water Management Plan (RCS) - Modification 8	**Water Management Plan Section**
15(i)	**Preparation Process**	
	Be prepared in consultation with DPI Water by a suitably qualified expert whose appointment has been approved by the Secretary	Section 1.2 - Statutory Requirements
15(ii)	**Site Water Balance**	
	Site water balance for the development, which includes details of sources and security of water supply, on site water use and management and off site water transfers and investigates and describes measures to minimise water use by the development.	Section 2.5 - Mine Water Balance; Table 7
15(iii)	**Surface Water Management Plan, which must include:**	
	Detailed baseline data of surface water flows and quality in the watercourses that could be affected by the development;	Section 5.1.1 - Design & Operational Safeguards
	Surface water impact assessment criteria, including trigger levels for investigating potentially adverse surface water impacts of the development;	Section 5.2.1 - Surface Water Trigger Levels; Table 11
	Program to monitor surface water flows and quality in the watercourse that could be affected by the development.	Section 4.2 - Surface water Monitoring Programme
15(iv)	**Groundwater Monitoring Plan**	
	Detailed baseline data of groundwater levels, yield and quality in the region, and privately owned groundwater bores, which could be affected by the development;	Section 6 - Groundwater Monitoring; Table 14
	Groundwater impact assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts of the development; and	Sections 7.2.1 - 7.2.2 - Groundwater Level & Quality Triggers; Table 23
	Groundwater inflows to the open cut mining operations; and impacts of the development on the regions aquifers, any groundwater bores, and surrounding watercourses, including monitoring to the western boundary of the mine lease	Section 7.1.1 - Open Cut Groundwater Inflows Section 7.2.6 - Loss of Flow in Glennie's and Station Creek
15(v)	**SW and GW Response Plan, which must include:**	
	Respond to any exceedances of the surface water and groundwater assessment criteria;	Section 7.2 - Corrective Measures
	Offset the loss of any baseflow to the surrounding watercourse and/or associated creeks caused by the development;	Section 5.2.6 - Restoration of Disturbed Catchments
	Compensate landowners of privately-owned land whose water supply is adversely affected by the development; and	Section 7.2.4 - Adverse Impact on Groundwater Users
	Mitigate and/or offset any adverse impacts on groundwater dependent ecosystems or riparian vegetation.	Section 7.2.8 - Groundwater Dependent Ecosystem Impacted
15ai	**Erosion and Sediment Control Plan**	
(ii)	Identify activities that could cause soil erosion and generate sediment;	Section 2.3 - Surface Water Management
(iii)	Describe measures to minimise soil erosion and the potential for transport of sediment to downstream waters;	Section 5.1.1 - Design & Operational Safeguards
(iv)	Describe the location, function, and capacity of erosion and sediment control structures; and	Section 2.3.5 - Surface Water Storage; Table 5
(v)	Describe what measures would be implemented to monitor and maintain the structures over time.	Section 5.2.6 - Restoration of Disturbed Catchments

Appendix B

Alluvial Groundwater Trigger Levels


Groundwater Level (mbgl)
GCP10
GCP23
GCP28
GCP30
GCP21
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1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
1/09/2012
1/11/2012
1/01/2013
1/03/2013
1/05/2013
1/07/2013
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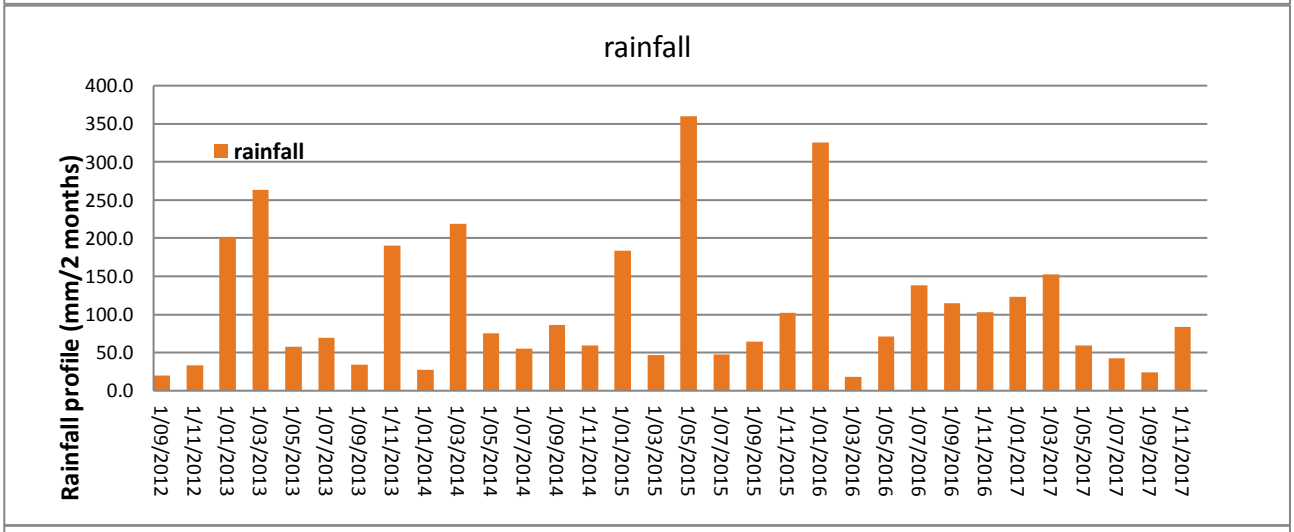
1/11/2017


rainfall
Rainfall profile (mm/2 months)
rainfall
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350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
1/09/2012
1/11/2012
1/01/2013
1/03/2013
1/05/2013
1/07/2013
1/09/2013
1/11/2013
1/01/2014
1/03/2014
1/05/2014
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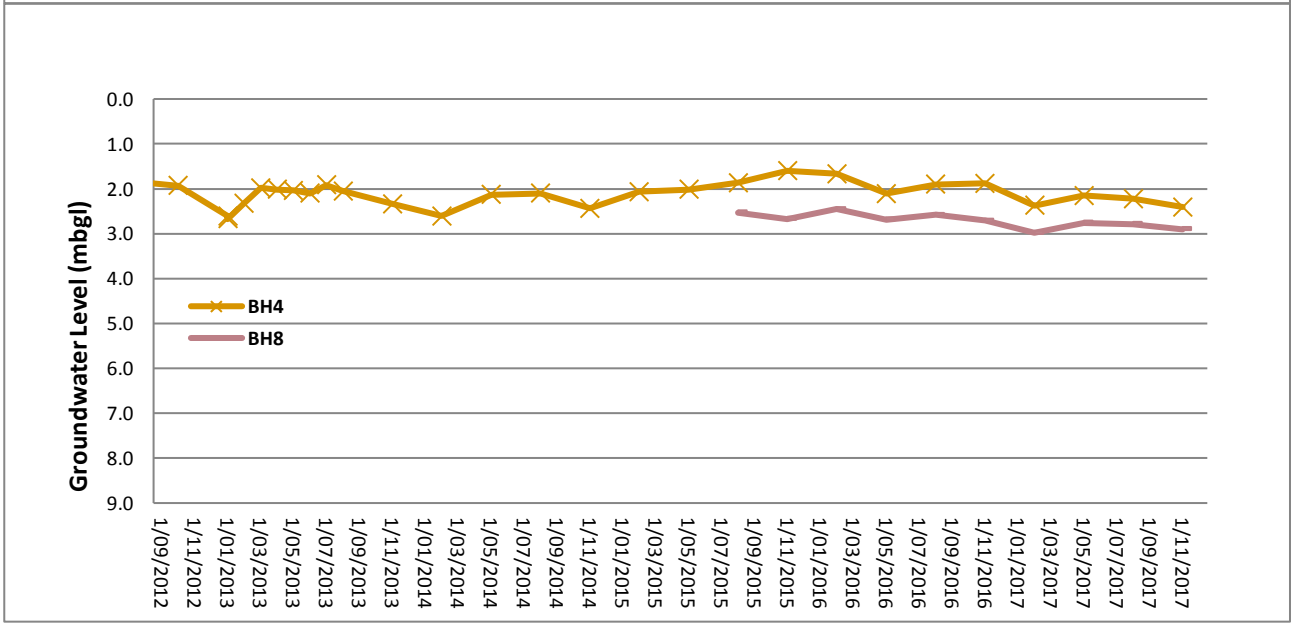
Groundwater Level (mbgl)
BH4
BH8
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
1/09/2012
1/11/2012
1/01/2013
1/03/2013
1/05/2013
1/07/2013
1/09/2013
1/11/2013
1/01/2014
1/03/2014
1/05/2014
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1/07/2016
1/09/2016
1/11/2016
1/01/2017
1/03/2017
1/05/2017
1/07/2017
1/09/2017
1/11/2017

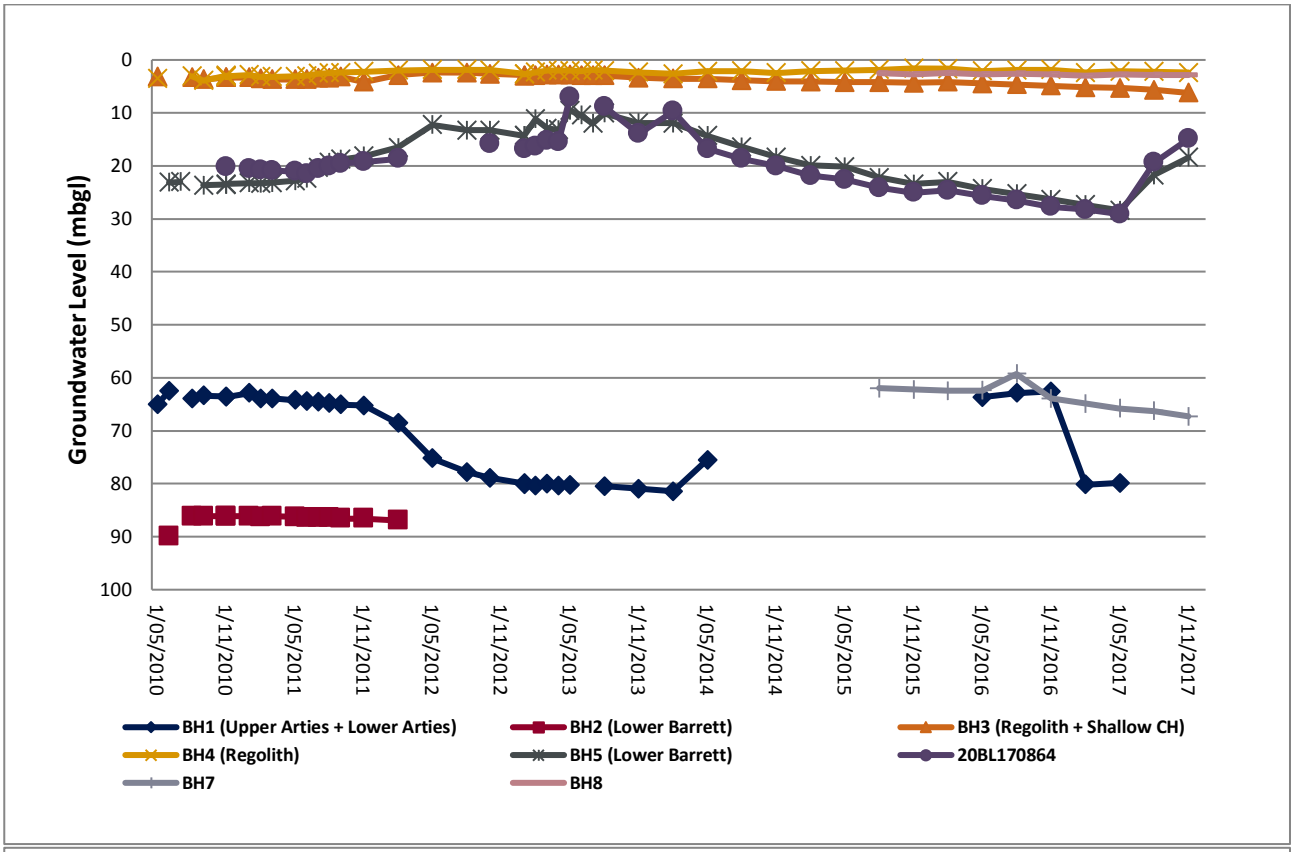
Alluvial Aquifer – hydrogeological interpretation of data

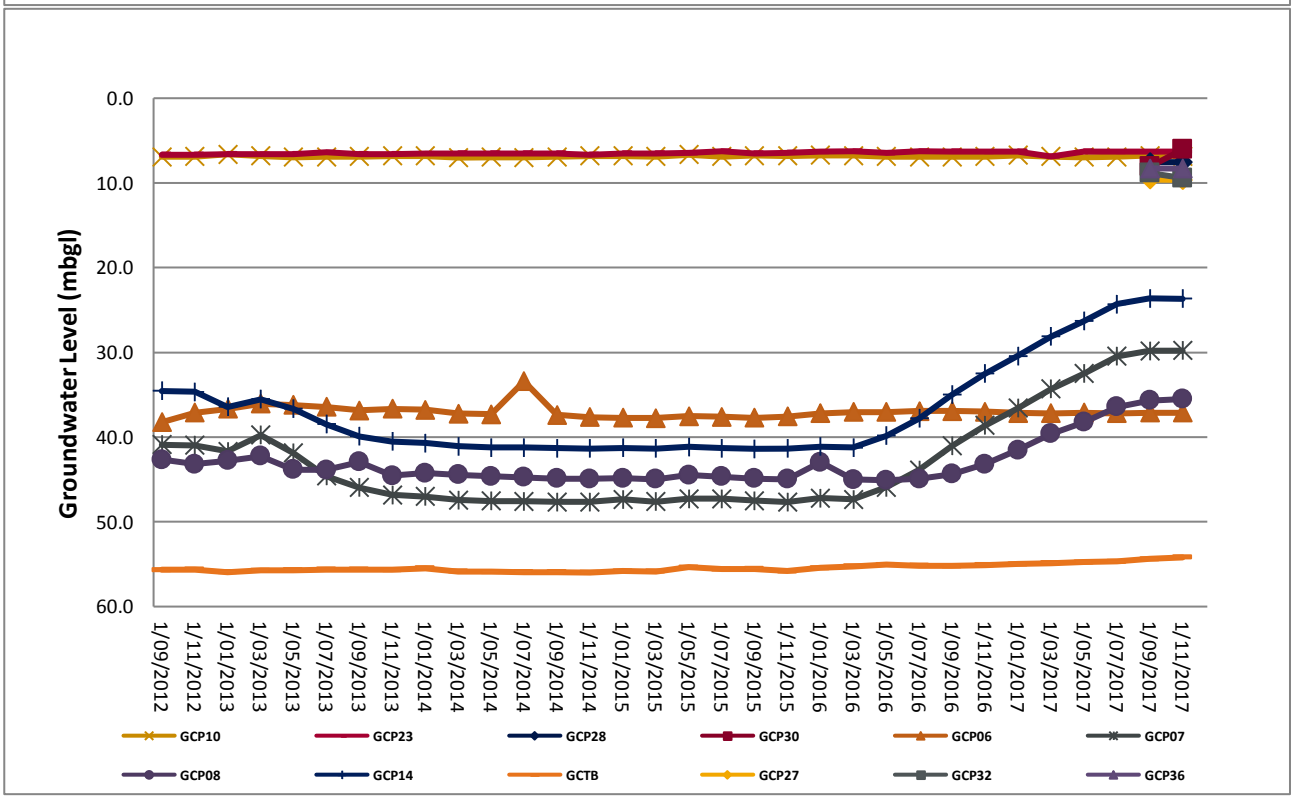
The bore hydrographs presented in the charts above are representing the bores installed and screened in the shallow alluvial aquifer within the project area, specifically:

- Rix's Creek North area – GCP10, GCP21, GCP23, GCP28 and GCP30
- Rix's Creek South area – BH4 and BH8

The historical rainfall chart has also been presented on the same bi-monthly scale to allow analysis and correlation between rainfall (and associated runoff and streamflow events) and the alluvial aquifer water level trends. Based on a dataset from 2010 to the end of 2017, we can observe the following:

- In both the northern and southern areas, the overall trend of the water levels in the alluvial aquifer has been stable – that is, there has not been a long-term declining trend that could be correlated to basement dewatering influences (see hydrographs below which show alluvial monitoring bores maintaining steady water levels over time; while the other hydrographs, from bores screened in various basement units, show a high range of fluctuation due to dewatering (and recovery) influences.
- In both the northern and southern areas, we can observe a correlation between short term water level rises (and a subsequent recession back to baseline levels) and major rainfall (and streamflow) events in the monitoring areas. This includes notable events in early 2013, and early to mid-2015 in particular. The last two years have been more moderate in terms of rainfall events, and the hydrographs have been more stable also.


Groundwater Level (mbgl)
0
10
20
30
40
50
60
70
80
90
100
1/05/2010
1/11/2010
1/05/2011
1/11/2011
1/05/2012
1/11/2012
1/05/2013
1/11/2013
1/05/2014
1/11/2014
1/05/2015
1/11/2015
1/05/2016
1/11/2016
1/05/2017
1/11/2017
BH1 (Upper Arties + Lower Arties)
BH2 (Lower Barrett)
BH3 (Regolith + Shallow CH)
BH4 (Regolith)
BH5 (Lower Barrett)
20BL170864
BH7
BH8


Groundwater Level (mbgl)
0.0
10.0
20.0
30.0
40.0
50.0
60.0
1/09/2012
1/11/2012
1/01/2013
1/03/2013
1/05/2013
1/07/2013
1/09/2013
1/11/2013
1/01/2014
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1/09/2016
1/11/2016
1/01/2017
1/03/2017
1/05/2017
1/07/2017
1/09/2017
1/11/2017
GCP10
GCP23
GCP28
GCP30
GCP06
GCP07
GCP08
GCP14
GCTB
GCP27
GCP32
GCP36

Appendix C - Regulator Consultation

Correspondence for consultation and endorsement of RCM Water Management Plan

Thu 19/04/2018 2:34 PM

Chris Quinn

Rix's Creek Mine Water Management Plan consultation

To 'minres.environment@industry.nsw.gov.au'; EPA RSD Hunter Region Mailbox; 'rog.hcc@environment.nsw.gov.au'; 'ssc@singleton.nsw.gov.au'; 'dan.adams@industry.nsw.gov.au'; 'Natasha Ryan'; 'steve.lewer@environment.nsw.gov.au'

Cc Luke Murray; Garry Bailey (gBailey@bloomcoll.com.au); Christopher Knight; Hannah Bowe

Message 20180418_RCM_Water_Management_MP_V2.2_Final reduced size.pdf

Hello,

In accordance with Rix's Creek North Project Approval (PA08_0102) and Rix's Creek South Development Consent(DA49/94), please find attached the Rix's Creek Mine Water Management Plan for review. Project Approval 08_0102 Schedule 3, Condition 36 (a) states that the Rix's Creek Mine Water Management Plan must be prepared in consultation with OEH, EPA, DRG and Singleton Council.

If you have any questions, comments or inclusions from the review of the Rix's Creek Mine Water Management Plan, please reply to myself via email in the first instance, or contact me via the phone number below.

Kind regards,

Chris Quinn
Environmental Advisor – Rix's Creek Mine
The Bloomfield Group - ***Celebrating over 80 years in Business***
PO Box 4, EAST MAITLAND NSW 2323
| Mob: 0427 169 302 | Fax: 02 6571 1066 |
Email: cquinn@rixs.com.au | Website: www.bloomcoll.com.au

Thu 19/04/2018 2:55 PM

Chris Quinn

Rix's Creek Mine Water Management Plan endorsement

To 'fergus.hancock@dpi.nsw.gov.au'

Cc Luke Murray; Garry Bailey (gBailey@bloomcoll.com.au); Christopher Knight; Hannah Bowe

Message 20180418_RCM_Water_Management_MP_V2.2_Final reduced size.pdf

Hello Fergus,

In accordance with Rix's Creek North Project Approval (PA08_0102) and Rix's Creek South Development Consent(DA49/94), please find attached the Rix's Creek Mine Water Management Plan for review. Project Approval 08_0102 Schedule 3, Condition 36 (a) and Development Application 49/94 Schedule 2, condition 15 states that the Rix's Creek Mine Water Management Plan must be endorsed by DPI Water.

If you have any questions, comments or inclusions from the review of the Rix's Creek Mine Water Management Plan, please reply to myself via email in the first instance, or contact me via the phone number below.

Kind regards,

Chris Quinn
Environmental Advisor – Rix's Creek Mine
The Bloomfield Group - ***Celebrating over 80 years in Business***
PO Box 4, EAST MAITLAND NSW 2323
| Mob: 0427 169 302 | Fax: 02 6571 1066 |
Email: cquinn@rixs.com.au | Website: www.bloomcoll.com.au

Appendix D - Letter of Approval DPE

Planning Services
Resource Assessments
Contact: Megan Dawson
Phone: 9274 6391
Email: megan.dawson@planning.nsw.gov.au

Mr Chris Knight
Environment Manager
The Bloomfield Group

Email: cknight@bloomcoll.com.au

Dear Mr Chris Knight

Rix's Creek Mine (PA 08_0102 and DA 49/94)
Water Management Plan

I refer to your email dated 21 May 2019, submitting a revised Water Management Plan for approval. The Department notes that the plan has been updated to clarify the water sharing arrangements between Rix's Creek North (PA 08_0102) and Integra Underground (PA 08_0101). A similar plan has also been provided for Integra Underground.

The Department has reviewed this plan and considers that it satisfies condition 36 of Schedule 3 of PA 08_0102 and condition 15 of Schedule 2 of DA 49/94. Consequently, the Secretary has approved this plan.

Please ensure a finalised copy of this plan is made available on the company's website.

Should you have any enquiries in relation to this matter, please contact Megan Dawson at the details above.

Yours sincerely

Howard Reed 24.5.19
Howard Reed
Director Resource Assessments
as nominee of the Secretary