Red Hill Mining Lease

EIS WATER BALANCE MODELLING

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SKM

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Glossary, Abbreviations and Units

Abbreviation	Definition
AWBM	Australian Water Balance Model
BMA	BHP Billiton Mitsubishi Alliance
BRM	Broadmeadow Mine
CHPP	Coal Handling and Preparation Plant
EA	Environmental Authority
EC	Electrical Conductivity
GMS	Goonyella Middle Seam
GRB	Goonyella Riverside and Broadmeadow
EHP	Department of Environment and Heritage Protection
EIS	Environmental Impact Statement
GRM	Goonyella Riverside Mine
IDC	Internally Draining Catchments
IMG	Incidental Mine Gas
IQQM	Integrated Quantity Quality Model
MIA	Mine Industrial Area
ML	Mine Lease
MLA	Mining Lease Application
RHM	Red Hill Mine
ROM	Run of Mine
SKM	Sinclair Knight Merz
TDS	Total Dissolved Solids
TSF	Tailings Storage Facility
Water Quality Objective	WQO

Units	Definition
GL	gigalitre
ha	hectare
km	kilometre
L/s	litres per second
m^3/s	cubic metres per second
mg/L	milligram per litre
ML	megalitre
ML/d	megalitres per day
ML/yr	megalitres per year
mm	millimetre
mtpa	megatonne per annum
µS/cm	micro Siemens per centimetre

1. Introduction

1.1 Purpose

Sinclair Knight Merz (SKM) was commissioned by BHP Billiton Mitsubishi Alliance (BMA) to prepare water balance modelling to support the Environmental Impact Statement (EIS) in association with the proposed Red Hill Mining Lease. The water balance model is required to represent the interface between the proposed RHM and the existing Goonyella Riverside and Broadmeadow (GRB) mine complex.

The study was undertaken using a water balance model developed for the GRB mine complex operation using the GoldSim software modelling package. This study builds on the operational model to provide input to the EIS.

This investigation has been developed using the existing GoldSim model to represent the following two EIS scenarios:

- Baseline Scenario – Model represents the mining arrangements for the GRB mine complex at 2015. The existing complex site coal production is approximately 18 Mtpa.
- Project Case Scenario – The Baseline scenario model is used to assess the impact of proposed RHM. This includes the addition of the new Underground, Coal Handling and Preparation Plant (CHPP), Mine Industrial Area (MIA) and 50 ML dam. The combined site coal production for GRB and the project is approximately 32.5 Mtpa.

This investigation builds upon the operational GoldSim model of the GRB mine complex developed by Engeny (2013 - model last modified February 2013). The GoldSim model has been updated to represent the Baseline scenario.

1.2 Background

The GRB mine complex is operated by BMA and consists of two mining operations in Goonyella Riverside Mines (GRM) and Broadmeadow Underground Mine (BRM). The GRM is an open cut operation, which started in 1971, while the BRM is a punch longwall underground mine, which accesses the coal seam from a previous open cut pit (currently Ramp 2, was Ramp) and which commenced operation in 2003.

Supporting the mining operation, the GRB mine complex has two CHPPs which are located at the Goonyella and Riverside MIA's. Coal produced here is transported by rail to the BMA owned Hay Point Coal Terminal for export.

Water management for the GRB mine complex operates under the approved Environmental Authority (EA) (No. MIN100921609 dated 28th February 2013; now EA No. EPML00853413). Opportunities for the release of mine affected water are conditioned by this EA.

1.3 The Project

The Red Hill Mining Lease Project is located adjacent to the existing GRB mine complex in the Bowen Basin, approximately 20 kilometres north of Moranbah and some 135 kilometres south-west from Mackay, Queensland.

BMA, through its joint venture manager, BM Alliance Coal Operations Pty Ltd, proposes to convert the existing Red Hill mining lease application (MLA) 70421 to a mining lease and thus enable the continuation and potential future expansion of existing mining operations associated with the GRB mine complex. Specifically, the mining lease conversion will allow for:

- An extension of three longwall panels (14, 15 and 16) of the existing BRM.
- A future incremental expansion option of the existing GRM.
- A future Red Hill Mine (RHM) underground expansion option located to the east of the GRB mine complex.

The three project elements described above are collectively referred to as 'the project'. The project elements include the following components:

1. The extension of BRM longwall panels 14, 15, and 16 into MLA70421. Key elements include:
   - No new mining infrastructure is proposed other than infrastructure required for drainage of incidental mine gas (IMG) to enable safe and efficient mining.
   - Management of waste and water produced from drainage of IMG will be integrated with the existing BRM waste and water management systems.
   - The mining of the BRM panel extensions is to sustain existing production rates of the BRM mine and will extend the life of mine by approximately one year.
   - The existing BRM workforce will complete all work associated with the extensions.
2. The incremental expansion of the GRM including:
   - underground mining associated with the RHM underground expansion option to target the Goonyella Middle Seam (GMS) on mine lease (ML) 1763;
   - a new mine industrial area (MIA);
   - a CHPP adjacent to the Riverside MIA on MLA1764 and ML1900 − the Red Hill CHPP will consist of up to three 1,200 tonne per hour (tph) modules;
   - construction of a drift for mine access;
   - a conveyor system linking RHM to the Red Hill CHPP;
   - associated coal handling infrastructure and stockpiles;
   - a new conveyor linking product coal stockpiles to a new rail load-out facility located on ML1900;
   - means for providing flood protection to the mine access and MIA, potentially requiring a levee along the west bank of the Isaac River.
3. A potential new Red Hill underground mine expansion option to the east of the GRB mine complex, to target the GMS on MLA70421. The proposed mine layout consists of:
   - a main drive extending approximately west to east with longwall panels ranging to the north and south;
   - a network of bores and associated surface infrastructure over the underground mine footprint for mine gas pre-drainage (IMG) and management of goaf methane drainage to enable the safe extraction of coal;
   - a ventilation system for the underground workings;
   - a bridge across the Isaac River for all-weather access. This will be located above the main headings, and will also provide a crossing point for other mine related infrastructure including water pipelines and power supply;
   - a new accommodation village (Red Hill accommodation village) for the up to 100% remote construction and operational workforces with capacity for up to 3,000 workers;
   - potential production capacity of 14mtpa of high quality hard coking coal over a life of 20 to 25 years

1.3.1 Groundwater Dewatering

Interception of groundwater has the potential to generate water at the future RHM. The interception of groundwater was assessed through modelling (URS, 2011) and is predicted to be approximately 35,000 ML over a 23 year mine life. This includes groundwater generated from gas drainage, underground dewatering and groundwater incidental to the raw coal. The average rate of groundwater generation is predicted to be approximately 1,200 ML/annum with a predicted peak at just under 2,000 ML/annum about 15 years after the commencement of operations.

Groundwater modelling was undertaken in order to predict the potential groundwater level draw down and recoveries that are likely to occur for the RHM. It is considered that the assumptions of the groundwater model are conservative when using the predictions as inputs into water balance modelling.

1.3.2 CHPP Mine Water Demand

The coal production profile highlights that the RHM and infrastructure associated with the GRM incremental expansion has the potential to extract and process 234 Mt (ROM) over 23 years. Based on this production profile, the average annual water usage through the CHPP is predicted to be approximately 1,300 ML/year, while the peak requirement of 2,300 ML/year is predicted to occur 8 years after commencement of operations.

1.3.3 Water Position

Figure 1-1 shows the water position estimated as the balance between water make through groundwater dewatering and the mine water demand from the proposed Red Hill CHPP. The low and high cases represent the range in predictions from the groundwater modelling.

It can be seen that later in the life of the project the demand for mine water re-use within the future RHM is exceeded by the water make achieved through groundwater dewatering. It is estimated that this results in an average surplus of 640 ML/yr, which is made up of approximately 500 ML/yr from groundwater dewatering and 140 ML/yr from recovery of water used in the underground mining operation.

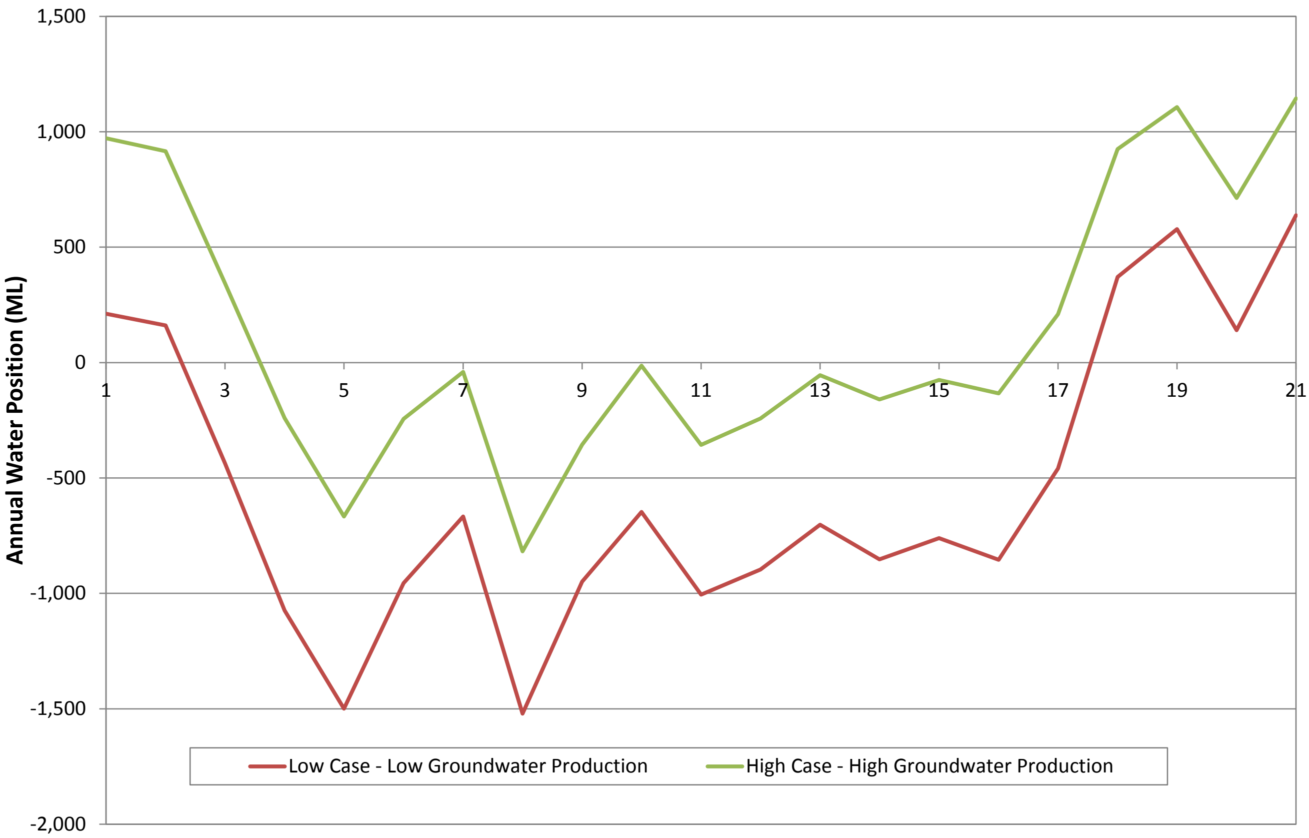


Figure 1-1 Red Hill Water Position

The water position for the RHM is predicted to vary between surplus and deficit over the life of the mine. This is due to the balance between the pre-mining drainage of groundwater and the production schedule. There are three phases of water positions in the project life:

- Years 1 to 3 – initial surplus – this is a result of the pre-mining drainage of groundwater coupled with lower production at project start up;
- Year 3 to 17 – deficit – this is due to the production demand being in excess of the projected groundwater generation;
- Year 18 to 23 – average annual surplus of approximately 640 ML/yr – projected groundwater generation peaks after the peak in production demand.

1.4 Management of Potential Surplus

As detailed in **Section 1.3.3**, there is the potential for the RHM to have a surplus of water both in the early and latter stages of the mine life. Whilst there is still uncertainty in the predictions, it is anticipated that when in surplus conditions, the future RHM may generate an average annual surplus of approximately 640 ML/yr.

Groundwater from the future RHM will be dewatered to a 50 ML transfer dam. There is opportunity for re-use of small quantities on site; however any surplus water will be transferred to the GRB mine water management system. Under normal conditions any surplus water produced would be used by the GRB mine complex operation, which includes the processing of RHM coal. However, the occurrence of any potential RHM surpluses during periods of high rainfall may require additional management actions at the GRB mine complex (e.g. additional storage, water releases, reduce minimum inventory).

The initial surplus between 1 and 3 is a result of pre-mining drainage of gas and associated groundwater. This potential surplus may vary between 200 and 1,000 ML in the initial stages. The range in the potential surplus is due to the schedule of the pre-mining drainage of groundwater not being finalised. The short term surplus would be integrated into the GRB mine complex operations for use. This storage is temporary because if not consumed by the GRB mine complex, the surplus will be consumed in processing RHM coal after year 3 as the RHM annual water position is predicted to become a deficit.

The average surplus of the project in the latter stages of the project is potentially up to 640 ML/yr. The potential surplus is expected to be less than 640 ML/yr as a schedule of pre-mining drainage of groundwater will be developed and integrated into the production schedule to optimise the water management at RHM. A 640 ML/yr surplus is considered to be the worst case for assessing the potential impacts of a RHM surplus on the GRB mine water management system. The water balance assessment has been undertaken on this basis to determine any management actions required for the RHM.

1.5 Previous Investigations

Water management within the GRB mine complex has been an evolving system over time with the installation of new infrastructure and amendments to the release conditions referenced within the site's EA. As such, water management of the site has been subject to a number of previous investigations undertaken by URS and Engeny.

As part of these works, Engeny has recently developed a GoldSim model to represent the operations of the site. The most recent background documentation of modelling undertaken is titled *"Goonyella Riverside Mine Water Balance Model, Technical Report, February 2013 (Ref: M11000_018)"*.

This current investigation has built upon this GoldSim model in order to represent the 2015 Baseline scenario and the proposed RHM.

2. Project Data

2.1 Base Model

The water balance model developed by Engeny in 2013 was used as the basis for this assessment. The development of that model is documented in *"Goonyella Riverside Mine Water Balance Model, Technical Report, February 2013 (Ref: M11000_018)"*.

2.2 Climate Data

Rainfall and evaporation data used within the model was run for the period of 01/01/1900 to 31/12/2007. This climate data was sourced from the Queensland Climate Change Centre of Excellence Climate Data Bank – SILO data drill that was obtained via http://www.longpaddock.qld.gov.au/silo/datadrill/index.php. The two reference locations were used to represent the variation of rainfall in the area, locations requested were:

- GRM catchments climate data extracted for 147.95'E, 21.75'S;
- Upper Isaac catchments data extracted for 148.05'E, 21.65'S.

Actual data recorded by the GRB mine complex through its hydrological monitoring system operated by Ecowise Environmental for the 2007/2008 wet season were used to replace the corresponding values in the SILO data set. Summary of the long term climate data is detailed in **Table 2-1** and **Figure 2-1**. **Figure 2-2** presents the annual rainfall for the GRM over 108 year period.

Table 2-1 Long Term Climate Averages (mm)

Climate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly
Rainfall	97	88	58	27	24	27	18	15	12	28	50	80	523
Evaporation	230	187	194	151	118	95	105	134	180	225	234	243	2,096

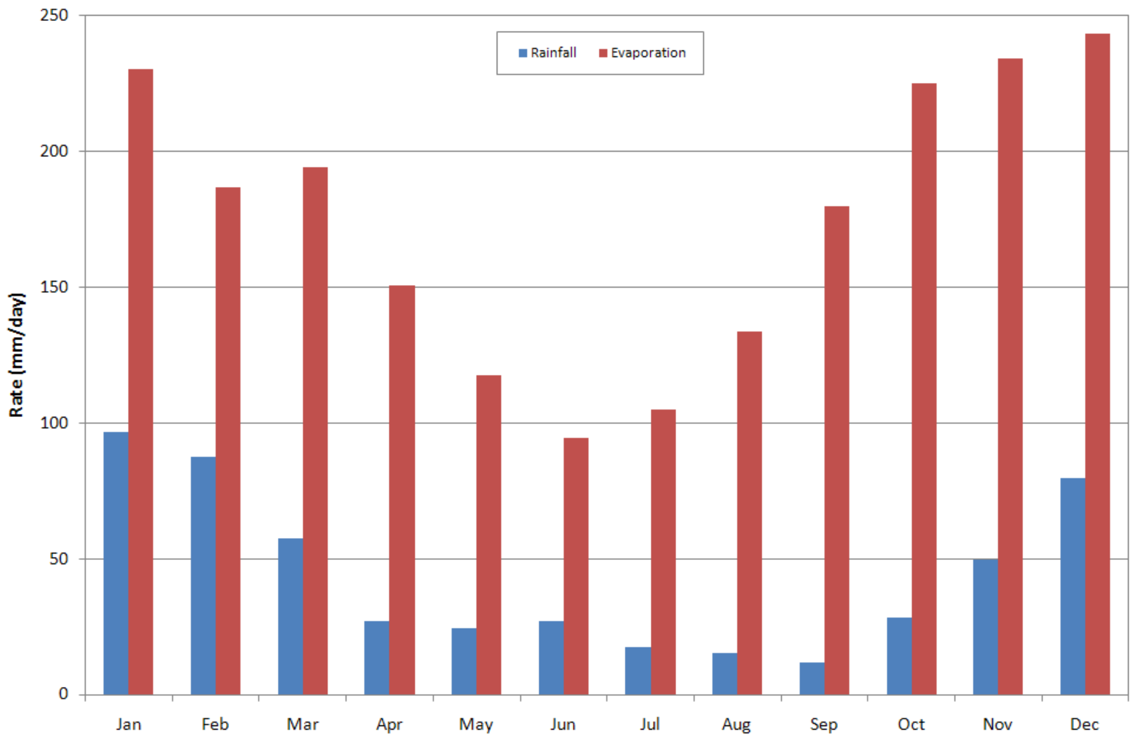


Figure 2-1 Long Term Climate Data (SILO Data Drill)

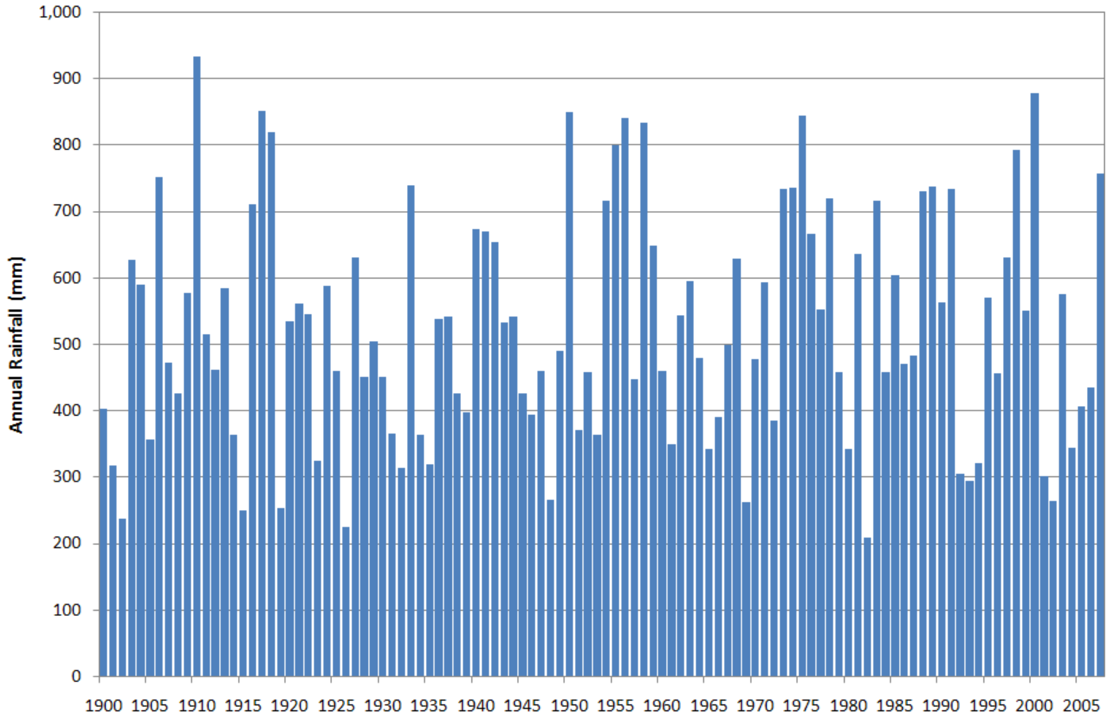


Figure 2-2 GRB Mine Complex Annual Rainfall Data (SILO Data Drill)

2.3 IQQM Model

Burton Gorge Dam is located on the Isaac River in the Upper Isaac River catchment approximately 40 km upstream of GRM. This dam is privately owned and operated and has a capacity of 18,000 ML. Water from the dam is extracted under the terms of a water licence to supply water to coal mines in the area.

The current EA release conditions for the GRB mine complex (dated 28th February 2013) require the release flow to be calculated on the basis of flow at the gauging station on the upper Isaac River, approximately 15 km downstream of the dam. The catchment area to this point is approximately 760 km^2, of which 80% is above the Burton Gorge Dam. Therefore, the Burton Gorge Dam catchment has the potential to contribute significant flows to the Isaac River when overflow of the dam occurs. To ensure the frequency and magnitude of the overflows from Burton Gorge Dam were represented appropriately; the *Water Resources (Fitzroy Basin) Plan 2011* was reviewed.

The *Water Resources (Fitzroy Basin) Plan 2011* includes an Integrated Quantity Quality Model (IQQM) of Isaac and Connors Rivers sub-catchments. The IQQM model was obtained through EHP under licence CAS2089. Investigation of the IQQM results for the Burton Gorge Dam showed that when overtopping of the dam occurred, significant flow volumes were conveyed downstream.

Figure 2-3 details the theoretical flow duration for the overflows estimated from the Burton Gorge Dam and the upper Isaac River catchment below the Burton Gorge Dam to the GRB mine complex over the 108 year period from 1900 to 2007. The Burton Gorge Dam overflows from the IQQM model were used in the water balance model to predict the flows at the upper Isaac River gauging station.

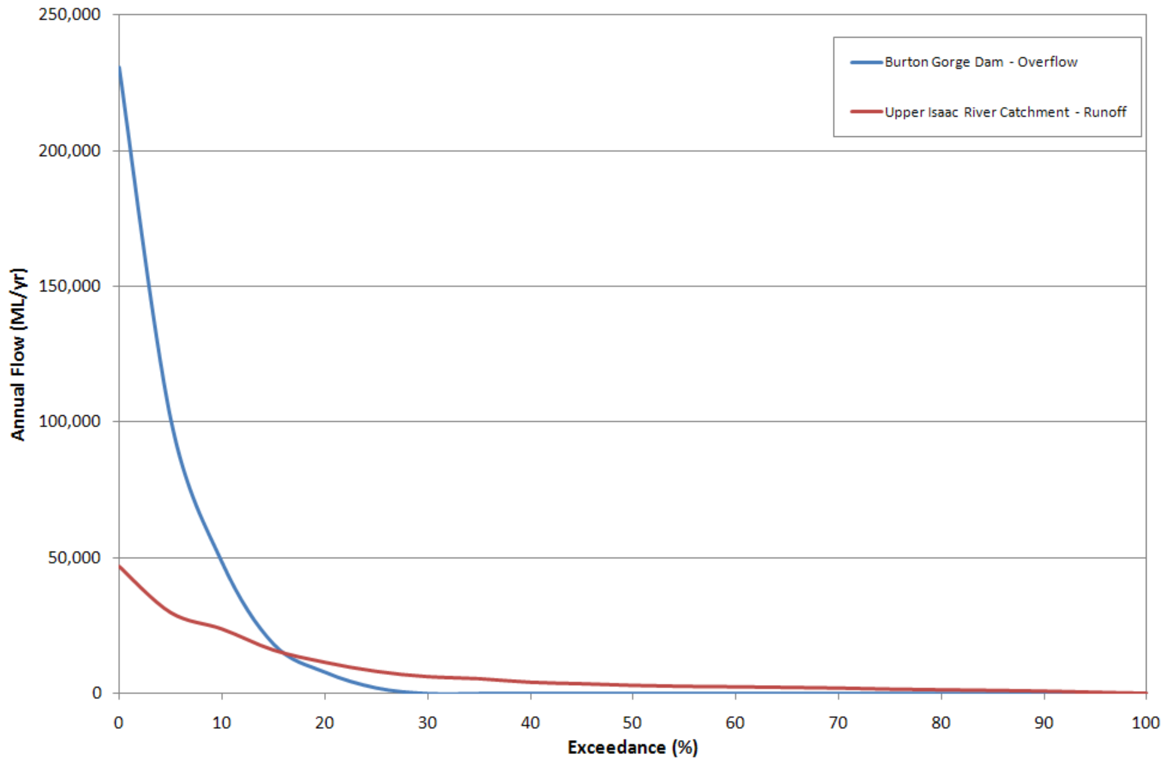


Figure 2-3 Burton Gorge Dam Overflows and Upper Isaac River Flows

2.4 Demands

2.4.1 CHPP

A summary of the water demand of the existing Goonyella and Riverside CHPP, as well as the proposed Red Hill CHPP for use within the Baseline and Project Case scenario have been provided by BMA and are detailed below in **Table 2-2**.

Table 2-2 CHPP Water Demand

Item	Demand (ML/yr)
Goonyella CHPP	1,600
Riverside CHPP	1,600
Red Hill CHPP	1,300*
Total	

**this demand is averaged over the project life and is significantly less than the current Goonyella/Riverside operations due to incorporation of belt press filter technology*

2.4.2 Raw Water Demands

Demands for raw water supply for use within the BRM and RHM underground mining operations as well as raw water uses for the CHPP and potable water are detailed below in **Table 2-3**.

Table 2-3 Raw Water Demand

Item	Demand (ML/yr)
Broadmeadow Underground	365
Goonyella and Riverside CHPP*	180
Water Treatment Plant	180
Red Hill Potable	145
Red Hill Underground	730
Red Hill CHPP	30
Total	**1,630**

* combined value for both CHPPs

2.4.3 Haul Road Dust Suppression

Demands for haul road dust suppression used in the EIS Baseline scenario are the same as assumed in the reporting by Engeny (2013). Demands are split evenly between the Goonyella and Riverside mining operations and detailed in **Table 2-4**. As the RHM does not have any demands for dust suppression, demand assumptions remain the same in the Baseline and Project Case scenario.

Table 2-4 Haul Road Dust Suppression Demands

Item	Demand (ML/yr)
Goonyella	1,100
Riverside	1,100
Total	**1,760**

2.4.4 MIA Demand

Demands for use within the MIA used in the EIS Baseline scenario have been provided by BMA and details are outlined in **Table 2-5**.

Table 2-5 MIA Demands

Item	Demand (ML/yr)
GRB mine complex*	500
Red Hill	70
Total	**570**

* there are three MIAs at the GRB mine complex

2.5 AWBM Catchment Runoff Parameters

The Australian Water Balance Model (AWBM) catchment runoff is used in modelling of the EIS Baseline and Red Hill scenario. A summary of the AWBM parameters are presented in **Table 2-6**.

Table 2-6 AWBM Catchment Runoff Parameters

	Area Fractions			Soil Storage (mm)			Surface	Baseflow	
	A1	A2	A3	C_1	C_2	C_3	Ks	Kb	BFI
Natural	0.134	0.433	0.433	10	55	115	0.3	0.60	0.45
Spoil	0.134	0.433	0.433	10	50	120	0.1	0.60	0.35
Rehabilitated	0.134	0.433	0.433	12	71	141	0.1	0.60	0.35
Hardstand	0.134	0.433	0.433	5	20	40	0.1	1.00	0.00
Tailings	0.134	0.433	0.433	10	20	40	0.1	1.00	0.00

2.6 Catchment Characteristics

A summary of the catchments and land-use applied in both modelling scenarios is provided below in **Table 2-7**. A detailed breakdown of individual catchments is provided in **Appendix A**.

Table 2-7 Catchment Characteristics

Catchments	Land-Use Classification (ha)					
	Natural	Spoil	Rehabilitated	Hardstand & Pits	Tailings	Total
Northern Storages	779	1,613	366	785	0	3,543
Central Storages	808	1,106	464	1,130	297	3,805
South Storages	446	724	215	885	105	2,375
Regional Waterways	48,891	168	201	77	0	2,375
Total	50,924	3,611	1,246	2,877	402	59,060

2.7 Water Quality (Salinity)

A summary of the salinity parameters applied within the water balance model is detailed in **Table 2-8** and **Table 2-9**.

Table 2-8 Catchment Runoff Salinity Parameters

Land-Use	Reference Depth	A	B	Maximum TDS (mg/L)	Maximum EC (µS/cm)
Natural	Excess Runoff	65	-0.25	700	1,190
Rehabilitated	Excess Runoff	65	-0.25	2,200	3,730
Spoil	Excess Runoff	1,500	-0.20	1,500	2,540
Hardstand	Excess Runoff	1,000	-0.20	700	1,10
Hardstand – Water Storage Pit	90 Day Rainfall	16,000	-0.20	16,000	27,120
Hardstand – Active Pit	90 Day Rainfall	16,000	-0.35	22,000	37,290
GS1 TSF	28 Day Rainfall	6,000	-0.16	3,000	5,080
RS1 TSF	28 Day Rainfall	3,800	-0.14	6,000	10,1710

TDS loadings for each catchment are determined through application of following:

- Natural, spoil and hardstand – *Runoff TDS (mg/L) = A x Runoff (mm/day)* ^{B}
- Mining Pits – *Runoff TDS (mg/L) = A x 90 day rainfall (mm)* ^{B}
- Tailings Dam – *Runoff TDS (mg/L) = A x 28 day rainfall (mm)* ^{B}

Table 2-9 Water Source Salinity

Water Source	TDS (mg/L)	EC (µS/cm)
Groundwater	3,000	5,080
Raw Water	200	340
Underground Mining Dewatering	4,270	7,240

2.8 Storage Characteristics

Storage characteristics are used to represent each of the storages and pits within the model. Details of the storage capacities are represented in **Appendix B**.

2.9 Groundwater

Potential groundwater inflows into pits and the undergrounds, and gas dewatering have be represented in the model. The groundwater rates applied to each system are outlined below in **Table 2-10**.

Table 2-10 Groundwater Inflow / Dewatering Rates

System	Rate (ML/day)
Open Cut Pits	0
Broadmeadow Underground	2.4
Red Hill Underground	4.1

2.10 Release Conditions

2.10.1 Environmental Authority

GRM operates under EA No. EPML00853413 dated 6th September 2013 (formerly No. MIN100921609 dated 28th February 2013). This details compliance requirements for the GRB mine complex in relation to discharges of mine water. In relation to water management, this EA permits the release of mine affected water from the GS4A dam into the Isaac River when the following criteria are satisfied:

- Natural flow rate measured at the upstream Isaac River gauging station (upstream of confluence with Goonyella Creek) > 3 m^3/s.
- Release criteria under flow conditions:
  - The salinity of mine affected water released from GS4A must not exceed an EC of 10,000 µS/cm; and
  - The salinity in the Isaac River at the downstream release point must not exceed an EC of 2,000 µS/cm.

It is to be noted that the water balance modelling undertaken only estimates the salinity of the system. The EA also refers to the monitoring of the water quality parameters pH, turbidity and sulphates. Whilst salinity is considered the dominant contaminant for modelling purposes, it has been assumed that the GRB mine complex will also monitor these additional parameters in accordance with the EA before commencing a release.

2.10.2 Release from GS4A

Releases from the GRB mine complex are simulated to occur when a release is made through the release gate or when the capacity of GS4A of 250 ML is exceeded. The following functionality has been applied to potential sources of inflow into GS4A:

- Ramp 21/22 Release – The release system associated with the Ramp 21/22 storage will be the main release source of mine affected water. Releases from this storage are calculated to ensure that both the quantity and quality of release volumes are in accordance with the requirements of the EA. The release system has a maximum capacity of 6.8 m^3/s (587 ML/d). The release is restricted if the mine water from when the total site water inventory becomes less than 14,000 ML. This condition is aimed at maintaining a minimum inventory of water on site for water supply purposes.
- Storage Overflow – Mine affected water may contribute through uncontrolled overflow to GS4A via the overtopping of the GS3, RS10 and Sediment Dams 1 to 7. The model is set up to identify if these sources result in the exceedence of the prescribed water quality criteria.
- Mine Water Transfers – Mine affected water is directed to GS4A via mine water transfers within the site. Under the Baseline and Project Case scenarios only, dewatering of Ramps 0, 2, 4 and 10 is directed to GS4A.

3. Model Configuration

3.1 Baseline Scenario

The GoldSim model prepared by Engeny (2013) which is used as the operational water balance model for the GRB mine complex has been used as the basis for modelling undertaken as part of the EIS. To represent the Baseline scenario the following updates have been made as provided by BMA:

- High dump area overflows (sediment dams 1 to 7) to GS4A;
- CHPP tonnages and demands; and
- Minimum site water inventory of 14,000 ML.

Outlined below in **Table 3-1** are the operational rules that have been used to represent the Baseline scenario and the water balance model schematic for the Baseline scenario is presented in **Appendix D**.

Table 3-1 Operational Rules for Baseline Scenario

Source	Destination	Pump Rate (l/s)
Ramp 0	GS4A	450
Ramp 2 (BRM Sumps)	GS4A	400
Ramp 4 (BRM Sumps)	GS4A	160
Ramp 6	Ramp 21/22	200
Ramp 8	Ramp 21/22	200
Ramp 10 North	RS7	200
Ramp 10 South	GS4A	300
Ramp 12 (North)	Old Ramp 28	200
Ramp 12 (South)	RS7	200
Ramp 14	Old Ramp 28	200
Ramp 24	RS6	160
Ramp 25	Ramp 21/22	200
Ramp 31	Ramp 21/22	100
Ramp 32	Ramp 21/22	200
H13	Truck Fill Points	80
	RS3	160
Old Ramp 28	H13	160
RS1 (TSF Decant)	RS2	150
RS3	Riverside CHPP	100
	H13	110
RS6	Ramp 21 Fill Point	100
RS10	RS3	100
Ramp 21/22	Controlled Release (via GS4a)	6,800
	GS3	160
	GS2	160
GS1A	Ramp 23 Fill Point	80
	GS2	130
	GS3	130
GS2	Goonyella CHPP	100
GS3	Twin Tanks Fill Point	200

Source	Destination	Pump Rate (l/s)
GS1 (TSF Decant)	GS1A	150
GS4A	Ramp 21/22	500 L/s – On RL 244.6 – Off RL 244.5 500 L/s – On RL 244.9 – Off RL 244.8 500 L/s – On RL 245.2 – Off RL 245.1 500 L/s – On RL 245.5 – Off RL 245.4

3.2 Project Case Scenario

The Project Case scenario has been developed to assess any impacts that may result from the inclusion of water from the future RHM within the overall GRB mine water management system. As such, to assess what impacts may result as part of this EIS assessment; the Baseline scenario has formed the basis for this assessment. To represent the Project Case scenario the following updates have been made to the Baseline scenario model.

- Red Hill underground mine;
- Red Hill CHPP (up to an additional 18 Mtpa ROM);
- Red Hill MIA;
- Red Hill 50 ML dam.
- Excess water from RHM is dewatered to Ramp 21/22 via the Red Hill 50 ML dam.

Outlined below in **Table 3-2** are the operational rules that have been used to represent the Project Case scenario and the water balance model schematic is represented in **Appendix E**.

Table 3-2 Changes to Operational Rules for Red Hill Scenario

Source	Destination	Pump Rate (l/s)
RH Dam	Ramp 21/22	150
RH Dam	Red Hill CHPP	50

3.3 Starting Inventory

Estimates of the starting water inventory at the commencement of the RHM were not available at the time of this assessment. The timing for commencement and the rate of development have not yet been determined by the project owners. For the purposes of modelling, an assumed starting inventory of approximately 40,000 ML was used. A full breakdown of the starting inventory is presented in **Appendix C**.

3.4 Model Limitations and Exclusions

Several important limitations of the water balance model are important to note for evaluation of the model results.

The water balance model does not include any allowance for seepage or transmission loss from dams and open channel drains. This assumption will tend to overestimate mine water volumes in the mine water management system and potential salt loads. This is conservative from the perspective of assessing containment performance and release compliance, and also risks of prolonged water accumulation in the open cut mine pits. This assumption is not conservative for assessing the availability of mine water to be reused in mine operations.

The model does not include representation of any other mines discharging waters into the Isaac River or other creeks represented in the model catchments. The potential releases from the existing Goonyella North Mine (Peabody operation north of the GRB mine complex) cannot be represented because details of releases from this mine are not known to BMA.

The mine water balance model simulations are undertaken for a static configuration of the mine representative of a given point in time, which for the purposes of the project mine water balance assessment and baseline is nominally 2015. The simulation periods are performed with the complete 108 years of climate data (to test extremes of climate influence) and time series results are produced for water volumes (or flows in waterways) and salinity for every part of the model.

4. Modelling Results – Baseline Scenario

The mine water balance model has been used to assess the performance of the Baseline GRB mine water management system prior to the implementation / operation of the proposed RHM. There are a number of performance indicators used to characterise the expected Baseline water management performance which include:

- compliance of releases (overflows and gate releases) at GS4A with the EA criteria;
- regulatory requirements for regulated structures;
- statistics of the total mine water volume (inventory) in the mine water management system which provides an indication of whether the total system storage capacity is sufficient, and how often low priority mine pits will be required for use as contingency mine water storage;
- assessment of the risk from external factors on utilisation of release opportunity; and
- external water requirements for mining operations.

4.1 Compliance of Releases at GS4A with Environmental Authority Criteria

For compliance with the current EA release conditions, a number of flow and water quality criteria must be met. The following figures are presented to demonstrate capacity to comply with the respective water quality (salinity) and flow criteria including:

- salinity level of releases for the end of pipe limit (**Figure 4-1**);
- salinity level at the downstream compliance point of the Isaac River (**Figure 4-2**); and
- flow rate of releases in relation to the flow conditions of the Isaac River (**Figure 4-3**).

The EA conditions require that releases from GS4A meet prescribed water quality limits for EC of 10,000 µS/cm as the end of pipe limit. The ability of the GRB mine complex, under the Baseline scenario, to comply with this criterion is presented in **Figure 4-1**, which shows the modelled flow release of GS4A against the release salinity (EC). This figure shows there are no exceedances, in the 108 year modelling period, of the end of pipe limit.

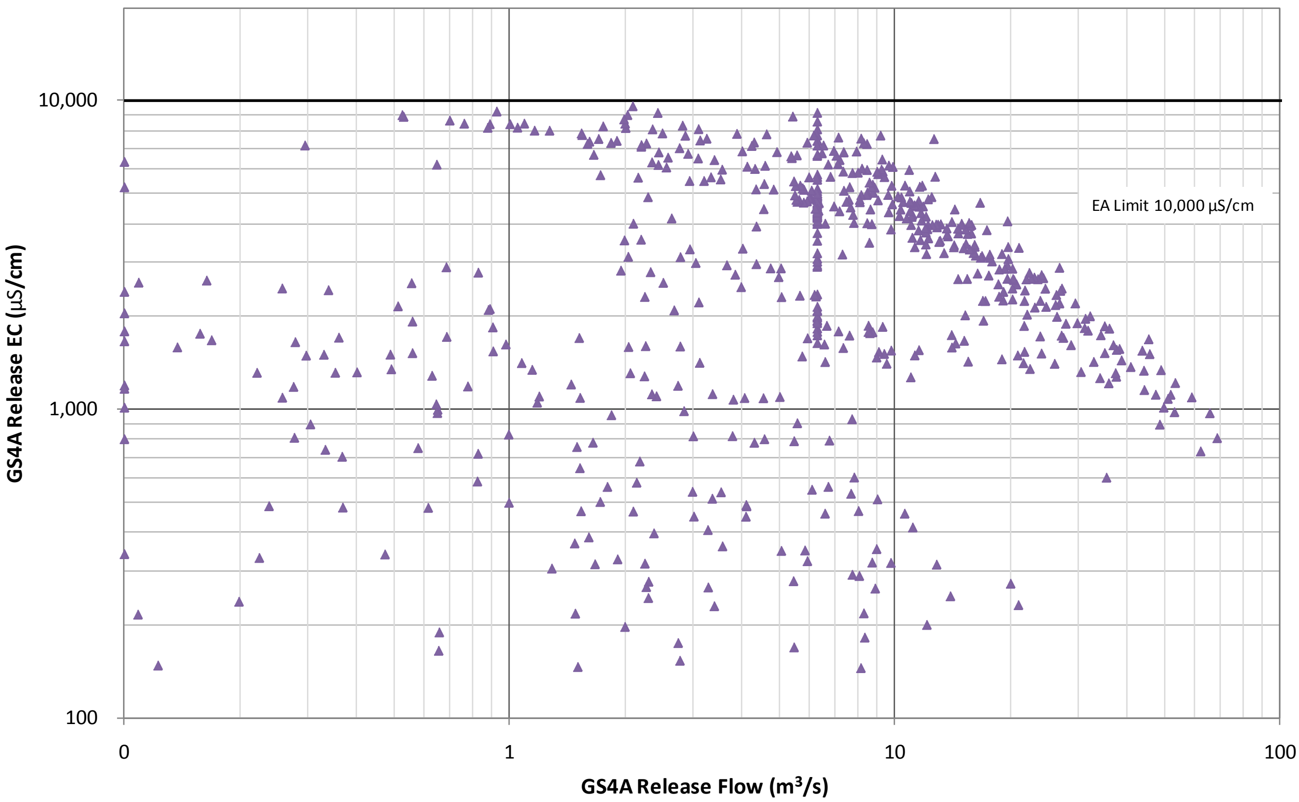


Figure 4-1 Baseline Scenario Modelled Compliance with End of Pipe Limit

The EA conditions require that in addition to releases from GS4A meeting prescribed water quality limits at the end of pipe, that salinity thresholds also apply to the downstream Isaac River Diversion salinity; after mixing of the GS4A releases and Isaac River flows. The ability of the GRB mine complex, under the Baseline scenario, to comply with this criterion is presented in **Figure 4-2**, which shows the modelled flow days (expressed as an exceedance) against downstream Isaac River salinity (EC).

Figure 4-2 shows the EA receiving water trigger level of 2,000 µS/cm is met of the majority of the flow days and demonstrates that releases under the Baseline scenario are managed appropriately to ensure compliance with the applicable salinity limits in the Isaac River downstream of the mine's release point.

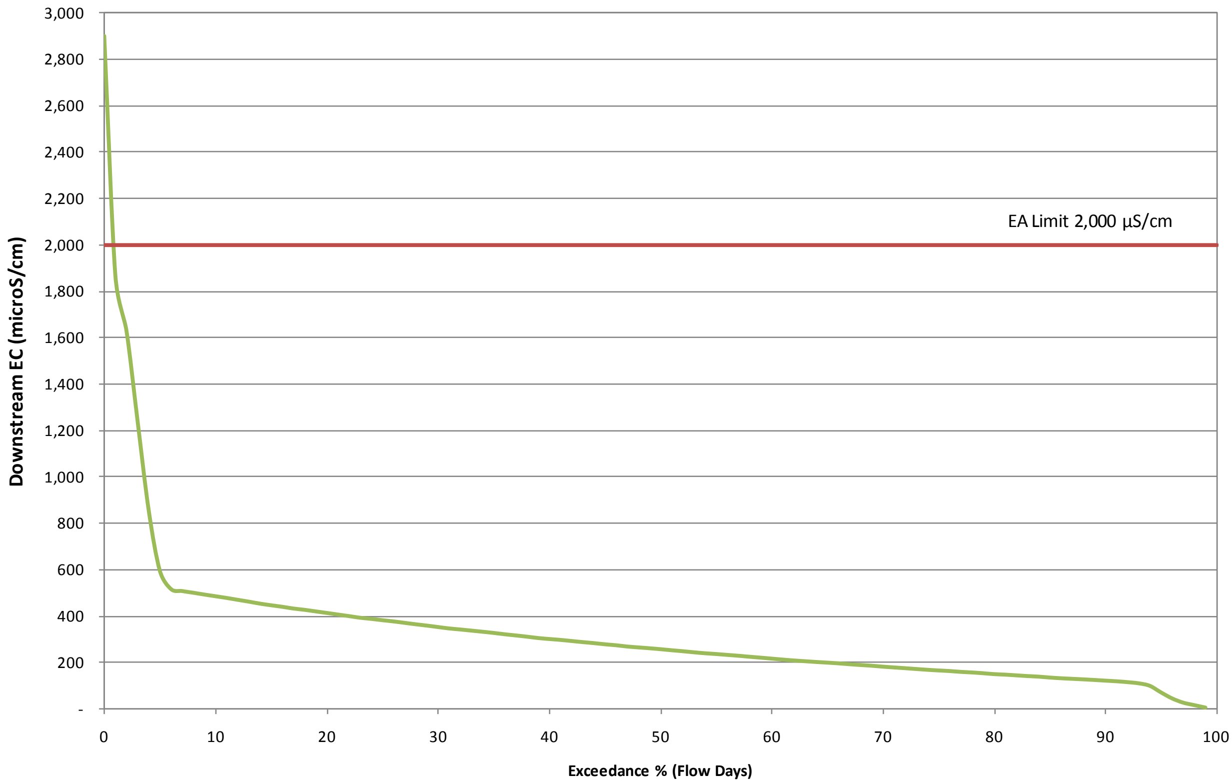


Figure 4-2 Baseline Scenario Modelled Downstream Isaac Salinity Compliance

The model identified three one-day occurrences, during the 108 year modelling period, that the EC of releases from GS4A causes the downstream EA receiving water trigger level of 2,000 µS/cm to be exceeded. Details of each of the exceedances are outlined in **Table 4-1**. These exceedances are a result of flows entering GS4A, from both natural and site catchments, that are in excess of the 2 m^3/s pumping capacity from GS4A, while there is no flow in the Isaac River.

Table 4-1 Site Release Exceedances

Event	Flow Eureka Creek to GS4A (m^3/s)	Site Runoff to GS4A (m^3/s)	GS4A Overflow (m^3/s)	GS4A Overflow EC (µS/cm)	Receiving Water Flow (m^3/s)	Receiving Water EC (µS/cm)
1	0.04	2.8	0.8	2,787	0.8	2,778
2	0.05	2.6	0.3	2,444	0.3	2,443
3	0.06	2.5	0.7	2,901	0.7	2,899

The existing GRB mine complex EA conditions require that the flow rate of releases from GS4A must only occur when the flow in the upper Isaac River is greater than 3 m^3/s or there is a natural flow measured at Eureka Creek at monitoring point 2. **Figure 4-3** shows the modelled GS4A release flow against the modelled upper Isaac River flow. This figure demonstrates that releases under the Baseline scenario are managed appropriately to ensure compliance with the relative flow criteria.

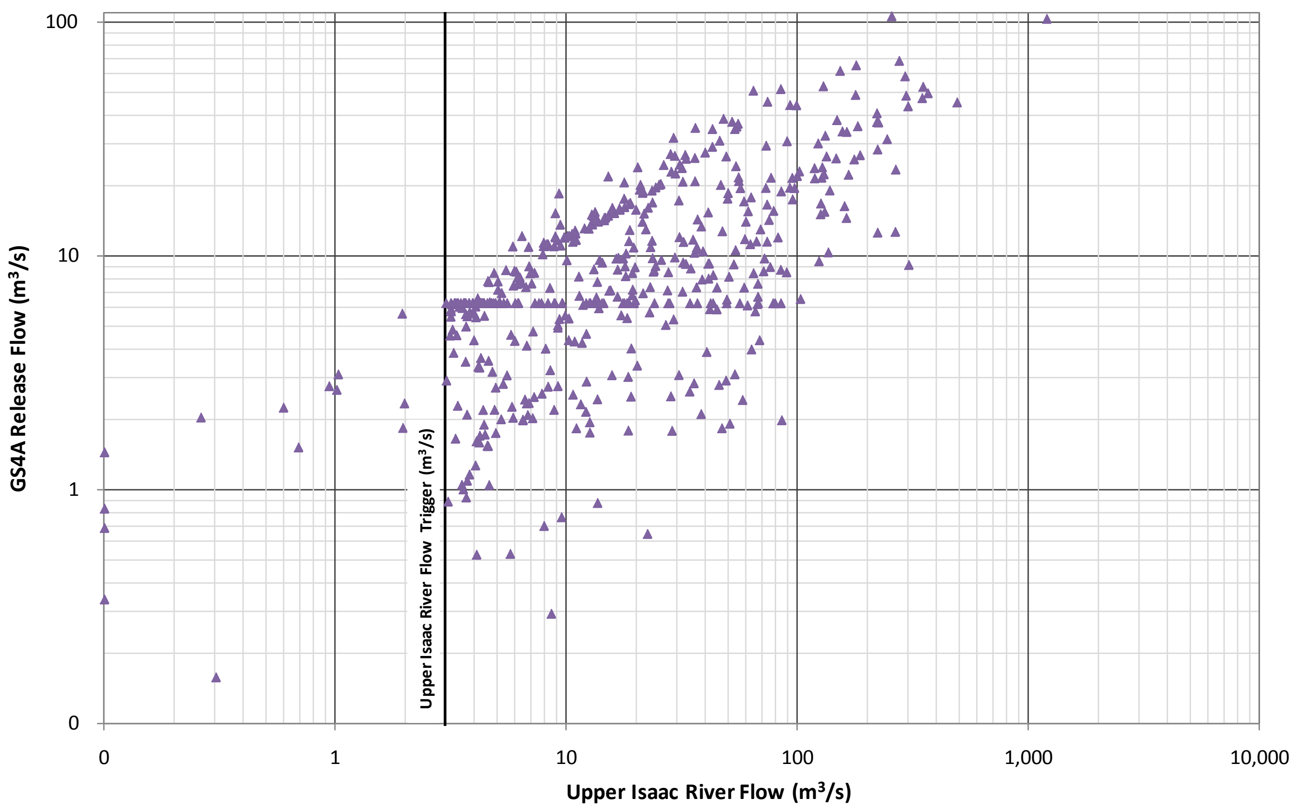


Figure 4-3 Baseline Scenario Modelled Compliance with Flow Trigger

The model identified 14 occurrences, during the 108 year modelling period, of the flow release from GS4A when the flow in the upper Isaac River is less than 3 m^3/s and the release volume is greater that the natural flow recorded at monitoring point 2 on Eureka Creek. There are no active releases made from storages on the site in these events. The exceedances of the flow criteria is a result of variable rainfall in the area. More rainfall has fallen in the Eureka Creek catchment than in the upper Isaac River catchment. The rainfall in the Eureka Creek and site catchments has caused the pumps of GS4A to be overwhelmed and overflow has occurred from GS4A. Although there are 14 occurrences of overflows from GS4A, as identified in **Table 4-1**, only three of these overflows result in non-compliance with the receiving water quality limit.

4.2 Regulatory Requirements for Regulated Structures

Under the EA, a number of structures are regulated and require specific management including management of levels prior to the 1st of November each year. The EA conditions require that the mine water system has sufficient capability to have no unauthorised discharges of mine water for wet season rainfall events up to a 1 in 10 year ARI wet season.

Figure 4-4 shows a comparison between the site storage capacity for regulated dams, the percentage exceedance for the 1st of November volumes and the percentage for the peak wet season inventory. It should be noted that the tailings facilities and Ramp 0 are classified as regulated structures and have been included in the site storage capacity.

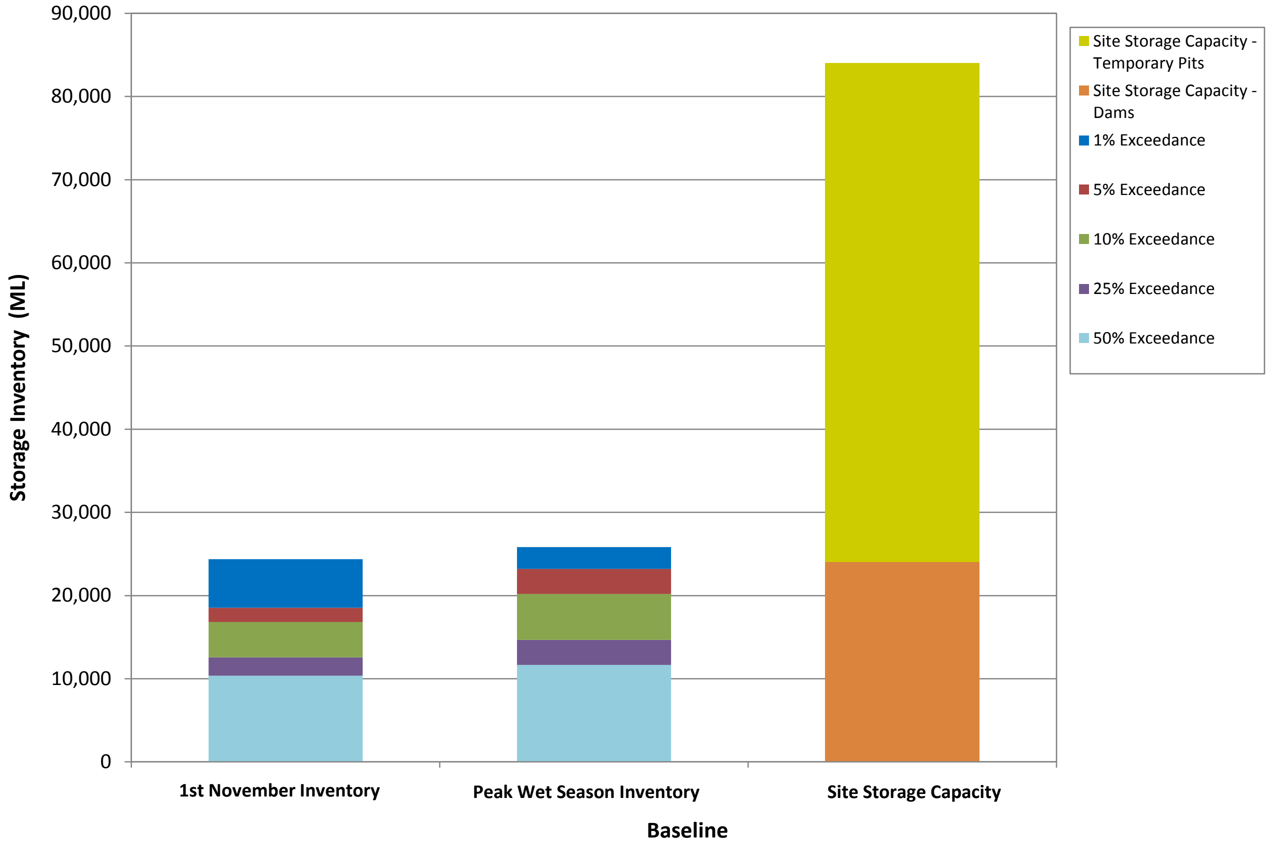


Figure 4-4 Baseline Scenario Regulatory Requirements for Regulated Structures

The 10 % and 1 % exceedance for the peak wet season inventory volume are 20,200 ML and 25,800 ML respectively. This is compared to the site storage capacity for site storages of 24,000 ML of which the regulated dams account for 17,000 ML. **Figure 4-4** shows the predicted peak wet season volumes may require the use of temporary storage in mining pits on site.

The storage inventory may be distributed around the site, meaning that overflows may occur from a section of the mine water system. However, as discussed in **Section 4.1**, the modelling indicates there are only three non-compliant releases over the 108 year simulation. This demonstrates that the GRB mine complex system has sufficient capacity to manage wet seasons up to the 1 in 10 year ARI.

4.3 System Storage Inventory

The total mine water volume in the mine water management network and frequency of when large quantities of mine water need to be managed are valuable indicators of whether the Baseline scenario has sufficient total storage capacity to manage extreme wet periods and how often low priority mine pits will be required for use as contingency storage.

In order to demonstrate the variability of mine water inventory over time, the Baseline scenario results are presented as an exceedance probability of the total mine water inventory (including water in both dams and pits) in **Figure 4-5**. The combined storage capacity for water storages at the GRB mine complex is 24,000 ML (the tailings facilities are noted as regulated storages in the EA, however have been excluded from this assessment as they do not allow for the active management of water captured on site). The site operating inventory level is 14,000 ML.

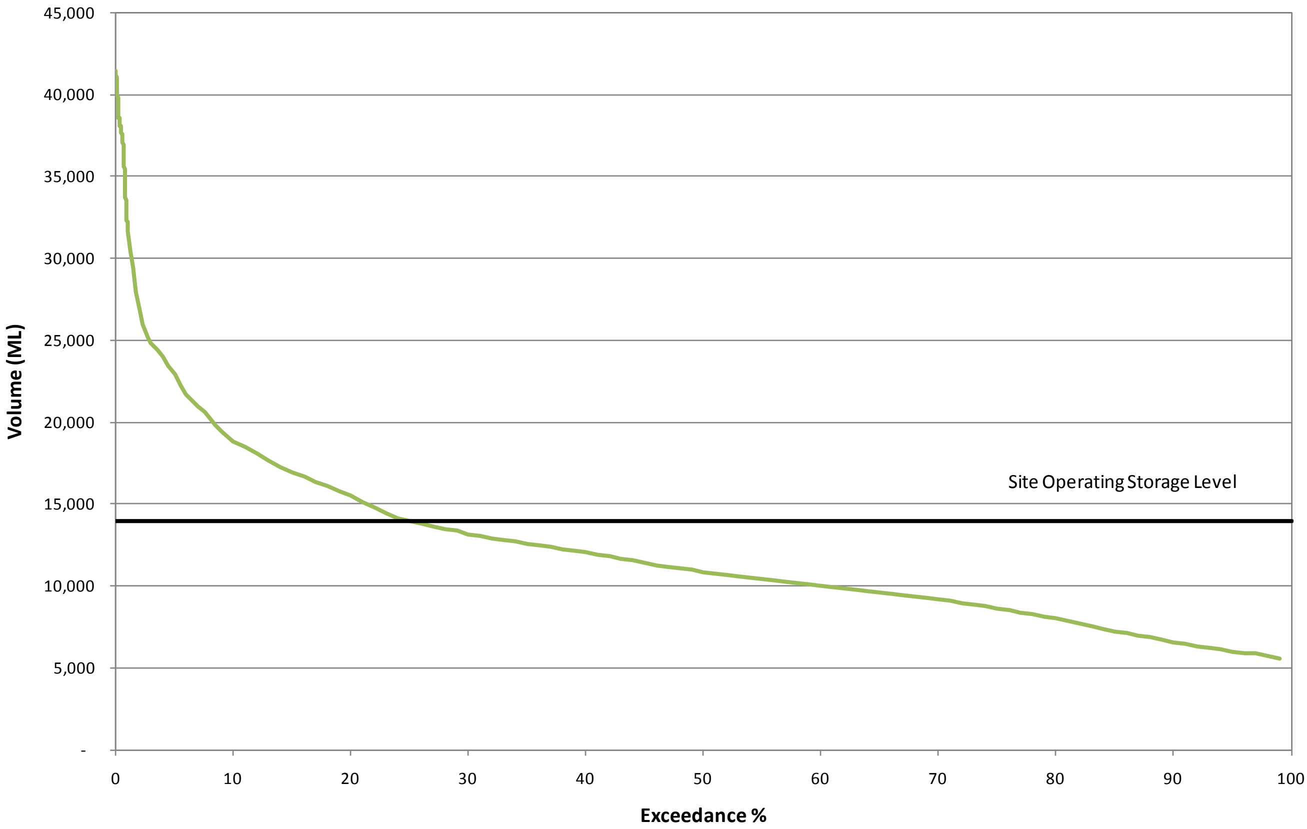


Figure 4-5 Baseline Scenario Modelled Exceedance of Site Water Volumes

Figure 4-5 shows that the on-site storages alibility to capture and manage water on site. The percentage exceedance greater than the site operating storage level is a result of the starting water inventory of 40,000 ML on site and the management capacity of infrastructure.

4.4 Release Opportunity Utilisation

As identified in **Section 3.4**, the water balance model excludes the releases of other mining operations upstream of the GRB mine complex. **Figure 4-6** presents the modelled release opportunity and the release utilisation for the Baseline scenario. The release opportunity is calculated to ensure compliance with the EA and is based on:

- Flow in the upper Isaac River;
- Flow and water quality of Eureka Creek;
- Flow and water quality of site catchments;
- The flow and water quality of the Isaac River upstream of the GRB mine complex;
- Site water storage inventory volume; and
- Water quality and level of Ramp 21/22.

This figure shows that in the Baseline scenario approximately 14 % of the release opportunity is being utilised. This shows that should other mining operations impact on the release opportunities of the GRB mine complex, significant release opportunities remain for the GRB mine complex.

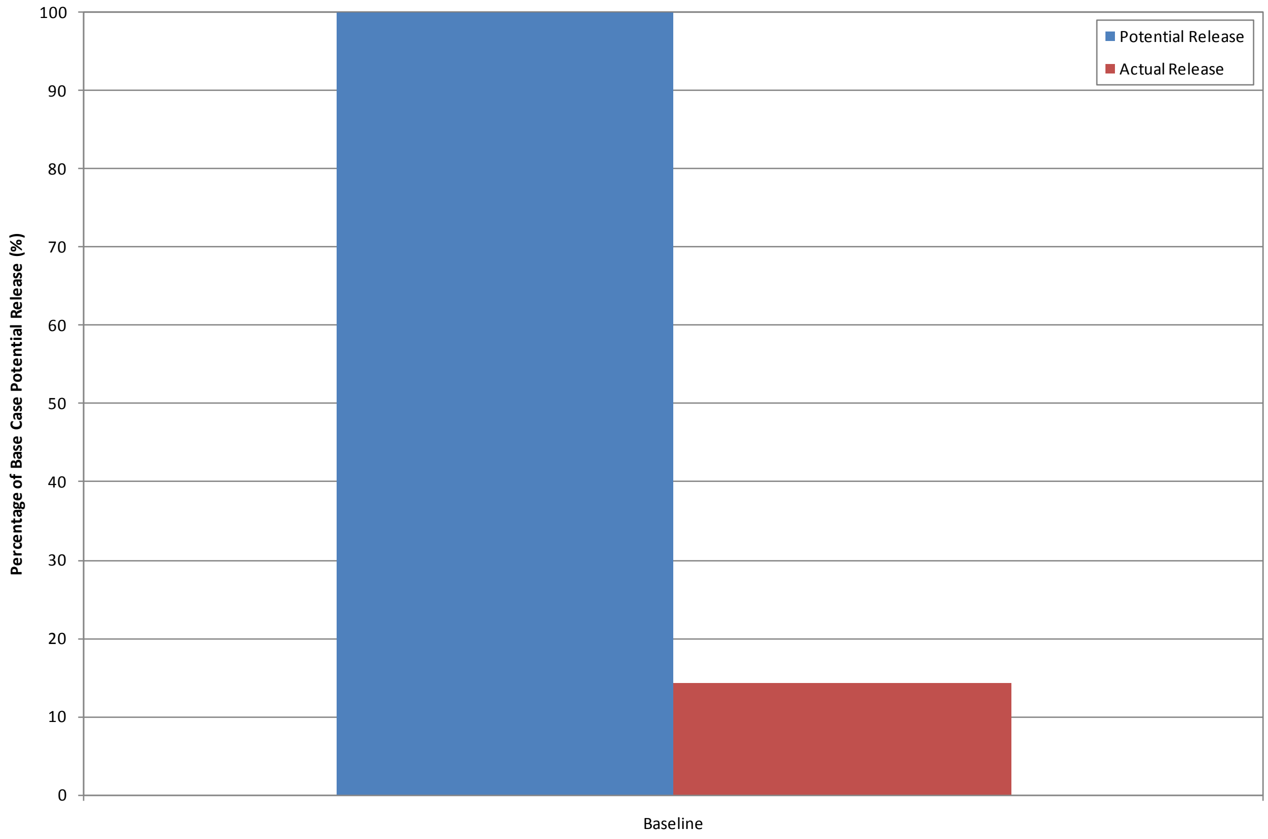


Figure 4-6 Baseline Scenario Modelled Release Utilisation

4.5 External Mine Water Supply

The GRB mine complex has a number of allocations for external water sources for the supply of water to the site to meet a shortfall in mine water requirements. The allocations that are held by BMA in the region are sufficient to supply the potential water usage requirements for the GRB mine complex.

4.6 Summary

The Baseline scenario water balance modelling assessments of the GRB mine water management prior to implementation and operation of the proposed project indicates that:

- infrastructure capacity and operations capability is sufficient to comply with the EA criteria with a high level of confidence for releases from GS4A including respective salinity criteria and flow criteria;
- infrastructure capacity and operations capability is sufficient to comply with the EA criteria for salinity compliance limits applicable in the Isaac River downstream of the mine releases;
- allocations are sufficient to external water sources to meet shortfalls in site demands;
- the utilisation of release opportunities is approximately 14 %, which allows for potential reduction of release opportunities by external operations without significant impact on the GRB mine complex;
- The Baseline scenario has sufficient storage capacity (including use of low priority pits for contingency storage) to cater for maximum mine water volumes that could occur (based on climate extremes evident in available historical data).

5. Modelling Results – Project Case Scenario

The water balance model for the Baseline scenario was updated to incorporate the RHM. The assessment was undertaken to compare the Project Case and Baseline results to determine the potential impacts due to the development of the RHM and the transfer of mine water from RHM to the GRB mine complex.

5.1 Compliance of Releases at GS4A with Environmental Authority Criteria

For compliance with the current EA release conditions, a number of flow and water quality criteria must be met. The following figures are presented to demonstrate capacity to comply with the respective water quality (salinity) and flow criteria including:

- Salinity level of releases for the end of pipe limit (**Figure 5-1**);
- Salinity level at the downstream compliance point of the Isaac River (**Figure 5-2**)
- Flow rate of releases in relation to the flow conditions of the Isaac River (**Figure 5-4**);

The existing GRB mine complex EA conditions require that releases from GS4A meet prescribed water quality limits for EC of 10,000 µS/cm as the end of pipe limit. The ability of the GRB mine complex, under the Project Case scenario, to comply with this criterion is presented in **Figure 5-1**, which shows the modelled flow release of GS4A against the release salinity (EC). This figure shows there are no exceedances, in the 108 year modelling period, of the end of pipe limit for the Project Case Scenario which is no change from the Baseline scenario.

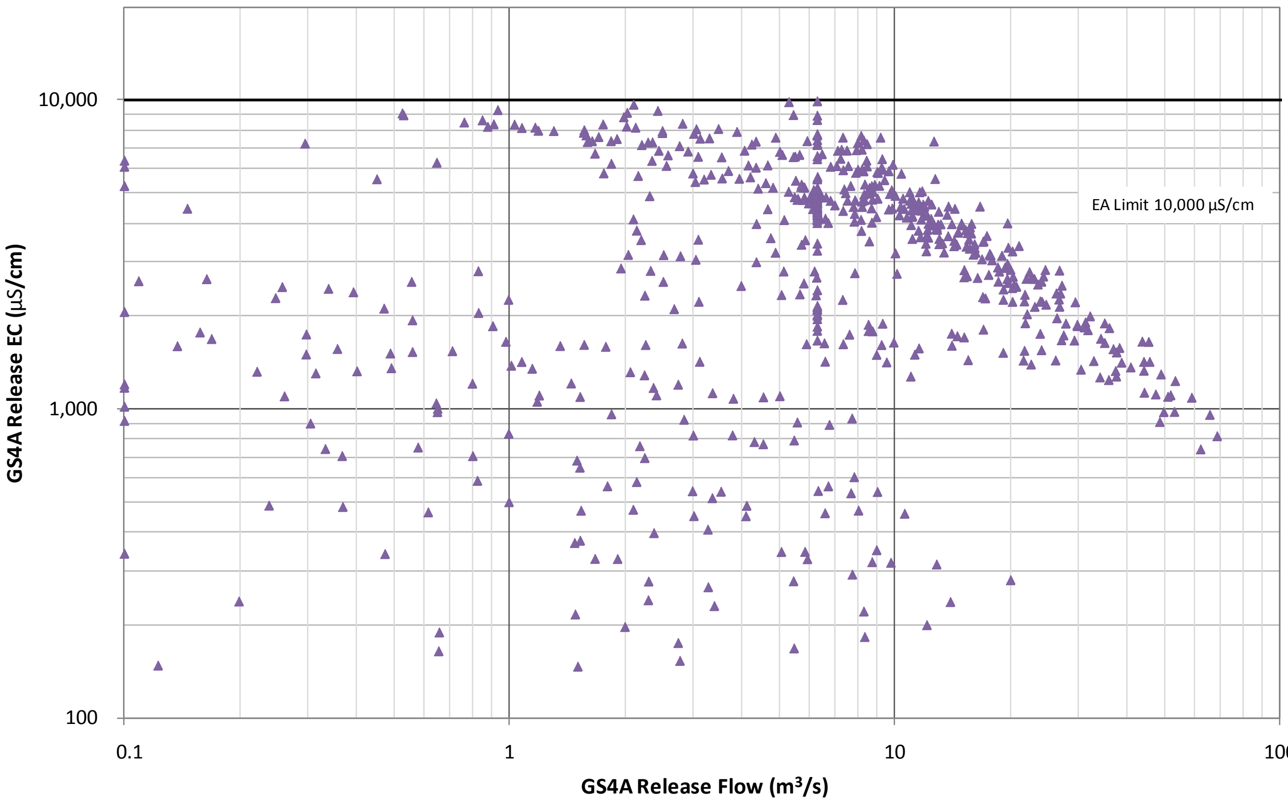


Figure 5-1 Project Case Scenario Modelled Compliance with End of Pipe Limit

The EA conditions require that in addition to releases from GS4A meeting prescribed water quality limits, that salinity thresholds also apply to the downstream Isaac River Diversion; after mixing of the GS4A releases and Isaac River flows. The ability of the GRB mine complex, under the Project Case scenario, to comply with this criterion is presented in **Figure 5-2**, which shows the modelled flow days (expressed as an exceedance) against downstream Isaac River salinity (EC).

Figure 5-2 shows the EA receiving water trigger level of 2,000 µS/cm is met on the majority of the flow days and demonstrates that releases under the Project Case scenario are managed appropriately to ensure compliance with the applicable salinity limits in the Isaac River downstream of the mine's release point.

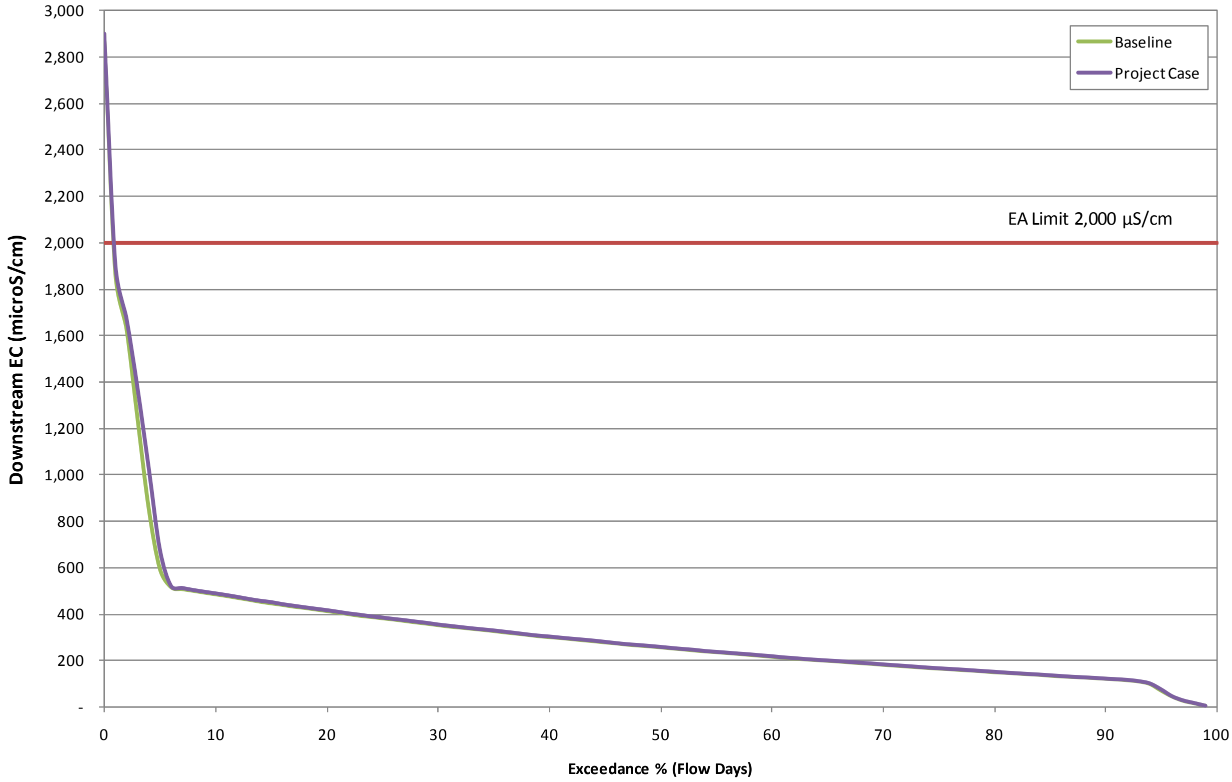


Figure 5-2 Project Case Scenario Modelled Downstream Isaac Salinity Compliance

As in the Baseline scenario (**Section 4.1**), the model identified three one-day occurrences, during the 108 years modelling period, that EC of releases from GS4A causes the downstream EA receiving water trigger level of 2,000 µS/cm to be exceeded in the Project Case scenario. Details of each of the modelled exceedances are outlined in **Table 5-1**, with a comparison to the Baseline scenario. These modelled exceedances are a result of flows entering GS4A, from both natural and site catchments, that are in excess of the 2 m^3/s pumping capacity from GS4A, while there is no flow in the Isaac River. There is no change in compliance in the Project Case scenario for this condition from the Baseline scenario.

Table 5-1 Site Release Exceedances – Comparison to Baseline

Event	GS4A Overflow EC (µS/cm)		Receiving Water EC (µS/cm)	
	Baseline	Project Case	Baseline	Project Case
1	2,787	2,787	2,778	2,778
2	2,444	2,444	2,443	2,443
3	2,901	2,281	2,899	2,280

The modelled impact on the downstream water quality between the Project Case and Baseline scenario is shown in **Figure 5-3.** This figure shows there is a very minor increase in the downstream water quality levels between the 1 – 6 % flow exceedance, however this is below the 2,000 µS/cm receiving waters trigger level.

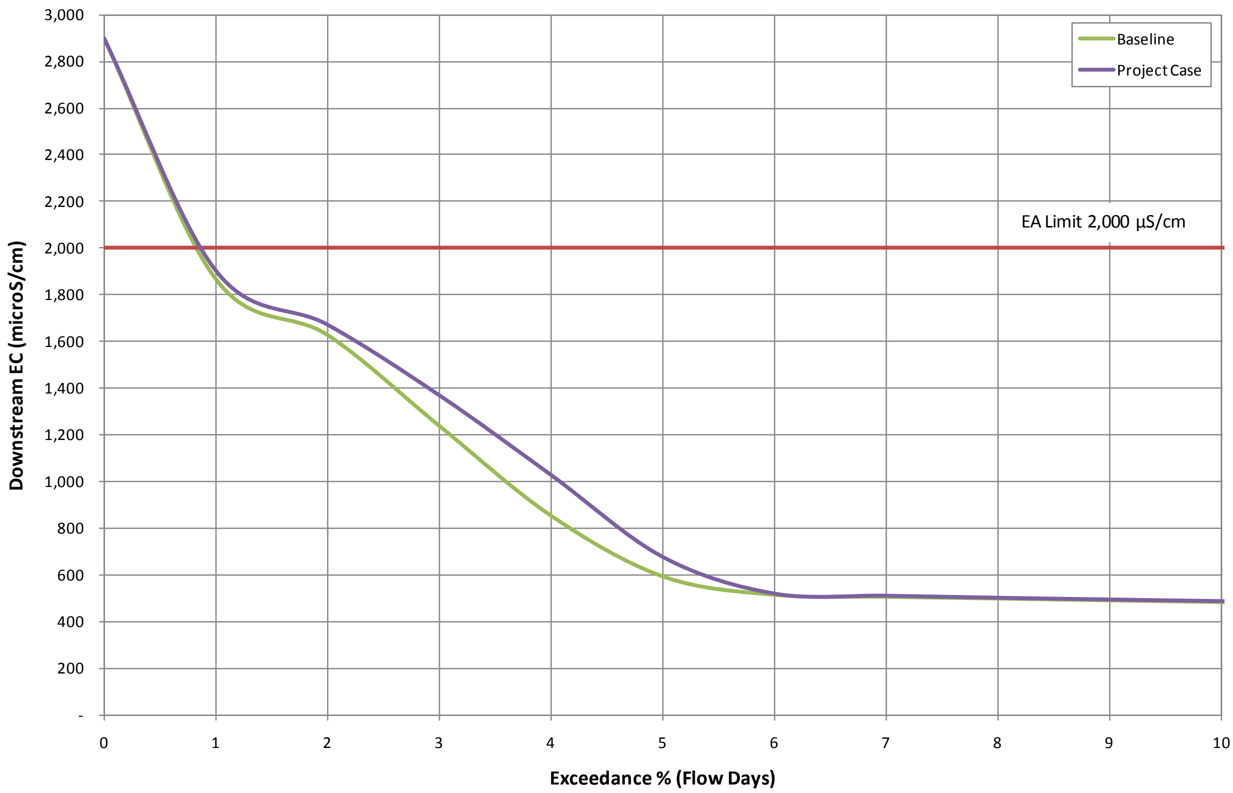


Figure 5-3 Project Case Scenario Modelled Downstream Isaac Salinity Compliance – Zoom

The existing GRB mine complex EA conditions require that the flow rate of releases from GS4A must only occur when the flow in the upper Isaac River is greater than the 3 m^3/s or there is a natural flow measured at Eureka Creek at monitoring point 2. **Figure 5-4** shows the modelled GS4A release flow against the modelled upper Isaac River flow. This figure demonstrates that releases under the Baseline scenario are managed appropriately to ensure compliance with the relative flow criteria.

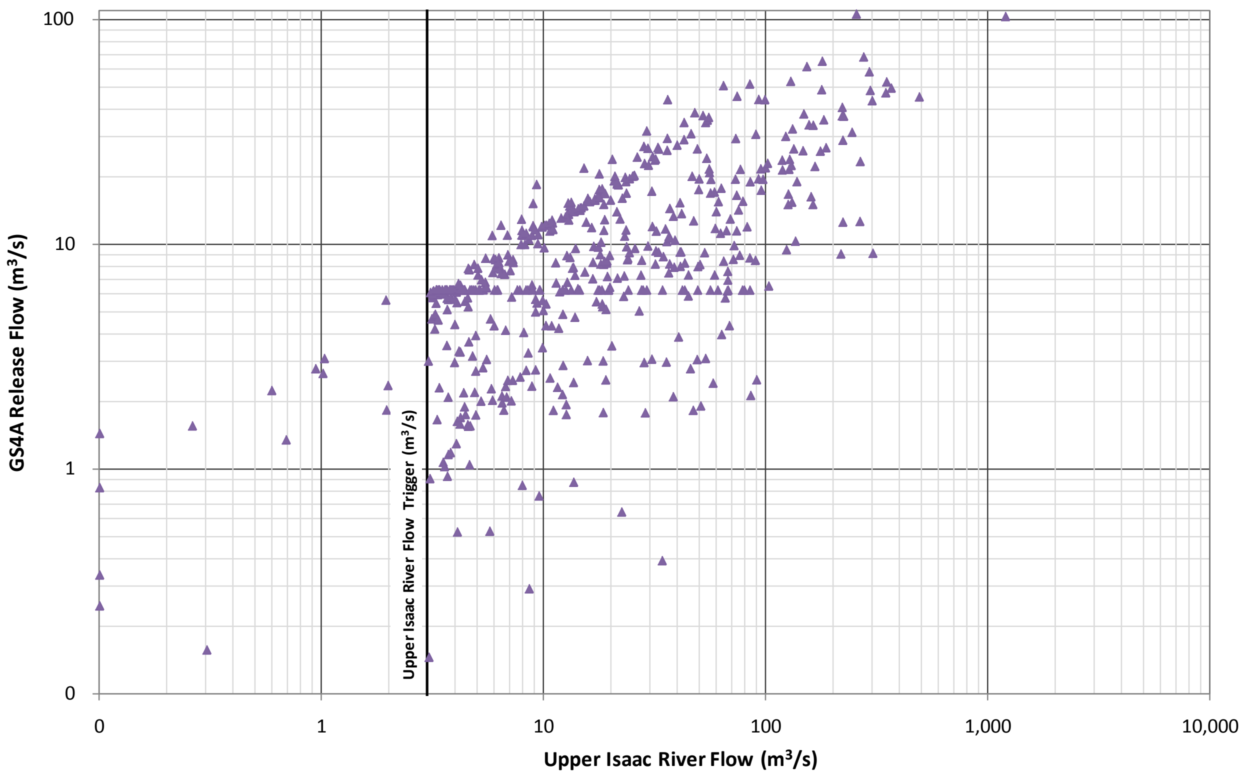


Figure 5-4 Baseline Scenario Modelled Compliance with Flow Trigger

As in the Baseline scenario (**Section 4.1**), the model identified 14 occurrences, during the 108 year modelling period, of the flow release from GS4A when the flow in the upper Isaac River is less than 3 m^3/s and the release volume is greater that the natural flow recorded at monitoring point 2 on Eureka Creek. There are no active releases made from storages on the site in these events. The modelled exceedances of the flow criteria is a result of variable rainfall in the area. More rainfall has fallen in the Eureka Creek Catchment than in the upper Isaac River catchment. The rainfall in the Eureka Creek and site catchments has caused the pumps of GS4A to be overwhelmed and overflow has occurred from GS4A. Although there are 14 occurrences of overflows from GS4A as identified in **Table 5-1**, only three of these modelled overflows result in non-compliance with the receiving water quality limit. There is no change in compliance in the Project Case scenario for this condition from the Baseline scenario.

5.2 Regulatory Requirements for Regulated Structures

Under the EA, a number of structures are regulated and require specific management including management of levels prior to the 1st of November each year. The existing GRB mine complex EA conditions require that the mine water system has sufficient capability to have no unauthorised discharges of mine water for wet season rainfall events up to a 1 in 10 year ARI wet season.

Figure 4-4 shows a comparison between the site storage capacity for regulated dams, the percentage exceedance for the 1st of November volumes and the percentage exceedance for the peak wet season inventory. It should be noted that the tailings facilities and Ramp 0 are classified as regulated structures and have been included in the site storage capacity.

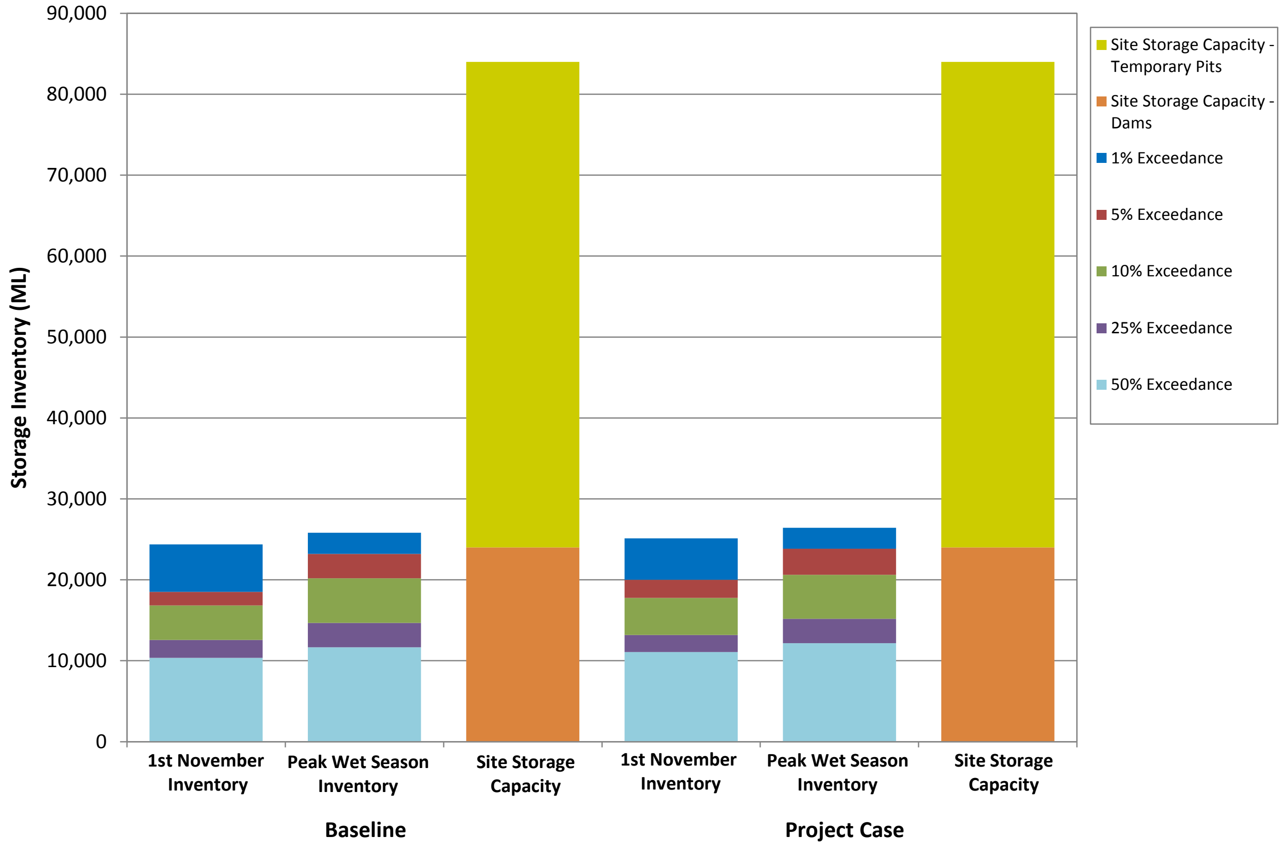


Figure 5-5 Baseline Scenario Regulatory Requirements for Regulated Structures

The 10 % and 1 % exceedance for the peak wet season inventory volume are 20,600 ML and 26,400 ML respectively. This figure shows the predicted peak wet season volumes on site are accommodated with site storage capacity with the addition of the water from the RHM.

There is predicted to be approximately a 2 % increase to the both the 10 % and 1 % exceedance peak wet season inventory volume in the Project Case. This minor increase is due to a slightly higher inventory on site as a result of the surplus from RHM. However, this increase is accommodated with the site storage capacity and as discussed in **Section 5.1**, there is no change to the level of compliance with the discharge frequency requirements in the Project Case from Baseline.

5.3 System Storage Inventory

The total mine water volume in the mine water management system and frequency of when large quantities of mine water need to be managed are valuable indicators of whether the Baseline scenario has sufficient total storage capacity to manage extreme wet periods and how often low priority mine pits will be required for use as contingency storage.

In order to demonstrate the variability of mine water inventory over time, the Baseline scenario and Project Case results are presented as an exceedance probability of the total mine water inventory (including water in both dams and pits) in **Figure 5-6**. The combined storage capacity for water storages at the GRB mine complex is 24,000ML (the tailings facilities are noted as regulated storages in the EA, however have been excluded from this assessment as they do not allow for the active management of water captured on site). The site operating inventory level is 14,000 ML.

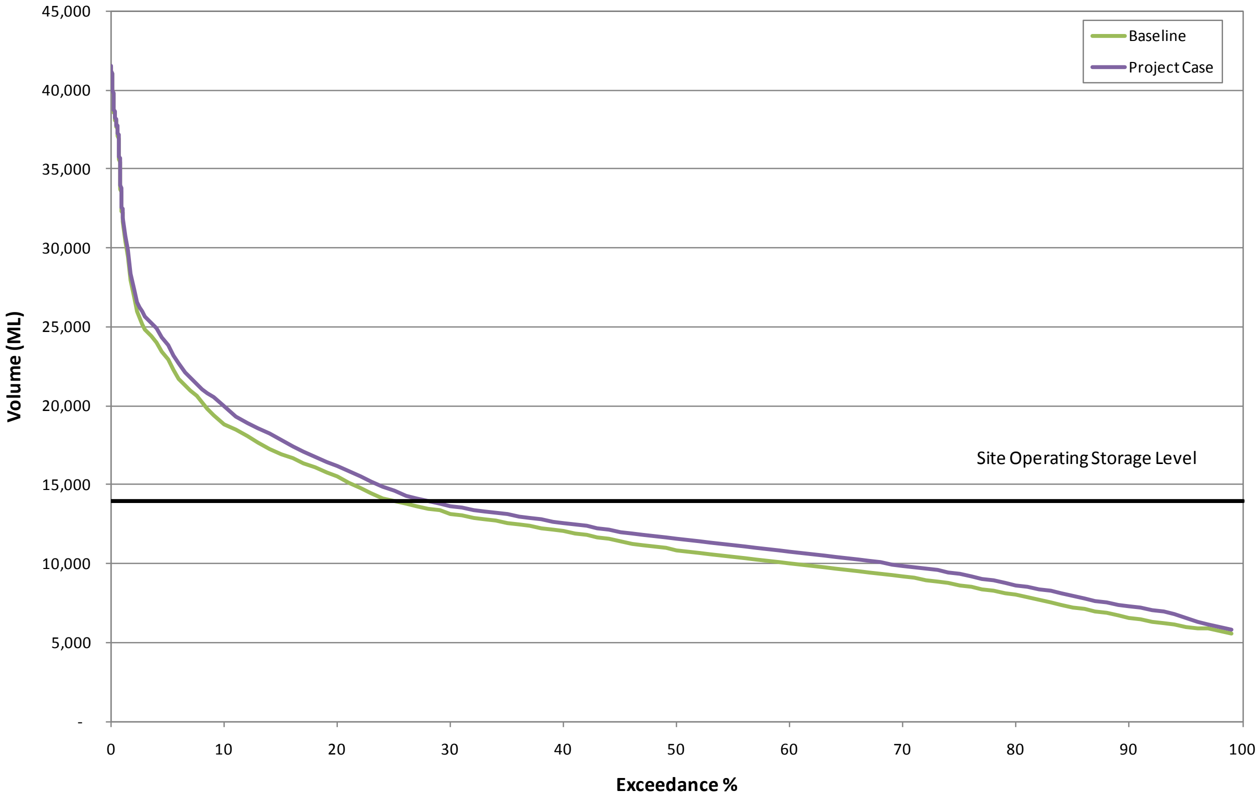


Figure 5-6 Project Case Scenario Modelled Exceedance of Site Water Volumes

Figure 5-6 shows that the on-site storages alibility to capture and manage water on site. The percentage exceedance greater than the site operating storage level is a result of the starting water inventory of 40,000 ML on site and the management capacity of infrastructure. The Project Case scenario show a minor increase the water inventory at GRM, however this increases is accommodated in the site storage capacity.

5.4 Release Opportunity Utilisation

An exclusion of the water balance modelling, as identified in **Section 3.4**, is the ability to represent the releases of other mining operations upstream of the GRB mine complex. **Figure 5-7** presents the modelled release opportunity and the release utilisation for the Baseline Scenario and the Project Case.

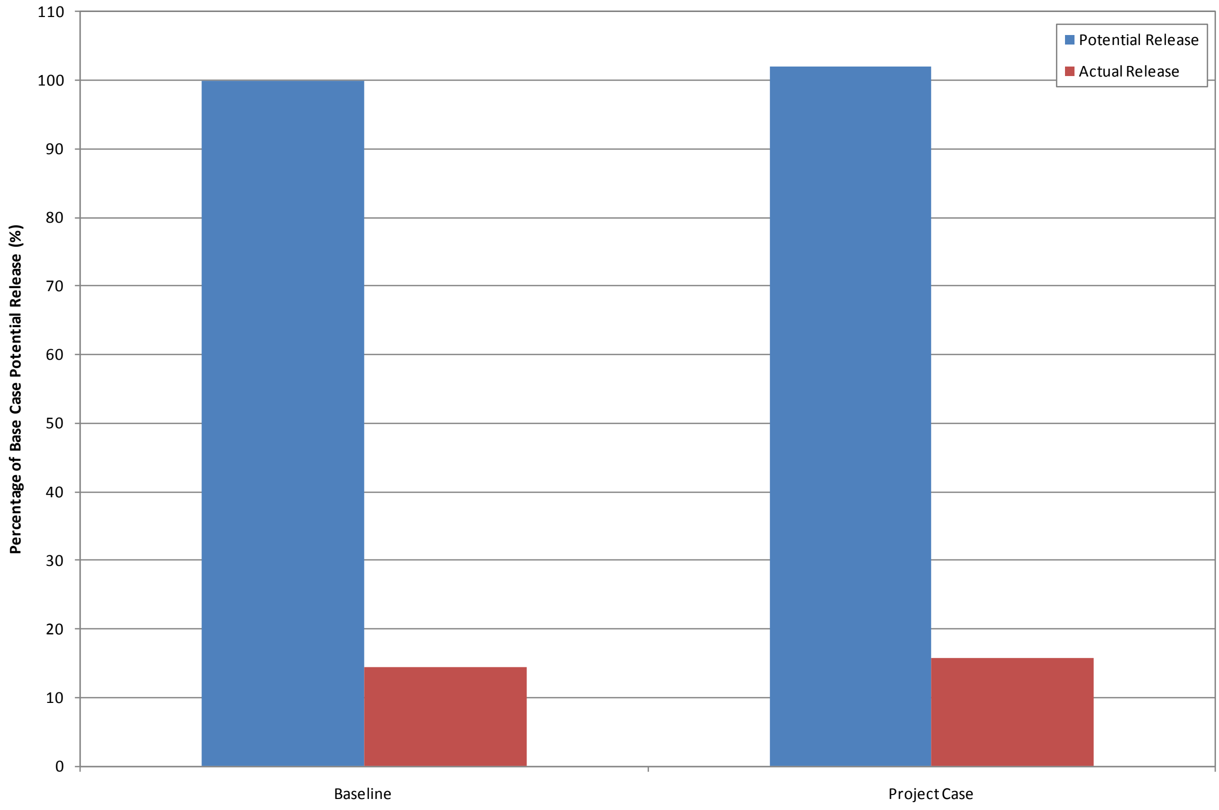


Figure 5-7 Project Case Scenario Modelled Release Utilisation

This figure shows that the release opportunity and release utilisation is slightly increased in the Project Case scenario (by approximately 2 %) due to the small predicted increase in the site water volume as a result of the surplus of groundwater from RHM.

There is still significant release opportunity to be utilised in the Project Case scenario with a release utilisation of 16 %.

5.5 External Mine Water Supply

As discussed in **Section 1.3.3**, the water position for the RHM is predicted to vary between surplus and deficit over the mine life. It is predicted that in the periods of surplus there could be an average surplus of up to 640 ML/yr of mine water. This additional water would be used in the GRB mine complex to meet the 5,000 ML/yr demand, reducing the raw water requirement for the GRB mine complex.

During periods of potential deficit, water for the operations could be sourced from mine water on the GRB mine complex or from external sources. This water demand would be sourced with BMA's current water allocations.

The RHM will require the use of raw water in the underground operations. This demand is predicted to be approximately 730 ML/yr over the mine life. This water demand would be sourced with BMA's current water allocations.

5.6 Summary

The Project Case scenario water balance modelling assessments of the GRB mine water management prior to implementation and operation of the proposed project indicates that:

- infrastructure capacity and operations capability is sufficient to comply with the existing GRB mine complex EA criteria with a high level of confidence for releases from GS4A including respective salinity criteria and flow criteria;
- infrastructure capacity and operations capability is sufficient to comply with the EA criteria for salinity compliance limits applicable in the Isaac River downstream of the mine releases;
- allocations of external water sources are sufficient to meet shortfalls in site demands;
- the utilisation of release opportunities is approximately 16 %, which allows for potential reduction of release opportunities by external operations without significant impact on GRB mine complex;
- The Project Case Scenario has sufficient storage capacity (including use of low priority pits for contingency storage) to cater for maximum mine water volumes that could occur (based on climate extremes evident in available historical data).

6. Mine Water Management Impact Summary

The assessment of the Project Case water balance model against the Baseline scenario indicates that:

- The project will not adversely impact on the capability of the GRB mine water management system to comply with EA conditions for release of mine water from GS4A for respective salinity criteria and flow criteria;
- The project will not adversely impact on the capability of the GRB mine water management system to comply with the EA criteria for salinity compliance limits applicable in the Isaac River downstream of the mine releases;
- There will not be a significant impact on the requirements for external water supply;
- There is negligible change to the water quality in the Isaac River downstream of the GRB mine complex; and
- The GRB mine water management network has sufficient storage capacity (including use of low priority pits for contingency storage) to cater for maximum mine water volumes from the combined GRB mine complex and proposed project operations that could occur (based on climate extremes evident in available historical data).

7. References

EHP (28th February 2013), "*Environmental Authority (No. MIN100921609)".*

Engeny *"Goonyella Riverside Mine Water Balance Model, Technical Report, February 2013 (Ref: M11000_018)*

Appendix A Catchment Area Breakdown

Catchment	Total Catchment (ha)	Natural Catchment (ha)	Spoil (ha)	Hardstand & Pits (ha)	Tailings Beaches (ha)	Rehabilitated Spoil (ha)
SD1	61.4	22.0	28.0	4.0	0.0	7.4
SD2	83.6	6.6	23.0	3.0	0.0	51.0
SD3	11.0	5.0	0.0	2.0	0.0	4.0
SD4	60.0	3.0	55.0	2.0	0.0	0.0
SD5	72.0	12.0	57.0	0.0	0.0	3.0
SD6	70.0	16.0	0.0	0.0	0.0	54.0
SD7	183.3	166.0	1.2	0.0	0.0	16.1
GS9	99.1	0.0	83.1	2.0	0.0	14.0
H13	17.0	2.0	8.0	7.0	0.0	0.0
RS5	197.8	186.4	5.3	6.1	0.0	0.0
RS7	56.3	0.0	43.6	12.6	0.0	0.1
GS16	42.0	1.0	12.0	0.0	0.0	29.0
OLD RAMP 28	78.2	1.0	73.1	3.4	0.0	0.7
RAMP 13 VOID	125.5	0.0	107.7	17.8	0.0	0.0
Kakadu	370.3	218.4	53.0	21.9	0.0	77.0
Ramp 12	344.9	0.0	270.1	74.7	0.0	0.0
Ramp 14	478.4	0.0	248.6	229.8	0.0	0.0
IDC02	52.0	11.0	20.0	0.0	0.0	21.0
Ramp 10	557.0	8.0	305.0	244.0	0.0	0.0
Ramp 27	249.0	0.0	131.0	118.0	0.0	0.0
GR_S55	10.3	1.5	2.9	3.0	0.0	3.0
GR_S79	30.8	0.0	18.6	12.2	0.0	0.0
GR_S8	13.8	0.0	13.7	0.1	0.0	0.0
GR_S3	63.1	46.6	13.1	3.4	0.0	0.0
GR_S157	10.8	0.0	0.0	0.0	0.0	10.8
GR_S32	73.7	72.7	1.0	0.0	0.0	0.0
GR_S150	131.4	0.0	38.5	18.0	0.0	74.9
RS1N	409.6	409.6	0.0	0.0	0.0	0.0
RS1 TSF	518.0	154.0	11.0	0.0	297.0	56.0
RS2	78.0	6.0	0.0	67.0	0.0	5.0
RS3	2.0	0.0	0.0	2.0	0.0	0.0
RS6	771.9	122.0	212.7	211.3	0.0	225.9
RS10	145.0	69.0	1.0	21.0	0.0	54.0
GR_S126	29.5	0.0	28.3	1.1	0.0	0.0
Ramp 4	260.0	25.0	123.0	107.0	0.0	5.0
Ramp 6	260.0	9.0	88.0	163.0	0.0	0.0
Ramp 8	323.0	3.0	173.0	147.0	0.0	0.0
Ramp 21/22/23	461.0	0.0	243.0	215.0	0.0	3.0
Ramp 24	68.0	0.0	57.8	10.3	0.0	0.0
Ramp 25	328.9	0.0	137.2	178.7	0.0	13.0

Catchment	Total Catchment (ha)	Natural Catchment (ha)	Spoil (ha)	Hardstand & Pits (ha)	Tailings Beaches (ha)	Rehabilitated Spoil (ha)
RS4	0.5	0.0	0.0	0.5	0.0	0.0
GR_S19	6.1	5.5	0.0	0.6	0.0	0.0
GR_S2	26.4	0.0	4.0	0.1	0.0	22.3
GR_S4	9.7	4.1	0.0	5.4	0.0	0.2
GR_S95	53.2	0.0	3.1	0.2	0.0	49.9
GR_S64	0.4	0.4	0.0	0.0	0.0	0.0
GR_S151	32.9	0.0	24.3	0.0	0.0	8.6
GR_S31	21.1	0.0	0.0	0.0	0.0	21.1
GS1A	115.0	0.0	0.0	115.0	0.0	0.0
GS1 TSF	105.4	0.0	0.0	0.6	104.8	0.0
GS2	19.0	0.0	0.0	19.0	0.0	0.0
GS3	82.6	0.0	0.0	79.6	0.0	3.0
GS4A	750.0	268.0	103.0	236.0	0.0	143.0
GS14	9.7	0.5	0.0	9.2	0.0	0.0
Ramp 0	231.0	28.0	92.0	105.0	0.0	6.0
Ramp 2	227.0	25.0	120.0	82.0	0.0	0.0
Ramp 31	187.0	0.0	104.0	83.0	0.0	0.0
Ramp 32	211.0	0.0	122.0	85.0	0.0	4.0
GR_S6	78.6	8.7	32.5	37.5	0.0	0.0
IDC04	46.9	0.0	33.6	13.3	0.0	0.0
GR_S87	10.9	0.0	10.6	0.3	0.0	0.0
GR_S136	40.1	0.0	38.6	1.5	0.0	0.0
GR_S149	3.1	0.6	0.0	2.5	0.0	0.0
GR_S153	58.0	27.0	9.7	3.4	0.0	17.9
GR_S154	20.6	0.0	3.1	0.0	0.0	17.5
GR_S155	91.9	56.6	23.6	11.7	0.0	0.0
GR_S158	23.3	0.0	0.0	0.0	0.0	23.3
GR_S159	8.4	8.4	0.0	0.0	0.0	0.0
GR_S162	55.3	23.8	31.6	0.0	0.0	0.0
SITE TOTAL	**9,723**	**2,033**	**3,443**	**2,800**	**402**	**1,045**

Catchment	Total Catchment (ha)	Natural Catchment (ha)	Spoil (ha)	Hardstand & Pits (ha)	Tailings Beaches (ha)	Rehabilitated Spoil (ha)
Upper Isaac River Node 1	16,450.0	16,450.0	0.0	0.0	0.0	0.0
Goonyella Creek Node 1	6,230.0	6,230.0	0.0	0.0	0.0	0.0
Goonyella Creek Node 2	4,140.0	4,140.0	0.0	0.0	0.0	0.0
Middle Isaac River Node 2	11,555.7	11,110.1	167.8	76.7	0.0	201.0
Isaac River Diversion Node 3	2,640.0	2,640.0	0.0	0.0	0.0	0.0
Eureka Creek Node 1	7,390.0	7,390.0	0.0	0.0	0.0	0.0
Eureka Creek Node 2	930.0	930.0	0.0	0.0	0.0	0.0
RECEIVING WATERWAYS TOTAL	**49,336**	**48,890**	**168**	**77**	**0**	**201**

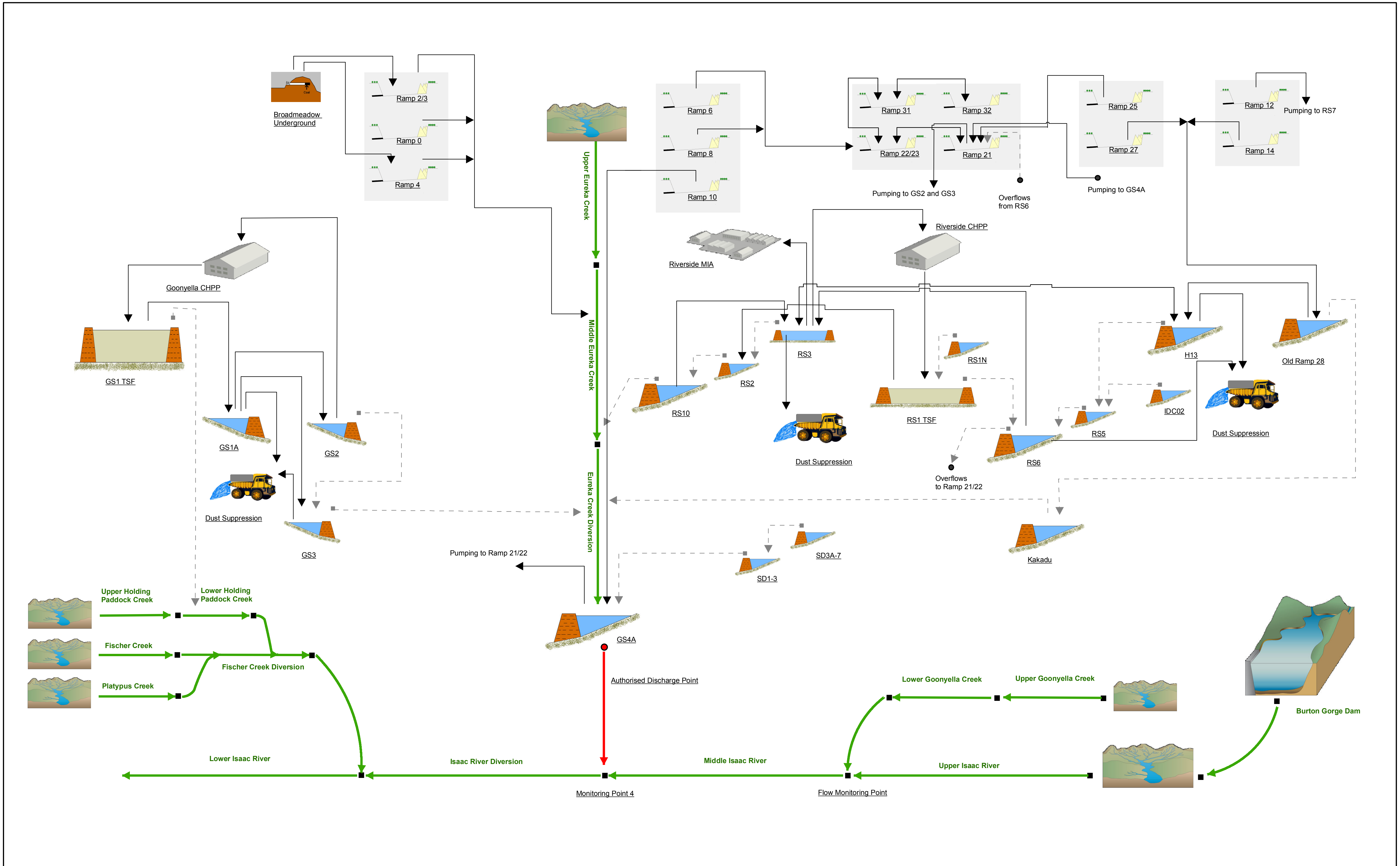
Appendix B Storage Capacities

Water Storages	Storage Capacity (ML)	Water Storages	Storage Capacity (ML)
GS1 TSF	644	Ramp 21/22/23	49,635
GS1A	1,791	Ramp 24	858
GS2	94	Ramp 27	1,664
GS3	82	GR_S126	2,760
GS4A	252	GR_S55	29
GS14	65	GR_S79	165
GS16	547	GR_S8	64
RS1 TSF	7,956	GR_S3	81
RS1N	756	GR_S157	6
RS2	135	GR_S32	25
RS3	44	GR_S150	184
RS5	956	GR_S19	68
RS6	549	GR_S2	189
RS7	24	GR_S4	19
RS10	1,160	GR_S95	110
H13	805	GR_S51	115
SD1	59	GR_S64	6
SD2	34	GR_S151	15
SD3	9	GR_S31	209
SD4	10	GR_S6	54
SD5	32	GR_S87	42
SD6	18	GR_S136	8
SD7	44	GR_S149	49
GS9	110	GR_S153	21
IDC02	330	GR_S154	2
IDC04	732	GR_S155	217
Old Ramp 28	103	GR_S158	266
Ramp 13 Void	4,199	GR_S159	128
Kakadu	6,000	GR_S162	22

Appendix C Water Storage Inventories

Water Storages	Starting Inventory (ML)	Water Storages	Starting Inventory (ML)
GS1 TSF	30	Ramp 21/22/23	26,860
GS1A	1,308	Ramp 24	950
GS2	82	Ramp 27	1
GS3	55	GR_S126	1,000
GS4A	104	GR_S55	15
GS14	30	GR_S79	80
GS16	250	GR_S8	30
RS1 TSF	1	GR_S3	40
RS1N	150	GR_S157	3
RS2	10	GR_S32	12
RS3	43	GR_S150	90
RS5	690	GR_S19	35
RS6	196	GR_S2	90
RS7	12	GR_S4	10
RS10	1,160	GR_S95	50
H13	463	GR_S51	50
SD1	30	GR_S64	3
SD2	15	GR_S151	6
SD3	5	GR_S31	100
SD4	5	GR_S6	25
SD5	16	GR_S87	20
SD6	9	GR_S136	4
SD7	22	GR_S149	25
GS9	55	GR_S153	10
IDC02	150	GR_S154	1
IDC04	350	GR_S155	100
Old Ramp 28	363	GR_S158	130
Ramp 13 Void	652	GR_S159	60
Kakadu	3000	GR_S162	10

Appendix D Baseline Water Balance Model Schematic



Creek / River
Authorised Release
Pump / Pipeline Transfer
Two-way Pump / Pipeline Transfer
Spillway Overflow
Natural Catchment
Mining Pit
Underground Mine
Water Storage
Tailings Storage Facility
Coal Handling and Preparation Plant
Mining Industrial Area

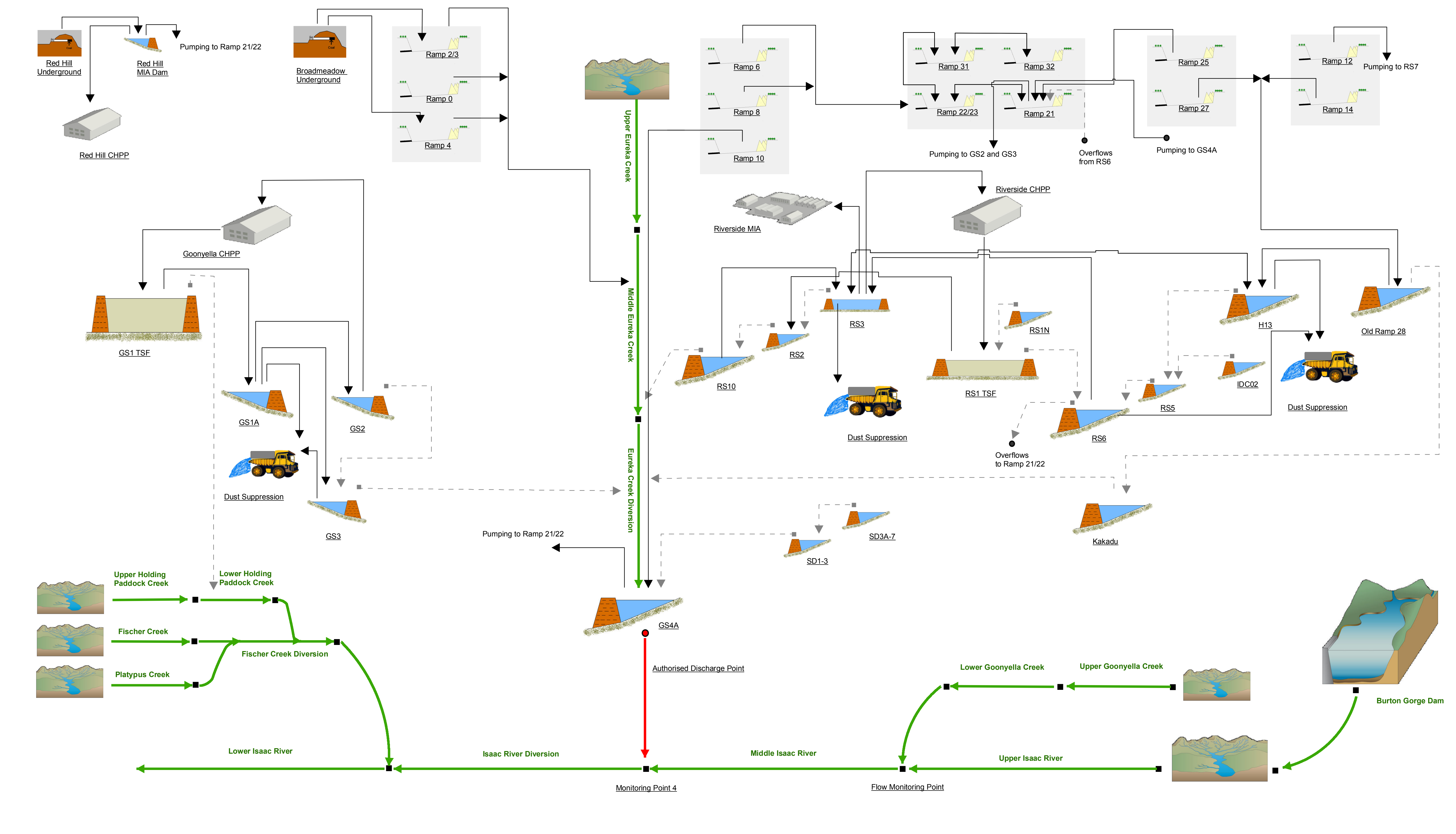
BMA
BHP Billiton Mitsubishi Alliance

RED HILL MINING LEASE
EIS Water Balance Modelling
Baseline Water Balance Model Schematic

Job No: QE06596
Last Modified: 26 August 2013
By: Sarah Buckley

SINCLAIR KNIGHT MERZ
SKM

Appendix E Project Case Water Balance Model Schematic



Creek / River
Authorised Release
Pump / Pipeline Transfer
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RED HILL MINING LEASE
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Project Case Water Balance Model Schematic

SINCLAIR KNIGHT MERZ SKM

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