  

Boggabri Coal Operations Pty Ltd

# Site Water Balance

May 2017

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BOGGABRI COAL

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## Revision Control Chart

| Revision | Date | Prepared by | Reviewed by | Approved by |
|---|---|---|---|---|
| 0 | 27/04/2012 | L Doeleman | L Gleeson,<br>T Swanson | J Rennick |
| 1 | 14/09/2012 | L Doeleman | B Bird | J Green |
| 2 | 19/07/2013 | N Harcombe,<br>A Hedjripour | S Trott,<br>V O'Keefe | C Dingle |
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| 4 | 18/11/2013 | N Harcombe | S Trott | J Green |
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| 8 | 18/05/2017 | T Tinkler,<br>A Wyatt | H Russell | P Forbes |

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# Abbreviations

| Abbreviation | Term |
|---|---|
| **AEMR** | Annual Environmental Management Report |
| **ARI** | Average Recurrence Interval |
| **AWBM** | Australian Water Balance Model |
| **AWD** | Available Water Determinations |
| **BCM** | Boggabri Coal Mine |
| **BCOPL** | Boggabri Coal Operations Pty Limited |
| **BOM** | Bureau of Meteorology |
| **BTM Complex** | Boggabri-Tarrawonga-Maules Creek Complex |
| **CCC** | Community Consultative Committee |
| **CD** | Clean Water Highwall Dam |
| **CHPP** | Coal Handling and Preparation Plant |
| **DP&E** | NSW Department of Planning and Environment |
| **EA** | Environmental Assessment |
| **EC** | Electrical Conductivity |
| **EPA** | Environment Protection Authority |
| **EP&A Act** | *Environmental Planning and Assessment Act, 1979* |
| **EPL** | Environment Protection Licence |
| **GWMP** | Groundwater Management Plan |
| **HD** | Highwall Dam |
| **IFD** | Intensity-Frequency-Duration |
| **MCCM** | Maules Creek Coal Mine |
| **MIA** | Mine Infrastructure Area |
| **ML** | Megalitres |
| **Mtpa** | Million Tonnes Per Annum |
| **MWD** | Mine water dam |
| **NLLS** | North West Local Lands Services (formerly Namoi Catchment Management Authority) |
| **DPI Water** | Department of Primary Industry – Water (formerly NSW Office of Water) |
| **PAC** | NSW Planning Assessment Commission |
| **ROM** | Run of Mine |
| **SD** | Sediment dam |
| **SWB** | Site Water Balance |
| **SWMP** | Surface Water Management Plan |
| **TCM** | Tarrawonga Coal Mine |
| **TCPL** | Tarrawonga Coal Pty Ltd |
| **WAL** | Water Access Licence |
| **WMP** | Water Management Plan |
| **WSP** | Water Sharing Plan |

# 1. Introduction

This Site Water Balance (SWB) has been developed for Boggabri Coal Mine (BCM) which is managed by Boggabri Coal Operations Pty Ltd (BCOPL). BCOPL is owned by Idemitsu Australia Resources Pty Limited (80%), Chugoku Electric Power Australia Resources Pty Ltd (10%) and NS Boggabri Pty Limited (10%). BCM is located 15 km north-east of the township of Boggabri in north-western New South Wales, as shown in Figure B-1.

BCM is an open cut coal mine that has been operating since 2006. Truck and excavator operations are used to mine a run-of-mine (ROM) coal which is crushed and screened to produce a thermal coal product or washed in the Coal Handling Preparation Plant (CHPP) to produce Coking or Pulverised Coal Injected product. Product coal is loaded onto trains via a train loading facility at the mine site and transported by rail to the Port of Newcastle for overseas consumption.

BCM is managed by BCOPL, who also operate the Coal Handling and Preparation Plant (CHPP). BCOPL engages a Mining Operator to undertake open cut mining activities. All contractors working at the BCM are required to operate in compliance with the Water Management Plan (WMP), of which this Site Water Balance (SWB) forms a component.

Project Approval number 09_0182 for the Boggabri Coal Project, granted by the NSW Planning Assessment Commission (PAC) under Part 3A of the *Environmental Planning and Assessment Act* 1979 (EP&A Act) on 18 July 2011, as modified from time to time, (Project Approval) allows BCOPL to extend its mining operations for a further 21 years, and increase its production rate to 8.6 Mtpa of ROM coal from a total resource of 145 Mt.

In 2015, BCOPL lodged an application under Section 75W of the EP&A Act 1997 to modify PA09_0182 (MOD 5). The modification was supported by an Environmental Assessment (Parsons Brinckerhoff, 2015) for the conversion of existing test bores to operational production bores for the supply water to BCM and the installation of ancillary infrastructure on adjoining properties. The application was determined by the NSW Department of Planning and Infrastructure, Executive Director under delegation by the Minister for Planning and was approved on 30 August 2016

Schedule 3, Condition 38 (a) of the state Project Approval requires the preparation of a SWB. This SWB has been prepared in fulfilment of these requirements. The specific requirements of the SWB are listed in Table 1.3.

Conditions of approval under the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) were granted by the then Commonwealth Department of Sustainability, Environment, Water, Population and Communities (now Department of Environment and Energy (DoEE)) on 11 February 2013 (EPBC Approval). The EPBC Approval conditions do not relate specifically to the SWB, but rather to the Surface Water Management Plan (SWMP). The SWB forms part of the SWMP.

The SWB considers the current Life-of-Mine planning and information available to define components of the SWB. To ensure clarity throughout the SWB, reference is made to two distinct mine plans for which demand, usage and storage characteristics are based, specifically the:

1. Revised Draft Mining Operations Plan (MOP): lodged with the NSW Division of Resources and Energy (DRE) in January 2017. The MOP spans a period between 2015 and 2019. Mine plan snapshots and water management systems relevant to mine years existing and 2018, are aligned with the MOP.
2. Environmental Assessment (EA) Mine Plan: lodged in 2009 and conditionally approved by the NSW Minister for Planning and Infrastructure (now Minister for Planning) in July 2012. The EA mine plan spans a 21 year period between 2013 and 2034. Mine plan snapshots and water management system for years 2022 and 2033 in this SWMP are based on the EA mine plan.

## 1.1 Application of the SWB

This SWB applies to all employees and contractors at the Boggabri Coal Mine and covers all areas within the 'Project Boundary' described in Appendix 1 of the Project Approval and shown in Figure B-1.

## 1.2 Related water management documents

This SWB report has been prepared as an integral part of, and should be read in conjunction with the documents listed in Table 1-1. The WMP document hierarchy is shown in Figure 1.1.

**Table 1-1 Related water management documents**

| Document | Description |
|---|---|
| Boggabri Tarrawonga Maules Creek (BTM) Complex Water Management Strategy | Regional strategy prepared in consultation with Tarrawonga Coal Pty Ltd (TCPL) and Maules Creek Coal Project (MCC) |
| Water Management Plan | Overarching document setting out water management framework, statutory requirements and procedural requirements |
| Surface Water Management Plan | Surface water baseline data, performance criteria, monitoring program, response plan, water management system description, erosion and sediment controls |
| Groundwater Management Plan | Groundwater baseline data, performance criteria, monitoring program, response plan, groundwater model validation program |
| Site Water Balance report | Mine water balance modelling methodology, assumptions and results, mine water management system operating philosophy |

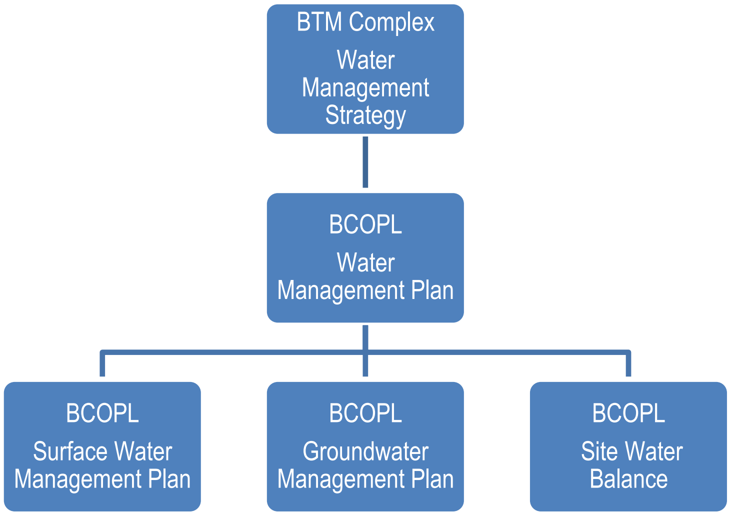



**Figure 1.1 Document hierarchy**

## 1.3 Consultation

Previous versions of this SWB have been prepared in consultation with representatives from the NSW Environment Protection Agency (EPA), NSW Department of Primary Industry – Water (DPI Water) (formerly Office of Water), North West Local Land Services (NLLS) (formerly Namoi Catchment Management Authority and the Community Consultative Committee (CCC).

The SWB has been prepared by suitably qualified persons approved by DP&E to undertake this work. The SWB has been reviewed by DP&E and comments have been addressed.

Previous versions of the SWB have been submitted to regulators (EPA and DPI Water

), NLLS and the CCC, and have been updated to incorporate feedback from regulators and the CCC.

## 1.4 Conditions of the Project Approval

The Project Approval conditions outlining the requirements for the SWB are provided in Section 3.3 of the WMP and summarised in Table 1-2.

## 1.5 Environment Protection Licence

The existing conditions described in this SWB reflect the conditions set out in the current EPL (12407, as at the date of the SWB). Condition L1.1 requires compliance with Section 120 of the *Protection of the Environment Operations Act 1997*. EPL discharge points will be reviewed and updated in consultation with the EPA. Discharge criteria are outlined in the Surface Water Management Plan (SWMP).

**Table 1-2 Project conditions of approval – Planning and Assessment Commission of NSW**

| Applicable Condition | Requirement | SWB Reference |
| --- | --- | --- |
| Schedule 3, Condition 38(a) | The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Secretary. This plan must be prepared in consultation with OEH, DPIW, North Water Local Land Service and the CCC, by suitably qualified and experienced person/s whose appointment has been approved by the Secretary, and be submitted to the Secretary for approval within 6 months of the date of this approval [which shall include]: | This SWB forms part of the WMP. Suitably qualified and approved persons have prepared the plan in accordance with this requirement. |
| | ▪ a Site Water Balance, that:<br>▪ includes details of: | Refer to Section 4 and Section 6 |
| | ‣ sources and security of water supply, including contingency for future reporting periods; | Refer to Section 4.5 and Table 6-1 |
| | ‣ prioritisation strategy for water sources; | Refer to Section 3.2 |
| | ‣ water use on site; | Refer to Section 4.6 |
| | ‣ water management on site; | Refer to Section 3 |
| | ‣ any off-site water discharges; | Refer to Section 4.7.3 and Table 6-1 |
| | ‣ reporting procedures, including the preparation of a site water balance for each calendar year; | Refer to Section 8.3 |
| | ‣ a program to validate the surface water model, including monitoring discharge volumes from the site and comparison of monitoring results with modelled predictions; | Refer to Section 8.2 |
| | ‣ methodologies used in the preparation of the site water balance, including provision of data sources, measurement type (direct sample / mass balance / engineer calculations / factors) and formulas used for all inflows, processes and outflows; and | Refer to Section 4 and Appendix A |
| | ▪ is supported by an annual improvement program to identify and address deficiencies and improvements within monitoring, measurement and calculation methods; and | Refer to Section 8.1 |
| | ▪ includes an action plan and schedule to implement annual water efficiency initiatives and the recommendations in the Advisian peer review report titled "Peer Review of Site Water Balance Use Aspects of Boggabri Coal MOD 5 Project, 22 July 2016" as set out in Appendix 6A; and | Refer to Section 7 |
| | ▪ describes the measures that would be implemented to minimise clean water use on site | Refer to Section 3.1.1 |

# 2. Existing environment

## 2.1 Catchment description

The Boggabri Coal Mine and Mine Infrastructure Area (MIA) are contained within the catchment of an unnamed ephemeral drainage line locally referred to as Nagero Creek. Nagero Creek is an ephemeral stream that is a tributary of the Namoi River.

The Nagero Creek catchment is described in the Surface Water Management Plan (SWMP).

## 2.2 Climate data

Daily rainfall and evaporation data for the site for the 126 year period between 1889 and 2016 was obtained from the Bureau of Meteorology (BOM) Data Drill service. The Data Drill accesses grids of data derived by interpolating the BOM's station records, as described in Jeffrey, Carter, Moodie & Beswick (2001). The data in the Data Drill are all synthetic; no original meteorological station data are left in the calculated grid fields. However, the Data Drill does have the advantage of being available for any set of coordinates in Australia (BOM, 2006).

The Data Drill is considered superior to individual BOM station records and site meteorological station data for long-term water balance modelling purposes because it draws on a greater dataset, both spatially and in time. The Data Drill is also considered superior for modelling purposes as it does not contain gaps.

Plots of Data Drill sourced annual rainfall and annual lake evaporation for the 126 year period between 1889 and 2015 are provided in Figure 2.1 and Figure 2.2 respectively. A plot of Data Drill sourced average daily lake evaporation for each month of the year is provided in Figure 2.3. Summary statistics of Data Drill sourced annual rainfall and evaporation are provided in Table 2-1.

Daily evaporation estimates for open water bodies were obtained from the Data Drill based on Morton's Lake evaporation data. SILO calculates Morton's Lake evaporation using Morton's formula for shallow lakes as described in Morton (1983). Evapotranspiration estimates were based on Data Drill sourced daily FAO56 short crop as described in Smith (1998).

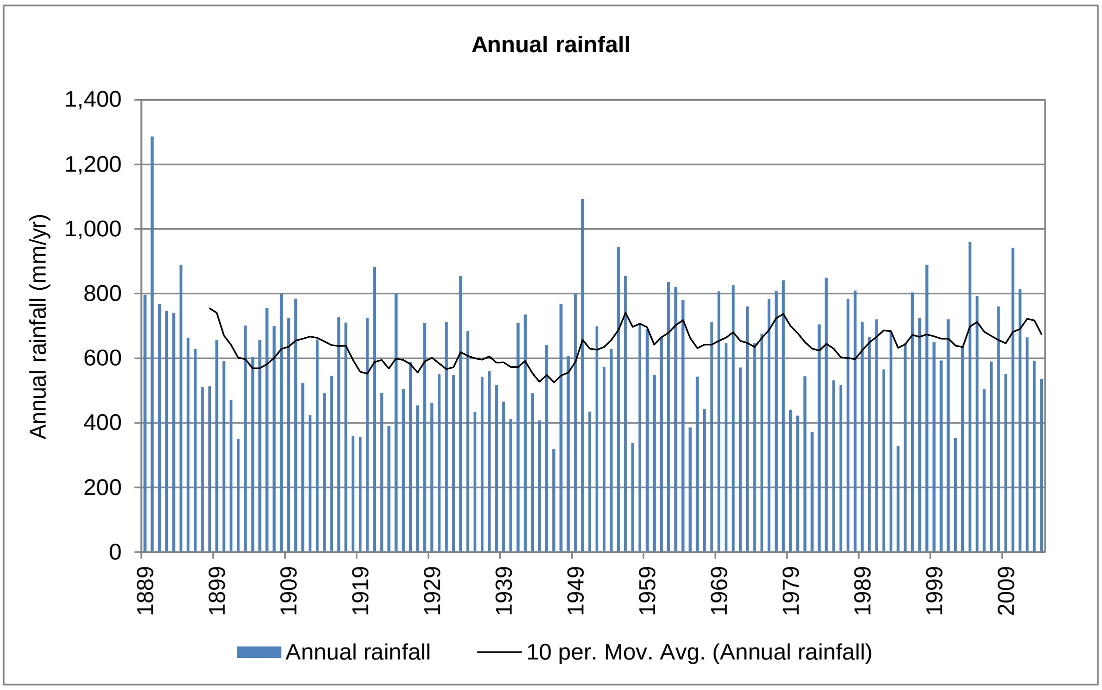



**Figure 2.1 Annual rainfall for Boggabri from 1889 to 2015 (Data Drill)**

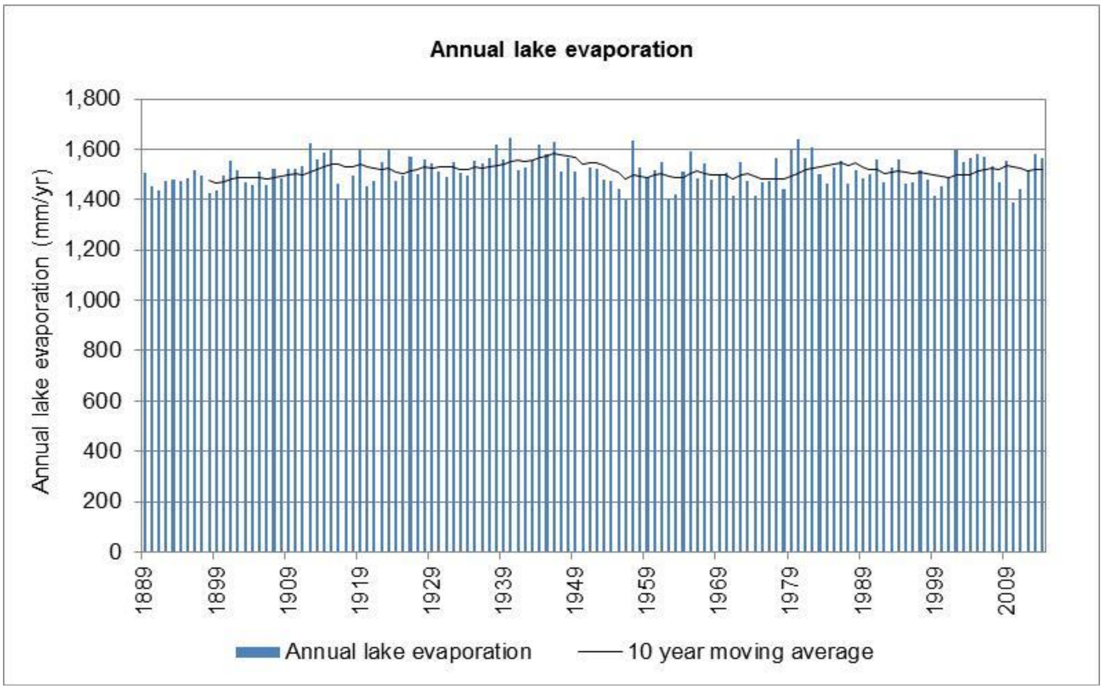



**Figure 2.2 Annual lake evaporation for Boggabri from 1889 to 2015 (Data Drill)**

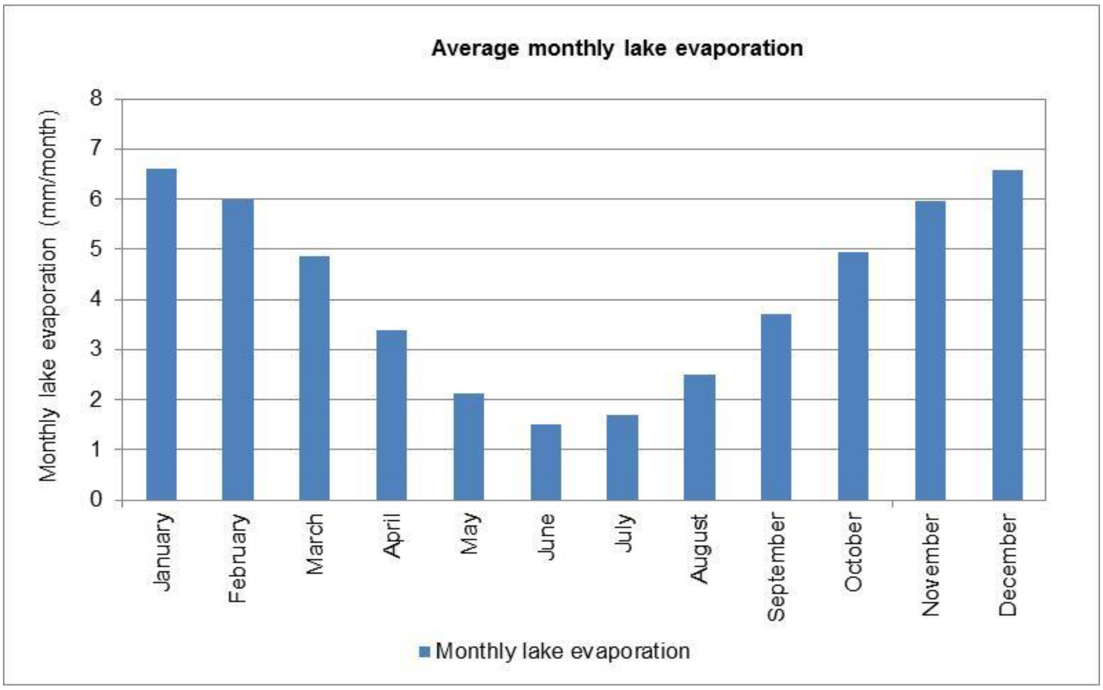



**Figure 2.3 Average daily lake evaporation for Boggabri from 1889 to 2015 (Data Drill)**

**Table 2-1 Annual rainfall and evaporation statistics for Boggabri from 1889 to 2015 (Data Drill)**

| Percentile | Annual rainfall (mm/yr) | Annual potential evapotranspiration (mm/yr) [1] | Annual lake evaporation (mm/yr) [2] |
|---|---|---|---|
| minimum | 319 | 1,253 | 1,389 |
| 5th percentile | 363 | 1,310 | 1,414 |
| 10th percentile | 423 | 1,339 | 1,441 |
| 50th percentile | 658 | 1,418 | 1,511 |
| 90th percentile | 831 | 1,536 | 1,594 |
| 95th percentile | 887 | 1,574 | 1,617 |
| maximum | 1,287 | 1,634 | 1,643 |

1 Potential evapotranspiration calculated using the Penman-Monteith formula given in Irrigation and Drainage paper No. 56 Food and Agriculture Organization of the United Nations (Smith, 1998).

2 Lake evaporation calculated using Morton formula for shallow lakes given in the Journal of Hydrology, Volume 66, page 1-77, paper (Morton, 1983).

Daily rainfall data has been recorded at the Boggabri Coal Mine meteorological station since July 2006. The site meteorological station data has been used to verify the water balance model against site monitoring results recorded for the period from 2013 to 2015 (discussed in Section 5).

## 2.3 Design rainfall data

### 2.3.1 Intensity-frequency-duration rainfall data

Design intensity-frequency-duration (IFD) rainfall data for the mine site area was obtained from the BOM website, and is provided in Table 2-2. This information is typically used in the sizing of contaminated water dams (i.e. 100 year Average Recurrence Interval (ARI) 72 hour volume is typically used to achieve the no spills principle).

**Table 2-2 IFD data for Boggabri Coal Mine site**

| Duration | Rainfall intensity (mm/hr) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 year ARI | 2 year ARI | 5 year ARI | 10 year ARI | 20 year ARI | 50 year ARI | 100 year ARI |
| 5 mins | 70.7 | 92.9 | 123 | 144 | 171 | 209 | 240 |
| 10 mins | 53.6 | 70.4 | 93.5 | 109 | 129 | 158 | 181 |
| 20 mins | 39.3 | 51.6 | 68.3 | 79.3 | 93.9 | 115 | 131 |
| 30 mins | 31.9 | 41.8 | 55.3 | 64.1 | 75.9 | 92.6 | 106 |
| 1 hr | 21.1 | 27.7 | 36.6 | 42.4 | 50.2 | 61.2 | 70.2 |
| 2 hrs | 13.2 | 17.3 | 22.9 | 26.6 | 31.5 | 38.4 | 44 |
| 3 hrs | 9.84 | 12.9 | 17.1 | 19.9 | 23.6 | 28.8 | 33 |
| 6 hrs | 5.91 | 7.77 | 10.3 | 12 | 14.3 | 17.4 | 20 |
| 12 hrs | 3.58 | 4.71 | 6.29 | 7.34 | 8.73 | 10.7 | 12.3 |
| 24 hrs | 2.19 | 2.9 | 3.9 | 4.58 | 5.47 | 6.73 | 7.77 |
| 48 hrs | 1.33 | 1.76 | 2.39 | 2.82 | 3.39 | 4.20 | 4.86 |
| 72 hrs | 0.95 | 1.26 | 1.73 | 2.04 | 2.46 | 3.06 | 3.55 |

### 2.3.2 Five day rainfall depths

Five day rainfall depths for the mine site have been estimated based on the values provided for Gunnedah in the guidelines *Managing Urban Stormwater – Soils and Construction – Volume 1* (Landcom, 2004), and are provided in Table 2-3. These depths are typically used in the sizing of sediment dams. The guidelines recommend designing to the 90$^{th}$ percentile storm event for a sediment dam with duration of disturbance greater than three years and with a standard receiving environment.

**Table 2-3 5-day rainfall depths for Boggabri Coal Mine site**

| Percentile | 5-day rainfall depth (mm) |
|---|---|
| 75$^{th}$ percentile | 20.0 |
| 80$^{th}$ percentile | 24.1 |
| 85$^{th}$ percentile | 30.2 |
| 90$^{th}$ percentile | 38.4 |
| 95$^{th}$ percentile | 53.0 |

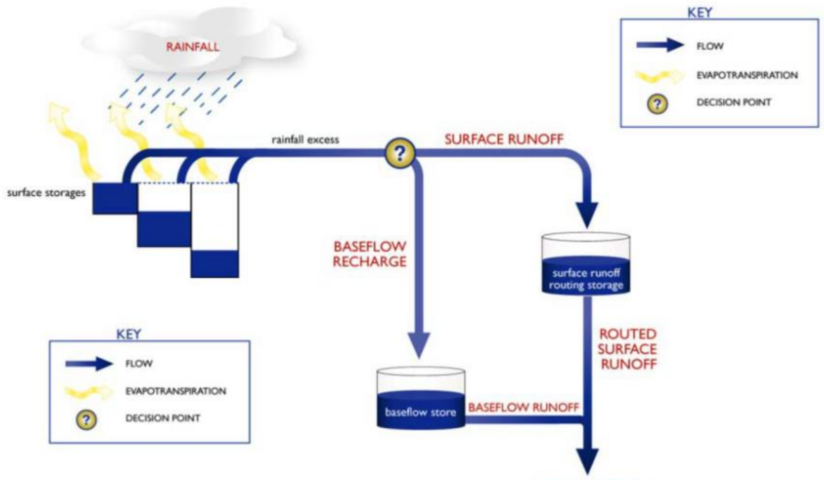
## 2.4 Rainfall-runoff

The volume of surface water runoff in the mine site catchment has been estimated using the Australian Water Balance Model (AWBM) rainfall-runoff model that has been incorporated into the site water balance model.

### 2.4.1 AWBM rainfall-runoff model

The AWBM (Boughton, 1993) was used to estimate catchment runoff from various land uses in the catchment area of the site. The catchment area reporting to each surface water storages at the site was distributed spatially to different land use categories. The land use categories considered were undisturbed, rehabilitated spoil, industrial (hardstand and infrastructure areas), mining void (pit), active spoil and pre-strip.

The AWBM is a partial area saturation overland flow model. The use of the partial area saturation overland flow approach is simple, and provides a good representation of the physical processes occurring in most Australian catchments (Boughton, 1993). This is because daily infiltration capacity is rarely exceeded, and the major source of runoff is from saturated areas. A schematic layout of the AWBM is provided in Figure 2.4.




Adapted from CRC for Catchment Hydrology (2004)

**Figure 2.4 Schematic layout of the AWBM rainfall-runoff model**

To implement the AWBM in a given catchment, a set of nine parameters must be defined as summarised in Table 2-4.These parameters define the generalised model for a particular catchment. The model parameters were calibrated to produce the best match between the site observations and corresponding modelled variables. The calibration process and the adopted parameter values are described in Section 5.

**Table 2-4 AWBM parameters**

| Parameter | Description |
|---|---|
| A1, A2, A3 | Partial areas represented by surface storages |
| C1, C2, C3 | Surface storage capacities |
| $K_s$ | Daily surface flow recession constant |
| BFI | Baseflow index |
| $K_{base}$ | Daily baseflow recession constant |

# 3. Surface water management system

## 3.1 Design objectives

The key objectives of the water management system design for the Boggabri Coal Mine are to:

- segregate clean runoff, dirty runoff and contaminated water generated from rainfall events and mining operations where reasonable and feasible
- minimise the volume of contaminated mine water (surface runoff draining to pit) generated by the Project
- provide sufficient on-site storage to store contaminated water that could affect the quality of downstream watercourses
- where reasonable and feasible treat dirty runoff from un-rehabilitated overburden areas to settle coarse suspended solids
- where reasonable and feasible divert clean runoff to downstream creeks

The following definitions have been adopted for the various runoff types:

- **Clean runoff** is defined as runoff from catchments that is not disturbed by mining operations.
- **Dirty runoff** is defined as runoff from disturbed areas within the mine site and includes runoff from the spoil dumps, haul roads and parts of the MIA. This water contains high levels of suspended solids.
- **Contaminated runoff** is defined as runoff generated from coal stockpiles, the CHPP, parts of the MIA and the mining void, as well as groundwater inflows to the mining void. This water contains high levels of suspended solids and is mildly saline.

Water management system indicative layout plans for existing, 2018, 2022 and 2033 are provided in Figure B-2 to Figure B-5, Appendix B. Schematic diagrams showing the general connectivity between water sources, demands and storages for existing, 2018, 2022 and 2033 are also provided in Figure B-6 to Figure B-9, Appendix B. Note year 2022 corresponds to 'Year 10' from the EA, and year 2033 corresponds to 'Year 21' from the EA.

### 3.1.1 Clean water management system

The clean water management system will, where reasonable and feasible, divert clean water runoff from undisturbed catchments around the mine working area and into Nagero Creek. This minimises the clean catchment runoff entering the dirty and contaminated water systems and therefore minimise the clean water use on site.

In some instances, as the mine pit footprint changes, remnant undisturbed catchments that are unable to be feasibly diverted around the pit via clean water drains due to topographical limitations may remain. In these instances, where feasible, highwall dams

(HD) will be constructed upslope of the pit to intercept these flows and provide temporary storage, with subsequent controlled pump-out and discharge to a suitable receiving creek system at a downstream point.

In other locations it is not feasible to provide diversion drains or highwall dams due to the advancing topsoil stripping and stockpiling. In these circumstances clean water will be allowed to enter the active mining areas and the dirty water diversion system. BCOPL will be required to account for the additional captured water and hold adequate licences or harvestable rights.

### 3.1.2 Dirty water management system

Dirty water runoff will be captured in sediment dams to encourage the settling of suspended solids. Runoff from large storm events (i.e. typically exceeding the 90$^{th}$ percentile 5 day rainfall depth) will overtop sediment dams and discharge to Nagero Creek. Captured water will either be discharged to Nagero Creek (where the water quality meets EPL12407 requirements) or pumped to mine water dams (MWDs) for storage and reuse. This will depend on water quality and the SWB.

Water captured in sediment dams should be suitable for release following settling of suspended solids. However, as spoil dump runoff has the potential to have elevated acidity, salinity, dissolved metals and oils and greases, sediment dams will be provided with manually operated valves on the outlet pipes. Alternatively, sediment dams will be provided with a mobile pump out system only. This will minimise discharge to the creek if water quality is not suitable (and to allow for flocculation or other measures required to attain the approved discharge water quality criteria).

During 2013 and 2014, site catchment inflows (direct rainfall, catchment runoff and groundwater inflows into the mine void) exceeded site water demands. This resulted in an annual water surplus at the BCM. Sediment dam water were therefore discharged to Nagero Creek following settling under normal operating conditions in 2013 and 2014 to minimise the volume of water that accumulated onsite (when the EPL discharge criteria was met). Sediment dam water was only reused onsite in 2013 and 2014 when water quality was not suitable for discharge to the creek system.

Following the commissioning of the CHPP in 2015, the site demands increased and exceeded the average site catchment inflows. Therefore, the BCM moved to, and is predicted to remain in, an annual water deficit under most climatic conditions.

### 3.1.3 Contaminated water management system

Contaminated water will be stored in contaminated water dams, MWDs or the mining void and will not be discharged to Nagero Creek. The water management system will reuse as much contaminated water as possible onsite for dust suppression and coal washing (excluding a minimum imported water component required for potable and washdown demand). When the capacity of MWDs is reached surplus contaminated water will either be treated to meet the EPL water quality criteria for a controlled discharged or will be stored in the pit void.

## 3.2 Water source prioritisation strategy

Water required to satisfy the site demands will be sourced from onsite surface water storages and supplemented with imported water, in order of priority, from:

1. Surface water stored in water storages (consisting of contaminated water stored in mining water storages and pit void, and dirty water in sediment dams).

2. Imported water (consisting of groundwater from the Upper Namoi Zone 4 Groundwater Source via the borefield and river water from the Lower Namoi Regulated River Water Source via the pump station on the Namoi River).

On a day to day operational basis, imported water may be sourced while stored water is present onsite in order to meet operational demands. However, on average over the longer term, contaminated and dirty water will be used in preference to imported water.

The water quality of contaminated and dirty water make it unsuitable for some water demands in the CHPP and washdown facilities (refer to Section 4.6.3). Therefore, imported water will be used for the supply of water for use on site facilities (i.e. administration buildings and bathhouses) and for washdown facilities.

## 3.3 Design criteria

### 3.3.1 Dirty water sediment dams

Dirty water sediment dams have been sized based on the criteria recommended in the guidelines *Managing Urban Stormwater - Soils and Construction - Volume 2E Mines and Quarries* (DECCW, 2008) (The Blue Book).

The Blue Book guidelines recommend that Type F/D sediment basins be provided for catchments with fine or dispersible soils. These are ‘wet basins’, comprising a ‘settling zone’ for temporary treatment storage and a ‘sediment zone’ for storage of sediment.

The Blue Book guidelines recommend that the ‘settling zone’ be sized to capture the 90$^{th}$ percentile 5 day duration storm event, and the ‘sediment zone’ be sized at 50% of the ‘settling zone’ volume. This sizing is based on site disturbance duration of more than three years, and results in an average sediment dam overflow frequency of approximately two to four overflows per year. For sizing purposes, a runoff coefficient of 0.75 has been adopted for disturbed areas such as overburden emplacement areas and topsoil stockpiles. A runoff coefficient of 0.4 has been adopted for undisturbed areas. As sediment dams have been sized for a 5 day management period, the ‘settling zone’ should be drained or pumped out within 5 days following a rainfall event that results in runoff entering the sediment dam.

Sediment dams in the MIA are sized in accordance with “Blue Book” requirements. MIA sediment dams will not capture contaminated runoff. In particular, any contaminated water from the vehicle washdown bay in the MIA will be recirculated within the wash down bay system or drained to the CHPP contaminated water dams. A runoff coefficient of 0.85 has been adopted for disturbed areas in the upgraded MIA, which are expected to comprise mainly hardstand surfaces. A runoff coefficient of 0.75 was adopted for the existing MIA, which comprises a mix of hardstand surfaces and grassed surfaces.

Key design features of dirty water sediment dams are as follows:

- Configured as Type F/D basins as described in the Blue Book guidelines.
- 'Settling zone' for temporary treatment storage.
- 'Sediment zone' for sediment storage.
- Slotted riser and discharge pipe with valve arrangement to allow manual operation of pipe (alternatively a mobile pump-out system).
- Slotted riser and discharge pipe sized to drawdown 'settling zone' over three days.

Dirty water sediment dams are to be maintained in a drawn down state as much as practical, thus ensuring that sufficient capacity is available in the 'settling zone' to capture water from subsequent storm events. Water will only be stored in the 'settling zone' of dirty water sediment dams on a temporary basis (i.e. the nominated 5 day management period) following a rainfall event of sufficient depth to result in runoff entering the sediment dam. If water stored in the sediment dam is not suitable for discharge, or is to be reused onsite. The sediment dam water would need to be pumped to the much larger MWDs for long term storage and onsite reuse.

### 3.3.2 Contaminated water dams

#### 3.3.2.1 Contaminated water dams

Contaminated water dams (also called coal contact dams) capture runoff from the coal stockpile pads in the CHPP. Water stored in contaminated water dams is reused onsite for dust suppression or CHPP process water, or pumped to MWDs for storage.

Contaminated water dams have been designed to store runoff from a 100 year ARI 72 hour duration design storm event, with a 20% allowance for sediment storage. A runoff coefficient of 0.85 has been adopted for disturbed areas in the CHPP, which are expected to comprise mainly hardstand surfaces. A runoff coefficient of 0.75 was adopted for the existing coal crushing and handling area which comprises a mix of hardstand surfaces and grassed surfaces.

Key design features of contaminated water dams are as follows:

- 'sediment zone' for storage of sediment.
- 'storm zone' for storage of the design storm storage.
- pump and pipeline system to draw down the 'settling zone' to the MWDs.

Contaminated water dams are to be maintained in a drawn down state as much as practical, so that sufficient capacity is available to capture water from subsequent storm events and minimising the risk of a wet weather overflow. Following a rainfall event, water held within contaminated water dams may be pumped to MWDs.

Contaminated water dam SD10 has an additional 'reuse zone' to provide operational capacity for the CHPP. SD10 has an additional 'reuse zone' for storage of 38.4 ML (on top of a 'sediment zone' for storage of 13.0 ML of sediment). Water can be stored in the 'reuse zone' of SD10 on a long term basis. The 'storm zone' would need to be maintained in a drawn down state. Excess water captured in contaminated water dams can be pumped to the MWDs and/or the pit, mitigating potential overflows.

#### 3.3.2.2 Mine water dams

MWDs hold water of similar quality to the contaminated water dams. However, they generally only receive runoff from a small surface water catchment (i.e. they are primarily a permanent storage facility and are likely to have a ‘turkey’s nest’ configuration). The MWDs are intended to receive and store contaminated water pumped from the sediment dams, contaminated storage dams or in-pit areas. MWDs may also hold imported water as outlined in Section 4.5.3 and will store water on a long term basis. The dams are operated with a freeboard sufficient to contain the 100 year ARI 72 hour duration storm event (refer to Section 4.4.3).

The design of MW5 was based on previous water balance modelling to the criteria of achieving retention of contaminated water generated within the site based on pit dewatering under historical climate conditions. The results of the water balance modelling indicate that the MWDs, as designed, are not expected to overflow. However, a spillway will be provided to allow for the contingency of an emergency overflow. Boggabri Mine MWDs are not prescribed dams listed under the NSW Dam Safety Regulation so are not subject to specific design requirements under this regulation.

### 3.3.3 Clean water dams

Clean water highwall dams capture runoff from undisturbed catchments ahead of the pit where reasonable and feasible in order to reduce inflows to the pit and maintain more natural flows in the downstream creek system. Highwall dams are to be maintained in a drawn down state, and are to be pumped out following a rainfall event of sufficient depth to result in runoff entering the dam. Where water quality meets the EPL discharge quality criteria highwall dams will be pumped out to the creek system.

Clean water highwall dams are sized to capture runoff from the 100 year ARI 24 hour storm event for the remnant catchment, assuming a runoff coefficient of 0.4 for undisturbed areas. Extreme events in excess of this capacity will spill into the pit. The pump-out systems for highwall dams are sized to empty the dam within 10 days. Clean water highwall dams are only present for the 2033 conceptual layout plan. In 2033 water from the clean water dams will be pumped to the east and then south around the edge of the mine disturbance area. The pumped clean water will be discharged into an existing drainage line/natural depression, which flows back to Nagero Creek north of the rail loop. Where required erosion sediment control measures will be used to minimise the potential for erosion at the pump outlet.

### 3.3.4 Diversion drains

Clean, dirty and contaminated water diversion drains are to be designed to convey the peak flow rate from a 100 year ARI time of concentration ($t_c$) storm event.

## 3.4 Existing water management system

The existing water management system is shown in Figure B-2 and schematically in Figure B-6, Appendix B. A summary of the existing storage characteristics is provided in Table C 1, Appendix C. The ‘required minimum capacity’ in Table C 1 is the minimum capacity required to store the design event and the nominated sediment allowance.

Existing MWD MW2 has a capacity 175.8 ML. Existing MWD MW3 has a capacity of 116.4ML. The total out-of-pit MWD storage in MW2 and MW3 is 292.2 ML.

Contaminated water dams SD28 (capacity 3.5 ML) and SD29 (capacity 10.5 ML) were commissioned at the beginning of 2015 as part of the MIA and CHPP upgrades. SD12 was upgraded in 2015 to a capacity of 200 ML (previous capacity 25.9 ML). The upgrade to SD12 catered for the expanded MIA and CHPP and haul road catchments.

Temporary in-pit mine water storage is provided to cater for surplus mine water in-pit until additional out-of-pit mine water storage is constructed onsite. The temporary storage is a segregated void area within the advancing mining pit area (Strip #9).

A diversion drain ahead of the mining void diverts runoff from undisturbed areas to the north of the mining void into the Nagero Creek system. Remnant undisturbed catchments to the east of the pit void drain directly into the mining void and this water is managed within the contaminated water management system.

An existing topsoil stockpile is situated to the north west of the clean water diversion drain ahead of the mining void. Temporary erosion and sediment measures control runoff from disturbed areas. Erosion and sediment controls are outlined in the SWMP.

Sediment dam SD3 was upgraded in 2015 to a capacity of 100 ML (previous capacity 31.8 ML). This upgrade catered for the expanding overburden catchment from 2015 to 2019. As the topography of the overburden dump does not allow for water stored in SD7 to be released to the creek system, water stored in SD7 is reused onsite.

A diversion drain diverts overflows from the Tarrawonga Coal Mine (TCM) northern waste rock emplacement area dams around the BCOPL MIA. The TCM diversion drain does not interact with BCOPL onsite water storage infrastructure.

A summary of the existing discharge points is provided in Table C 2, Appendix C. These are the existing discharge points and types listed in Section P1.3 of the EPL (12407, 4 April 2016).

## 3.5 2018 water management system

An indicative layout of the proposed 2018 water management system is shown in Figure B-3 and schematically in Figure B-7, Appendix B. A summary of the proposed 2018 storage characteristics is provided in Table C-3, Appendix C.

Existing MWD MW2 (capacity 175.8 ML) is planned to be decommissioned in 2017 as mining disturbs this area. A new MWD, MW5 (capacity 2000 ML), will be commissioned to replace MW2. Mine water from the mining void will be pumped to MWDs MW5 or MW3. The total out-of-pit MWD storage in MW3 and MW5 will be 2116.4 ML. Strips #9 and #45 will be mined through by 2017. However, water will still be stored in-pit during extreme wet weather. The borefield will be commissioned and be in operation during 2017.

An existing topsoil stockpile is situated to the north west of the clean water diversion drain ahead of the mining void. Pre-stripping occurs to the north east of the clean water diversion drain ahead of the mining void. Temporary erosion and sediment controls will be installed to control runoff from disturbed areas. Erosion and sediment controls are outlined in the SWMP.

A summary of the proposed 2018 discharge points is provided in Table C-4, Appendix C. EPL discharge points will be reviewed and updated in consultation with the Environment Protection Authority (EPA). Discharge criteria are outlined in the SWMP.

An existing topsoil stockpile is situated to the north west of the clean water diversion drain ahead of the mining void. Pre-stripping occurs to the north east of the clean water diversion drain ahead of the mining void. Temporary erosion and sediment controls will be installed to control runoff from disturbed areas. Erosion and sediment controls are outlined in the SWMP.

A summary of the proposed 2018 discharge points is provided in Table C 4, Appendix C. EPL discharge points will be reviewed and updated in consultation with the EPA.

## 3.6 2022 water management system

An indicative layout of the proposed water management system is shown in Figure B-4 and schematically in Figure B-8, Appendix B. A summary of the proposed 2022 storage characteristics is provided in Table C 5, Appendix C.

A new dirty water sediment dam SD14 will be provided to cater for runoff from the cleared area ahead of the mining void. The topography of the overburden dump will allow water stored in SD7 to be released to the creek system following settling (assuming that the EPL discharge criteria is met).

A new diversion drain will divert runoff from the active overburden dump, as well as overflows from SD7 to SD3. SD3 will be upgraded in 2022 to a capacity of 209 ML (from existing capacity of 100 ML). Note that the upgrade to SD3 in 2022 is required as it is no longer proposed to commission sediment dam SD13 (as proposed in the EA) within the overburden emplacement area and storage capacity previously allocated to SD13 is now provided in SD3. Alternatively, if SD3 remains at 100 ML in 2022, it may be necessary to provide the appropriate additional storage capacity elsewhere.

A summary of the proposed 2022 discharge points is provided in Table C-6, Appendix C. EPL discharge points will be reviewed and updated in consultation with the Environment Protection Agency.

## 3.7 2033 water management system

An indicative layout of the proposed water management system is shown in Figure B-5 and schematically in Figure B-9, Appendix B. A summary of the proposed 2033 storage characteristics is provided in Table C 7, Appendix C.

New dirty water sediment dams SD19, SD20, SD21, SD22 and SD24 will be provided to cater for runoff from the expanded spoil dump. SD7 will be decommissioned by 2033 as the overburden catchment draining to this sediment dam is expected to be fully rehabilitated.

New clean water highwall dams CD5, CD6, CD7 and CD8 will be provided to minimise inflows from the natural catchment to the mining void. The highwall dams will be pumped out to the Nagero Creek system, however, they will overtop to the mining void during large storm events.

A summary of the proposed 2033 discharge points is provided in Table C-8, Appendix C. EPL discharge points will be reviewed and updated in consultation with the Environment Protection Authority.

# 4. Site water balance model methodology

## 4.1 Modelling approach

A water balance model of the water management system of Boggabri Coal Mine was developed. The model was used to quantify the water inflows (rainfall, catchment runoff, groundwater inflows, water imported from the borefield and the Namoi River) and outflows (evaporation, CHPP usage, dust suppression usage), and likely range of water deficits, surpluses and discharges from Boggabri Coal Mine.

The SWB model is used as a strategic planning tool to assess the performance of the water management system for the Boggabri Coal Mine under a wide range of climate scenarios (sampled from a historical rainfall record) that may occur over the life of the Project.

The water balance is modelled as lumped mass balance and considered each storage in the water management system.  A site specific water balance equation was derived from the catchment scale water balance equation as described in Ladson (2008). The water balance equation applies conservation of mass to derive an ordinary differential equation governing the volume $V$ in each storage varying through time $t$:

$$\frac{dV}{dt} = P \cdot A(V) + \boldsymbol{R}(\boldsymbol{S}, P, E_t) \cdot \boldsymbol{C}\left(1 - \frac{A(V)}{\| \boldsymbol{C} \|}\right) + G + I - E \cdot A(V) - O$$

where:

- $P$, $E$ and $E_t$were precipitation, potential open water evaporation and potential evapotranspiration sampled concurrently from the historical record as described in Section 2.2;
- $A(V)$ was the water surface area of the storage as described in Section 4.4.1;
- $\boldsymbol{R}(\boldsymbol{S}, P, E_t)$ was the runoff for each surface type estimated using the AWBM as described in Section 2.4 (which accounts for the soil moisture state $\boldsymbol{S}$);
- $\boldsymbol{C}$ was the catchment area reporting to the storage distributed over the landuse types,
- $G$ was the groundwater inflows; $I$ was the pumped and surface transfers into the storage and $O$ was the pumped and surface transfers out of the storage.

Effectively, the change in site water storage is simply the sum of all water inflows (rainfall, catchment runoff, groundwater inflows and pumped transfers into the site) minus all water outflows (evaporation and pumped transfers off site).

The evaporative losses and pumped outflow were limited by the available volume in the storage. If the volume exceeded the capacity $C$ of the storage, the discharge, or overflow, rate $D$ was calculated as:

$$D = \frac{dV}{dt} \qquad\qquad if\ V > C$$

## 4.2 Numerical implementation

The water balance model of the Boggabri Coal Mine was implement using GoldSim 11.1.5. Goldsim is computer simulation software widely used for mine site water balance studies. Goldsim uses the forward Euler method to solve the equations described in Section 4.1. A basic timestep of 1 day was used with shorter time steps inserted to represent the switching of pumps.

The water management system plans and schematics provided in Appendix B show the layout and interconnectivity of storages for the mine site.

The GoldSim model was used to simulate the water management system for an 18-year duration (i.e. from 2016 to 2033). The model simulated 127 realisations (i.e. sequences) of climate data and probability distributions of the model variables were summarised from the set of results from each realisation.

## 4.3 Modelling assumptions

The following assumptions are included in the water balance model:

- Pumping operations based on the existing and proposed infrastructure has been included in the water balance model. It is assumed that pumping occurs at an average pump rate and no allowance has been made for changes of flow rate with changes in head.
- Low flow outlets from dirty water sediment dams are opened after a period of two days of no rainfall. This was assumed to be sufficient period for water quality criteria to be met. Low flow outlets have been represented in the water balance model such that the dams empty over a period of three days.
- The bottom half of the 'sediment zone' of dirty water sediment dams and contaminated water dams is half full of sediment throughout the simulation. Water that ponds in the top half of the 'sediment zone' evaporates over time and is not be used to supply dust suppression water or CHPP process water.
- No allowance has been made for seepage from water storages.
- Diversion drains capture all runoff from their local catchments and there is no bypass of diversion drains.
- Adequate surface water allocations or alternative water sources are available to make-up the external water requirement. Where the annual external water requirement exceeds BCOPL's current water entitlements, it was assumed that BCOPL would secure additional water to make up the difference.
- The Tarrawonga Coal Mine (TCM) catchment area to Nagero Creek discharging across the western boundary of mining lease 1579 (at Tarrawonga's LDP1) discharges directly to Nagero Creek, bypassing the Boggabri Coal Mine water management system via a clean water diversion drain.

- While the model assesses the performance of the system under historical extremes that may reasonably be expected to recur in the future. It does not explicitly consider the potential impact of future climate change.

- MW2 and Strip #9 are mined through and MW5 is commissioned as a mine water storage in 2017 (assumed to occur on 1 July 2017) .

- SD7 is diverted to SD3 at 1 January 2022 and the capacity of SD3 is increased from 100 ML to 209 ML at 1 January 2021.

- The borefield, as approved as part of MOD 5, is commissioned and becomes fully operational of 1 July 2017.

- The mine development over the life of the Project was represented in the model by linearly interpolating between the existing, 2018, 2022 and 2033 'snapshot' landforms. The interpolation of catchment areas between the snapshots is compared to the assumptions of staging of MW2, Strip #9, MW5, SD7 and SD3 in Figure 4.1.

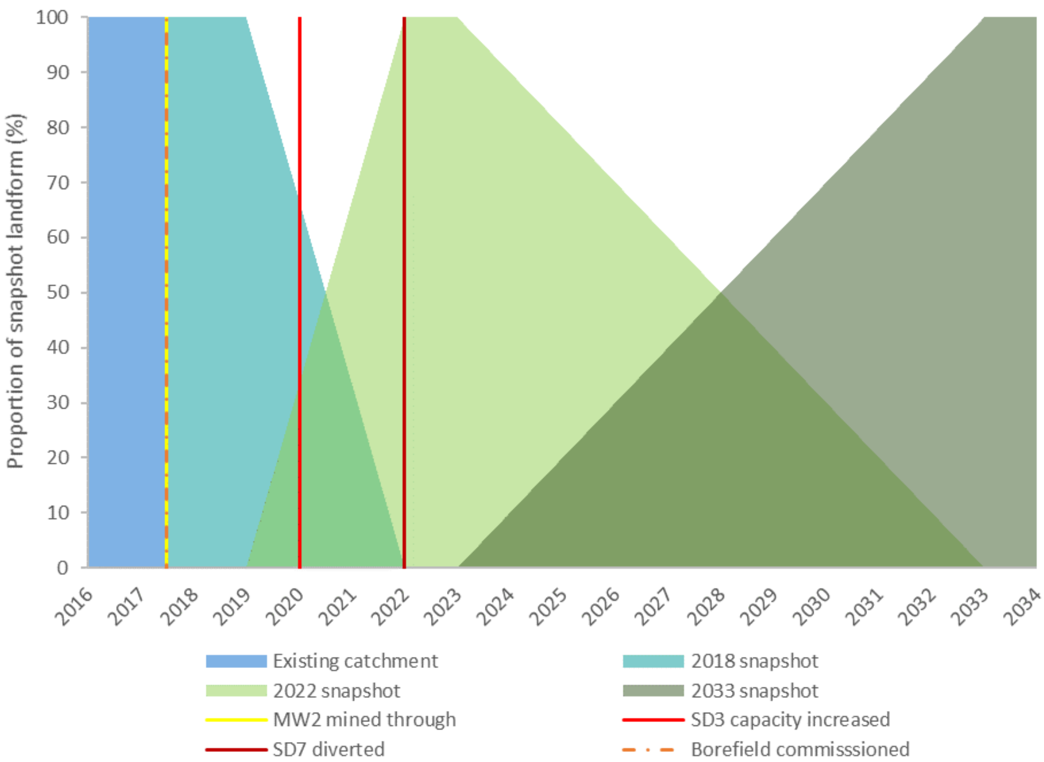



**Figure 4.1** **Interpolation of snapshot catchment areas and staging assumptions**

## 4.4 Site data

### 4.4.1 Storages

The storages in the water balance model are summarised in Table 4-1. The capacities are summarised from Table C.1, Table C.3, Table C.5 and Table C.7, referred to in Appendix C. The maximum water surface areas were measured from elevation data for existing storages, and design spatial data for future storages. The shape factor was used to estimate the geometry of storages for which stage storage relationships were not available. The value of the factor was inferred from elevation data and site experience and may vary from a value of 0, corresponding to a prismatic shape, to a value 1, corresponding to pyramidal shape.

**Table 4-1 Storages**

| Storage | Capacity (ML) | Maximum water surface area (ha) | Shape factor |
|---|---|---|---|
| MW2 | 175.8 | 1.1 | NA |
| MW3 | 153.5 | 5.6 | 0.2 |
| MW5 | 2000.0 | 15.8 | 0.6 |
| Pit | 10 000 (nominal) | 100 (nominal) | 0.3 |
| SD10 | 116.4 | 3.3 | 0.3 |
| SD11 | 16.4 | 0.5 | 0.3 |
| SD12 | 206.6 | 3.0 | 0.3 |
| SD14 | 72.7 (design) | 3.6 | 0.3 |
| SD19 | 179.9 (design) | 6.34 | 0.3 |
| SD20 | 41.8 (design) | 2.2 | 0.3 |
| SD21 | 55.6 (design) | 2.7 | 0.3 |
| SD22 | 2.4 (design) | 0.2 | 0.3 |
| SD23 | 9.5 | 0.8 | 0.4 |
| SD24 | 7.3 (design) | 0.3 | 0.4 |
| SD28 | 3.5 | 0.3 | 0.3 |
| SD29 | 10.5 | 0.5 | 0.3 |
| SD3 | 102.3 (increased to 209.3 in 2022) | 2.3 | 0.3 |
| SD6 | 52.2 | 1.9 | 0.3 |
| SD7 | 95.1 | 2.4 | 0.3 |
| SD8 | 9.8 | 0.9 | 0.5 |
| Strip #9 | 3426 | 5.8 | 0.4 |

The ‘pit’ storage corresponds to a number of storages (currently (Strip 45, MW4 and MW6) that are in the pit void or would spill into the pit void. These storages are relatively temporary and vary with open cut mining operations. Therefore they have been grouped as a nominal ‘pit’ storage that also includes all other such storages that may exist in the future as the open cut pit void develops.

In order to calculate direct rainfall and actual evaporation, the water surface area of each storage was calculated from the stage storage relationships where available (for MW2), referred to in Table D-1 of Appendix D. For other storages, the water surface area $A$ corresponding the water volume $V$ was approximated using the approach described in Brooks and Hayashi (2002) from the maximum surface area $A_{max}$ estimated from elevation data, the capacity $C$ and the shape factor $p$ as:

$$A = A_{max}\left(\frac{V}{C}\right)^p$$

### 4.4.2 Catchments

Catchment areas adopted in the water balance model are provided in Table 4.2. The study catchment was Nagero Creek to the point where the creek meets the floodplain approximately 1 km downstream of Boggabri Coal Mine.

**Table 4-2 Catchment areas**

| System | Storage | Existing | 2018 | 2022 | 2033 |
|---|---|---|---|---|---|
| Boggabri Coal Mine contaminated water dams [1] | MW2 | 5 | - | - | - |
| | MW3 | 22 | 22 | 22 | 22 |
| | MW5 | - | 15 | 15 | 15 |
| | SD10 | 27 | 27 | 27 | 27 |
| | SD11 | 4 | 4 | 4 | 4 |
| | SD12 | 64 | 53 | 53 | 53 |
| | SD28 | 1 | 1 | 1 | 1 |
| | SD29 | 4 | 4 | 4 | 4 |
| | Strip #9 | 22 | - | - | - |
| | Pit | 899 | 857 | 402 | 535 |
| | *Subtotal* | *1049* | *984* | *528* | *661* |
| Boggabri Coal Mine dirty water dams | SD3 | 140 | 213 | 642 | 198 |
| | SD6 | 64 | 64 | 64 | 64 |
| | SD7 | 159 | 229 | 247 | 0 |
| | SD8 | 13 | 13 | 13 | 13 |
| | SD14 | - | - | 313 | - |
| | SD19 | - | - | - | 415 |
| | SD20 | - | - | - | 101 |
| | SD21 | - | - | - | 127 |
| | SD22 | - | - | - | 6 |
| | SD23 | 20 | 20 | 20 | 20 |
| | SD24 | - | - | - | 17 |
| | *Subtotal* | *396* | *539* | *1299* | *960* |
| Boggabri Coal Mine clean water dams | CD5 | - | - | - | 20 |
| | CD6 | - | - | - | 21 |
| | CD7 | - | - | - | 103 |
| | CD8 | - | - | - | 18 |
| | *Subtotal* | - | - | - | *162* |
| Rehabilitation released directly to Nagero Creek | | - | - | - | 466 |
| TCM water management system within Nagero Creek catchment [2] | | 400 | 400 | 400 | 400 |
| Undisturbed Nagero Creek catchment | | 2431 | 2353 | 2049 | 1626 |
| **Total** | | **4275** | **4275** | **4275** | **4275** |

[1] Excludes approved irrigation area draining to Bollol Creek catchment.
[2] TCM lease area within Nagero Creek catchment assumed based on proposed operations at TCM.

The area of rehabilitated catchment increases from existing conditions to 2033. Progressive rehabilitation is undertaken and where the landform is stable with no sediment laden or otherwise polluted runoff, then runoff from catchment areas is returned to the natural system. While some of the rehabilitated areas have been rehabilitating for approximately five years, this rehabilitated area is unable to be segregated from the remaining overburden dump. For this reason, runoff from rehabilitated areas occurs only in 2033 when the clean water can be segregated from the dirty water runoff, captured and released.

### 4.4.3 Operating rules

The modelled rules for the operation of the pumps and outlets are summarised in Table 4-3 The pumps were modelled to switch on and the valves modelled to open when the *on trigger* occurred if the *conditions* were true. The pump remained on and the valve remained open until the *off trigger* occurred or the *conditions* became false. The low operating volumes (LOV) and high operating volumes (HOV) are summarised in Table 4-4.

The dewatering and release of sediment basins was subject to two site wide conditions:

- *Contaminated water excess*: the site was in contaminated water excess if the total volume of contaminated water exceeded the capacity of the contaminated water storages. Effectively, this prevented reuse of dirty water if there was water in -pit.
- *Discharge allowed*: offsite releases from dirty water dams were allowed if there had been a 2 day period without rainfall. This condition was assumed to approximate the time required for the water quality in the dirty water storages to reach an adequate standard to allow off-site release.

The dewatering of contaminated storages to MW2 or MW5 was not constrained by the volume in these storages. If the volume in MW2 and MW5 exceeded the HOV, the transfer was diverted to Strip #9 until it was mined through and afterwards to the pit.

**Table 4-3 Operating rules**

| Pump / Valve | Pump rate (ML/day) | On trigger | Off trigger | Conditions |
|---|---|---|---|---|
| Dewater SD10 to MW2/MW5 | 10.0 | SD10 greater than HOV | SD10 less than HOV | MW5 less than HOV |
| Dewater SD10 to MW3 | 10.0 | SD10 greater than HOV | SD10 less than HOV | MW3 less than HOV<br>MW2/MW5 greater than HOV |
| Dewater SD10 to Strip #9 or Pit | 10.0 | SD10 greater than HOV | SD10 less than HOV | MW3 greater than HOV<br>MW2/MW5 greater than HOV |
| Dewater SD11 to SD10 | 2.0 | SD11 greater than HOV | SD11 less than LOV | SD10 less than HOV |
| Dewater SD12 to MW2/MW5 | 20.0 | SD12 greater than HOV | SD12 less than LOV | |
| Dewater SD28 to SD11 | 1.0 | SD28 greater than HOV | SD28 less than LOV | SD11 less than HOV |
| Dewater SD29 to SD11 | 1.5 | SD29 greater than HOV | SD29 less than LOV | SD11 less than HOV |
| Dewater Pit to MW2/MW5 | 5.0 (10.0 if pit volume | Pit greater than HOV | Pit less than LOV | MW2/MW5 less than HOV |

| Pump / Valve | Pump rate (ML/day) | On trigger | Off trigger | Conditions |
|---|---|---|---|---|
| | exceeds 200 ML) | | | |
| Makeup Strip #9 to MW2/MW5 | 5.0 | MW2/MW5 less than LOV | MW2/MW5 greater than HOV | Pit less than HOV<br>Strip #9 greater than LOV |
| Makeup MW2/MW5 to SD10 | 5.0 | SD10 less than LOV | SD10 greater than HOV | MW2/MW5 greater than LOV |
| Makeup MW3 to SD10 | 3.5 | SD10 less than LOV or<br>MW3 greater than HOV | SD10 greater than HOV or<br>MW3 less than LOV | MW3 greater than LOV and<br>SD10 less than HOV |
| Dewater SD3 to SD12 | 5.0 | SD3 greater than HOV | SD3 less than LOV | SD12 less than HOV<br>Not contaminated water excess |
| Dewater SD19 to MW2/MW5 | 20.0 | SD19 greater than HOV | SD19 less than LOV | Not contaminated water excess |
| Dewater SD23 to MW5 | 3.0 | SD23 greater than HOV | SD23 less than LOV | Not contaminated water excess |
| Dewater SD6 to SD10 | 2.0 | SD6 greater than HOV | SD6 less than LOV | SD10 less than HOV<br>Not contaminated water excess |
| Dewater SD8 to SD6 | 1.0 | SD8 greater than HOV | SD8 less than LOV | SD6 less than HOV<br>Not contaminated water excess |
| Release SD3 to Creek (valve) | 40.0 | SD3 less than 40 ML below capacity | SD3 more than 40 ML below capacity | Rainfall exceed 1 mm/day |
| Release SD14 to Creek (valve) | 17.0 | SD14 greater than HOV | SD14 less than LOV | Discharge allowed |
| Release SD19 to Creek (valve) | 62.0 | SD19 greater than HOV | SD19 less than LOV | Discharge allowed and pump not on |
| Release SD20 to SD19 (valve) | | SD20 greater than HOV | SD20 less than LOV | Discharge allowed |
| Release SD21 to Creek (valve) | | SD21 greater than HOV | SD21 less the LOV | Discharge allowed |
| Release SD22 to Creek (valve) | | SD22 greater than HOV | SD22 less than LOV | Discharge allowed |
| Release SD23 to Creek (valve) | | SD23 greater than HOV | SD23 less than LOV | Discharge allowed |
| Release SD24 to Creek (valve) | | SD24 greater than HOV | SD24 less than LOV | Discharge allowed |
| Release SD6 to Creek (valve) | | SD6 greater than HOV | SD6 less than LOV | Discharge allowed and pump not on |
| Release SD8 to SD6 (valve) | | SD8 greater than HOV | SD8 less than LOV | Discharge allowed and pump not on |
| Release CWDs to Creek (valve) | | CWD greater than HOV | CWD less than LOV | |

**Table 4-4 Assumed operating volumes**

| Storage | LOV (ML) | HOV (ML) |
|---|---|---|
| MW2 | 87.7 | 163.6 |
| MW3 | 5.0 | 131.0 |
| MW5 | 1000.0 | 1994.9 |
| Strip #9 | 5.0 | 3369.3 |
| Pit sump | 5.0 | 10.0 |
| SD10 | 19.4 | 61.7 |
| Contaminated water dams (except SD10) | Sediment zone volume less 1 ML | Sediment zone volume |
| Dirty water sediment dams | Sediment zone volume less 1 ML | Sediment zone volume |
| Clean water dams | 0 | 1 |

Due to the approximations required to model the importation of water into the site, as discussed in Section 4.5.3, the import of water from the borefield and the Namoi River was modelled according to the following rules:

- If the volume in either SD10 or MW2/MW5 fell below the LOV, water was supplied to meet the simulated CHPP and dust suppression demand and the simulated evaporative losses at up to the maximum borefield extraction rate, with SD10 given the first preference.
- If the volume in either SD10 or MW2/MW5 fell below a nominal low threshold of 5 ML, water was supplied from the river to meet the simulated CHPP and dust suppression demands and the simulated evaporative losses.

The effect of this was to maximise the use of available extraction capacity of borefield until the site had exhausted the storages on site, before importing water the river.

## 4.5 Water sources

Water sources for the BCM comprise:

- rainfall-runoff
- groundwater inflows to the mining void
- imported water

### 4.5.1 Rainfall and runoff

Contaminated surface water runoff is captured in dams or the mining void and stored for onsite reuse. Dirty water runoff is also captured in sediment dams for settling of suspended solids prior to discharge to Nagero Creek (assuming that water quality criteria are met).

The volume of inflows into each storage was calculated as the sum of the direct rainfall on to the water surface and the surface water runoff. The volume of direct rainfall was calculated as the product of the simulated rainfall depth (refer to Section 2.2) and area of water storages, calculated as described in Section 4.4.1. The volume of catchment runoff was calculated as the product of the catchment area (refer to Section 4.4.2) and the runoff depth calculated using the AWBM as described in Section 2.4.

### 4.5.2 Groundwater inflows to mining void

Seepage rates of groundwater into the mining void have been estimate from the results of the Continuation of Boggabri Coal Project Groundwater Assessment (AGE, October 2010). The estimate adopted was a worst case cumulative groundwater impact assessment considering cumulative impacts associated with the concurrent operation of the Boggabri, Tarrawonga and Maules Creek coal mines. A summary of the groundwater inflows adopted in the water balance model is provided in Figure 4.2.

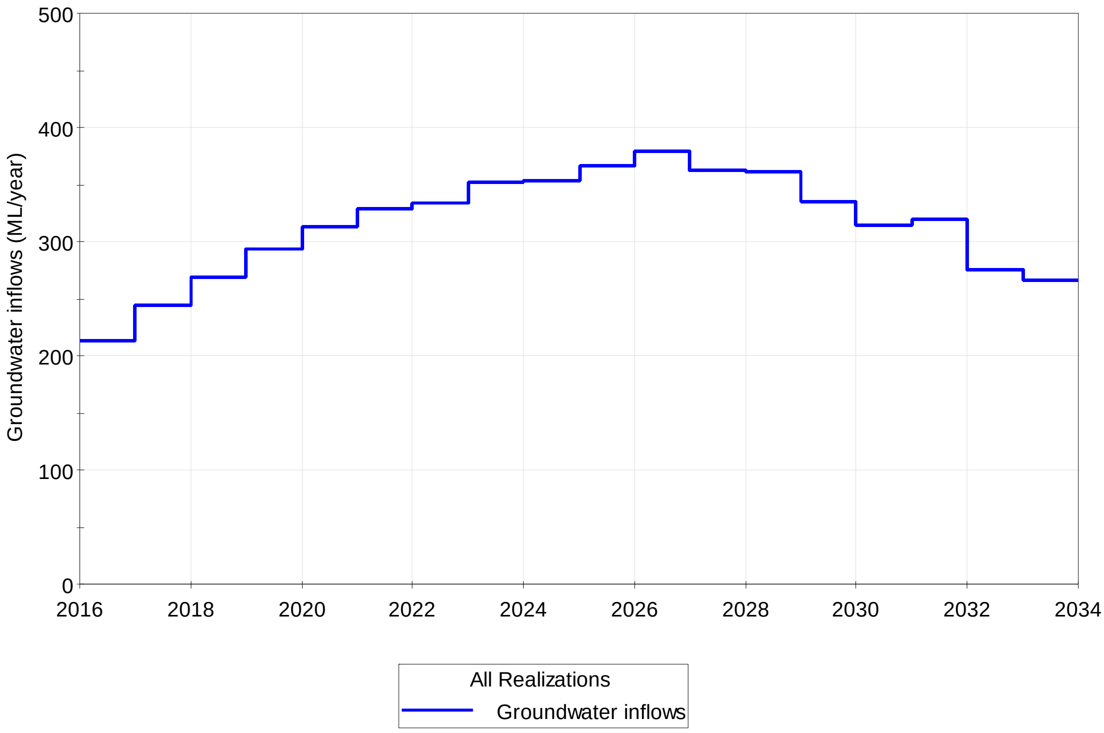



**Figure 4.2 Estimated groundwater inflows to mining void**

From Figure 4.2 it can be seen that groundwater inflow to the mining void is expected to increase until approximately 2026. After 2026, it is predicted that groundwater make within the mine void at Boggabri may be reduced by up to 40 % due to cumulative impacts from operations at Tarrawonga and Maules Creek coal mines. Some of the predicted pit inflows will be lost through evaporation, however inflows that collect in the mine void will be pumped to mining water storages for onsite reuse.

### 4.5.3 Imported water

#### 4.5.3.1 Groundwater entitlements

BCOPL currently holds licences for the Upper Namoi Zone 4 Namoi Valley Groundwater Source and the Gunnedah-Oxley Basin. Details of these water access licences (WALs) are provided in Table 4-5.

**Table 4-5 Summary of groundwater WALs currently held by BCOPL**

| Source | WAL category | WAL No. | Share (units) | Expiry | Current reliability (%) |
|---|---|---|---|---|---|
| **Groundwater** | | | | | |
| Upper Namoi Zone 4 Groundwater Source | Aquifer | WAL 15037 | 172 | Perpetuity | 95-100 |
| Upper Namoi Zone 4 Groundwater Source | Aquifer | WAL 24103 | 275 | Perpetuity | 95-100 |
| Upper Namoi Zone 4 Groundwater Source | Aquifer | WAL 12691 | 457 | Perpetuity | 95-100 |
| Upper Namoi Zone 4 Groundwater Source | Aquifer | WAL 12767 | 3 | Perpetuity | 95-100 |
| Upper Namoi Zone 4 Groundwater Source | Aquifer | WAL 36547 | 37 | Perpetuity | 95-100 |
| Upper Namoi Zone 4 Groundwater Source | Aquifer | WAL 37519 | 84 | Perpetuity | 95-100 |
| **Total** | | | **1028** | | |
| **Groundwater – pit interference** | | | | | |
| Gunnedah-Oxley Basin MDB | Aquifer | WAL 29562 | 700 | Perpetuity | 100 |
| Gunnedah-Oxley Basin MDB | Aquifer | WAL 29473 | 142 | Perpetuity | 95-100 |
| **Total** | | | **842** | | |

A total of 1028 unit shares of groundwater would be available to BCOPL from the aquifer access licences for the Upper Namoi Zone 4 Groundwater Source. The actual volume of groundwater available would depend on the Available Water Determinations (AWD) made under the Water Sharing Plan (WSP), these are likely to be at or close to 1 ML per unit share from the water access licences. Water derived from the pit inflows can be reused onsite under WAL29562 providing further capacity for supplementation.

BCOPL currently uses groundwater pumped from Lovton and Daisymede Bore for existing operations. BCOPL has approval to expand its bore water supply network within alluvial aquifer to include additional bores on BCOPL and privately owned land. BCOPL will possess the necessary additional WALs required to extract water from the approved borefield.

Groundwater pumped from Daisymede Bore is currently used onsite for potable water and vehicle washdown, as well as dust suppression. Groundwater pumped from Lovton Bore is used for amenities and fire suppression.

Groundwater can also be traded on a temporary or permanent basis within the greater Gunnedah-Oxley Basin Groundwater Source, and within Zone 4 of the Upper Namoi Valley (Keepit Dam to Gins Leap) Ground Water Source, subject to local impact considerations.

#### 4.5.3.2 Surface water entitlements

BCOPL currently holds general security and supplementary water access licences for the Lower Namoi Regulated River Water Source. Details of these water access licences are provided in Table 4-6. The total share component under these licences is 422 unit shares of general security water and 32.2 unit shares of supplementary water. The actual volume of river water available to BCOPL from the general security licences would depend on the Available Water Determinations (AWD) made from time to time in accordance with the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2003. Supplementary access is also 'announced' from time to time, and is dependent on the presence of unregulated flows in the regulated river, and on the operation of the WSP rules.

**Table 4-6 BCOPL water access licences for Lower Namoi Regulated River Water Source**

| Source | Water Access Licence category | Water Access Licence number | Share component (units) |
|---|---|---|---|
| Lower Namoi River | General Security | WAL 2571 | 51 |
| Lower Namoi River | General Security | WAL 2595 | 243 |
| Lower Namoi River | Supplementary Water | WAL 2596 | 26.6 |
| Lower Namoi River | Supplementary Water | WAL 2572 | 5.6 |
| Upper Namoi River | General Security | WAL 37067 | 128 |

The Namoi Regulated River water sharing plan estimates that there are in total 256,400 unit shares of general security access licences and 115,000 unit shares of supplementary water access licences. Access to entitlement will vary from year to year depending on climatic conditions and water availability.

A continuous accounting system is used in the Namoi Valley for general security entitlements. The maximum that may be held in an account is 2.0 ML per unit share. The amount carried over from one year to the next is unlimited (maximum account balance effectively limits carryover volumes). The maximum usage (including trade) in any season is 1.25 ML per unit share. The maximum water use over any 3 consecutive years is 3.0 ML per unit share (Ribbons, 2009).

BCOPL is able to access surface water from the Namoi River in accordance with its surface water licences via a pump station from the Namoi River which has been constructed. BCOPL can also trade additional water, either temporarily or permanently, to make up shortfalls on a contingency basis.

#### 4.5.3.3 Import water model

In the absence of detailed model of the entire Namoi River catchment, a conceptual model, consistent with the groundwater modelling described in Parsons Brinkerhoff (2015), was developed to estimate the likely volume extracted from the borefield and Lower Namoi River. The average rainfall over the previous four years was used as proxy for the water available for extraction from Lower Namoi Regulated River Source, and therefore in turn as a proxy for the likely borefield extraction rate, as shown in Figure 4.3. This model approximates the likely management of the borefield: during periods when water is available for extraction from the Lower Namoi Regulated Source, extraction from the borefield is likely be less than the maximum rate of 9.4 ML/day in order to minimise the risk of impact on surrounding water users. It was assumed that sufficient additional surface water access licences will be acquired when required and sufficient volume will be available from the Namoi River. The relationship between 4 year average rainfall and borefield extraction rate in shown in Figure 4.3. This model does not account for actual daily management of the borefield and river extraction, but it consistent with groundwater modelling described in Parsons Brinkerhoff (2015) and is representative the average of operational conditions.

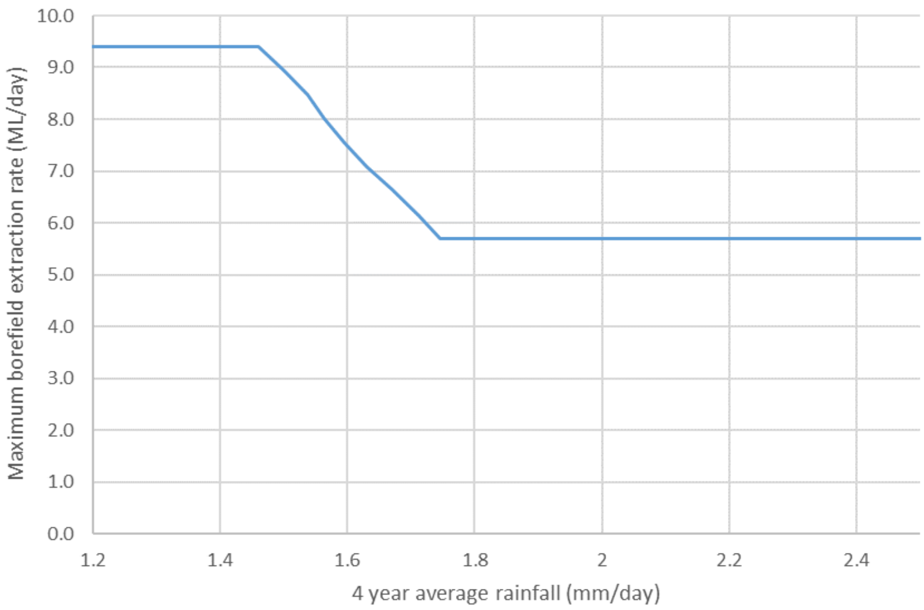



**Figure 4.3 Assumed borefield extraction rate varying with 4 year average rainfall**

## 4.6 Water demands

Water demands comprise:

- dust suppression water
- CHPP make-up water
- vehicle washdown water
- potable water (for drinking water and amenities)

Water demand information has been provided by BCOPL. The demands provided in the Boggabri Coal Project Surface Water Assessment (Parsons Brinckerhoff, 2010) were revised based on more detailed project design and engineering work that has occurred since the Surface Water Assessment was undertaken in 2010, and updated demand information in line with the latest revision of the MOP.

### 4.6.1 Dust suppression

Water is required for dust suppression on haul roads and other disturbed areas. Dust suppression for the CHPP coal stockpiles, coal crushing areas, and coal loading areas and MIA are accounted for in the CHPP demands (refer to Section 4.6.2).

BCOPL has provided revised estimates of dust suppression demands for the project. A summary of the haul road dust suppression demands adopted in the water balance model is provided in Table 4-7. Haul road dust suppression numbers have been revised following lodgement of the EA, largely due to adjustments to the MOP (refer to MOP Amendment A) and more detailed project design and engineering work having been undertaken. BCOPL estimates haul road dust suppression demand to be 4 ML/day on days when it is required.

**Table 4-7 Haul road dust suppression demand estimates (average)**

| Project year | Dust suppression demand (ML/day) |
| --- | --- |
| Existing | 4 |
| 2018 | 4 |
| 2022 | 4 |
| 2033 | 4 |

Historical water cart usage information is summarised in Figure 4.4. Variance in the amount of water used during later years is likely.

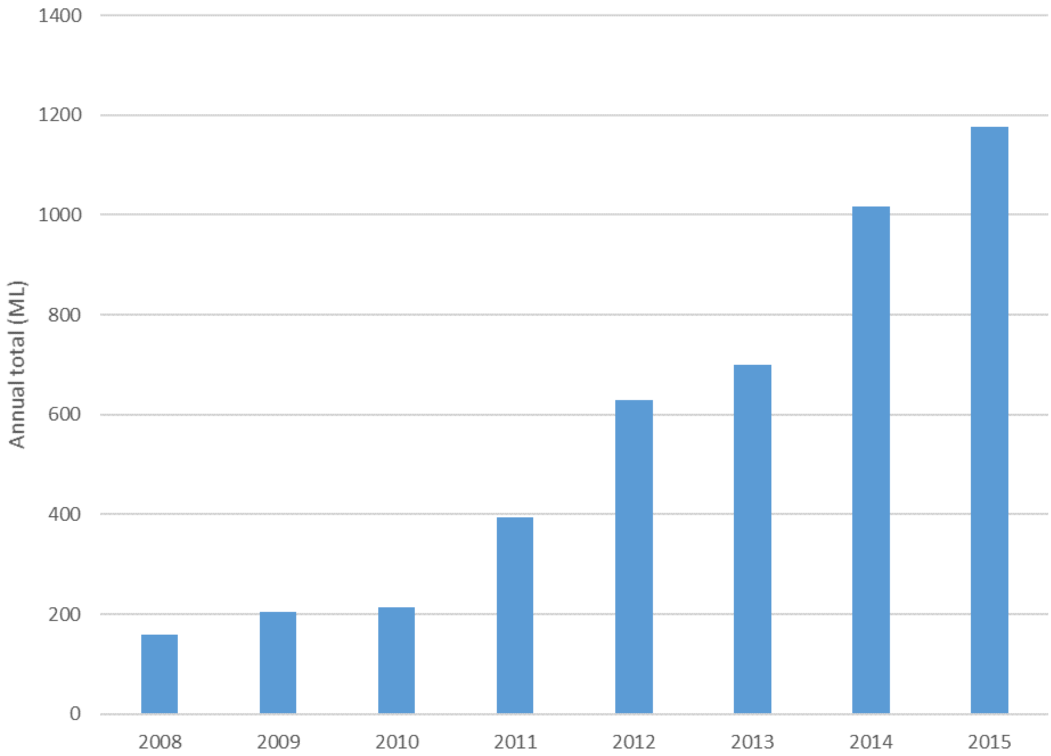



**Figure 4.4 Observed water usage for dust suppression of haul roads**

Water used for dust suppression at the mine site is sourced as a priority from recycled contaminated water contained in MW2 and MW3. When required, imported water will be used to supplement recycled water sourced from MW2 and MW3.

For the purposes of the water balance analysis, it is assumed that dust suppression water will not be required on days with a total rainfall depth for more than 5 mm. On average, approximately 35 days per year have more than 5 mm of rainfall based on the historical rainfall record.

### 4.6.2 Coal handling and preparation plant

BCOPL estimates the net CHPP water demand to be approximately 4 ML/day (equivalent to 1461 ML/annum). This water is required for coal washing, dust suppression and MIA washdown water. This is the net demand and accounts for water that is reused within the process. This net demand is simulated in the model as a constant flow rate. The assumption of constant flow rate is of suitable accuracy for the purpose of the SWB model as actual day to day variations in operations will be attenuated by the water storage on site.

The CHPP was commissioned in 2015 and processes up to 4.2 Mtpa of coal from Boggabri Coal Mine. The breakdown of CHPP demands is summarised in Table 4-8.

**Table 4-8 CHPP demand estimates**

| Project year | Coal washery feed (Mtpa) | Annual CHPP demand (ML) |
|---|---|---|
| Existing | 4.2 | 1,461 |
| 2018 | 4.2 | 1,461 |
| 2022 | 4.2 | 1,461 |
| 2033 | 4.2 | 1,461 |

### 4.6.3 MIA and potable water

Water is required for vehicle washdown in the MIA. Washdown water is recycled; however, water is required to make-up evaporative losses. Make-up water for vehicle washdown is currently sourced from groundwater pumped from Daisymede Bore.

Potable water is used in the administration building and amenities during operations. Potable water is currently sourced from groundwater entitlements (WAL 29473) assigned to the Lovton Bore. Wastewater from the administration building and amenities will be treated in an onsite Envirocycle treatment plant. Wastewater generated by the onsite Envirocycle treatment plant has not been considered in the water balance analysis.

BCOPL estimates that approximately 1 ML/day (equivalent to 365 ML/yr) of water will be required for the MIA and potable water. This net demand is simulated in the model as a constant flow rate. The assumption of constant flow rate is of suitable accuracy for the purpose of the SWB model as actual day to day variations in operations will be attenuated by the water storage on site.

## 4.7 Other losses

### 4.7.1 Evaporation

Evaporative losses from storages was calculated as the product of the evaporation depth for open water, as described in Section 2.2, and the water surface area of the storage, as described in Section 4.4.1.

Evaporative surface area for dams has been estimated as described in Section 4.4.1.

### 4.7.2 Seepage from dams

Some water will be lost from dams as a result of seepage through the foundation. Site dams should have low seepage losses and, depending on the subsoils, an engineered liner will be required. All dams are constructed with the best material available as water is a critical resource for BCOPL.

Water balance modelling has assumed seepage losses to be negligible. This assumption is intended to be conservative from the perspective of containment performance but may not be conservative for other outcomes of operational simulation modelling (such as water supply reliability).

### 4.7.3 Off-site releases

Modelled releases from site were comprised of:

- Pumped releases of clean water from high wall dams, that were modelled according to the operating rules in Section 4.4.3.

- Overflows of dirty water from dirty water dams due to rainfall events that exceeded the design rainfall event when the volume of storage exceeded the capacity of storage, as described in Section 4.1.

- Controlled releases of dirty water from dirty water dams, that were modelled accoding to the operating rules in Section 4.4.3. In reality, these releases will only occur when the water quality of the water is adequate, as described in Section 3.1.2.

# 5. Site water balance model validation

As part of the update of the site water balance model, site observations from 2013 to 2015 for Boggabri Coal Mine were used to update the calibration of the runoff model (described in Section 2.4) and to validate the model.

## 5.1 Data and assumptions

The data and assumptions used in the validation are summarised in Table 5-1.

**Table 5-1 Validation data and assumptions**

| Data | Source | Assumptions |
|---|---|---|
| Storage water volumes | Observed storage volume for mine water dams on a weekly basis | Stage-storage relationship derived from the observed water levels and volumes. |
| CHPP usage | Estimated annual averages | 1 ML/day from January 2015 to June 2015 and 4 ML/day from July 2015 onwards |
| Dust suppression usage | Observed from meters at truckfill points as monthly totals | Annual totals were distributed monthy by scaling seasonally with potential evaporation and calibrating to 2015 monthly totals. |
| MIA and potable use | Estimated annual average | MIA and potable demand was supplied exclusively by bores and that the bores contributed only to the MIA and potable demand at a constant 1 ML/day. |
| River extractions | Observed river extractions as monthly totals | The January 2016 was included in the 2015 annual total. |

## 5.2 Runoff model calibration

A significant source of uncertainty in the SWB model is the estimation of catchment runoff. As described in Section 2.4, the Australian Water Balance Model (AWBM) is used to estimate the catchment runoff. AWBM is defined by nine parameters: three soil capacities; three proportional areas; and three recession parameters. The SWB model identified six land usage types, each with a unique set or AWBM parameters. As a result, runoff is parameterised by a total of 54 AWBM parameters. The previously adopted values for these 54 parameters were reviewed and found to be generally within the typical range adopted for the identified land use areas, however had not been calibrated to local conditions.

As the available observed data was limited to mostly total storage volumes, the capacity to refine the parameter values further was limited. Therefore, a simplified calibration approach was adopted, with a scale factor used to adjust the three soil moisture capacities for all land use type. This approach allows for the adjustment of modelled catchment runoff with a single parameter (the soil moisture storage scale factor) whilst the preserving the variable soil storage pattern. Approximately, such a scale factor varies inversely with average annual catchment runoff.

In order to identify suitable values of the soil moisture scale factor, a Monte-Carlo sampling method was adopted. Using this method, values of the soil moisture scale factor are randomly sampled from a specified range, and the response of the water management system modelled using the SWB model. A total of 1000 parameter samples where modelled, for the period from 1/1/2013 to 1/1/2016 using the actual climatic conditions and assumed production demands.

The performance of the SWB model over the simulation period was measured by the difference between the total site demand to the observed imported volumes. A plot of this difference against the soil moisture scale factor is shown in Figure 5-1.

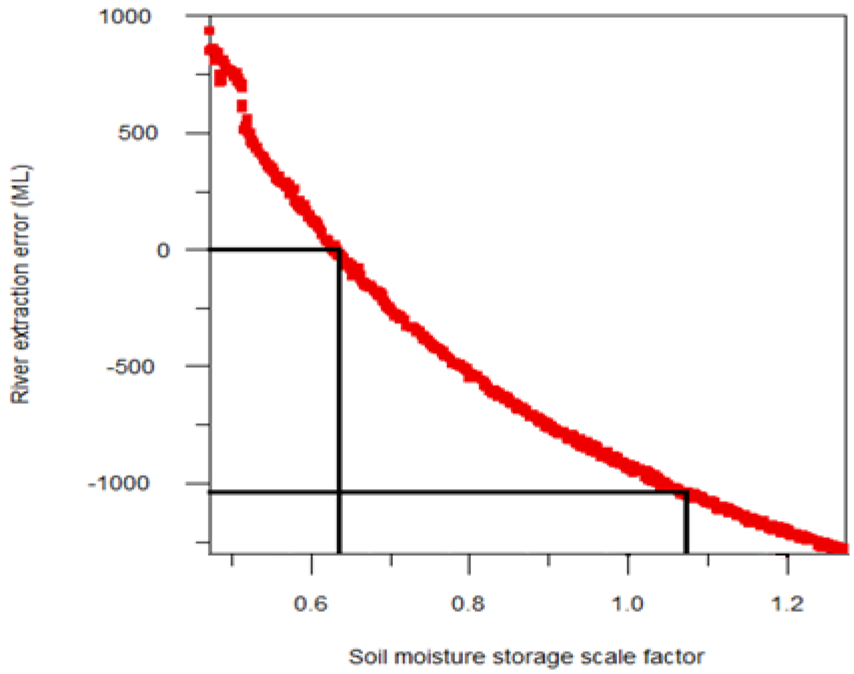



**Figure 5-1 Calibration result - River extraction (observed minus modelled)**

From Figure 5-1 it can be seen that the previous parameter set (a soil moisture storage scale factor of 1.0) overestimated river extraction requirements by approximately 1050 ML over the three year period modelled

From Figure 5-1 it can be seen that a soil moisture storage scale factor of 0.63 results in the modelled cumulative river extractions matching the observed river extractions. This soil moisture factor was adopted, and the corresponding *C1*, *C2* and *C3* parameter values for all land use types, as presented in Table 5-2, were used.

**Table 5-2 Adopted AWBM parameter values**

| Landuse | BFI | $K_{base}$ | A1 | A2 | A3 | C1 | C2 | C3 |
|---|---|---|---|---|---|---|---|---|
| Undisturbed | 0.05 | 0.803 | 0.134 | 0.433 | 0.433 | **14.2** | **145.2** | **290.5** |
| Rehabilitated spoil | 0.2 | 0.98 | 0.134 | 0.433 | 0.433 | **3.6** | **36.4** | **72.9** |
| Industrial | 0 | NA | 0.134 | 0.433 | 0.433 | **1.4** | **14.4** | **28.8** |
| Mining void | 0 | NA | 0.2 | 0.2 | 0.6 | **3.2** | **44.1** | **56.7** |
| Active spoil | 0.8 | 0.7 | 0.3 | 0.3 | 0.4 | **18.9** | **37.8** | **75.6** |
| Pre-strip | 0.2 | 0.98 | 0.134 | 0.433 | 0.433 | **2.9** | **29.3** | **58.6** |

## 5.3 Validation

The calibrated SWB model was used simulate the site water balance over the calibration period (from 1/1/2013 to 1/1/2016) using the updated AWBM parameters. The modelled (or "hindcasted") results were then compared against observations.

Due to the coarseness of the river extraction data (annual totals), the daily extraction rate was modelled such that it "targeted" the observed water volumes. This captured the variation in operations and river flow that cannot be replicated in the model.

The time series of the observed and modelled total storage volume shown in Figure 5-2. The total storage volume was considered as the total of MW2, MW3, SD10 and Strip #9, shown in Figure 5-3, Figure 5-4, Figure 5-5 and Figure 5-6 respectively. The monthly usage, river extraction and discharge is shown in Figure 5-7.

A satisfactory fit of modelled variables to observations was achieved by allowing the volume in the pit to increase to 600 ML after the rainfall event in March 2014. After November 2014, this volume was allowed to be drawn down. It is understood that this volume corresponds approximately to the reported capacity of Strip #45, however, no record of volume in strip storages other than Strip #9 were available to confirm that such a volume of water was stored on site during this period.

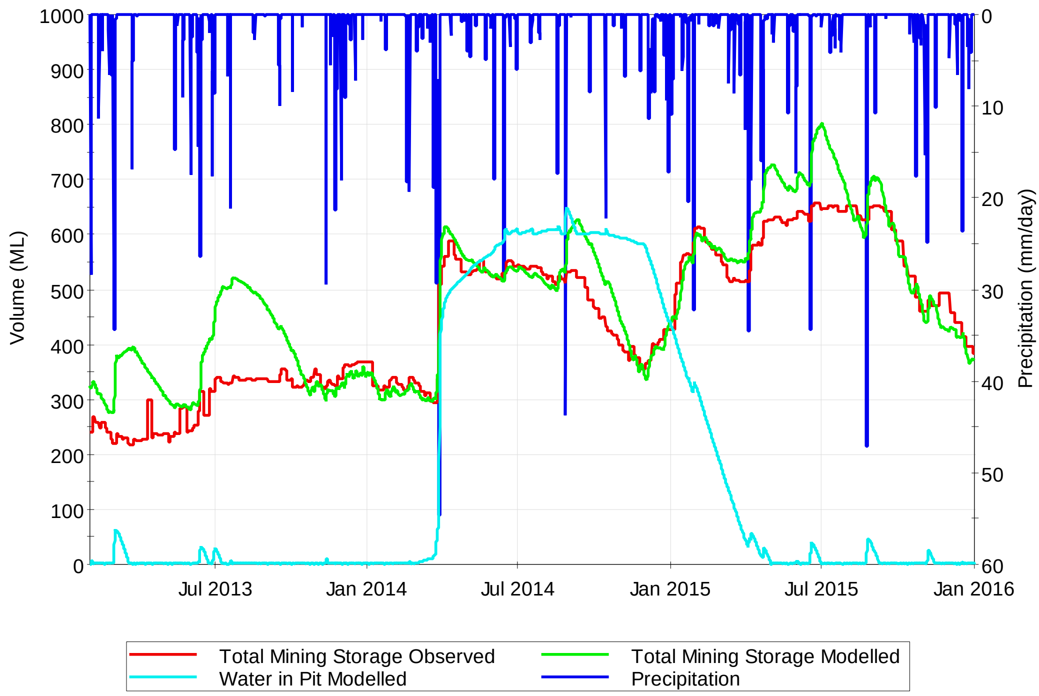



**Figure 5-2 Observed and modelled total mining water storage volume**

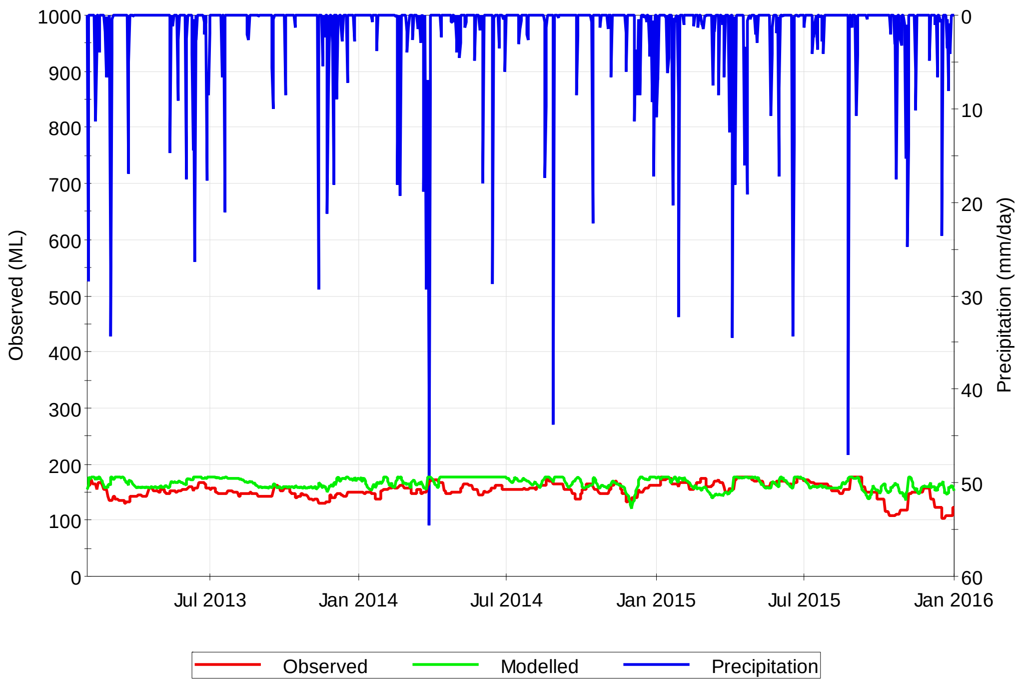



**Figure 5-3 Observed and modelled MW2 water storage volume**

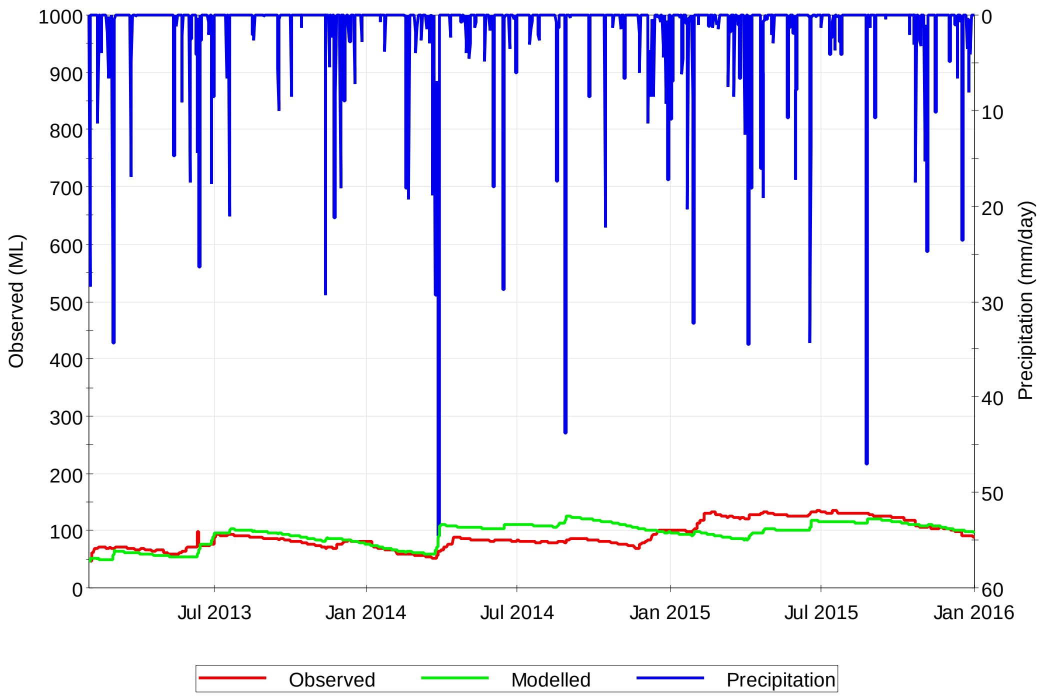



**Figure 5-4 Observed and modelled MW3 water storage volume**

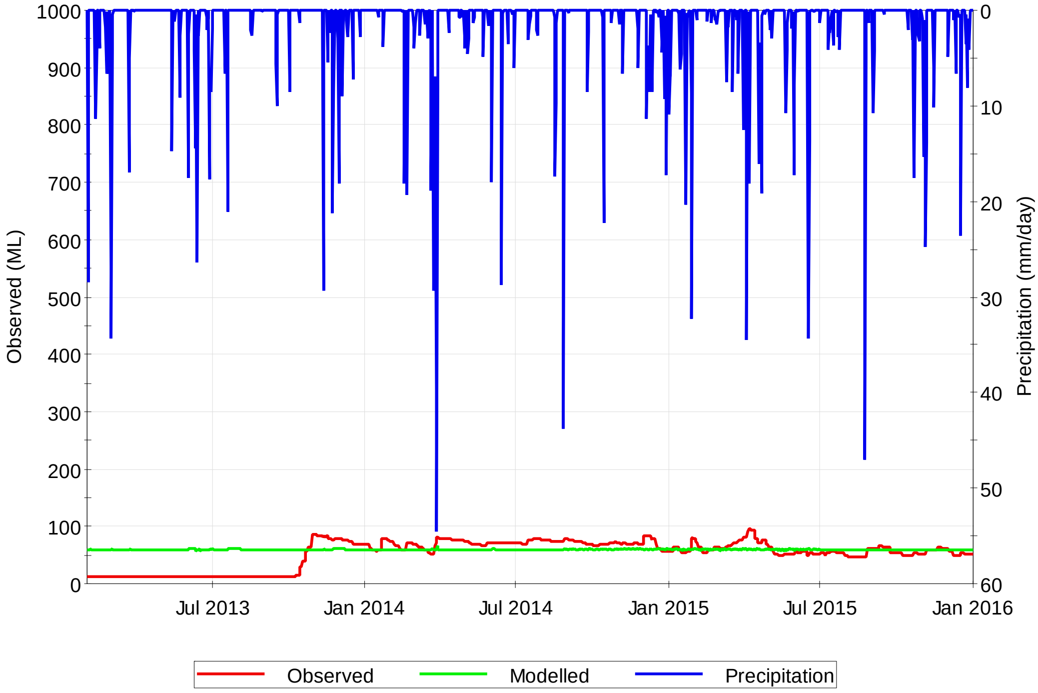



**Figure 5-5 Observed and modelled SD10 storage volume**

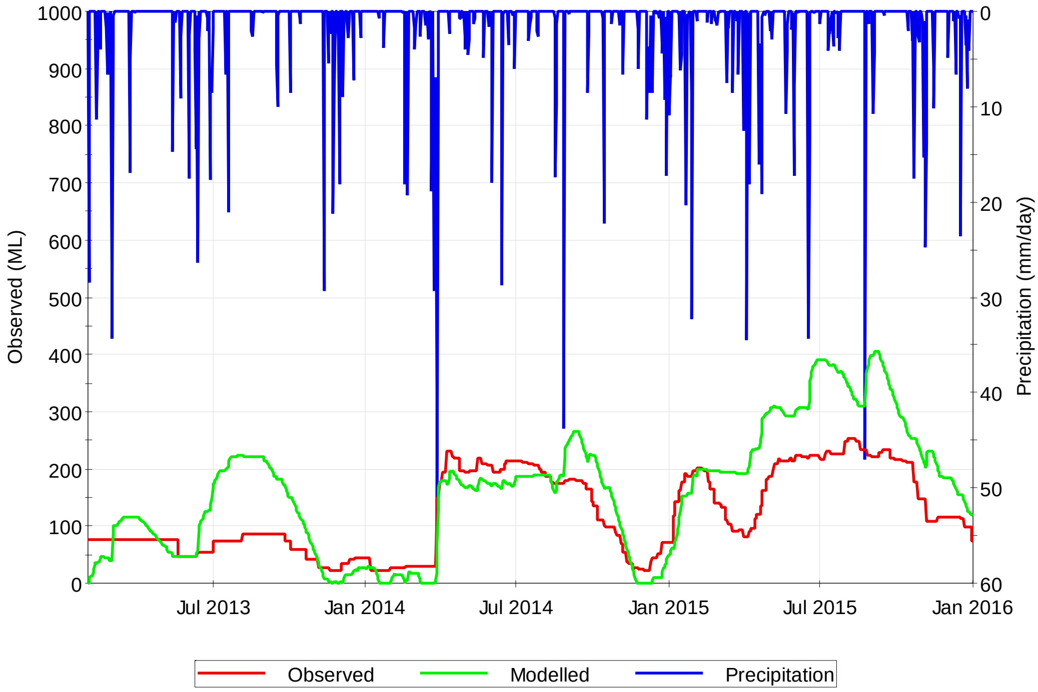



**Figure 5-6 Observed and modelled Strip #9 water storage volume**

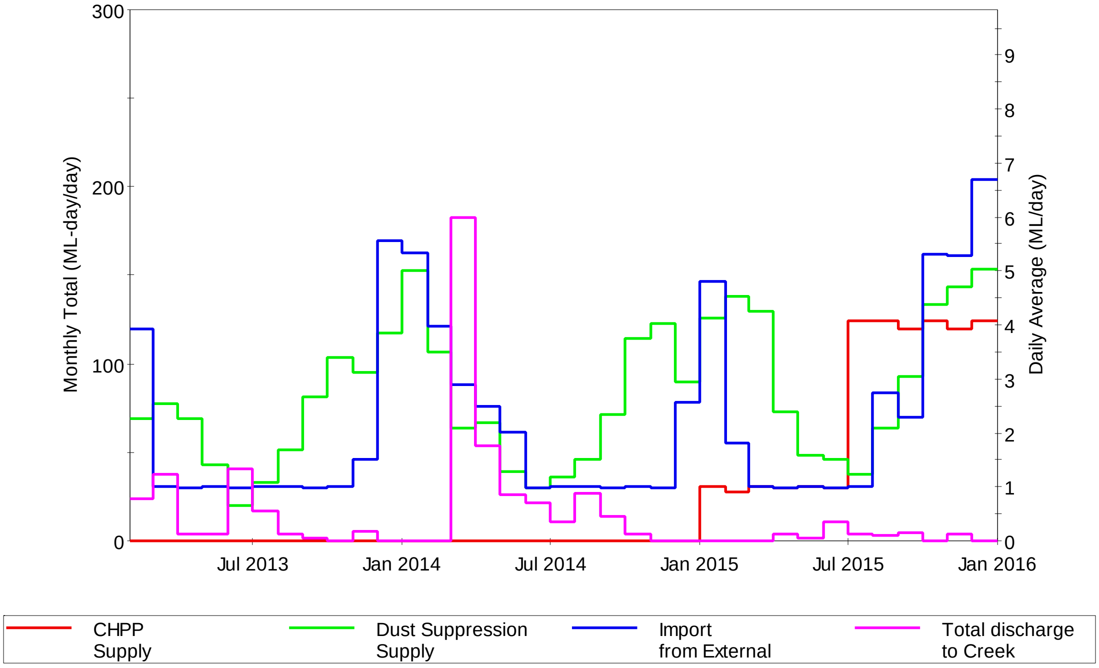



**Figure 5-7 Modelled monthly usage and supply**

Overall, the modelled total storage volume has higher runoff driven peaks than the observed data, which considered on its own, would indicate that the adopted runoff parameters may be overestimating runoff. This is likely due to the model simulating immediate and complete dewatering of sediment basins whereas, in reality, practical requirements may have delayed and attenuated this dewatering. Therefore, the comparison of total annual volumes is a more appropriate indicator of model performance for this purpose of this validation.

The observed and modelled usage and supply are summarised in Table 5-3.

**Table 5-3 Validation of annual totals**

| Year | Observed (ML) | Modelled (ML) | Relative error |
|---|---|---|---|
| **Total CHPP usage** | | | |
| 2013 | 0 | 0 | |
| 2014 | 0 | 0 | |
| 2015 | 910 | 910 | 0 % |
| **Haul road dust suppression** | | | |
| 2013 | 699 | 760 | 9 % |
| 2014 | 1016 | 939 | -8 % |
| 2015 | 1176 | 1184 | 1 % |
| **Total imported water (including MIA and potable bore)** | | | |
| 2013 | 678 | 581 | -14 % |
| 2014 | 843 | 771 | -9 % |
| 2015 | 792 | 1036 | 31 % |
| Total | 2313 | 2388 | 3 % |
| **Discharge** | | | |
| 2013 | | 134 | |
| 2014 | | 273 | |
| 2015 | | 42 | |

The perfect fit for CHPP usage is expected, as constant demand was applied that was equal to the estimated actual usage. The modelled haul road dust suppression achieved a satisfactory fit to the observed annual totals.

The discharge volumes are unable to be validated as accurate sinces estimates of discharge volumes are unable to be made. However, as discharge only occurs during high rainfall periods when the storage capacity of BCM has already been exceeded this is unlikely to have a significant impact of the overall results.

The acceptable fit for river extractions for each individual year, in addition to the close fit for the total over calibration period, indicates that the SWB model is accurately representing the overall site water balance over the calibration period.

The results of the validation suggest that the revised SWB model is satisfactorily reflecting site conditions from period from 2013 to 2015.

# 6. Site water balance model results

The water balance model, described in Section 4, was used to simulated the water management system over the life of the Boggabri Coal Mine (from 2017 to 2033). The simulation was repeated 127 times using simulated climatic conditions sampled from the historical record (see Section 2.2). The results of the simulation were statistically summarised.

## 6.1 Overall site water balance

The median annual site water balance is provided in Table 6-1 for the existing, 2018, 2022 and 2033 'snapshot' year landforms.

**Table 6-1 Median site water balance for each of the snapshot years**

| | Existing | 2018 | 2022 | 2033 |
|---|---|---|---|---|
| **Inflows (ML)** | | | | |
| Runoff and direct rainfall: | | | | |
| ▪ Clean water (highwall) dams | - | - | - | 58 |
| ▪ Dirty water sediment dams | 321 | 481 | 1147 | 1131 |
| ▪ Contaminated water dams, MWDs and pit | 1050 | 1040 | 697 | 791 |
| Groundwater make | 213 | 269 | 334 | 266 |
| Imported water from borefield | 357 | 2081 | 2081 | 1763 |
| Import water from Namoi River | 1421 | 0 | 0 | 0 |
| **Total Inflows (ML)** | **3363** | **3871** | **4259** | **4008** |
| **Outflows (ML)** | 0 | | | |
| Demands | 0 | | | |
| ▪ Dust suppression - haul roads | 1374 | 1374 | 1374 | 1374 |
| ▪ CHPP | 1460 | 1460 | 1460 | 1460 |
| ▪ MIA and potable water | 364 | 365 | 365 | 365 |
| Evaporation: | 0 | | | |
| ▪ Clean water (highwall) dams | - | - | - | 23 |
| ▪ Dirty water sediment dams | 91 | 95 | 119 | 206 |
| ▪ Contaminated water dams, MWDs and pit | 224 | 345 | 327 | 336 |
| Site wide release to Nagero Creek | | | | |
| ▪ Clean water (highwall dam) controlled discharge to creek | - | - | - | 37 |
| ▪ Dirty water sediment dam overflows to creek | 0 | 0 | 62 | 0 |
| ▪ Dirty water sediment dam controlled discharge to creek | 133 | 115 | 717 | 138 |
| **Total Outflows (ML)** | **3646** | **3754** | **4425** | **3940** |
| **Change in storage (ML)** | **-287** | **117** | **-88** | **5** |

Due the intertwining of the different natural and operational processes in the SWB model, the median values of the different inflows and outflows do no coincide. Therefore, unlike mean values, the median of the total inflows and total outflows do not necessarily balance. Nonetheless, median values have been shown as they are a more representative measure of central tendency for processes with skewed distribution, such as rainfall.

Median dust suppression usage is less than 1416 ML/year as dust suppression is modelled to occur only on days with total daily rainfall depth is less than 5 mm (refer to Section 4.6.1).

## 6.2 Imported water requirements

A summary of the simulated water imported to site over the life of the Mine is provided in Figure 6.2 and a summary table for the snapshot years is provided in Table 6-2. Note that the values in Figure 6.2 and Table 6-2 are not limited by the existing entitlements held by BCOPL.

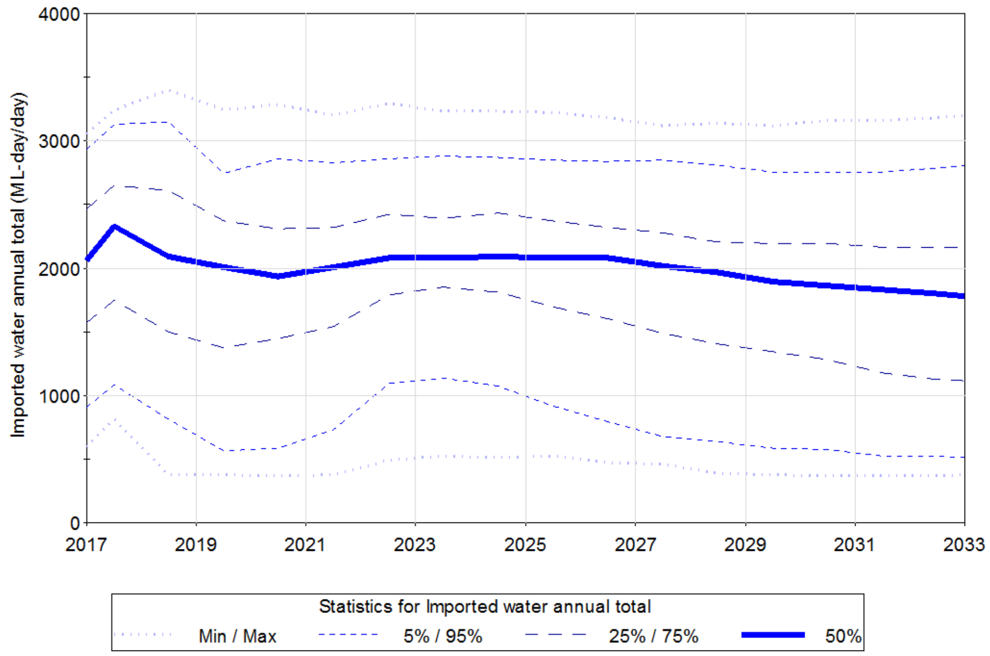



**Figure 6.1 Simulated time series of annual water imported to site**

**Table 6-2 Annual totals of imported water requirements**

| | Annual total (ML) | | | |
|---|---|---|---|---|
| | **Existing** | **2018** | **2022** | **2033** |
| 5th percentile (wet) | 723 | 809 | 1094 | 511 |
| 25th percentile | 1385 | 1496 | 1792 | 1091 |
| 50th percentile (median) | 1781 | 2088 | 2081 | 1763 |
| 75th percentile | 2262 | 2604 | 2420 | 2164 |
| 95th percentile (dry) | 2718 | 3143 | 2854 | 2823 |
| Greatest result (driest on record) | 2862 | 3393 | 3295 | 3216 |

Supplementary water will be imported to the BCM to meet dust suppression and CHPP process water demands. Even when the BCM is in a contaminated water surplus, high-quality imported water is required to meet the potable water and vehicle wash-down demands. The maximum modelled daily pump rate of imported water to the BCM was approximately 9.4 ML/day. The daily average pump rate is higher than the daily demand of 9.0 ML/day as it accounts for evaporation losses of imported water stored in SD10 and MW2 / MW5.

A total of 1028 unit shares of groundwater will be available to BCOPL from the existing Zone 4 Water Groundwater Source water access licences. The actual volume of groundwater available will depend on the Available Water Determination made under the relevant Water Sharing Plan. This entitlement does not include 842 unit shares of groundwater available to BCOPL from the existing Gunnedah Oxley Basin Groundwater Source aquifer licence. . Assuming an allocation of 1 ML per unit share, it can be expected that approximately 1870 ML/year be available to BCOPL from the existing water access licences.

BCOPL is able to access surface water from the Namoi River in accordance with its surface water licences via a pump station on the Namoi River. Assuming an allocation of 1 ML per unit share, BCOPL holds a total of 422 unit shares of general security surface water entitlements and an additional 32.2 unit shares which would be available to BCOPL from the Namoi River.

Under the existing water licences, a maximum of 2324 ML (the actual volume is dependent on annual Available Water Determinations) is available for the supply of water to BCM. Groundwater can be traded on a temporary or permanent basis within the greater Gunnedah-Oxley Basin Groundwater Source, and within Zone 4 of the Upper Namoi Valley (Keepit Dam to Gins Leap) Ground Water Source. BCOPL will source additional water by trading water, either temporarily or permanently so sufficient water is available for the operations at BCM.

## 6.3 Contaminated water storage and pit availability

Water balance modelling indicates that no overflows from mine water dams MW2 / MW5 and MW3 or contaminated water dams SD10, SD11, SD12, SD28 and SD29 are expected over the life of BCM.

Summaries of the simulated daily time series of water stored in the mining void, Strips #9, MW2, MW3 and MW5 over the life of BCM are provided in Figure 6.2, Figure 6.3, and Figure 6.4, respectively. Note that the percentiles shown in the daily time series plots are daily percentile ranks of the daily results, whereas the percentile shown in Table 6-1, and Figure 6.1 are percentile ranks of the annual results.

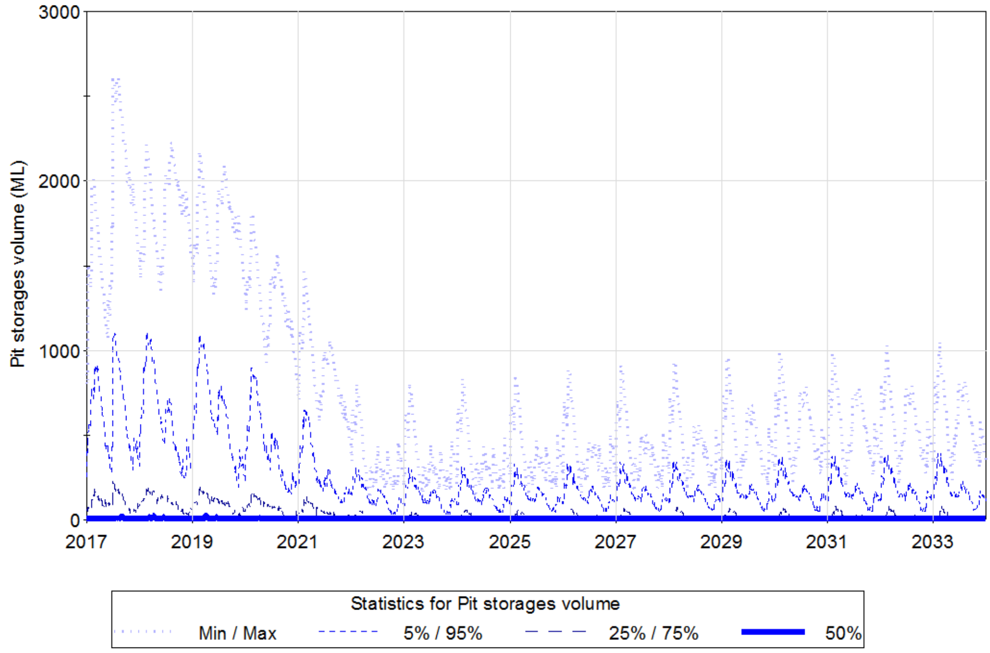



**Figure 6.2 Simulated time series of water stored in-pit sumps**

Figure 6.2 shows that the pit void is predicted to empty most of the time, however the volume stored at any one time may reach approximately 2000 ML. This maximum volume may reduce following 2023 as the catchment area reporting to the pit void is reduced.

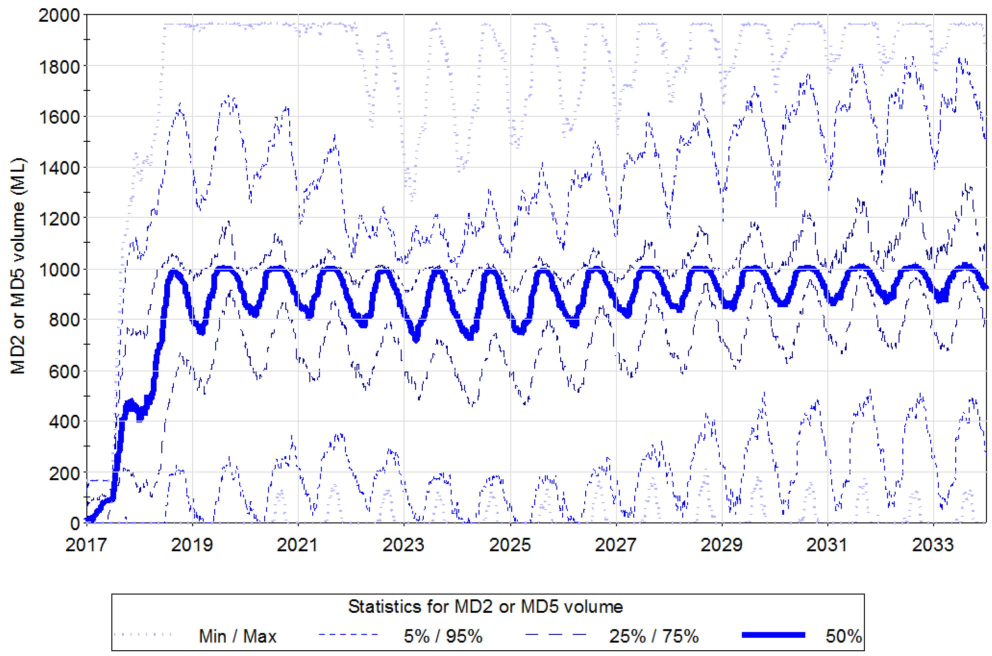



**Figure 6.3 Simulated time series of water stored in MW2 / MW5**

Figure 6.3 shows that the volume stored in MW5, after is construction, is predicted to most likely remain close the assumed normal operating volume of 1000 ML, but may increase to the high operating volume or empty.

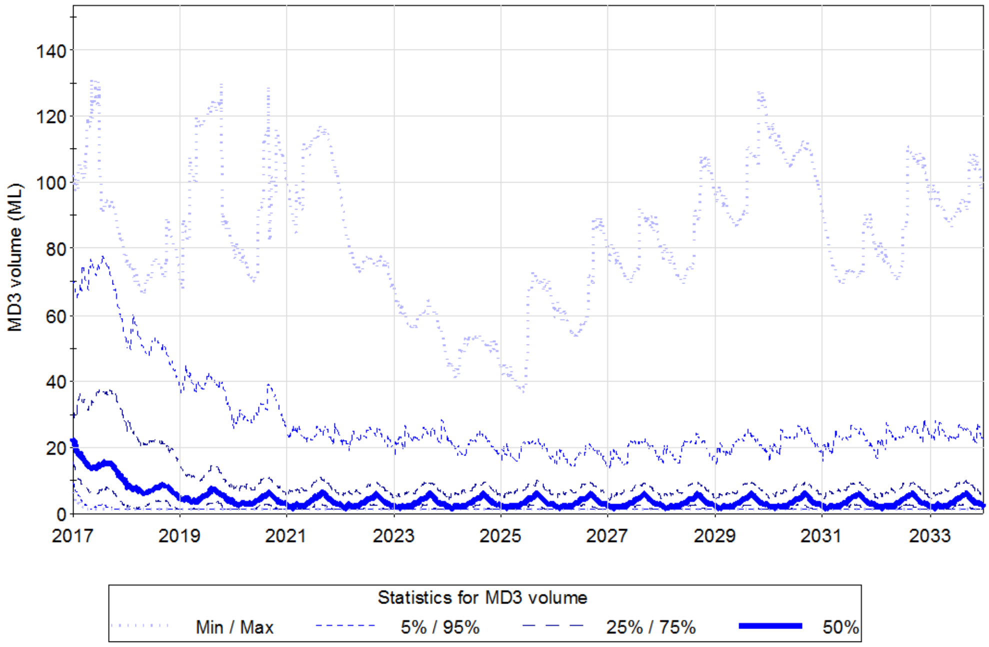



**Figure 6.4 Simulated time series of water stored in MW3**

Figure 6.4 shows that the volume stored in MW3 is predicted to remain relatively low, but may reach volumes at to approximately 130 ML. This reflects the assumed operating rules whereby MW3 is used as additional dewatering capacity for SD10 after MW2/MW5 reach their high operating volume.

# 7. Water efficiency initiatives

The action plan and schedule to implement water efficiency initiatives and the recommendations (Advisian, 2016) referenced in appendix 6A of the Project Approval are provided in Table 7.1.

**Table 7.1 Water Balance Initiatives Action Plan**

| BCOPL Water Efficiency Initiatives | |
|---|---|
| **Action Plan** | **Schedule** |
| Propose water efficiency initiatives during the SWB annual review process. | Annually during the SWB annual review process |
| Report on the effectiveness of water efficiency initiatives. | Annually in the AEMR |
| **Water Efficiency Initiatives Project Approval Appendix 6A** | |
| **Action Plan** | **Schedule** |
| 1. Install meters for all major water flows including: | |
| • Water transfers from sediment dams and mine pits into mine water storages. | By end 2017 |
| • All water-cart fill points. | By end 2017 |
| • All elements of the anticipated water demands for various purposes associated with CHPP (as identified in Table 4 of the letters dated 8 July) | By end 2017 |
| • All water imports including any bore water obtained onsite. | Within one week of commencing operation. |
| 2. Install water level meters on all significant water storage as a check on inflows and outflows and a means of assessing evaporation and seepage losses. This data will also provide a basis for improving estimates of the runoff from different surface types (hardstand, mine pit, "raw' overburden) | By end of June 2018 |
| 3. Collect moisture content data for all coal flows associated with the CHPP to permit full water balance accounting | By end 2017 |
| 4. Record all flow meters and water levels at least weekly (preferable by means for continuous recording) and analyse the data on a monthly basis to develop a full accounting of all water sources and losses. | Within one month of flow meters and water level instruments being installed. |
| 5. Compare monitored gains from rainfall and losses by evaporation from water storages to the rainfall and evaporation data from the weather station. | By end 2017 |
| 6. Update the site water balance annually bases on monitored data and provide details in the annual report to | Annual SWB revision as outlined in Section 8.3 |

| | |
|---|---|
| the Department. | |

# 8. Improvement and reporting

## 8.1 Annual Improvement Program

BCOPL will undertake an annual improvement program to identify and address deficiencies and improvements within monitoring, measurement and calculation methods presented in the SWB. The improvement program will include a review of the monitoring, measurements and calculation methods used in the SWB and where required outline any improvements to address deficiencies in these. The results of the improvement program will be incorporated into the annual revision of the SWB presented as part of the Annual Review required under Schedule 5, condition 4 of the Project Approval. .

## 8.2 Validation Program

BCOPL will perform a validation of the SWB model on an annual basis. The existing model will be used to simulate the water management system for the previous year using observed site rainfall. The observed borefield extraction, river water extraction, CHPP usage, dust suppression usage, potable/washdown usage, catchment areas, discharge events and storage volumes (in SD10, MW2, MW3, MW5, Strip #9 and in-pit) will be compared to modelled results on a monthly basis.

As the BCM is predicted to be in water deficit under most climatic conditions and the contaminated water system is designed to contain and manage the 100 year ARI 72 hour rainfall event, discharges from the BCM are expected to be only from sediment dams following significant rainfall events. Therefore, the discharge volumes from the BCM may be estimated and validated using observations of the incidence of discharge events.

If the SWB model is found to not be realistically representative of the management system, an investigation will be a undertaken that may involve a calibration process, similar to that described in Section 5, to identify the source of the discrepancy. The updated SWB model will be used to update predictions described in Section 6.

A summary of the validation will be incorporated into the annual revision of the SWB presented as part of the Annual Review.

## 8.3 Annual Review

The Annual Review summarises the environmental performance of the mine for the previous calendar year. In accordance with Schedule 5, condition 4 of the Project Approval, the relevant monitoring data will be used to revise the SWB annually and will be provided in the Annual Review.

The Annual Review will be made publically available on the Boggabri Coal Mine website [Idemitsu Approvals, Plans & Reports - Idemitsu](#)**.**

# 9. Review and revision

## 9.1 Review

Review of the SWB will be undertaken by BCOPL in accordance schedule 5 condition 5 of the Project Approval within 3 months of the submitting the following:

- Annual Review under condition 4 of the Project Approval.
- incident report under condition 8 of the Project Approval.
- audit under condition 10 of the Project Approval.
- a modification to the Project Approval.

Where this review results in revisions to the SWB, then within 4 weeks of the completion of the revision, unless the Secretary agrees otherwise, the revised document will be submitted to the Secretary for approval.

# 10. References

Australasian Groundwater & Environmental Consultants (AGE), October 2010. Continuation of Boggabri Coal Mine Project Groundwater Water Assessment.

Boggabri Coal Pty Limited (BCPL), March 2012. Mine Water Balance Review – Boggabri Coal Project.

Department of Environment, Climate Change and Water (DECCW), 2008. Managing Urban Stormwater - Soils and Construction - Volume 2E Mines and Quarries.

Smith M, 1998. Crop evapotranspiration: Guidelines for computing crop water requirements. Food and Agriculture Organization of the United Nations. Irrigation and Drainage paper No. 56.

Hansen Bailey, December 2010. Continuation of Boggabri Coal Mine Environmental Assessment.

Hansen Bailey, August 2011. Boggabri Coal Mine Environmental Assessment - Modification to Development Consent.

DECCW, 2008. *Managing Urban Stormwater - Soils and Construction - Volume 2E Mines and Quarries*. New South Wales Government.

Ladson, A., 2008. *Hydrology: An Australian Introduction.* Oxford University Press: Melbourne.

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Parsons Brinckerhoff (PB), 2009. Boggabri Coal Mine 2008 Site Water Balance.

Parsons Brinckerhoff (PB), 28 August 2015. Boggabri Coal Mine – Drawdown Impact Assessment of Proposed Borefield Operations (2200555A_WAT_REP_Borefield assessment_RevC)

Ribbons C, 2009. Water availability in New South Wales Murray–Darling Basin regulated rivers, NSW Department of Water and Energy, Sydney.

Stephen J. Jeffrey, John O. Carter, Keith B. Moodie, Alan R. Beswick, Using spatial interpolation to construct a comprehensive archive of Australian climate data, *Environmental Modelling & Software*, Volume 16, Issue 4, June 2001, Pages 309-330, ISSN 1364-8152, http://dx.doi.org/10.1016/S1364-8152(01)00008-1.

# Appendix A

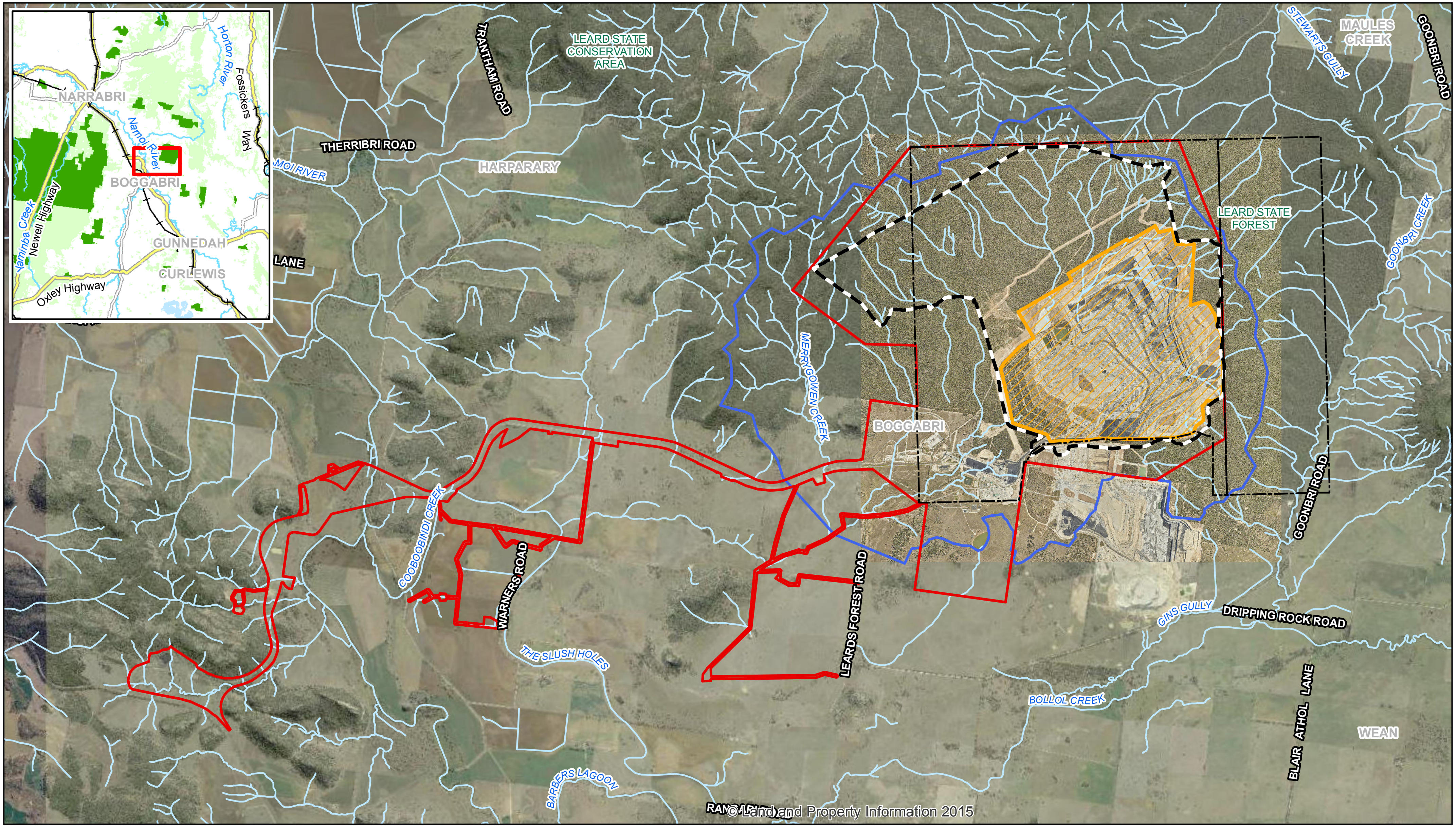
Summary of methodologies

**Table A.1 Summary of methodology**

| Process | Data source | Measurement type | Relevant formulas |
|---|---|---|---|
| Mass balance | NA | Mass conservation | Refer to Section 4.1 |
| Staging of storages | Life-of-Mine plans | Assumed | Refer to Section 4.3 |
| Historical rainfall | SILO Data Drill | Interpolated from observed rainfall gauges | Refer to Stephen et al. (2001) and Section 2.2 |
| Historical potential evapotranspiration depth | SILO Data Drill | Interpolated from observed data | Refer to Smith (1998) and Section 2.2 |
| Historical potential open water evaporation depth | SILO Data Drill | Interpolated from observed data | Refer to Morton (1983) and Section 2.2 |
| Future climatic conditions | SILO Data Drill | Sampled concurently from historical record | Refer to Section 2.2 |
| Existing catchment and landuse areas | LiDAR and aerial imagery | Measured | Refer to Section 4.4.2 and Appendix B |
| Future catchment and landuse areas | Life-of-Mine plans | Measured | Refer to Section 4.4.2 and Appendix B |
| Catchment runoff | NA | Estimated using AWBM with validated parameters | Refer to Section 2.4, Section 4.5.1 and Section 5 |
| Existing storage capacity | BCOPL | As constructed | Refer to Section 4.4.1 |
| Storage maximum surface area and geometry | LiDAR and aerial imagery | Measured | Refer to Section 4.4.1 |
| MW2 stage storage relationship | BCOPL | Measured by survey | Refer to Section 4.4.1 and Appendix D |
| Storage water surface area | NA | Calculated from stage storage relationships or approximated geometry | Refer to Section 4.4.1 |
| Direct rainfall | NA | Calculated from modelled rainfall and water surface area | Refer to Section 4.5.1 |
| Actual evaporation losses | NA | Calculated from modelled evaporation and surface area | Refer to Section 4.7.1 |
| Groundwater inflows | Groundwater model predictions | Calculated | Refer to AGE (2010) and Section 4.5.2 |
| Past CHPP usage | BCOPL | Estimated from site experience | Refer to Section 4.6.2 and Section 5 |
| Past dust suppression usage | BCOPL | Measured as monthly totals | Refer to Section 5 |
| Past potable and washdown usage | BCOPL | Estimated from site experience | Refer to Section 4.6.3 and Section 5 |
| Future CHPP usage | BCOPL | Estimated from site experience | Refer to Section 4.6.2 |
| Future dust suppression usage | BCOPL | Estimated from site experience | Refer to Section 4.6.1 |
| Future potable and washdown usage | BCOPL | Estimated from site experience | Refer to Section 4.6.3 |
| Site operating rules | BCOPL | Idealised from actual site management | Refer to Section 4.4.3 and Section 4.5.3 |
| Off-site releases | NA | Calculated from mass balance | Refer to Section 4.7.3 |

# Appendix B

Water management system plans and schematics




Paper Size A4

0 625 1,250 1,875 2,500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Mine disturbance area
- Federal approval limit
- Project approval area
- Mine tenement
- Study catchment

Boggabri Coal Operations Pty Ltd
Boggabri Coal Site Water Balance

| | |
|---|---|
| Job Number | 22-18361 |
| Revision | 0 |
| Date | 19 Jan 2017 |

Locality plan

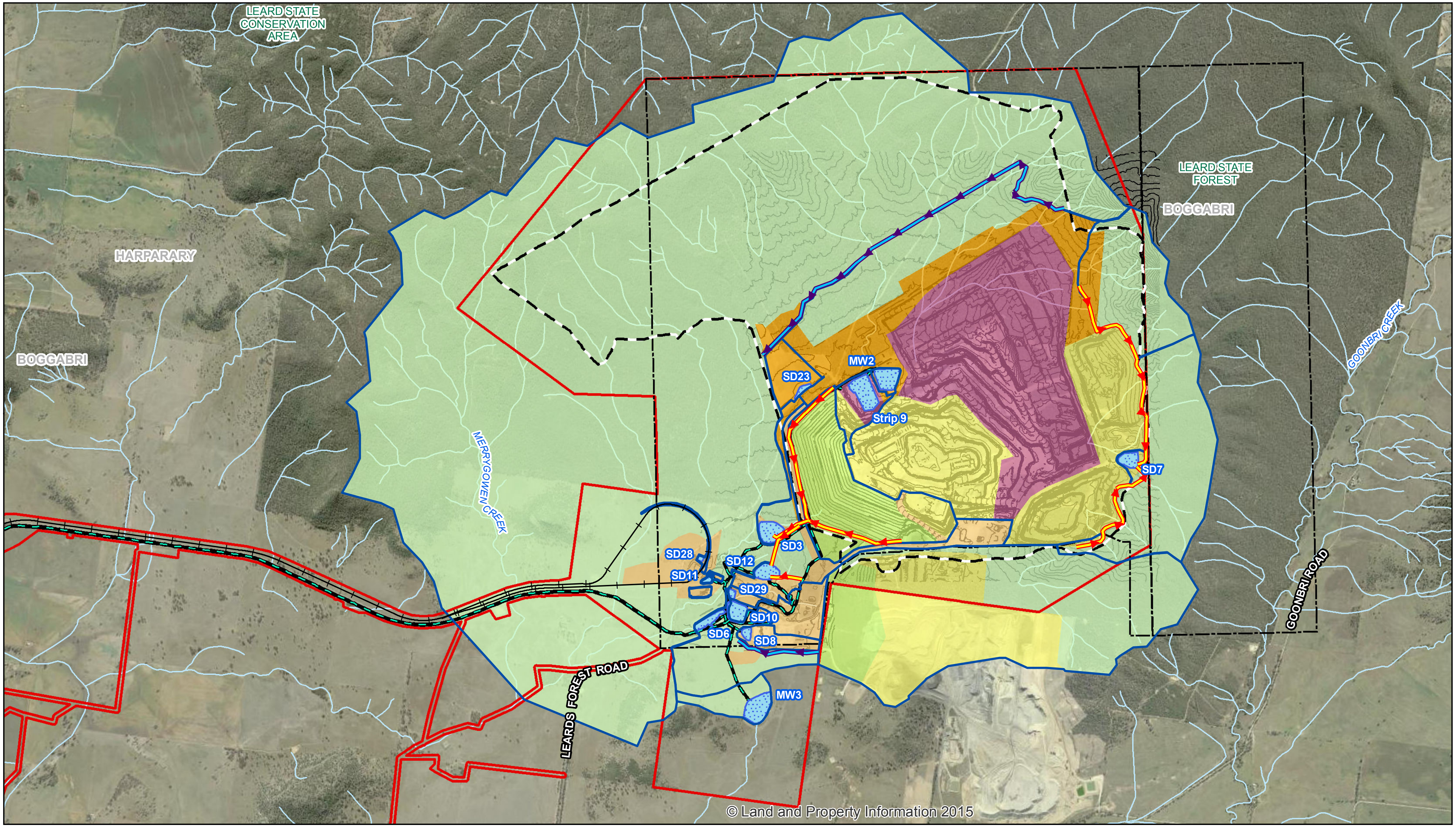
Figure B-1

G:\22\18361\GIS\Maps\Deliverables\SiteWaterBalance\2218361_SWB001_Locality_0.mxd

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au



Data source: Geoscience Australia: 250k Topographic Data Series 3, 2006; LPI: DTDB / DCDB, 2012, Aerial Imagery, 2016; BCOPL: Mining boundaries, 2016. Created by: fmackay




Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Federal approval limit
- Project approval area
- Mine tenement
- Rail loop
- Water storage
- Water balance catchment
- Clean water drain
- Dirty water drain
- Pump pipeline
- Contour
- Undisturbed
- Cleared
- Mining void
- Unshaped spoil dump
- Rehabilitation
- Road / industrial

Boggabri Coal Operations Pty Ltd
Boggabri Coal Site Water Balance

Job Number 22-18361
Revision 0
Date 19 Jan 2017

Water management system
Existing layout

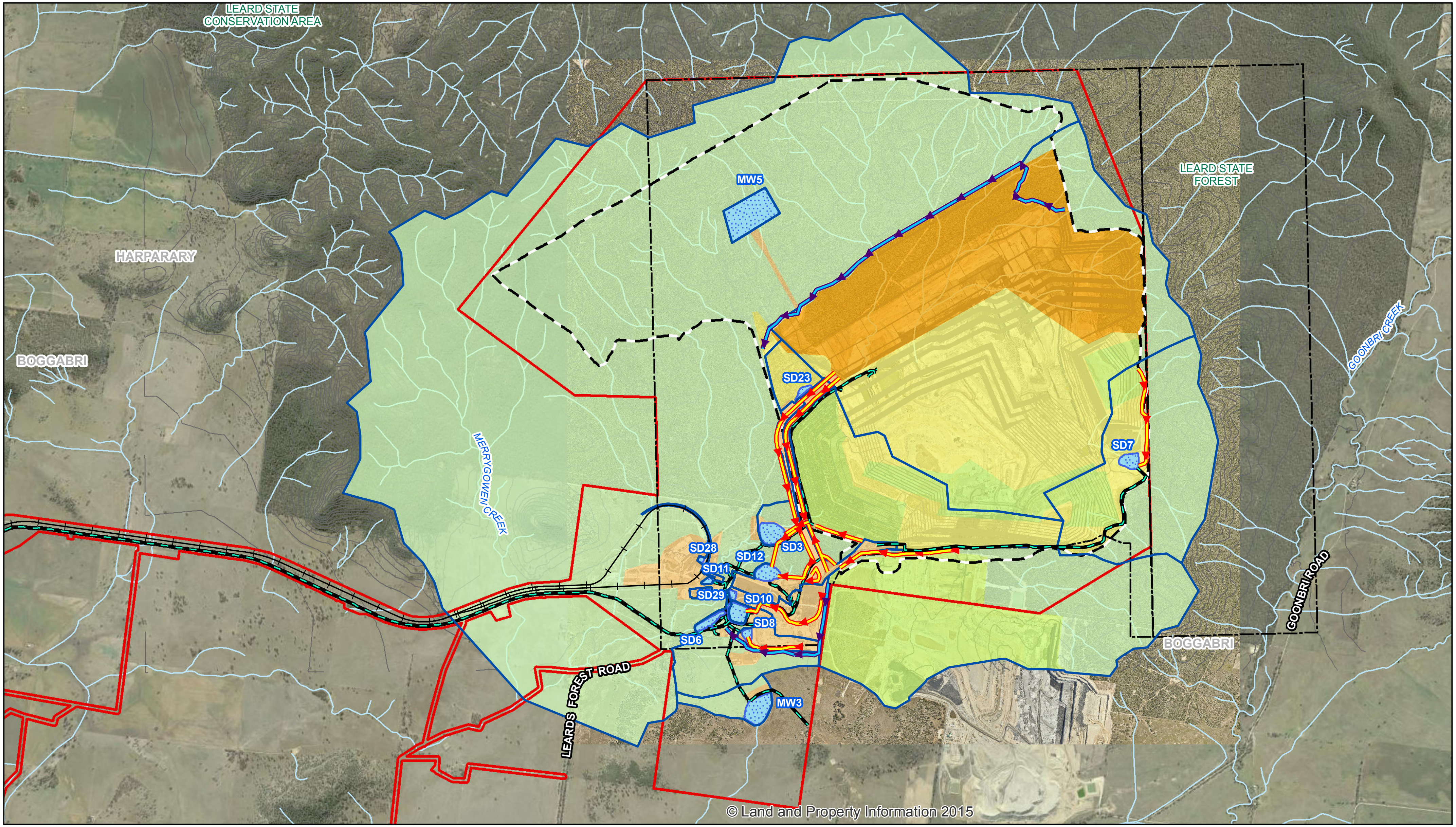
Figure B-2

\\ghdnet\ghd\AU\Newcastle\Projects\22\18361\GIS\Maps\Deliverables\SiteWaterBalance\2218361_SWB002_WaterManagement_Existing_0.mxd

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au



Data source: LPI: DTDB / DCDB, 2012, Aerial Imagery, 2016; BCOPL: Mining boundaries, 2016. Created by: fmackay




Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Federal approval limit
- Project approval area
- Mine tenement
- Rail loop
- Water storage
- Water balance catchment
- Clean water drain
- Dirty water drain
- Pump pipeline
- Contour
- Undisturbed
- Cleared
- Mining void
- Unshaped spoil dump
- Rehabilitation
- Road / industrial

GHD

Boggabri Coal Operations Pty Ltd
Boggabri Coal Site Water Balance

Job Number 22-18361
Revision 0
Date 19 Jan 2017

Water management system
Indicative layout (2018)

Figure B-3

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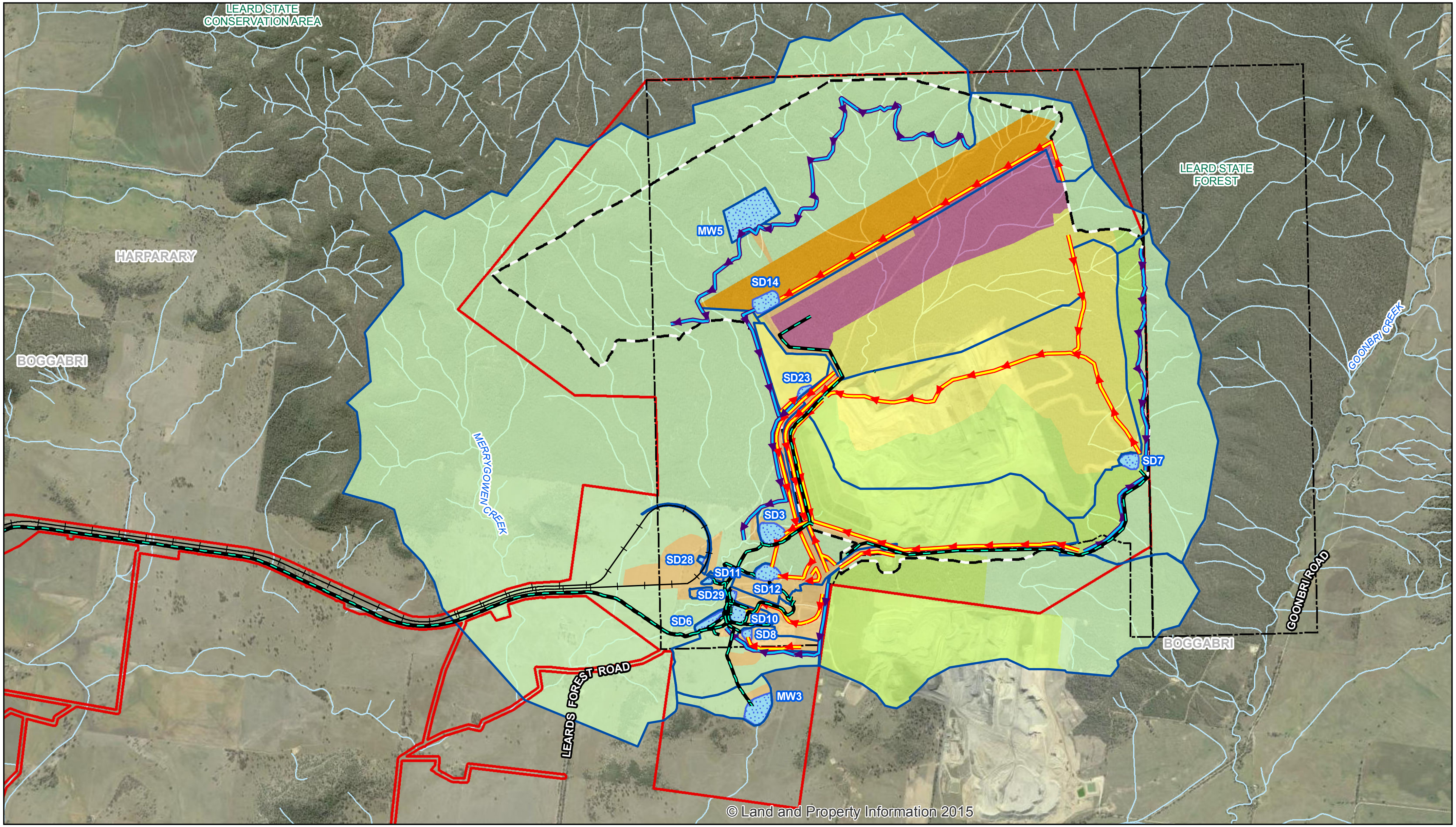
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au



Data source: LPI: DTDB / DCDB, 2012, Aerial Imagery, 2016; BCOPL: Mining boundaries, 2016. Created by: fmackay




Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Federal approval limit
- Project approval area
- Mine tenement
- Rail loop
- Water storage
- Water balance catchment
- Clean water drain
- Dirty water drain
- Pump pipeline
- Undisturbed
- Cleared
- Mining void
- Unshaped spoil dump
- Rehabilitation
- Road / industrial

Boggabri Coal Operations Pty Ltd
Boggabri Coal Site Water Balance

| | |
|---|---|
| Job Number | 22-18361 |
| Revision | 0 |
| Date | 19 Jan 2017 |

GHD

Water management system
Indicative layout (2022)

Figure B-4

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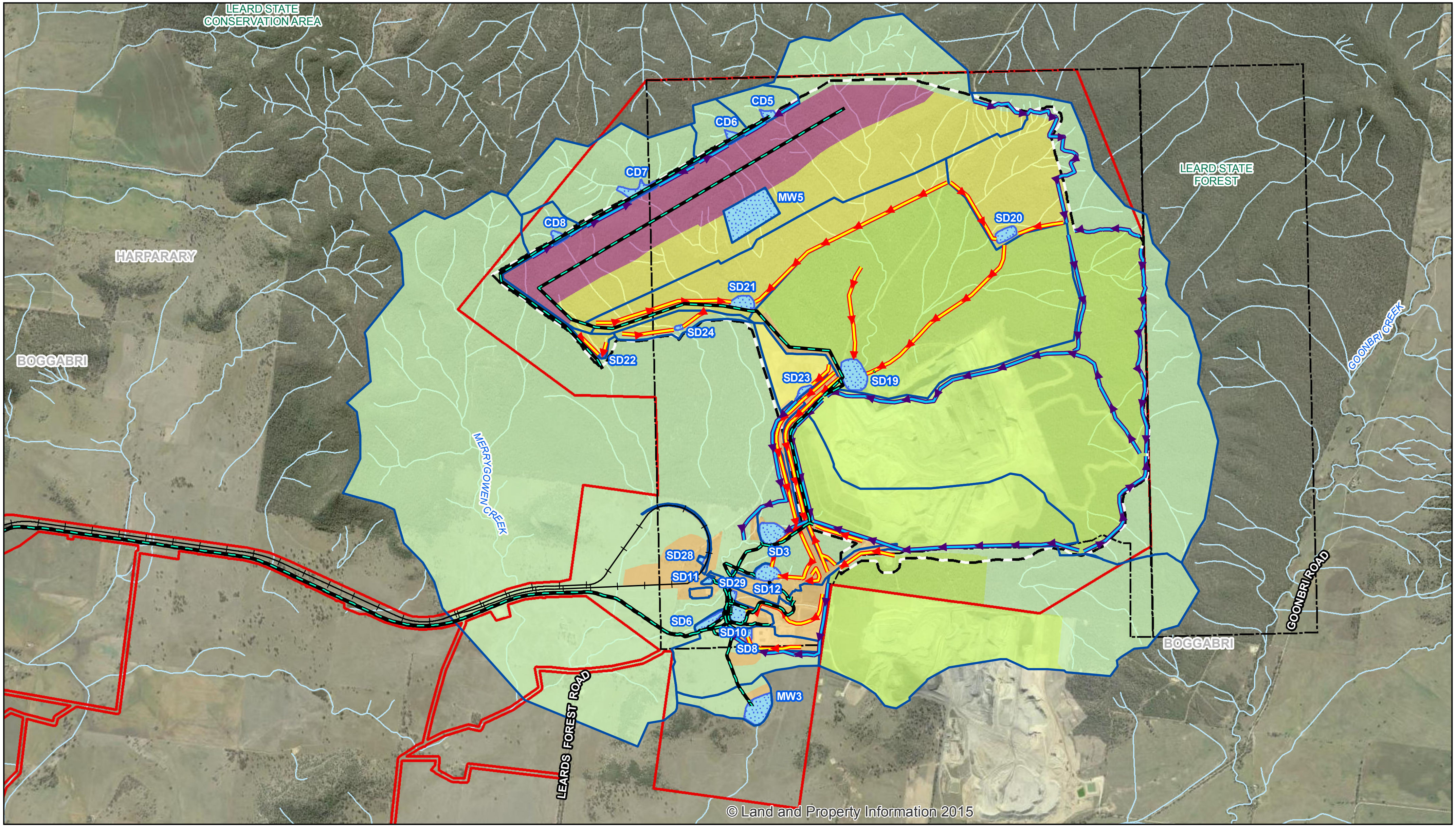
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au



Data source: LPI: DTDB / DCDB, 2012, Aerial Imagery, 2016; BCOPL: Mining boundaries, 2016. Created by: fmackay




Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Federal approval limit
- Project approval area
- Mine tenement
- Rail loop
- Water storage
- Water balance catchment
- Clean water drain
- Dirty water drain
- Pump pipeline
- Undisturbed
- Mining void
- Unshaped spoil dump
- Rehabilitation
- Road / industrial

GHD

Boggabri Coal Operations Pty Ltd
Boggabri Coal Site Water Balance

| | |
|---|---|
| Job Number | 22-18361 |
| Revision | 0 |
| Date | 19 Jan 2017 |

Water management system
Indicative layout (2033)

Figure B-5

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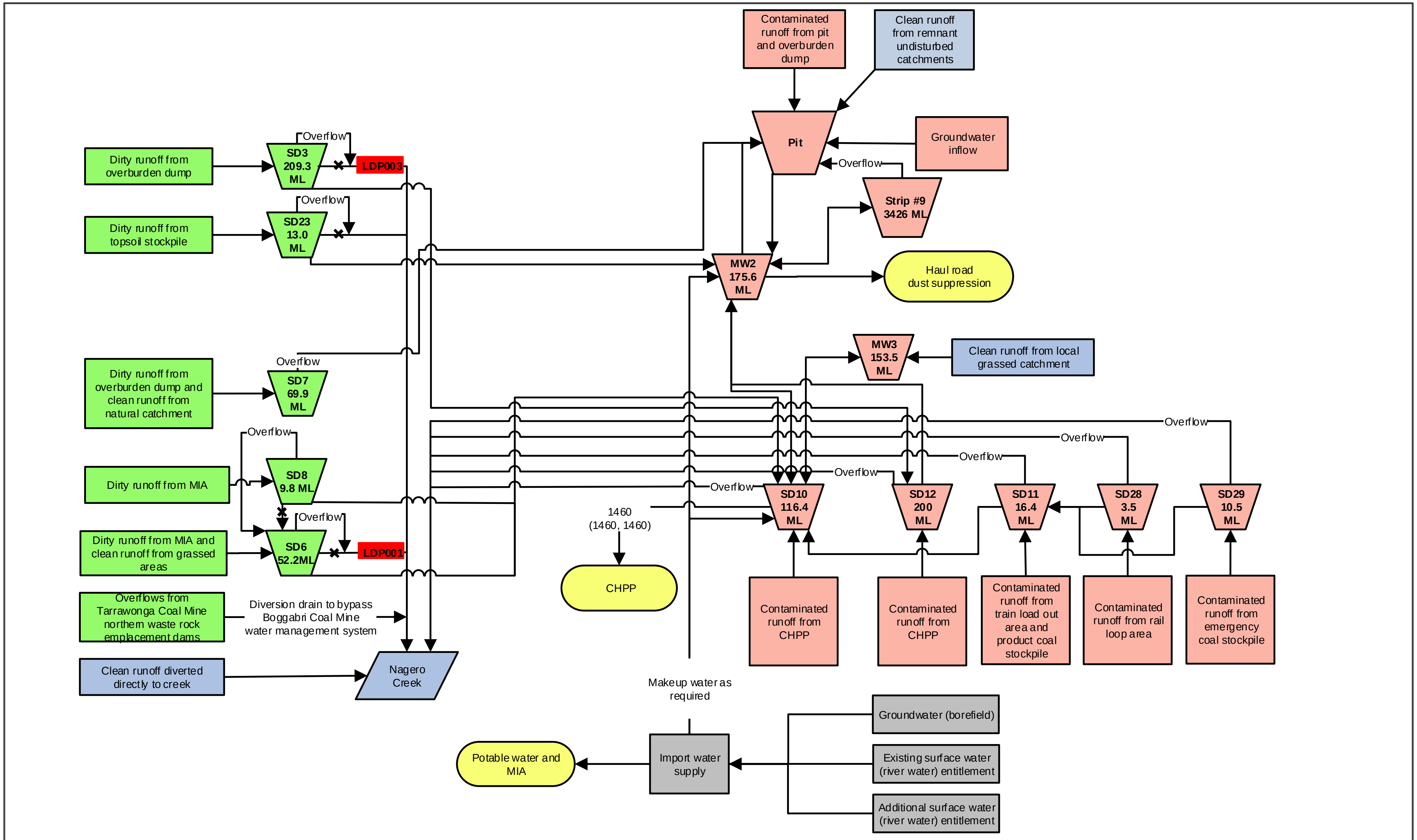
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au



Data source: LPI: DTDB / DCDB, 2012, Aerial Imagery, 2016; BCOPL: Mining boundaries, 2016. Created by: fmackay




LEGEND

Surface Water Transfer

Storage

Manually operated valve

XX (XX, XX) Median (ML/year) 10th, 90th percentile

Import water system

Dirty water system

Contaminated water system

Clean water system

Usage



| | |
|---|---|
| LOCATION | BCM |
| | |
| DRAWN | TT |
| CHECKED | AW |
| APPROVED | SG |
| SCALE | NTS |

Boggabri Coal Operations Pty Ltd
Boggabri Coal Mine
Site Water Balance

Water balance model schematic
Existing conditions

DATE 5 May 2017

Figure B-6

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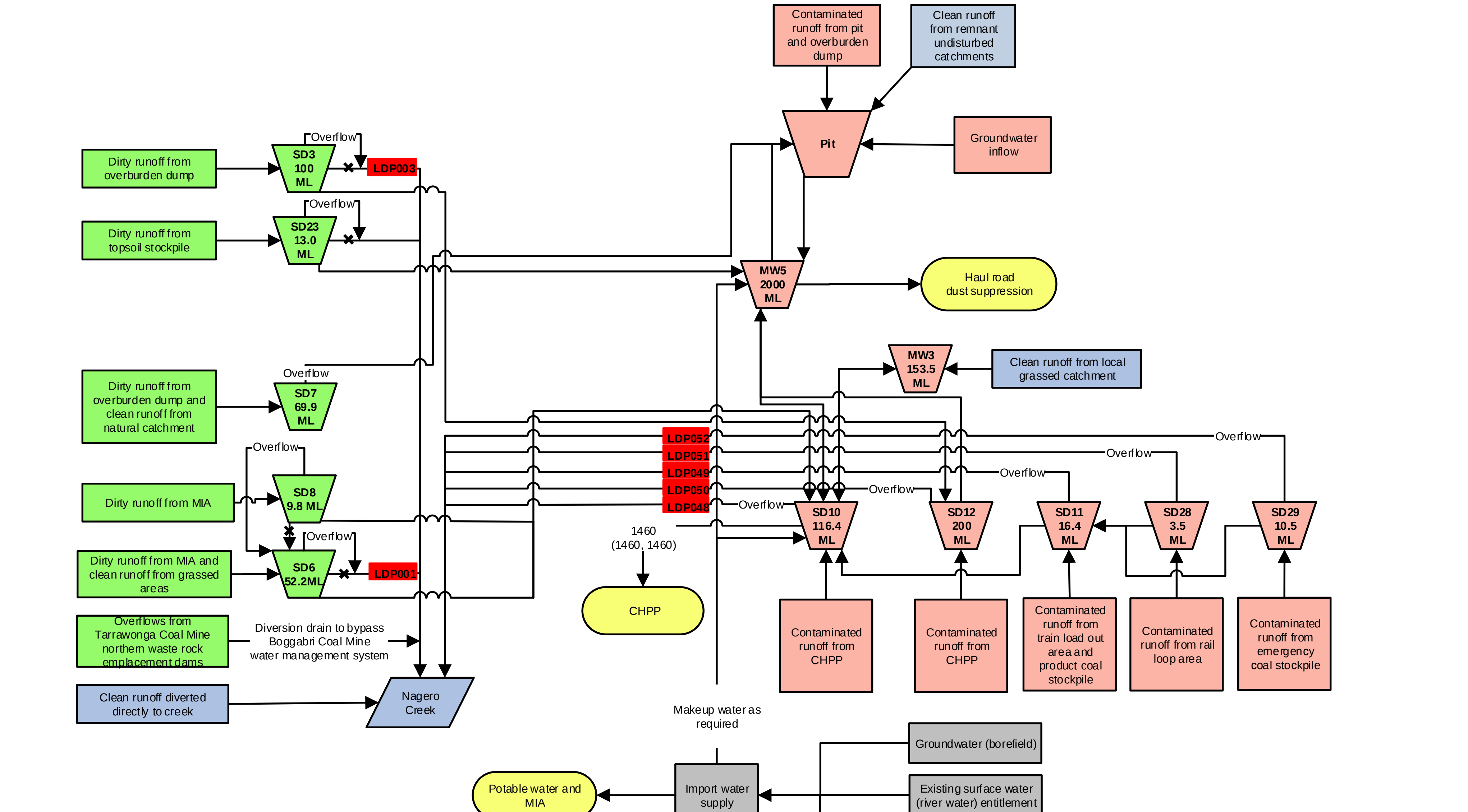



Note: The location and numbering of LDPs are indicative and may be subject to change depending on EPA licensing requirements.

LEGEND

- Surface Water Transfer
- Storage
- Manually operated valve
- XX (XX, XX): Median (ML/year) 10th, 90th percentile
- Import water system
- Dirty water system
- Contaminated water system
- Clean water system
- Usage



| | |
|---|---|
| LOCATION | BCM |
| | |
| DRAWN | TT |
| CHECKED | AW |
| APPROVED | SG |
| SCALE | NTS |

Boggabri Coal Operations Pty Ltd
Boggabri Coal Mine
Site Water Balance

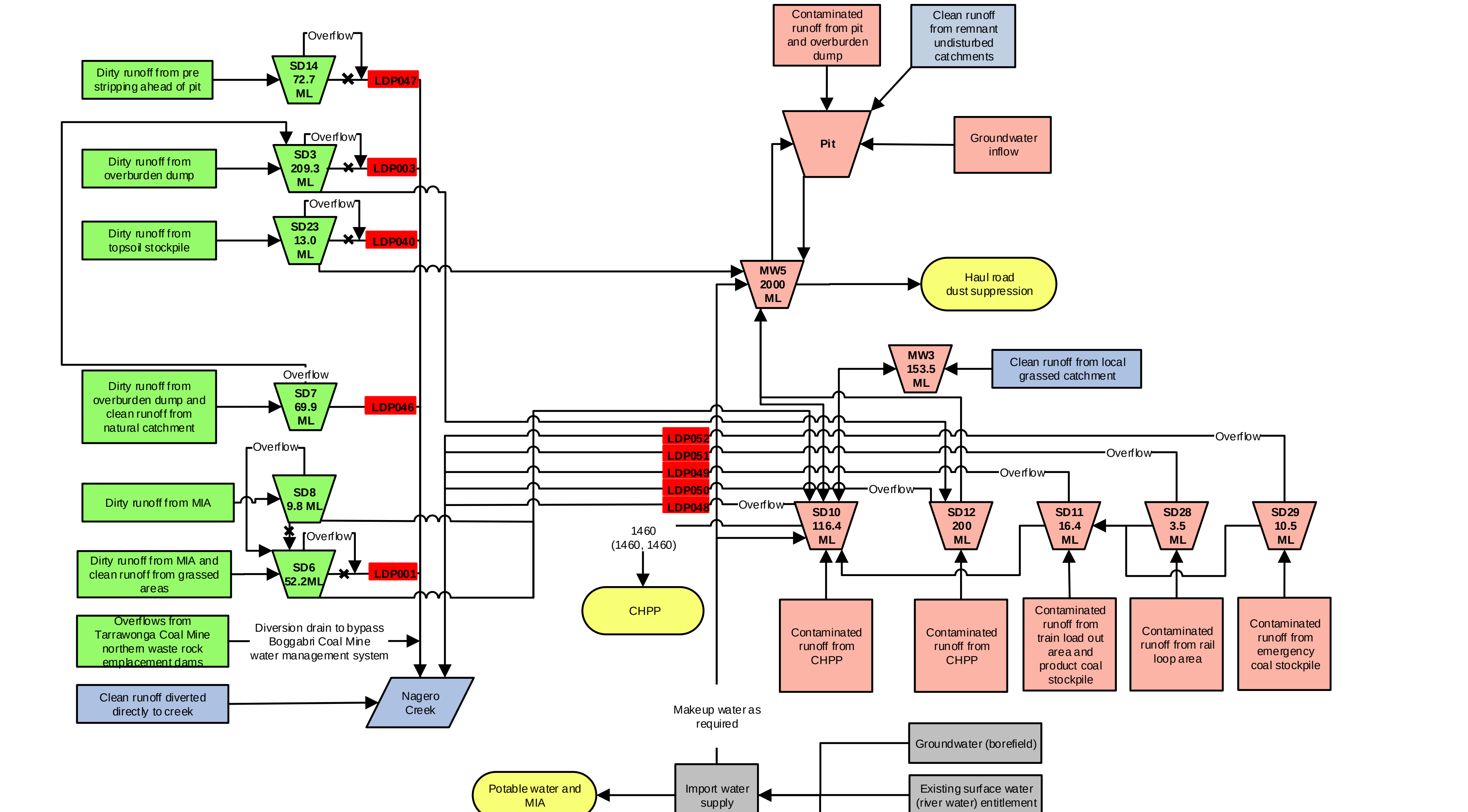
Water balance model schematic
Indicative conditions (2018)

IDEMITSU BOGGABRI COAL

DATE 5 May 2017

Figure B-7

\\ghdnet\ghd\AU\Newcastle\Projects\22\18361\Tech\Visio\Rev8\2218361-VIS-Water_Transfers.vsdx




Note: The location and numbering of LDPs are indicative and may be subject to change depending on EPA licensing requirements.

GHD

LEGEND

- Surface Water Transfer
- Storage
- Manually operated valve
- XX (XX, XX) — Median (ML/year) 10th, 90th percentile
- Import water system
- Dirty water system
- Contaminated water system
- Clean water system
- Usage



| | |
|---|---|
| LOCATION | BCM |
| | |
| DRAWN | TT |
| CHECKED | AW |
| APPROVED | SG |
| SCALE | NTS |

Boggabri Coal Operations Pty Ltd
Boggabri Coal Mine
Site Water Balance

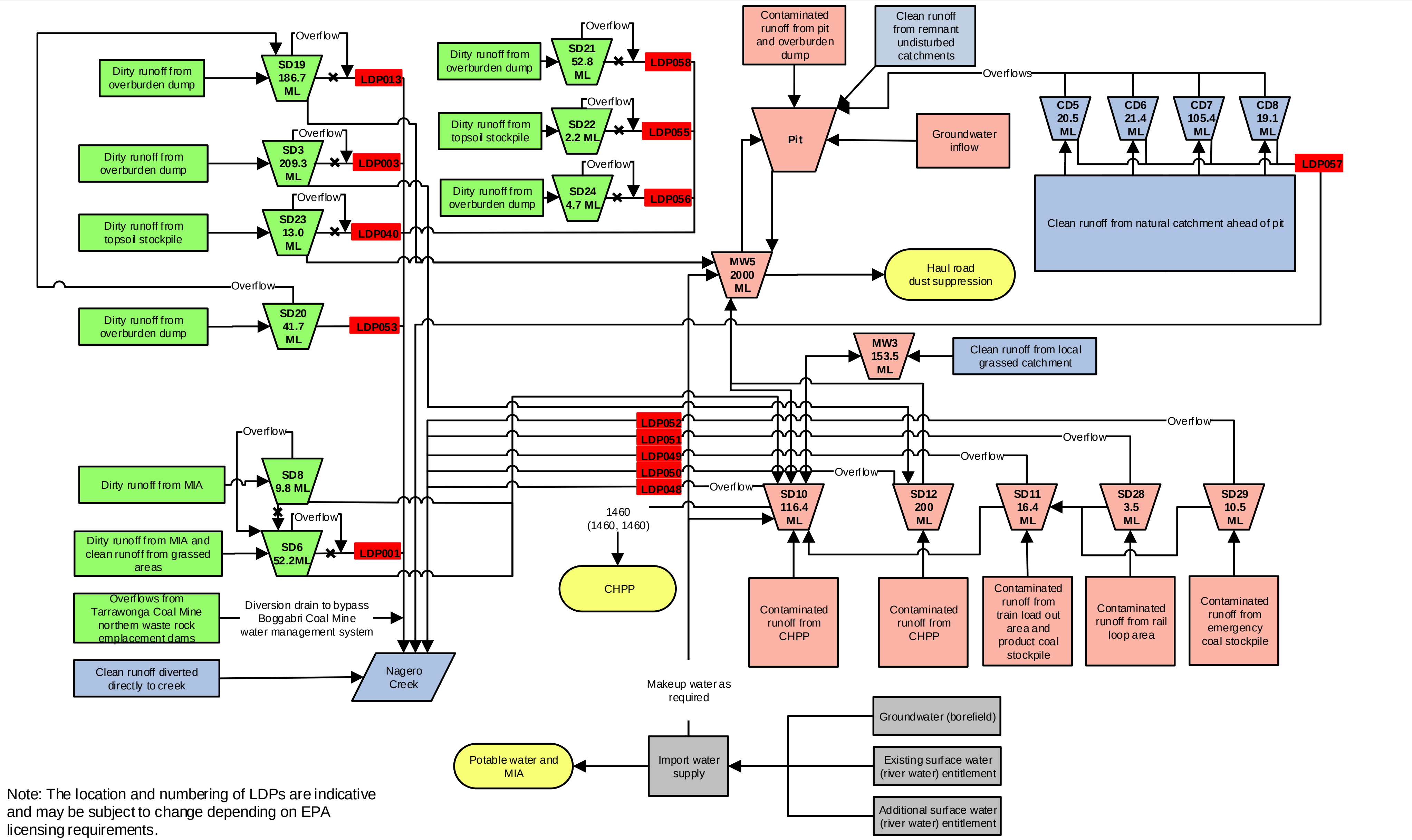
Water balance model schematic
Indicative conditions (2022)

IDEMITSU BOGGABRI COAL

DATE 5 May 2017

Figure B-8

\\ghdnet\ghd\AU\Newcastle\Projects\22\18361\Tech\Visio\Rev8\2218361-VIS-Water_Transfers.vsdx




Note: The location and numbering of LDPs are indicative and may be subject to change depending on EPA licensing requirements.

LEGEND

- Surface Water Transfer
- Storage
- Manually operated valve
- XX (XX, XX): Median (ML/year) 10th, 90th percentile
- Import water system
- Dirty water system
- Contaminated water system
- Clean water system
- Usage



| | |
|---|---|
| LOCATION | BCM |
| | |
| DRAWN | TT |
| CHECKED | AW |
| APPROVED | SG |
| SCALE | NTS |

Boggabri Coal Operations Pty Ltd
Boggabri Coal Mine
Site Water Balance

Water balance model schematic
Indicative conditions (2033)

DATE 5 May 2017

Figure B-9

\\ghdnet\ghd\AU\Newcastle\Projects\22\18361\Tech\Visio\Rev8\2218361-VIS-Water_Transfers.vsdx

# Appendix C

Summary of storages and discharge points

**Table C 1 Summary of existing storages**

| Storage | Location / description | Stored water | Design criteria | Additional sediment allowance | Runoff coefficient | Catchment area (ha) | Required minimum capacity (ML) | Existing capacity (ML) | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **Dirty water dams** | | | | | | | | | |
| SD3 | Sediment dam located south-west of spoil dump | Dirty runoff from partially rehabilitated spoil dump | $90^{th}$ %ile 5 day | 50% | 0.4 to 0.75 | 139.8 | 60.5 | 102.3 | Existing capacity of 102.3 ML exceeds required capacity. |
| SD6 | Sediment dam located downstream of MIA (referred to as Nagero Dam) | Runoff from grassed areas near MIA, and overflows from SD8 | $90^{th}$ %ile 5 day | 50% | 0.4 to 0.75 | 63.5 | 14.6 | 52.2 | Existing capacity of 52.2 ML exceeds required capacity. |
| SD7 | Sediment dam located in eastern spoil dump | Dirty runoff from spoil dump and clean runoff from undisturbed catchment | $90^{th}$ %ile 5 day | 50% | 0.4 to 0.75 | 158.9 | 45.8 | 69.9 | Existing capacity of 69.9 ML exceeds required capacity. Elevation of catchment does not allow return to environment. |
| SD8 | Sediment dam located in MIA | Dirty runoff from MIA | $90^{th}$ %ile 5 day | 50% | 0.75 | 13.0 | 5.6 | 9.8 | Existing capacity of 9.8 ML exceeds required capacity. |
| SD23 | Sediment dam located near topsoil stockpile | Dirty runoff from topsoil stockpile | $90^{th}$ %ile 5 day | 50% | 0.75 | 20.0 | 8.7 | 9.5 | Existing capacity of 9.5 ML exceeds required capacity. |
| **Contaminated water dams** | | | | | | | | | |
| SD10 | Contaminated water dam located in CHPP | Contaminated runoff from product coal stockpile | 100yr ARI 72hr | 20% | 0.85 | 27.1 | 70.7 | 116.4 | Existing capacity of 116.4 ML exceeds required capacity. SD10 includes ‘reuse zone’ for water supply to CHPP. |
| SD11 | Contaminated water dam located at rail loop | Contaminated runoff from rail loop | 100yr ARI 72hr | 20% | 0.85 | 3.8 | 10.0 | 16.4 | Existing capacity of 16.4 ML exceeds required capacity. |

| Storage | Location / description | Stored water | Design criteria | Additional sediment allowance | Runoff coefficient | Catchment area (ha) | Required minimum capacity (ML) | Existing capacity (ML) | Notes |
|---|---|---|---|---|---|---|---|---|---|
| SD12 | Contaminated water dam located in CHPP | Contaminated runoff from ROM coal stockpile | 100yr ARI 72hr | 20% | 0.85 | 63.8 | 165.7 | 206.6 | Existing capacity of 206.6 ML exceeds required capacity. |
| SD28 | Contaminated water dam located in CHPP | Contaminated runoff from rail loop area | 100yr ARI 72hr | 20% | 0.85 | 1.0 | 2.6 | 3.5 | Existing capacity of 3.5 ML exceeds required capacity. |
| SD29 | Contaminated water dam located in CHPP | Contaminated runoff from emergency coal stockpile | 100yr ARI 72hr | 20% | 0.85 | 4.0 | 10.4 | 10.5 | Existing capacity of 10.5 ML exceeds required capacity. |
| MW2 | Mine water dam located north-west of mining void (turkey's nest dam) | Contaminated water pumped from pit | 100yr ARI 72hr | 0% | 1.0 | 3.8 | 9.7 | 175.8 | Freeboard of 9.7 ML is maintained |
| MW3 | Mine water dam located south of MIA | Surplus contaminated water pumped from SD10 and clean runoff from small grassed catchment | 100yr ARI 72hr | 0% | 0.40 | 22.0 | 22.5 | 153.5 | Freeboard of 22.5 ML is maintained |
| Pit | In-pit storage during wet periods | Contaminated runoff and groundwater make captured in the mining void sumps | | | | | | | Surplus contaminated water stored in-pit when capacity of Strip #9 and MWDs reached |
| Strip #9 | Extra mine water storage for earlier surplus years | Surplus mine water from pit and from MW2 and MW5 | | 0% | 1.0 | 22.24 | 56.7 | 3426 | Freeboard of 56.7 ML is maintained. Surplus contaminated water stored in Strip #9 when capacity of MWDs reached |

**Table C 2 Summary of existing discharge points**

| EPL identification number | Discharge type | Storage | Location / description | Stored water |
|---|---|---|---|---|
| Point 2 | Discharge water quality monitoring and Wet weather discharge | SD3 | Sediment dam located south-west of spoil dump | Dirty runoff from partially rehabilitated spoil dump |
| Point 1 | Discharge water quality monitoring and Wet weather discharge | SD6 | Sediment dam located downstream of MIA (Nagero Dam) | Runoff from grassed areas near MIA, and overflows from SD8 |
| Point 4 | Discharge water quality monitoring and Wet weather discharge | SD4 | Sediment dam located downstream of train load out area west of BCM | Runoff from train load out area |

Table C 3 Summary of proposed 2018 storages

| Storage | Location / description | Stored water | Design criteria | Additional sediment allowance | Runoff coefficient | Catchment area (ha) | Required minimum capacity (ML) | Proposed capacity (ML) | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **Dirty water dams** | | | | | | | | | |
| SD3 | Sediment dam located south-west of spoil dump | Dirty runoff from partially rehabilitated spoil dump | $90^{th}$ %ile 5 day | 50% | 0.4 to 0.75 | 213.2 | 92.1 | 100.0 | |
| SD6 | Sediment dam located downstream of MIA (referred to as Nagero Dam) | Runoff from grassed areas near MIA, and overflows from SD8 | $90^{th}$ %ile 5 day | 50% | 0.4 to 0.75 | 63.5 | 14.6 | 52.2 | |
| SD7 | Sediment dam located in eastern spoil dump | Dirty runoff from spoil dump and clean runoff from undisturbed catchment | $90^{th}$ %ile 5 day | 50% | 0.4 to 0.75 | 229.1 | 64.4 | 69.9 | SD7 water is harvested as elevation of catchment does not allow for return to environment. SD7 overflows to pit in 2018. |
| SD8 | Sediment dam located in MIA | Dirty runoff from MIA | $90^{th}$ %ile 5 day | 50% | 0.75 | 13.0 | 5.6 | 9.8 | |
| SD23 | Sediment dam located near topsoil stockpile | Dirty runoff from topsoil stockpile | $90^{th}$ %ile 5 day | 50% | 0.75 | 20.0 | 8.7 | 9.5 | |
| **Contaminated water dams** | | | | | | | | | |
| SD10 | Contaminated water dam located in CHPP | Contaminated runoff from product coal stockpile | 100 yr ARI 72 hr + 'reuse zone' | 20% | 0.85 | 27.1 | 70.7 | 116.4 | |
| SD11 | Contaminated water dam located at rail loop | Contaminated runoff from rail loop | 100yr ARI 72hr | 20% | 0.85 | 3.8 | 10.0 | 16.4 | |

| Storage | Location / description | Stored water | Design criteria | Additional sediment allowance | Runoff coefficient | Catchment area (ha) | Required minimum capacity (ML) | Proposed capacity (ML) | Notes |
|---|---|---|---|---|---|---|---|---|---|
| SD12 | Contaminated water dam located in CHPP | Contaminated runoff from ROM coal stockpile | 100yr ARI 72hr | 20% | 0.85 | 52.6 | 136.6 | 206.6 | |
| SD28 | Contaminated water dam located in CHPP | Contaminated runoff from rail loop area | 100yr ARI 72hr | 20% | 0.85 | 1.0 | 2.6 | 3.5 | |
| SD29 | Contaminated water dam located in CHPP | Contaminated runoff from emergency coal stockpile | 100yr ARI 72hr | 20% | 0.85 | 4.0 | 10.4 | 10.5 | |
| MW3 | Mine water dam located south of MIA | Surplus contaminated water pumped from SD10 and clean runoff from small grassed catchment | 100yr ARI 72hr | 0% | 1.0 (Turkey's nest) | 22.0 | 22.5 | 153.5 | Freeboard of 22.5 ML will be maintained |
| MW5 | Mine water dam (turkey's nest dam) | Contaminated water pumped from pit | 100yr ARI 72hr | 0% | 1.0 (Turkey's nest) | 15.2 | 38.8 | 2000.0 | Freeboard of 38.8 ML will be maintained |
| In-pit | In-pit storage during wet periods | Contaminated runoff and groundwater make captured in the mining void sumps | Water balance | 0% | - | - | | - | Surplus contaminated water stored in-pit when capacity of MWDs reached |

### Table C 4 Summary of proposed 2018 discharge points

| EPL identification number | Discharge type | Storage | Location / description | Stored water |
|---|---|---|---|---|
| Point 3 | Discharge water quality monitoring and Wet weather discharge | SD3 | Sediment dam located south-west of spoil dump | Dirty runoff from partially rehabilitated spoil dump |
| Point 1 | Discharge water quality monitoring and Wet weather discharge | SD6 | Sediment dam located downstream of MIA (Nagero Dam) | Runoff from grassed areas near MIA, and overflows from SD8 |
| Point 4 | Discharge water quality monitoring and Wet weather discharge | SD4 | Sediment dam located downstream of train load out area west of BCM | Runoff from train load out area |

**Table C 5 Summary of proposed 2022 storages**

| Storage | Location / description | Stored water | Design criteria | Additional sediment allowance | Runoff coefficient | Catchment area (ha) | Required minimum capacity (ML) | Proposed capacity (ML) | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **Dirty water dams** | | | | | | | | | |
| SD3 | Sediment dam located south-west of spoil dump | Dirty runoff from partially rehabilitated spoil dump, and overflows from SD7 | 90th %ile 5 day | 50% | 0.4 to 0.75 | 641.5 | 209.3 | 209.3 | Upgrade from 100 ML to 209 ML required to cater for expanding spoil catchment (as SD13 is no longer proposed). Alternatively, if SD3 remains at 100 ML, a new sediment dam SD13 is required. |
| SD6 | Sediment dam located downstream of MIA (referred to as Nagero Dam) | Runoff from grassed areas near MIA, and overflows from SD8 | 90th %ile 5 day | 50% | 0.4 to 0.75 | 63.5 | 14.6 | 52.2 | |
| SD7 | Sediment dam located in eastern spoil dump | Dirty runoff from spoil dump and clean runoff from undisturbed catchment | 90th %ile 5 day | 50% | 0.4 to 0.75 | 247.0 | 57.7 | 69.9 | SD7 water released to environment following settling of suspended solids (assuming that the EPL discharge criteria is met) |
| SD8 | Sediment dam located in MIA | Dirty runoff from MIA | 90th %ile 5 day | 50% | 0.75 | 13.0 | 5.6 | 9.8 | |
| SD14 | Sediment dam located in pre-strip | Dirty runoff from cleared area ahead of mining | 90th %ile 5 day | 50% | 0.4 | 313.7 | 72.7 | 72.7 | New dam |
| SD23 | Sediment dam located near topsoil stockpile | Dirty runoff from topsoil stockpile | 90th %ile 5 day | 50% | 0.75 | 20.0 | 8.7 | 9.5 | |
| **Contaminated water dams** | | | | | | | | | |
| SD10 | Contaminated water dam located in CHPP | Contaminated runoff from product coal stockpile | 100 yr ARI 72 hr + ‘reuse zone’ | 20% | 0.85 | 27.1 | 70.7 | 116.4 | |

| Storage | Location / description | Stored water | Design criteria | Additional sediment allowance | Runoff coefficient | Catchment area (ha) | Required minimum capacity (ML) | Proposed capacity (ML) | Notes |
|---|---|---|---|---|---|---|---|---|---|
| SD11 | Contaminated water dam located at rail loop | Contaminated runoff from rail loop | 100yr ARI 72hr | 20% | 0.85 | 3.8 | 10.0 | 16.4 | |
| SD12 | Contaminated water dam located in CHPP | Contaminated runoff from ROM coal stockpile | 100yr ARI 72hr | 20% | 0.85 | 52.6 | 136.6 | 206.6 | |
| SD28 | Contaminated water dam located in CHPP | Contaminated runoff from rail loop area | 100yr ARI 72hr | 20% | 0.85 | 1.0 | 2.6 | 3.5 | |
| SD29 | Contaminated water dam located in CHPP | Contaminated runoff from emergency coal stockpile | 100yr ARI 72hr | 20% | 0.85 | 4.0 | 10.4 | 10.5 | |
| MW3 | Mine water dam located south of MIA | Surplus contaminated water pumped from SD10 and clean runoff from small grassed catchment | 100yr ARI 72hr | 0% | 1.0 (Turkey's nest) | 22.0 | 22.5 | 153.5 | Freeboard of 22.5 ML will be maintained |
| MW5 | Mine water dam (turkey's nest dam) | Contaminated water pumped from pit | 100yr ARI 72hr | 0% | 1.0 (Turkey's nest) | 15.2 | 38.8 | 2000.0 | Freeboard of 38.8 ML will be maintained |
| In-pit | In-pit storage during wet periods | Contaminated runoff and groundwater make captured in the mining void sumps | Water balance | 0% | - | - | Predicted maximum volume stored in pit 1120 ML | - | Surplus contaminated water stored in-pit when capacity of MWDs reached |

**Table C 6 Summary of proposed 2022 discharge points**

| EPL identification number | Discharge type | Storage | Location / description | Stored water |
|---|---|---|---|---|
| Point 2 | Discharge water quality monitoring and Wet weather discharge | SD3 | Sediment dam located south-west of spoil dump | Runoff from rehabilitated spoil dump and overflows from SD7 |
| Point 1 | Discharge water quality monitoring and Wet weather discharge | SD6 | Sediment dam located downstream of MIA (Nagero Dam) | Runoff from grassed areas near MIA, and overflows from SD8 |
| Point 40 | Discharge water quality monitoring and Wet weather discharge | SD23 | Sediment dam located near topsoil stockpile | Dirty runoff from topsoil stockpile |
| TBA | Discharge water quality monitoring | SD7 | Sediment dam located in eastern spoil dump | Dirty runoff from spoil dump and clean runoff from undisturbed catchment |
| TBA | Discharge water quality monitoring and Wet weather discharge | SD14 | Sediment dam located in pre-strip | Dirty runoff from cleared area ahead of mining |
| TBA | Wet weather discharge (>100yr ARI 72hr design event) | SD10 | Contaminated water dam located in CHPP | Contaminated runoff from product coal stockpile |
| TBA | Wet weather discharge (>100yr ARI 72hr design event) | SD11 | Contaminated water dam located at rail loop | Catchment is from Train Load Out (TLO) area and the product stockpile on the southern side of the rail loop |
| TBA | Wet weather discharge (>100yr ARI 72hr design event) | SD12 | Contaminated water dam located in CHPP | Contaminated runoff from ROM coal stockpile |
| TBA | Wet weather discharge (>100yr ARI 72hr design event) | SD28 | Contaminated water dam located in CHPP | Contaminated runoff from rail loop area |
| TBA | Wet weather discharge (>100yr ARI 72hr design event) | SD29 | Contaminated water dam located in CHPP | Contaminated runoff from emergency coal stockpile |

**Table C 7 Summary of proposed 2033 storages**

| Storage | Location / description | Stored water | Design criteria | Additional sediment allowance | Runoff coefficient | Catchment area (ha) | Required minimum capacity (ML) | Proposed capacity (ML) | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **Dirty water dams** | | | | | | | | | |
| SD3 | Sediment dam located south-west of spoil dump | Dirty runoff from partially rehabilitated spoil dump | 90th %ile 5 day | 50% | 0.4 to 0.75 | 197.7 | 49.6 | 209.3 | Sized for 2022 catchment |
| SD6 | Sediment dam located downstream of MIA (referred to as Nagero Dam) | Runoff from grassed areas near MIA, and overflows from SD8 | 90th %ile 5 day | 50% | 0.4 to 0.75 | 63.5 | 14.6 | 52.2 | |
| SD8 | Sediment dam located in MIA | Dirty runoff from MIA | 90th %ile 5 day | 50% | 0.75 | 13.0 | 5.6 | 9.8 | |
| SD19 | Sediment dam located in spoil dump | Runoff from recently rehabilitated spoil dump and overflows from SD20 | 90th %ile 5 day | 50% | 0.75 | 415.3 | 179.9 | 179.9 | New dam. Sized using 0.75 runoff coefficient for recently rehabilitated areas |
| SD20 | Sediment dam located in spoil dump | Dirty runoff from spoil dump | 90th %ile 5 day | 50% | 0.75 | 100.9 | 41.8 | 41.8 | New dam |
| SD21 | Sediment dam located in spoil dump | Dirty runoff from spoil dump | 90th %ile 5 day | 50% | 0.75 | 127.5 | 55.6 | 55.6 | New dam |
| SD22 | Sediment dam located in spoil dump | Dirty runoff from spoil dump | 90th %ile 5 day | 50% | 0.75 | 5.5 | 2.4 | 2.4 | New dam |
| SD23 | Sediment dam located near topsoil stockpile | Dirty runoff from topsoil stockpile | 90th %ile 5 day | 50% | 0.75 | 20.0 | 8.7 | 9.5 | |

| Storage | Location / description | Stored water | Design criteria | Additional sediment allowance | Runoff coefficient | Catchment area (ha) | Required minimum capacity (ML) | Proposed capacity (ML) | Notes |
|---|---|---|---|---|---|---|---|---|---|
| SD24 | Sediment dam located in spoil dump | Dirty runoff from spoil dump | 90th %ile 5 day | 50% | 0.75 | 16.9 | 7.3 | 7.3 | New dam |
| **Contaminated water dams** | | | | | | | | | |
| SD10 | Contaminated water dam located in CHPP | Contaminated runoff from product coal stockpile | 100 yr ARI 72 hr + 'reuse zone' | 20% | 0.85 | 27.1 | 70.7 | 116.4 | |
| SD11 | Contaminated water dam located at rail loop | Contaminated runoff from rail loop | 100yr ARI 72hr | 20% | 0.85 | 3.8 | 10.0 | 16.4 | |
| SD12 | Contaminated water dam located in CHPP | Contaminated runoff from ROM coal stockpile | 100yr ARI 72hr | 20% | 0.85 | 52.6 | 136.6 | 206.6 | |
| SD28 | Contaminated water dam located in CHPP | Contaminated runoff from rail loop area | 100yr ARI 72hr | 20% | 0.85 | 1.0 | 2.6 | 3.5 | |
| SD29 | Contaminated water dam located in CHPP | Contaminated runoff from emergency coal stockpile | 100yr ARI 72hr | 20% | 0.85 | 4.0 | 10.4 | 10.5 | |
| MW3 | Mine water dam located south of MIA | Surplus contaminated water pumped from SD10 and clean runoff from small grassed catchment | 100yr ARI 72hr | 0% | 1.0 (Turkey's nest) | 22.0 | 22.5 | 153.5 | Freeboard of 22.5 ML will be maintained |
| MW5 | Mine water dam (turkey's nest dam) | Contaminated water pumped from pit | 100yr ARI 72hr | 0% | 1.0 (Turkey's nest) | 15.2 | 38.8 | 2000.0 | Freeboard of 38.8 ML will be maintained |

| Storage | Location / description | Stored water | Design criteria | Additional sediment allowance | Runoff coefficient | Catchment area (ha) | Required minimum capacity (ML) | Proposed capacity (ML) | Notes |
|---|---|---|---|---|---|---|---|---|---|
| In-pit | In-pit storage during wet periods | Contaminated runoff and groundwater make captured in the mining void sumps | Water balance | 0% | - | - | Predicted maximum volume stored in pit 1310 ML | - | Surplus contaminated water stored in-pit when capacity of MWDs reached |
| **Clean water dams** | | | | | | | | | |
| CD5 | Highwall dam located ahead of pit | Undisturbed catchment runoff | 100yr ARI 72hr | 0% | 0.4 | 19.9 | 20.5 | 20.5 | New dam |
| CD6 | Highwall dam located ahead of pit | Undisturbed catchment runoff | 100yr ARI 72hr | 0% | 0.4 | 20.7 | 21.4 | 21.4 | New dam |
| CD7 | Highwall dam located ahead of pit | Undisturbed catchment runoff | 100yr ARI 72hr | 0% | 0.4 | 102.9 | 105.4 | 105.4 | New dam |
| CD8 | Highwall dam located ahead of pit | Undisturbed catchment runoff | 100yr ARI 72hr | 0% | 0.4 | 18.3 | 19.1 | 19.1 | New dam |

Table C 8 Summary of proposed 2033 discharge points

| EPL identification number | Discharge type | Storage | Location / description | Stored water |
|---|---|---|---|---|
| Point 2 | Discharge water quality monitoring and Wet weather discharge | SD3 | Sediment dam located south-west of spoil dump | Runoff from rehabilitated spoil dump |
| Point 1 | Discharge water quality monitoring and Wet weather discharge | SD6 | Sediment dam located downstream of MIA (Nagero Dam) | Runoff from grassed areas near MIA, and overflows from SD8 |
| Point 4 | Discharge water quality monitoring and Wet weather discharge | SD4 | Sediment dam located downstream of train load out area west of BCM | Runoff from train load out area |
| TBC | Discharge water quality monitoring.<br>Wet weather discharge. | SD8 | Sediment dam located in MIA | Dirty runoff from MIA |
| TBC | Discharge water quality monitoring.<br>Wet weather discharge. | SD20 | Sediment dam located in spoil dump | Dirty runoff from spoil dump |
| TBC | Discharge water quality monitoring.<br>Wet weather discharge. | SD19 | Sediment dam located in spoil dump | Dirty runoff from spoil dump |
| TBC | Discharge water quality monitoring.<br>Wet weather discharge. | SD22 | Sediment dam located in spoil dump | Dirty runoff from spoil dump |
| TBC | Discharge water quality monitoring.<br>Wet weather discharge. | SD24 | Sediment dam located in spoil dump | Dirty runoff from spoil dump |
| TBC | Discharge to waters | - | Outlet from clean water dams | - |

# Appendix D

Water management system stage-storage relationships

**Table D-1 MW2 stage-storage relationship (existing)**

| Level (m AHD) | Area ($m^2$) | Volume ($m^3$) |
|---|---|---|
| 279.8 | 49.042 | 1.562 |
| 279.9 | 97.532 | 8.873 |
| 280 | 155.495 | 21.301 |
| 280.1 | 240.064 | 40.558 |
| 280.2 | 314.951 | 68.145 |
| 280.3 | 382.472 | 102.512 |
| 280.4 | 447.984 | 143.313 |
| 280.5 | 512.777 | 190.44 |
| 280.6 | 596.572 | 244.183 |
| 280.7 | 714.557 | 308.446 |
| 280.8 | 824.031 | 384.208 |
| 280.9 | 953.826 | 469.709 |
| 281 | 1521.506 | 589.331 |
| 281.1 | 2021.335 | 763.473 |
| 281.2 | 2526.516 | 987.746 |
| 281.3 | 3064.19 | 1262.522 |
| 281.4 | 3639.896 | 1591.039 |
| 281.5 | 4279.468 | 1984.034 |
| 281.6 | 5044.956 | 2442.781 |
| 281.7 | 5691.622 | 2972.336 |
| 281.8 | 6299.459 | 3563.109 |
| 281.9 | 7031.475 | 4217.783 |
| 282 | 7687.273 | 4945.028 |
| 282.1 | 8243.562 | 5730.386 |
| 282.2 | 8849.38 | 6571.075 |
| 282.3 | 9766.201 | 7484.506 |
| 282.4 | 11586.72 | 8529.591 |
| 282.5 | 13691.36 | 9771.12 |
| 282.6 | 17622.04 | 11303.95 |
| 282.7 | 20294.43 | 13191.18 |
| 282.8 | 22763.67 | 15326.79 |
| 282.9 | 25053.48 | 17697.31 |
| 283 | 26406.67 | 20252.54 |
| 283.1 | 27139.94 | 22905.34 |
| 283.2 | 27727.45 | 25617.37 |
| 283.3 | 28274.48 | 28384.69 |
| 283.4 | 28963.76 | 31210.88 |
| 283.5 | 29545.87 | 34099.57 |
| 283.6 | 30013.92 | 37038.84 |
| 283.7 | 30359.94 | 40015.1 |
| 283.8 | 30708.19 | 43022.87 |
| 283.9 | 31077.74 | 46063.71 |
| 284 | 31395.93 | 49136.47 |
| 284.1 | 31643.57 | 52234.83 |
| 284.2 | 31875.33 | 55353.91 |
| 284.3 | 32128.47 | 58494.6 |
| 284.4 | 32347.38 | 61655.76 |
| 284.5 | 32550.46 | 64835.09 |

| Level (m AHD) | Area ($m^2$) | Volume ($m^3$) |
|---|---|---|
| 284.6 | 32748.67 | 68031.35 |
| 284.7 | 32974.38 | 71244.95 |
| 284.8 | 33191.01 | 74479.02 |
| 284.9 | 33319.45 | 77726.95 |
| 285 | 33433.76 | 80983.26 |
| 285.1 | 33547.47 | 84247.72 |
| 285.2 | 33660.58 | 87520.26 |
| 285.3 | 33773.09 | 90800.84 |
| 285.4 | 33884.99 | 94089.37 |
| 285.5 | 33996.29 | 97385.8 |
| 285.6 | 34106.99 | 100690.1 |
| 285.7 | 34217.08 | 104002.1 |
| 285.8 | 34326.58 | 107321.8 |
| 285.9 | 34435.47 | 110649.1 |
| 286 | 34543.76 | 113984.1 |
| 286.1 | 34651.45 | 117326.5 |
| 286.2 | 34758.53 | 120676.3 |
| 286.3 | 34865.01 | 124033.5 |
| 286.4 | 34970.89 | 127398.1 |
| 286.5 | 35076.39 | 130769.8 |
| 286.6 | 35206.88 | 134149.7 |
| 286.7 | 35379.38 | 137541.6 |
| 286.8 | 35564.89 | 140948.5 |
| 286.9 | 35751.15 | 144370.9 |
| 287 | 35938.83 | 147808.8 |
| 287.1 | 36123.04 | 151262.3 |
| 287.2 | 36294.49 | 154730.3 |
| 287.3 | 36454.73 | 158211.8 |
| 287.4 | 36618.07 | 161706.1 |
| 287.5 | 36787.39 | 165213.9 |
| 287.6 | 36988.58 | 168736.7 |
| 287.7 | 37240.17 | 172279.1 |
| 287.8 | 37515.36 | 175844.5 |