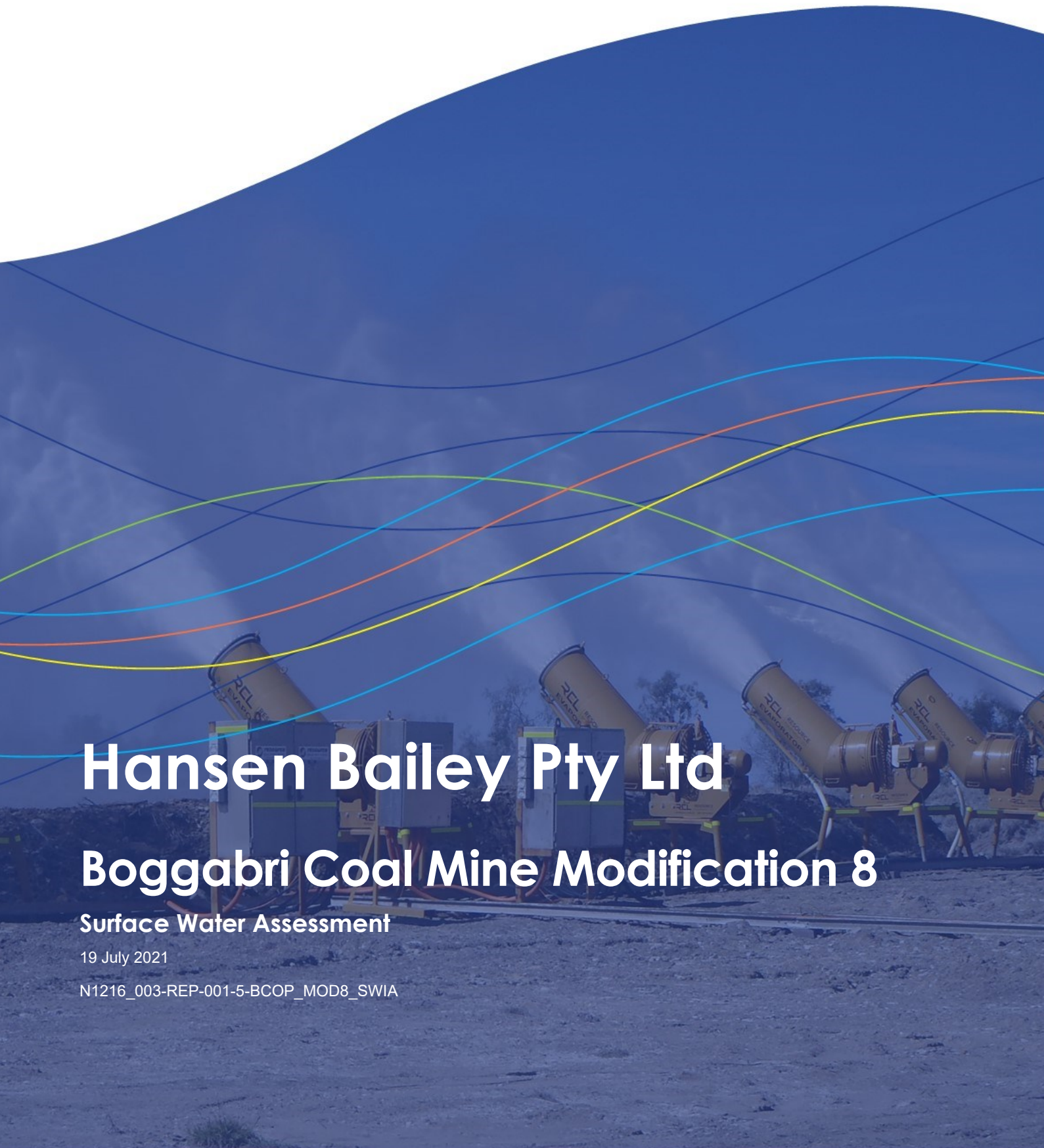
Appendix J

Surface Water Assessment

ENGENY
WATER MANAGEMENT

Hansen Bailey
ENVIRONMENTAL CONSULTANTS



Hansen Bailey Pty Ltd

Boggabri Coal Mine Modification 8

Surface Water Assessment

19 July 2021

N1216_003-REP-001-5-BCOP_MOD8_SWIA

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Signatures						

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1 INTRODUCTION

Engeny Water Management (Engeny) was engaged by Hansen Bailey Pty Ltd (Hansen Bailey) to undertake a surface water impact assessment (SWIA) for the proposed modification of open cut mining operations at Boggabri Coal Mine (BCM), located about 15 km north-east of the township of Boggabri in the north-west region of NSW. The SWIA will support the Modification Report being prepared for the proposed modification by Hansen Bailey.

1.1 MODIFICATION DESCRIPTION

Boggabri Coal Operations Pty Limited (BCOPL) intends to seek a Modification to State Significant Development (SSD) Approval 09_0182 under Section 4.55 of the *Environmental Planning & Assessment Act 1979* (EP&A Act) to increase the depth of approved mining operations and to facilitate the construction of a fauna movement crossing over the existing haul road at BCM (MOD 8).

A conceptual layout of MOD 8 is shown on Figure 1.1 and generally comprises the following:

- Increasing the approved maximum depth of mining down to the Templemore Coal Seam to recover an additional 61.6 Million tonnes (Mt) of Run of Mine (ROM) coal within the currently approved Mine Disturbance Boundary. It is expected that the additional ROM coal will be suitable for producing a lower ash, higher energy thermal, semisoft coking and pulverised coal injection (PCI) quality products for sale to the export market. This will result in the extension of the mine life by six (6) years; and
- Construction of a specifically designed fauna movement crossing over the existing haul road between the overburden emplacement area (OEA) and the western side of the regional biodiversity corridor. The establishment of the fauna movement crossing is proposed to improve the movement of fauna from the Leard State Forest through the Southern Rehabilitation Area (SRA).

The current approved mining operations allow an annual ROM coal extraction of up to 8.6 Million tonnes per annum (Mtpa). Under MOD 8, ROM coal production will generally remain within this approved rate, however a minor increase in the currently approved maximum production rate to 9.1 Mtpa of ROM coal will be required to facilitate efficient mine planning.

The proposed changes to mining operations will remain within the currently approved Mine Disturbance Boundary. Some very minor substitution of disturbance (less than 1.21 hectares (ha)) will be required to facilitate the construction of the fauna movement crossing within the MOD 8 Disturbance Footprint as shown in Figure 1.1. However, this will be immediately rehabilitated as part of the crossing construction program and overall there will be a net decrease in disturbance area of the project of approximately 1.86 ha. For the purposes of the technical consultant assessments, BCOPL has identified a survey area of approximately 110 ha as shown in Figure 1.1.

MOD 8 does not seek to make changes to various aspects of the BCM including (but not limited to): the approved Mine Disturbance Boundary, operational hours, mining methods, mining related infrastructure, coal handling, processing and transport methods and rates and access to the site. MOD 8 will facilitate the continued operations at BCM for a further six years, create additional direct and indirect employment and provide further royalties to the State Government.

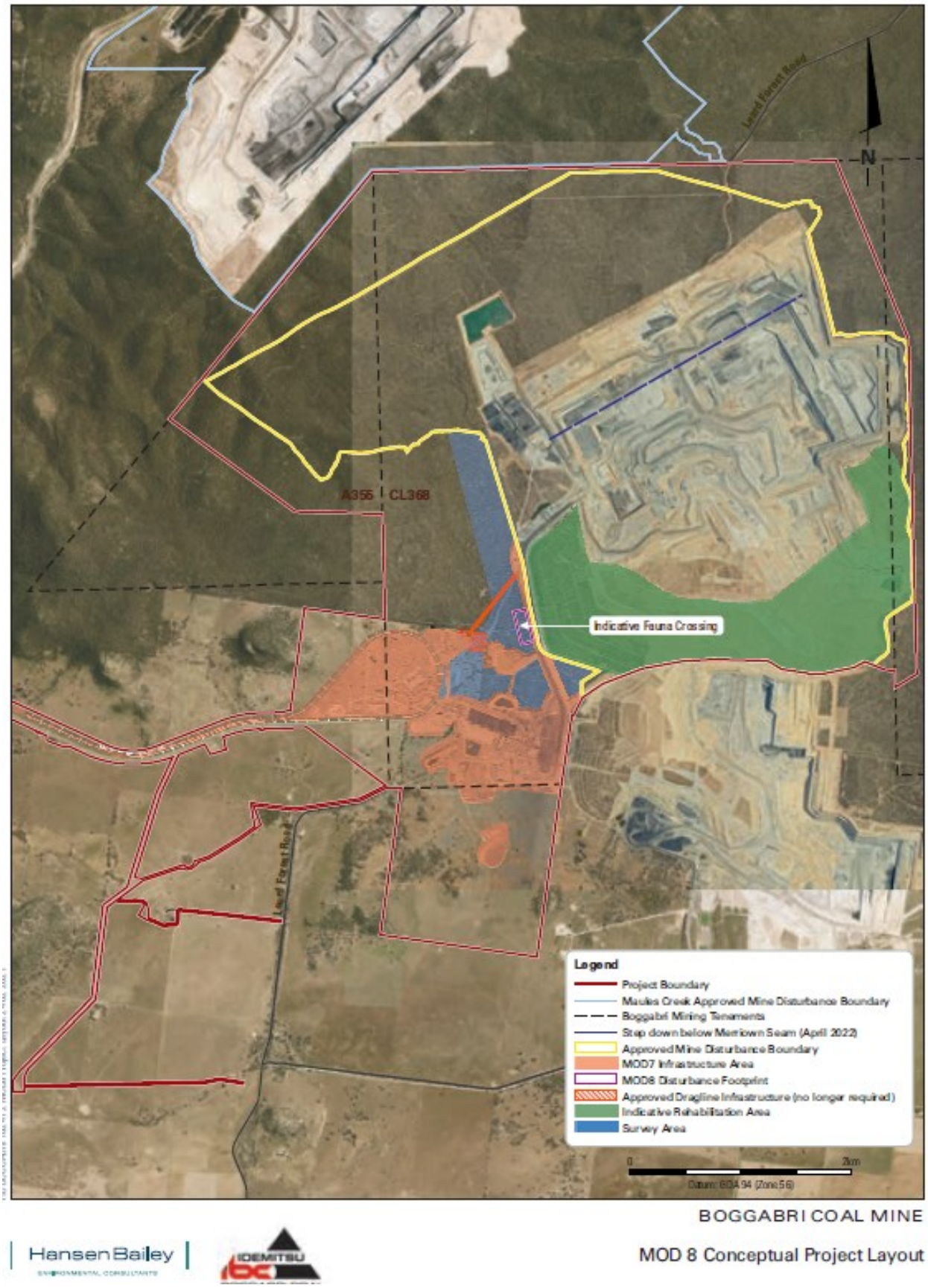

Figure 1.1: Conceptual Modification Layout

1.2 MEASURES TO MINIMISE OR AVOID POTENTIAL SURFACE WATER IMPACTS

Detailed mine planning and engineering studies have been undertaken in conjunction with the environmental assessments to inform the conceptual designs for MOD 8. This approach, in line with a range of other key factors has minimised the potential for MOD 8 to impact on surface water resources. The other key factors include:

- Proposed modifications are located within the approved disturbance boundary.
- Refinement of the approved conceptual final landform to include macro-relief to manage runoff generated by overburden emplacement area.
- Refinement of the rehabilitation schedule to reduce the volume of water managed within the site water management system and return flows to the downstream environment.
- Management of water take and discharges within regimes established by NSW water and pollution control legislation. NSW legislation provides for sustainable water take from water sources and management of water quality by licensing of discharges.
- Minor changes to the existing approved water management system (WMS).
- Design of WMS components to meet legislative requirements and relevant guidelines (e.g. guidelines for treatment of runoff from disturbed areas).
- Continued maximised water recycling within the WMS to minimise the total volume of water extracted from external supplies and discharge of excess water.

1.3 POTENTIAL SURFACE WATER IMPACTS

Notwithstanding the measures to minimise impacts, the aspects of MOD 8, outlined in Table 1.1 have the potential to impact on surface water resources.

Table 1.1: Potential Water Resources Impacts

Aspect	Expected Impacts
Landform changes, as a result of the open cut mining operations, including: • Open Cut Mining • Overburden emplacement areas	MOD 8 proposes to maintain mining operations and overburden emplacement areas within the approved Mine Disturbance Boundary (albeit deeper mining). As a result, impacts to downstream flow regimes, including flooding, are expected to be consistent with approved impacts.
Landform changes, as a result of the proposed fauna movement crossing of the existing haul road and associated changes to surface water drainage within these areas.	Localised drainage paths adjacent the existing haul road will require realignment to cater for the landform changes brought by the construction of the fauna movement crossing. Minimal downstream impacts are anticipated.
Changes to the water balance for the BCM, including the import and export of water to and from the site.	As MOD 8 does not propose to change the maximum product coal production rate for BCM, material changes to the existing water demands and discharges are not expected. The deeper mining activities and the augmentation of the existing OEA will likely result in additional groundwater inflows and surface runoff to manage within the WMS. The existing water demands and discharges will be extended by a further six-years as a result of the proposed extension to the mine life.

The following surface water aspects were reviewed as part of the SWIA:

- Flow regimes (associated with potential impacts on baseflows).
- Catchment area changes.
- Water quality.
- Geomorphological and hydrological values.
- Riparian and ecological values.
- Water users.

A detailed assessment of these potential impacts has been undertaken for MOD 8 with consideration of downstream impacts.

1.4 STRUCTURE OF THIS REPORT

The SWIA Report includes the following sections:

- Surface water context, including regulatory framework, catchments and watercourses, flow regimes, water quality and water users (Section 2).
- Water Management System (Section 3).
- Water Balance assessment (Section 4).
- Potential impacts, including consideration of cumulative impacts and proposed mitigation measures (refer to Section 5).
- Management, Monitoring, Licensing and Reporting (refer to Section 6).

2 SURFACE WATER CONTEXT

The BCM is in the catchment areas of Nagero Creek and Bollol Creek (Figure 2.1). Both Nagero Creek and Bollol Creek are tributaries of the Namoi River, which is a part of the Barwon-Darling River system. The BCM site lies North of Tarrawonga Coal Pty Ltd (TCPL), which is approved to operate until 2030, and South of Maules Creek Coal Project (MCCM) which is approved to operate until 2034.

The changes to mining operations and other aspects associated with MOD 8 are located within the BCOPL WMS (Figure 2.1).

2.1 REGULATORY FRAMEWORK

2.1.1 Relevant NSW Legislation

The Approved Operations and proposed changes associated with MOD 8 exist within a well-regulated system that has been designed to provide for the sustainable management of the State's water resources. This includes:

- licensing of allowable water-take with consideration of environmental flow requirements of watercourses and the needs of other water users.
- control of water pollution, including management of sustainable salt loads associated with all water sources, including mine water discharges and
- guidelines that govern the appropriate design of water management systems for mines to provide for appropriate water quality in accordance with Environment Protection Licence (EPL) requirements.

Further details of the NSW surface water regulatory framework and how it will continue to be applied to the changes sought by MOD 8 is provided below.

NSW Regulatory Requirements - Water Use/Take

There are two key acts that provide the regulatory framework for water management in NSW:

- Water Management Act 2000 (WM Act) and
- Water Act 1912.

The objective of the WM Act is the sustainable and integrated management of water in NSW and is based on the concept of ecologically sustainable development. The WM Act defines water access and water sharing strategies within NSW. The WM Act supersedes the provisions of the Water Act 1912 regarding water take works adjacent to or within watercourses (when a Water Sharing Plan (WSP) is in place).

As part of the WM Act, WSPs have been developed across NSW to protect the health of rivers, whilst at the same time securing sustainable access to water for all users. The WSPs specify maximum water extractions and allocations. By complying with the requirements of the WSPs, water take will be within the sustainable yield for the water system as determined by the NSW government. This in turn provides for sustainable environmental flows within the water systems.

The WSP for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016 (Namoi Regulated WSP) applies to the regulated watercourses, whilst the WSP for the Namoi and Peel Unregulated Rivers Water Sources 2012 (Namoi Unregulated WSP) applies to the unregulated watercourses in the vicinity of the BCM. The BCM is largely located within the catchment forming part of the Bluevale Water Source of the Namoi Unregulated WSP and extracts surface water from the Namoi River to the west of BCM, which forms part of the Lower Namoi Regulated Water Source of the Namoi Regulated WSP.

Licensing

All water extraction in NSW, apart from some exemptions for government authorities and basic landholder rights extractions, must be authorised by a water licence. Harvestable rights, which are a basic landholder right under the WM Act, allow a landholder to capture and use up to 10 per cent of the average regional runoff from their landholding. Basic landholder rights are exempt from licensing requirements. Further to this, dams constructed for the capture, containment, and recirculation of water to prevent the contamination of a water source and located on a minor stream are also exempt from licensing requirements.

Each water licence, referred to under the WSP system as a Water Access Licence (WAL), specifies a share component. The share components of specific purpose licences such as local water utility, major utility and domestic and stock are expressed as a number in megalitres per year. The share components of high security, general security and supplementary WALs are expressed as a number of unit shares for the water source. The value of each unit share is subject to Available Water Determinations (AWD's) as specified by WaterNSW.

Details of the licences currently held by BCOPL are included in Section 3.2 and licences required for MOD 8 are discussed in Section 7.2.

Environment Protection Licences

The Protection of the Environment Operations Act 1997 (POEO Act) is the key piece of environmental protection legislation administered by the NSW Environment Protection Authority (EPA). Where discharge of waters is permitted, it is controlled by licence conditions such that discharges do not result in significant impacts on water resources.

Under Section 120 of the POEO Act, it is an offence to pollute waters or cause harm unless licensed to do so. Pollution in NSW is regulated by the POEO Act with discharges from mine water management systems requiring licensing by an EPL if the discharge would otherwise constitute a pollution of waters (Section 120 of the POEO Act). Discharges from the BCOPL are licensed under the EPL.

A summary of water discharge requirements for the BCOPL, including the Approved Operations and for MOD 8, is included in Section 7.2.

2.1.2 Commonwealth Legislation

The aspects of MOD 8 which have the potential to result in impacts on Matters of National Environmental Significance (MNES) which are regulated under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were referred to the Commonwealth Department of Agriculture Water and the Environment (DAWE) on 17 February 2021 to determine whether the aspects are considered a controlled action. On 28 May 2021, DAWE made the decision that MOD 8 was a controlled action and would require approval under the Commonwealth EPBC Act. Further it was determined that the controlled action (as described within Referral EPBC 2021/8875) will be assessed by the NSW Government under the assessment bilateral agreement between the Commonwealth Government and the NSW Government. On 8 June 2021, the NSW Department of Planning Industry and Environment (DPIE) issued the bilateral agreement Secretary's Environmental Assessment Requirements (SEARs) to be addressed within the Modification Report. Appendix A includes the SEARs requirements relevant to this SWIA, and where each has been addressed.

It is noted that BCOPL currently operates in accordance with an EPBC approval, which includes a requirement for the site Water Management Plan (WMP) to be approved by DAWE prior to the commencement of mining operations.

A summary of the potential surface water impacts of MOD 8 in accordance with the requirements of the Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources (DoE 2013) has been prepared and is included in Section 6.

It is noted that the Namoi Surface Water Resource Plan has been prepared in accordance with the Commonwealth *Water Act 2007*, which includes the NSW WSPs, which have been submitted by DPIE to the Murray Darling Basin Authority and are pending commencement.

Legend

- Project Approval Boundary
- Approved Infrastructure Disturbance Boundary
- Approved Mine Disturbance Bouundary
- Rail
- Licensed Discharge Points
- Met Station
- Surface Water Monitoring Location
- Hydrolines

Strahler Stream Order
(within the vicinity of the project)

- 1
- 2
- 3
- 4
- 5

Maules Creek Mine
Merrygowen Creek
SW2
Leard State Forest
Boggabri Coal Mine
EPA 3
EPA 1
SW1
MIA
Goobobindi Creek
Goobobindi Creek
Nagero Creek
Goonbri Creek
Tarrawonga Mine
Gins Gully
Gins Gully
The Slush Holes
EPA 4
Bollol Creek
Bollol Creek
SD28
EPA 3
SD3
SD12
SD11
EPA 1
SD10
SW1
SD6
MIA
SD8

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Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Boggabri Coal MOD8 SWIA

Figure 2.1: Surface Water Context

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Revision: 0
Drawn: Nritta Manoharan
Checked: AW
Date: 6/7/2021

2.2 CATCHMENT AREAS AND WATERCOURSES

BCM is located within the catchment areas of Nagero Creek and Bollol Creek (Figure 2.1). Nagero Creek and Bollol Creek are within the Namoi River catchment.

Land uses within and immediately surrounding the BCM primarily include other mining operations, agricultural land, and rural residential land holdings. Downstream water users are discussed further in Section 2.4.

Previous mining operations have modified local catchments through the capture of runoff from mining areas within the WMS and diversion of upslope runoff around the mining operations.

2.2.1 Nagero Creek

Nagero Creek flows westwards from its headwaters in the Leard State Forest and BCM operations, through agricultural lands, to its confluence with the Namoi River (via Cooboobindi Creek) about 13 km downstream (west) of the BCM. Nagero Creek is ephemeral, with flows only occurring after significant or prolonged rainfall events. It should be noted that there were no observed flows in Nagero Creek from January 2015 to January 2020 at SW1 and to February 2020 at SW2. Downstream of BCM (west), Nagero Creek passes through mostly agricultural lands, and includes several in-line farms dams.

2.2.2 Bollol Creek

Bollol Creek flows from its headwaters east of the BCM, flowing westwards to the Namoi River via Barbers Ponds, south of both BCM and Tarrawonga mine. Bollol Creek flows through mostly agricultural lands, and generally consists of a shallow, U-shaped channel lined dense grasses and reeds, with several small in-line farm dams. Like Nagero Creek, Bollol Creek is ephemeral, with flows only occurring after significant or prolonged rainfall events.

The Bollol Creek catchment includes the BCM infrastructure area (i.e. no BCM mining areas).

2.3 WATER QUALITY

2.3.1 Monitoring Program

BCOPL undertake surface water monitoring in accordance with the surface water monitoring program outlined in the Surface Water Management Plan (2017). This plan includes monitoring of the following elements of the site water management system and surrounding catchment areas:

- Surface water quality and flows in upstream and downstream watercourses.
- Geomorphology condition of Nagero Creek, upstream and downstream of the site.
- Stream and riparian health conditions in Nagero Creek and the Namoi River.
- On-site water management, including water quality within dirty and mine water dams.

The surface water monitoring program covers all three water category areas within the BCM: clean; dirty; and mine water systems (Section 3). The surface water monitoring program requires quarterly monitoring at each water storage, and event-based monitoring of two external monitoring locations on Nagero Creek (upstream and downstream) for the following parameters:

- pH.
- Electrical conductivity (EC).
- Total suspended solids (TSS).

2.3.2 Historical Surface Water Quality Monitoring Results

Water quality monitoring data for pH, EC and TSS and temperature are reported in the BCOPL Annual Reviews. Water quality is monitored within sediment and mine water dams on a quarterly basis, and event-based monitoring at two external (clean water) monitoring points on Nagero Creek, one downstream (SW1) and one upstream (SW2) of BCOPL, in accordance with the EPL. Historical monitoring results from January 2015 to March 2020 indicate that there were no flow events in Nagero Creek, until January 2020 (SW1 only) and February 2020 (SW1 and SW2). Based on the limited monitoring results, ambient water quality within Nagero Creek is generally good, with relatively low salinity (as EC) and suspended solids (as TSS) (Table 2.1).

For the February 2020 event, the results at SW1 (downstream of BCM) and SW2 (upstream of BCM) were generally consistent with the exception of TSS. During the February 2020 event, a total of 102 mm of rainfall occurred over a 24-hour period and exceeded the design capacity of sediment dams. It is considered likely that discharges from both BCM and Tarrawonga Coal Mine (TCM) occurred during this event.

Table 2.1: Ambient Water Quality Laboratory Results

Statistic	Units	SW1		SW2
		January 2020	February 2020	February 2020
pH (lab)	-	7.14	7.87	7.08
EC (lab)	µS/cm	114	334	206
TSS	mg/L	262	506	11
Oil and Grease	mg/L	<5	<5	<5
Nitrate	mg/L	0.55	2.86	3.25
Nitrogen (total)	mg/L	4.1	4	4
Phosphorous (total)	mg/L	1.19	0.12	0.04
Reactive Phosphorous	mg/L	0.14	0.04	<0.01

2.3.3 Trigger Values

The NSW Water Quality and River Flow Objectives (as published by the Office of Environment and Heritage (OEH)) are the agreed environmental values and long-term goals for NSW surface waters. The objectives are consistent with the agreed national framework for assessing water quality as set out in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality Guidelines (2000) (ANZECC guidelines).

The ANZECC guidelines provide default trigger values and methods to determine site specific trigger values. The ANZECC guidelines indicate the preferred use of site-specific trigger values. The trigger values are not assessment criteria however are used to characterise the water quality and estimate the ecological integrity of a water resource.

The ANZECC guidelines provide a method for estimating site-specific trigger values, based on observed water quality data. As noted above (Section 2.3.2), there is limited available data for the ambient gauges (SW1 and SW2) for these methods to be used. Instead, interim trigger values for pH, EC, and TSS have adopted, based on the default values included in the ANZECC guidelines (Table 2.2).

Table 2.2: Water Quality Parameters and Trigger Values

Analyte	Units	Trigger
pH	-	6.5 – 8.0 [A]
Salinity (EC)	µS/cm	30 - 350 [B]
TSS	mg/L	40 [C]

[A] ANZECC (2000) Table 3.3.2 (Upland rivers)

[B] ANZECC (2000) Table 3.3.3 (Upland rivers)

[C] ANZECC (2000) Table 4.4.2 (Freshwater aquaculture)

2.4 WATER USERS

BCM is located within the Namoi River catchment. Water usage within the Namoi River is managed by the Namoi Regulated WSP, which covers two regulated water sources:

- Upper Namoi Regulated River Water Source - regulated river sections between Split Rock Dam and Keepit Dam.
- Lower Namoi Regulated River Water Source - regulated river sections downstream of Keepit Dam to the Barwon River.

A summary of water users within the Namoi Regulated WSP is included in Table 2.3. The largest water user in the Namoi River catchment is agriculture, primarily cotton irrigation.

Table 2.3: Water users in the Namoi Valley (Water NSW 2019)

Statistic	Water Source	
	Upper Namoi Regulated River	Lower Namoi Regulated River
Basic landholder rights – domestic and stock	160 ML/year	1,776 ML/year
Domestic and stock use	90 ML/year	1,998 ML/year
Local water utilities	515 ML/year	2,271 ML/year
High security	80 unit shares	3,904 unit shares
General security	11,454 unit shares	245,074 unit shares

A summary of WALs held by BCOPL to access surface water from the Lower Namoi Regulated River Water Source is included in Section 3.2.

3 WATER MANAGEMENT SYSTEM

The objectives of water management at BCM are to:

- Minimise the contamination of clean water runoff from catchment areas upslope of the operations.
- Minimise potential effects of erosion and its associated impacts due to mining operations.
- Securely contain mine water and other site water that comes into contact with areas disturbed by mining activities – including overburden emplacement areas, coal stockpiles and the Coal Handling Preparation Plant (CHPP) area.
- Maximise the re-use of mine water for on-site water use such as coal washing and dust suppression. Reusing mine water is preferred rather than using water from the Namoi River and/or groundwater borefield.
- Management of water during periods of shortfall (drought) and excess (flood).

3.1 APPROVED WMS

The approved WMS has the following key objectives and functions:

- Diversion of clean water around mining operations to minimise capture of upslope runoff and separate clean water runoff from mining activities.
- Segregating mine impacted water and runoff from undisturbed and revegetated areas with better water quality to minimise the volume of mine impacted water that requires reuse.
- Reuse of mine impacted water within the WMS to reduce reliance on raw/clean water.
- Minimising adverse effects on downstream waterways (i.e. hydraulic and water quality impacts).
- Reducing the discharge of contaminants from the mine to the environment.

Water management at the BCM considers three categories of water, each with different potential to cause environmental harm. The target design criteria for each of the three categories of water are summarised in Table 3.1.

Table 3.1: WMS – Design Criteria

Water Category	Water Description	Target Design Criteria
Clean	Runoff from undisturbed or rehabilitated areas.	Release, where practicable, to downstream environment.
Dirty	Runoff from disturbed areas (does not include water captured in mining pit areas or runoff from mine infrastructure areas).	Managed in line with the Blue Book (Managing Urban Stormwater: Soils and Construction Volumes 1 and 2E). Designed to manage runoff from the 5 day, 95th percentile rainfall event.
Mine	Runoff from areas exposed to coal or water used in coal processing or from coal stockpile areas.	Contained for events up to and including the 1% annual exceedance probability (AEP) 72-hour storm event.

One of the key objectives of the WMS is to convey clean water around the mining operations or, when runoff water from rehabilitated areas becomes clean, enable the runoff from these rehabilitated areas to flow directly to the downstream environment instead of being managed as part of the WMS.

Dirty water (i.e., runoff from disturbed areas outside the mining pit and infrastructure areas, such as overburden emplacement areas (both active and under rehabilitation) captured in the sediment dams) is pumped to storages within the WMS.

Mine water (i.e., runoff from areas exposed to coal or water used in coal processing or from coal stockpile areas) is managed as part of the mine WMS. Mine affected water is generally transferred to and stored within two dams (MW5 and MW3) for reuse on site.

3.2 WATER IMPORTS

The current surface and groundwater WALs held by BCOPL are summarised in Table 3.2. The groundwater WALs cover groundwater intercepted by the open cut pit, as well as groundwater extracted from the nearby alluvial borefield.

Table 3.2: BCOPL Water Access Licences

Source	Category	Water Access Licence number	Share component (units)
Upper and Lower Namoi Regulated River Water Source			
Lower Namoi River	General Security (Irrigation)	WAL 2571	51
	General Security (Irrigation, Mining)	WAL 2595	243
	Supplementary Water (Irrigation, Mining)	WAL 2596	26.6
	Supplementary Water (Irrigation)	WAL 2572	5.6
Upper Namoi River	General Security	WAL 37067	128
Groundwater Sources			
WSP for the NSW Murray Darling Basin Porous Rock Groundwater Sources Order 2020			
Gunnedah - Oxley Basin MDB Groundwater Source	Aquifer (Extraction Works)	WAL 29473	142
	Aquifer (Irrigation)	WAL 29562	700
WSP for the Namoi Unregulated and Alluvial Water Sources 2016			
Upper Namoi Zone 4 Groundwater Source	Aquifer (Industrial, Mining, Irrigation)	WAL 15037	172
		WAL 24103	275
		WAL 12691	457
		WAL 37519	84
	Aquifer (Irrigation)	WAL 12767	3
		WAL 36547	37
Maules Creek Zone 11 Groundwater Source	Aquifer	WAL 42234	20

3.3 LICENSED DISCHARGES

The EPL (No 12407: version date 5-Feb-2021) allows releases from sediment dams of surplus water via three licensed discharge points (LDPs): two into the Nagero Creek system and a third into a tributary of the Namoi River (refer to Figure 2.1). Discharges may only occur in accordance with the conditions of the EPL and the approved Water Management Plan.

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* (Department of Environment and Climate Change (DECC), 2008) (the Blue Book). The Blue Book guidelines recommend that the 'settling zone' be sized to capture the 90th percentile 5-day duration rainfall depth (39 mm), 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. A wet weather event is defined as an event which exceeds the design capacity of the dam (i.e. greater

than 39 mm of rainfall over a 5-day period). L2.5 of the EPL (No 12407) allows for TSS concentration limits to exceed 50 mg/L provided:

1. the discharge occurs solely as a result of rainfall measured at the premises that exceeds 38.4 millimetres over any consecutive 5-day period immediately prior to the discharge occurring; and
2. all practical measures have been implemented to dewater all sediment dams within 5 days of rainfall such that they have sufficient capacity to store run off from a 38.4 mm, 5-day rainfall event.

Mine water dams have been designed to store runoff from a 1% AEP 72-hour storm event, with a 20% allowance for sediment storage. BCM maintain sufficient freeboard in mine water dams to satisfy the design criteria. There have been no recent overflows recorded from mine water affected dams.

Table 3.3: Licensed Discharge Points

EPL Point	Type	Location	Overflow Destination
1	Wet weather discharge	SD6	Nagero Creek
3	Wet weather discharge	SD3	Unnamed Tributary of Nagero Creek
4	Wet weather discharge	SD4	Unnamed Tributary of the Namoi River

Note: refer to Figure 3.1, Figure 3.2, Figure 3.3, Figure 3.4 and Figure 3.5 for sediment dam locations

Overflows from dirty water sediment dams are expected to occur from SD3, SD4 and SD6 when the design capacity is exceeded (39 mm of rainfall over 5 days) via the dam spillway (as per DECC (2008)).

3.4 CHANGES WITH THE MODIFICATION

It is proposed to continue to utilise the existing WMS for MOD 8. That is, there are no appreciable changes to the approved WMS, except those associated with the extended mine life (to 2039).

The proposed WMS components for 2021, 2026, 2031, 2039, and the conceptual final landform are presented in Figure 3.1, Figure 3.2, Figure 3.3, Figure 3.4 and Figure 3.5.

It is important to note that the plans presented in Figure 3.1, Figure 3.2, Figure 3.3, Figure 3.4 and Figure 3.5 are concept designs. While the concept designs establish the design objectives and performance standards, the detailed designs will be determined by construction and mining schedules. The WMS will be constructed and modified, as and when required, to support the infrastructure and mine development, these changes will be captured within future water management plans. Further, the plans indicate only the components of the WMS which are required for a stage of the mine and does not preclude the construction of some components earlier.

Similarly, the conceptual storage capacities recommended for the various water management dams have been sized for the purposes of meeting environmental compliance requirements. The actual dam configuration and geometry for both the dirty water dams and dryland attenuation basins (detention basins) will be determined during future detailed engineering design stages. An initial review of existing sediment dams indicates sufficient capacity to manage the modified catchments, however this will be reviewed and confirmed as part of future water management plan updates. An additional sediment dam is expected to be required around 2026 (Figure 3.2) to manage dirty water runoff generated by a portion of the eastern embankment of the overburden emplacement area. This dam would have a catchment area of about 42 ha and be formed by a trapped low point within the design landform providing a capacity of about 9ML, which exceeds the design criteria for a sediment dam. The new dam is unlikely to spill, and instead would be dewatered via seepage (into pit back-fill) and evapotranspiration.

The existing WMS will continue to be used to manage runoff with all pit water and mine surface runoff directed to the WMS. There are no new diversions proposed or required as part of MOD 8. However, the currently approved diversions may remain in place for longer than previously proposed due to of the revised progression of mining operations associated with the increase in mining depths. Runoff from the clean catchment upslope of the pit will continue to be intercepted by mining operations. BCM are

currently reviewing licensing requirements for this intercepted runoff, including harvestable rights provisions. It is noted that the upslope catchment area will continue to reduce as mining progresses.

The conceptual final landform (Figure 3.5) will be generally free-draining, with the exception of a partially infilled shallow graded final void area, comparable in size to the approved conceptual final landform. The final void will be partially infilled to have a floor level of about 283 mAHD and a floor area of about 225 ha.

Table 3.4: Conceptual WMS

Aspect	Indicative Description
2021 WMS for Modification	No change from approved
2026 WMS for Modification	Additional sediment dam
2031 WMS for Modification	No change from approved
2039 WMS for Modification	Six-year extension to the approved mining operations
Conceptual Final Landform	Generally consistent with approved conceptual final landform drainage, including provision of macro-relief to provide long-term stable drainage for the final landform

Legend

- Project Approval Area
- Preliminary Fauna Corridor
- Approved Mine Disturbance Boundary
- Approved Disturbance Boundary
- Rail
- Catchments
- 10m Contours

Drains

- Clean Water Diversion (Existing)
- Dirty Water Drain (Existing)
- Dirty Water Drain (Proposed)
- Clean Water Diversion (Proposed)

Landuse

- Active Dumping
- Active Mining
- Available Permanent Rehabilitation
- Available Temporary Rehabilitation
- Permanent Rehabilitation
- Temporary Rehabilitation

N

Leard State Forest

MW5

Pit

Merrygowen Creek

Nagero Creek Catchment

SD3

SD7

SD28

SD10

SD12

SD11

SD6

SD8

Existing Dirtywater Catchment

Nagero Creek

MW3

Tarrawonga Mine

Level 5, 6 Bolton St Newcastle NSW 2300
PO Box 787 Newcastle
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ENGENY WATER MANAGEMENT

IDEMITSU BOGGABRI COAL

600 0 600 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Boggabri Coal MOD8 SWIA

Figure 3.1: Proposed Conceptual WMS - 2021

Job Number: N1216_003
Revision: 0
Drawn: MB
Checked: AW
Date: 2/7/2021

Legend

- Project Approval Area
- Preliminary Fauna Corridor
- Approved Mine Disturbance Boundary
- Approved Disturbance Boundary
- Rail
- Catchments
- 10m Contours

Drains

- Clean Water Diversion (Existing)
- Dirty Water Drain (Existing)
- Dirty Water Drain (Proposed)
- Clean Water Diversion (Proposed)

Landuse

- Active Dumping
- Active Mining
- Available Permanent Rehabilitation
- Available Temporary Rehabilitation
- Permanent Rehabilitation
- Temporary Rehabilitation

N

Leard State Forest

MW5

Pit

Merrygowen Creek

Nagero Creek Catchment

SD3

SD7

SD28

SD10

SD12

SD11

SD6

SD8

Existing Dirtywater Catchment

Nagero Creek

MW3

Tarrawonga Mine

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ENGENY WATER MANAGEMENT

IDEMITSU BOGGABRI COAL

600 0 600 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Boggabri Coal MOD8 SWIA

Figure 3.1: Proposed Conceptual WMS - 2021

Job Number: N1216_003
Revision: 0
Drawn: MB
Checked: AW
Date: 2/7/2021

Legend

- Project Approval Area
- Preliminary Fauna Corridor
- Approved Mine Disturbance Boundary
- Approved Disturbance Boundary
- Rail
- Catchments
- 10m Contours

Drains

- Clean Water Diversion (Existing)
- Dirty Water Drain (Existing)
- Dirty Water Drain (Proposed)
- Clean Water Diversion (Proposed)

Landuse

- Active Dumping
- Active Mining
- Available Permanent Rehabilitation
- Available Temporary Rehabilitation
- Permanent Rehabilitation
- Temporary Rehabilitation

N

Leard State Forest

MW5

Pit

Proposed Sediment Dam

Merrygowen Creek

Nagero Creek Catchment

SD3

SD28

SD10

SD12

SD11

SD6

SD8

Existing Dirtywater Catchment

Nagero Creek

MW3

Tarrawonga Mine

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ENGENY WATER MANAGEMENT

IDEMITSU BOGGABRI COAL

600 0 600 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Boggabri Coal MOD8 SWIA

Figure 3.2: Proposed Conceptual WMS - 2026

Job Number: N1216_003
Revision: 0
Drawn: MB
Checked: AW
Date: 2/7/2021

Legend

- Project Approval Area
- Preliminary Fauna Corridor
- Approved Mine Disturbance Boundary
- Approved Disturbance Boundary
- Rail
- Catchments
- 10m Contours

Drains

- Clean Water Diversion (Existing)
- Dirty Water Drain (Existing)
- Dirty Water Drain (Proposed)
- Clean Water Diversion (Proposed)

Landuse

- Active Dumping
- Active Mining
- Available Permanent Rehabilitation
- Available Temporary Rehabilitation
- Permanent Rehabilitation
- Temporary Rehabilitation

N

Leard State Forest

Pit

Merrygowen Creek

Nagero Creek Catchment

SD3

SD28

SD10

SD12

SD11

SD6

SD8

Existing Dirtywater Catchment

Nagero Creek

MW3

Tarrawonga Mine

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www.engeny.com.au
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ENGENY WATER MANAGEMENT

IDEMITSU BOGGABRI COAL

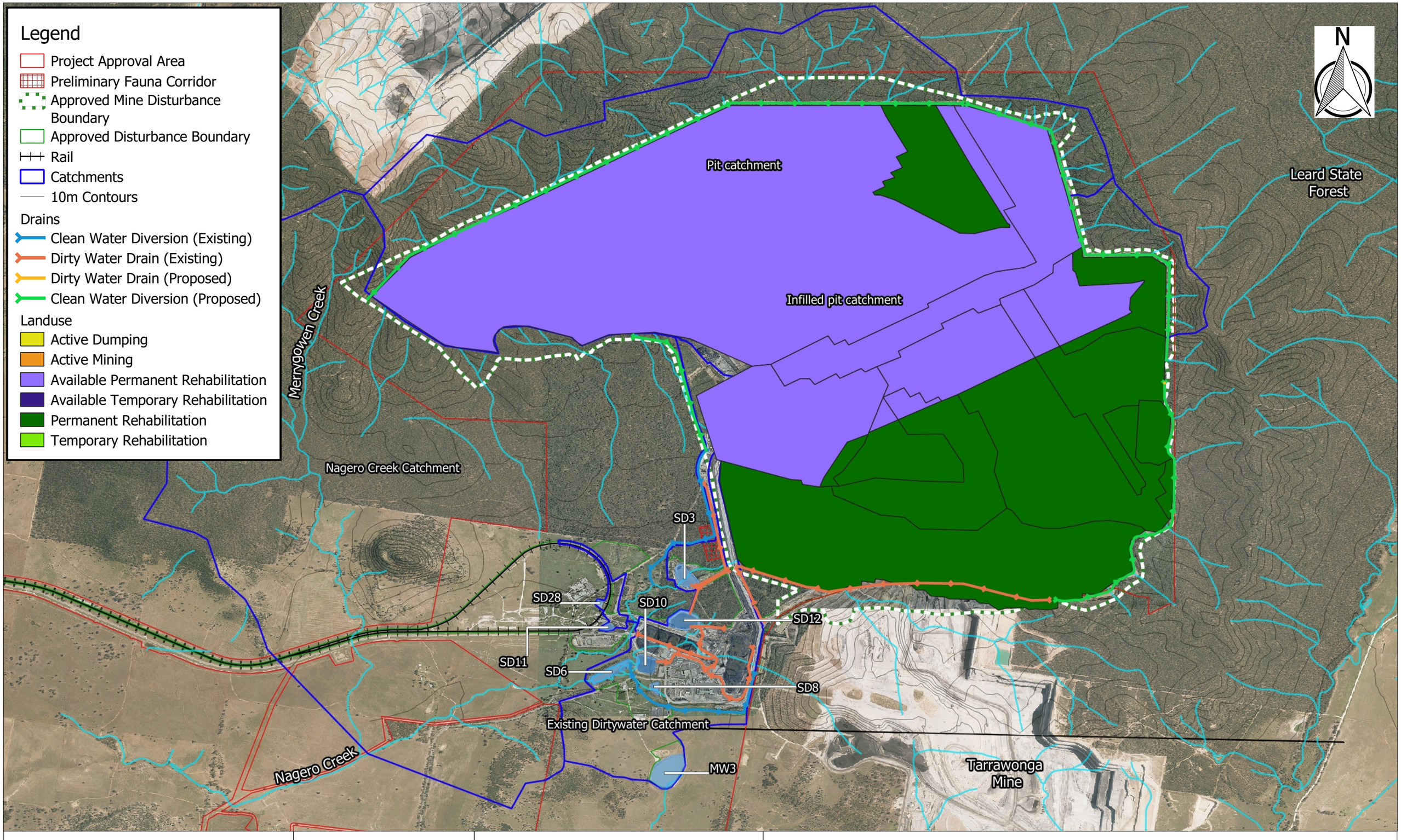
600 0 600 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Boggabri Coal MOD8 SWIA

Figure 3.3: Proposed Conceptual WMS - 2031

Job Number: N1216_003
Revision: 0
Drawn: MB
Checked: AW
Date: 2/7/2021



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600 0 600 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Boggabri Coal MOD8 SWIA

Figure 3.4: Proposed Conceptual WMS - 2039

Job Number: N1216_003
Revision: 0
Drawn: MB
Checked: AW
Date: 2/7/2021

Legend

- Project Approval Area
- Preliminary Fauna Corridor
- Approved Mine Disturbance Boundary
- Approved Disturbance Boundary
- Rail
- Catchments
- 10m Contours

Drains

- Clean Water Diversion (Existing)
- Dirty Water Drain (Existing)
- Dirty Water Drain (Proposed)
- Clean Water Diversion (Proposed)

Landuse

- Active Dumping
- Active Mining
- Available Permanent Rehabilitation
- Available Temporary Rehabilitation
- Permanent Rehabilitation
- Temporary Rehabilitation

N

Final Void Catchment

Leard State Forest

Merrygowen Creek

SD3

SD28

SD10

SD12

SD11

SD6

SD8

MW3

Nagero Creek

Tarrawonga Mine

Level 5, 6 Bolton St Newcastle NSW 2300

PO Box 787 Newcastle

www.engeny.com.au

P: 02 4926 1225

ENGENY WATER MANAGEMENT

IDEMITSU BOGGABRI COAL

600 0 600 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Boggabri Coal MOD8 SWIA

Figure 3.5: Proposed Conceptual WMS - Final Landform

Job Number: N1216_003
Revision: 0
Drawn: MB
Checked: AW
Date: 2/7/2021

3.4.1 Additional Water Management Infrastructure During Operations

The conceptual WMS for MOD 8 includes an additional sediment dam, located within a trapped low point formed within the eastern edge of the dump ("Proposed Sediment Dam", Figure 3.2). As specified in the Water Management Plan (BCOPL 2017) and accompanying subplans, sediment dams will be designed in accordance with Managing Urban Stormwater: Soils and Construction (the Blue Book), Volumes 1 and 2E - Mines and Quarries (Landcom 2004 and DECC 2008). Overflows from the sediment dams during events that exceed the design criteria (refer to Table 3.1) enter the Nagero Creek catchment.

Pumps, pipes and drain infrastructure to support the management of existing and new water management dams/storages will also be relocated and/or constructed as part of the progression of mining operations associated with MOD 8.

3.4.2 Clean Water Capture and Harvestable Rights

The existing approved operations capture runoff from undisturbed catchments areas (i.e. clean) either in pit or within highwall dams. Runoff captured by the highwall dams is discharged by pumping into Nagero Creek.

As the pit and dams within the Project Boundary are not used for stock watering purposes, and the intercepted watercourses are not first or second order watercourses (Figure 2.1), water captured will either need to be licensed, or covered by harvestable rights provisions, or other licence exemption. BCOPL owns about 10,450 ha of land, with a total harvestable right of about 680 ML. This, combined with the surface water WALs currently held by BCOPL (about 450 ML: Section 2.1.4) equates to a total licensed surface water right of about 1,130 ML.

4 WATER BALANCE

4.1 OVERVIEW

The GoldSim site water balance model for the BCM was initially developed as part of the surface water impact assessment (PB 2010) undertaken to support the BCM Continuation of Mining Operations Project Environmental Assessment (Boggabri EA) (Hansen Bailey 2010). As part of the consent conditions, the water balance model has been reviewed annually as part of a continuous improvement process. The last revision was undertaken by Engeny on behalf of BCOPL (2021). Appendix B: provides a standalone document describing the methodology and assumptions for the development, validation, and results of the BCM SWB which has been utilised for MOD 8.

The SWB model was updated to simulate the mining and coal handling characteristics because of MOD 8. The model considers existing and future operations and is used to estimate the likely water surplus/deficits and requirements into the future. The model allows detailed analysis, and considers:

- Direct rainfall onto dam/water storage surfaces.
- Water loss due to evaporation from water storages and pits.
- Runoff from natural, rehabilitated and disturbed catchment areas.
- Groundwater inflow to open cut pits.
- Water lost to product coal through the CHPP and ROM coal through the crusher (based on projected production rates).
- Water used for on-site dust suppression (haul roads and stockpiles).
- External water supplies.
- Site discharges.

The assessment of the potential impacts of MOD 8 on the predicted water balance is based on the outcomes of a GoldSim model. The model uses the SILO climate data for 126 years. The potential impacts of MOD 8 were assessed using 126 possible climatic sequences and as such assesses the water balance for many rainfall possibilities.

The predicted water balance for the Approved Operations is presented in Table 4.1.

Table 4.1: Summary of Average Predicted Water Balance – Approved Operations

Water Management Element	2021	2026	2031
Inflows (ML)			
Direct rainfall and runoff:			
• Clean water (highwall) dams	0	12	55
• Dirty water (sediment) dams	762	1,093	1,834
• Contaminated water dams, MWDs and Pit	1,634	1,423	922
Groundwater make	329	377	319
Licensed imported water	1,211	581	838
Total inflows (ML)	3,936	3,486	3,968
Outflows (ML)			
Demands:			
• Dust suppression	1,396	1,403	1,339

Water Management Element	2021	2026	2031
• CHPP	1,252	1,249	1,249
• MIA and potable water	365	364	364
Evaporation:			
• Clean water (highwall) dams	-	2	17
• Dirty water (sediment) dams	133	220	248
• Contaminated water dams, MWDs and Pit	388	365	334
Licensed discharges to Nagero Creek:			
• Clean water (highwall) dam discharges	-	8	31
• Dirty water (sediment) dam discharges	136	499	751
Dam overflows to Nagero Creek:			
• Dirty water (sediment) dam overflows	131	123	216
Total Outflows (ML)	3,802	4,232	4,548
Change in storage (ML)	**134**	**-746**	**-580**

4.2 POTENTIAL IMPACTS WITH MOD 8

Table 4.2 presents a summary of the water balance results for MOD 8. The predicted water inventory is also shown on Figure 4.1.

Table 4.2: Summary of Average Proposed Water Balance – with MOD 8

Water Management Element	2021	2026	2031	2039
Inflows (ML)				
Direct rainfall and runoff:				
• Clean water (highwall) dams	0	31	0	0
• Dirty water (sediment) dams	680	333	330	334
• Contaminated water dams, MWDs and Pit	1,429	1,272	1,266	1,616
Groundwater make	173	517	401	202
Licensed imported water	470	644	486	565
Total Inflows (ML)	**2,751**	**2,797**	**2,483**	**2,716**
Outflows (ML)				
Demands:				
• Dust suppression	639	1,643	895	720
• CHPP	989	1,048	1,040	393

Water Management Element	2021	2026	2031	2039
• MIA and potable water	365	365	362	365
Evaporation:				
• Clean water (highwall) dams	0	1	0	-
• Dirty water (sediment) dams	133	109	99	102
• Contaminated water dams, MWDs and Pit	406	367	384	510
Licensed discharges to Nagero Creek:				
• Clean water (highwall) dam discharges	-	24	0	-
• Dirty water (sediment) dam discharges	175	44	50	68
Overflows to Nagero Creek:				
• Dirty water (sediment) dam overflows	133	12	14	16
Total Outflows (ML)	***2,841***	***3,613***	***2,844***	***2,173***
Change in storage (ML)	**-90**	**-815**	**-361**	**543**

The water balance modelling indicates total water inventory (Figure 4.1Figure 4.1) on site is primarily driven by groundwater inflows into the pit, and licensed imported water. However, the uncertainty in the modelled total water inventory (Figure 4.1Figure 4.1) is largely a result of the range of climatic conditions (i.e. flood and drought) that would alter the volume of surface water captured by the WMS.

The modelling indicates a period of decline in total site water inventory prior to 2027 (Figure 4.1), due to reduced groundwater extraction between 2021and 2024 (Figure 4.2). During this period, there is an increased risk of water shortage should prolonged or severe drought occur. Under these conditions, site water inventories have the potential to drop below about 1,000 ML (Figure 4.1), requiring licensed Namoi River extractions to be maximised (Figure 4.3), and additional external water supplies may be required (Figure 4.4), in the form of temporary WALs (e.g. from Lake Keepit), consistent with existing operations.

During wet weather conditions, the water balance modelling indicates that the total site water inventory (Figure 4.1) remains within the target site-wide operating volume for scenarios up to the 95th percentile. Only extreme rainfall events are expected to result in an exceedance of the site wide target operating volume. During these periods, mining operations are unlikely to be possible, allowing for the use of the pit as emergency water storage (Figure 4.1).

The water balance modelling indicates that, for average conditions, MOD 8 will result in an increase in the water imported from the borefield after 2021, however this increase is not expected to result in the need to purchase any additional WALs, as the modelled imported water from the Lower Namoi River Regulated Water Source is reduced. The water balance modelling suggests that there is likely to be sufficient WALs to allow for increased coal production.

The water balance modelling indicates that the volume of uncontrolled discharges (overflows) of water from sediment dams is expected to reduce over time (Table 4.2) largely as a result of the rehabilitation of the overburden emplacement areas and subsequent release of runoff to the downstream environment. The rehabilitation of the catchment areas reduces the overall volume of water intercepted by and managed within the dirty water management system (sediment dams). This reduction is considered a more realistic reflection of current site operations and rehabilitation strategies. It is noted that should runoff generated within the rehabilitated catchment area continue to be managed within the dirty water system, external water supplies (i.e. Namoi River extraction) would be reduced.

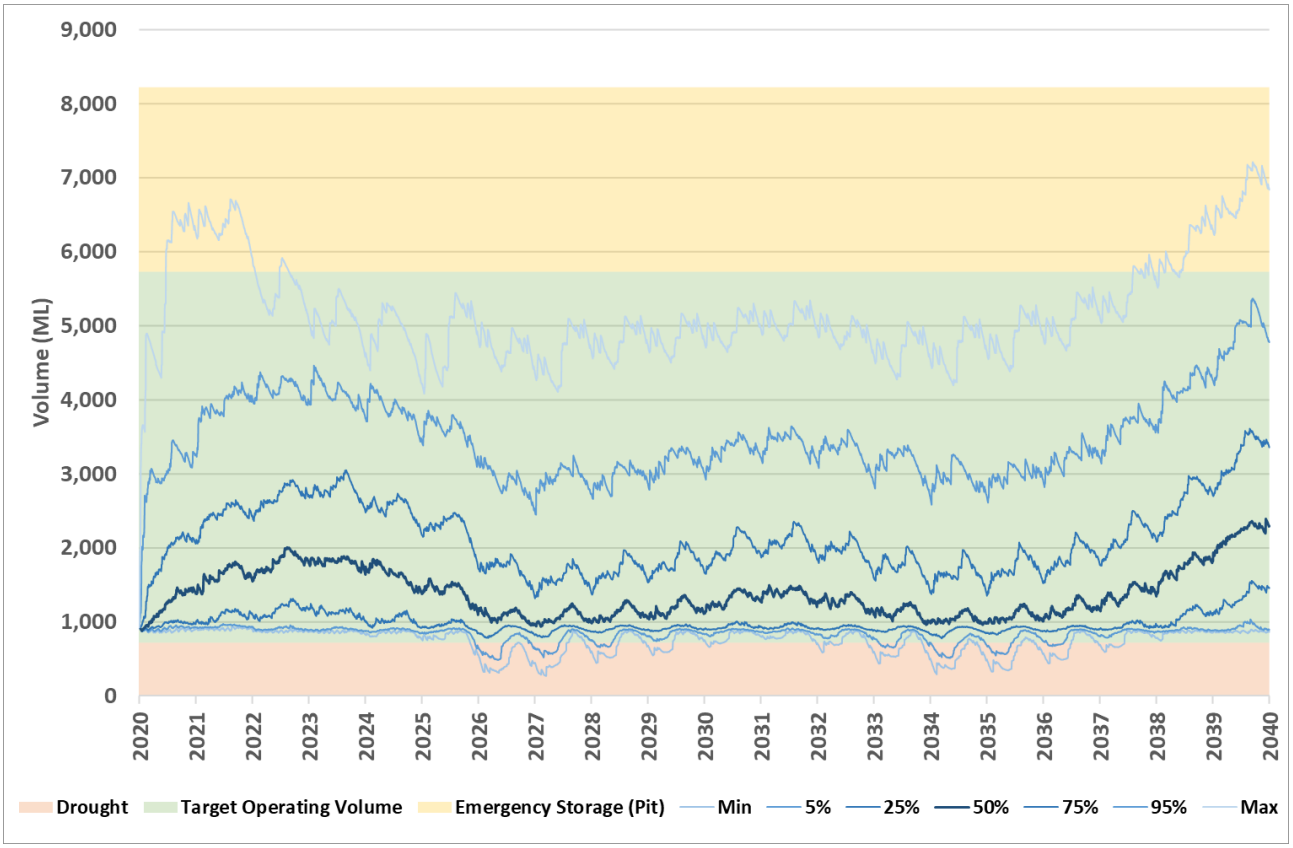

Figure 4.1: Predicted Water Storage Inventory

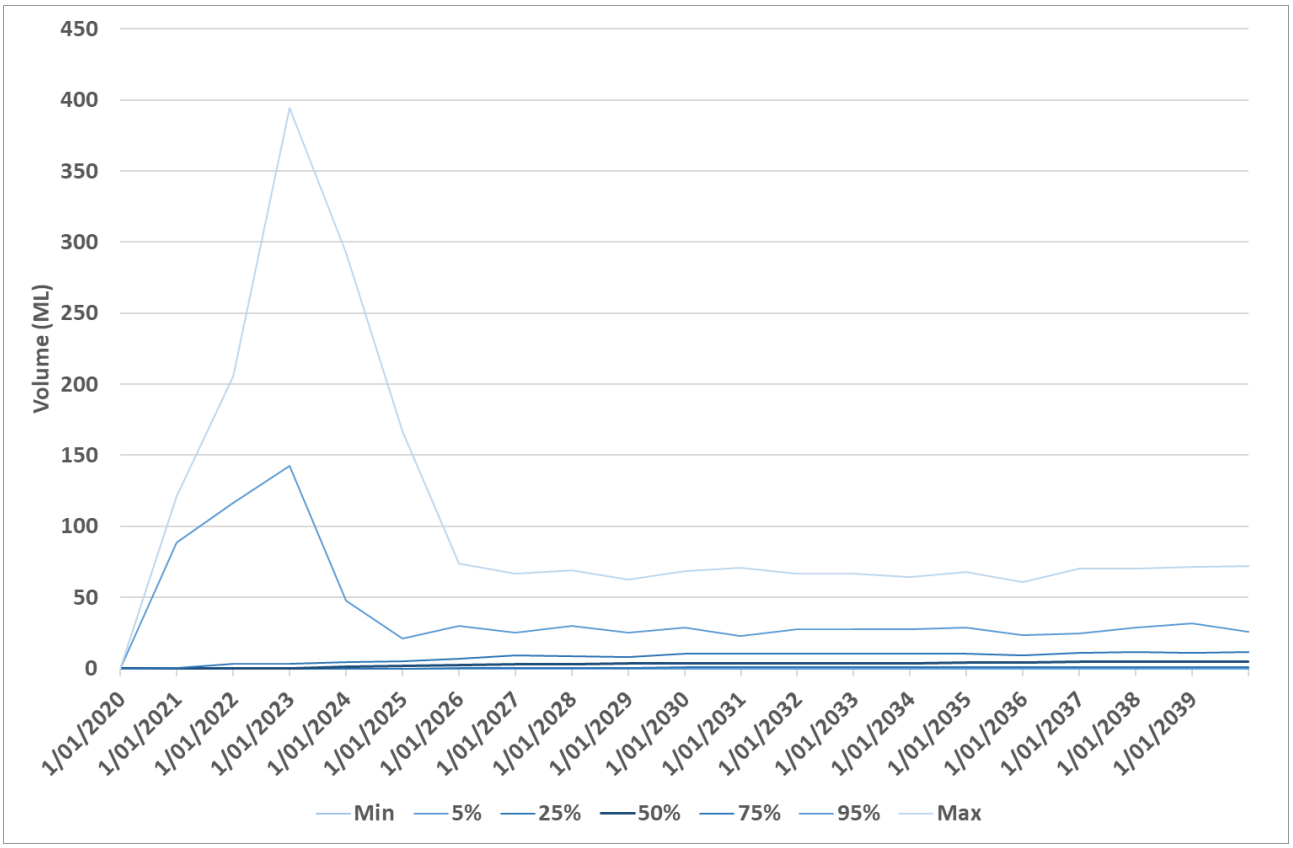

Figure 4.2: Modelled Sediment Dam Overflows

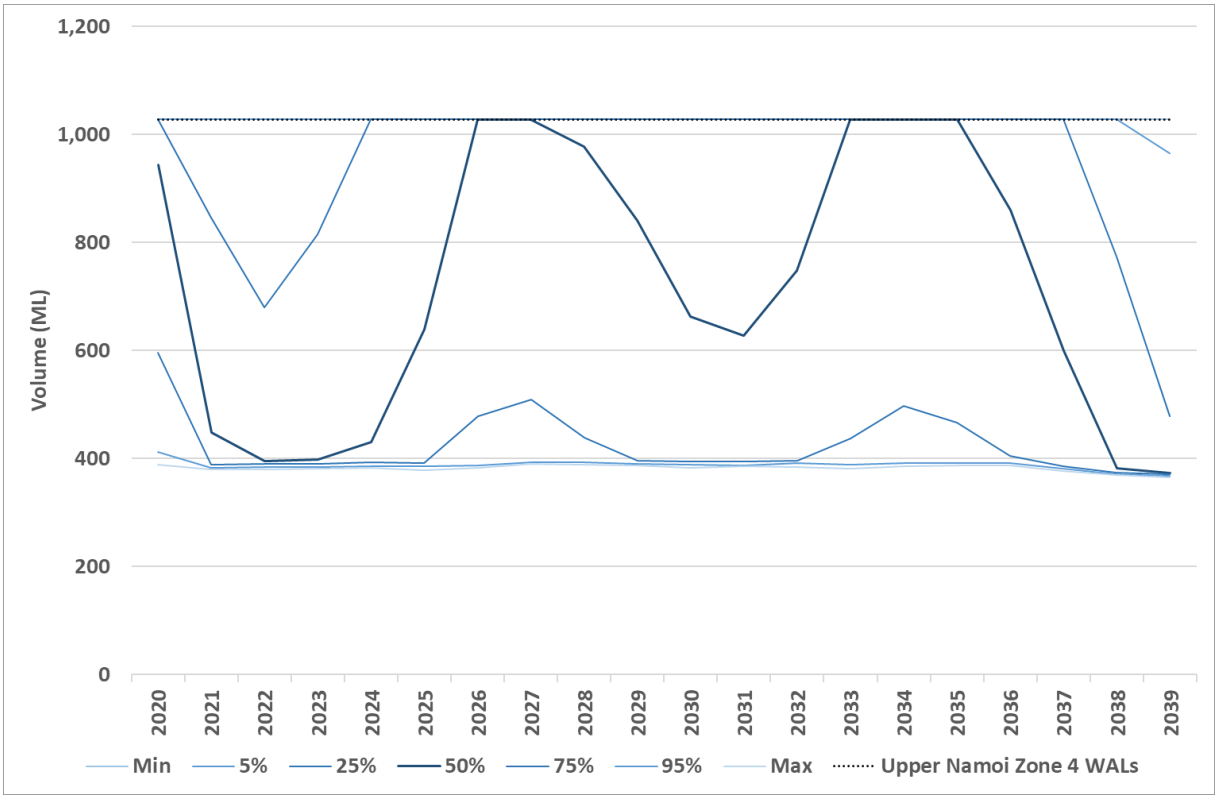

Figure 4.3: Total Modelled Groundwater Extraction (pit and borefield)

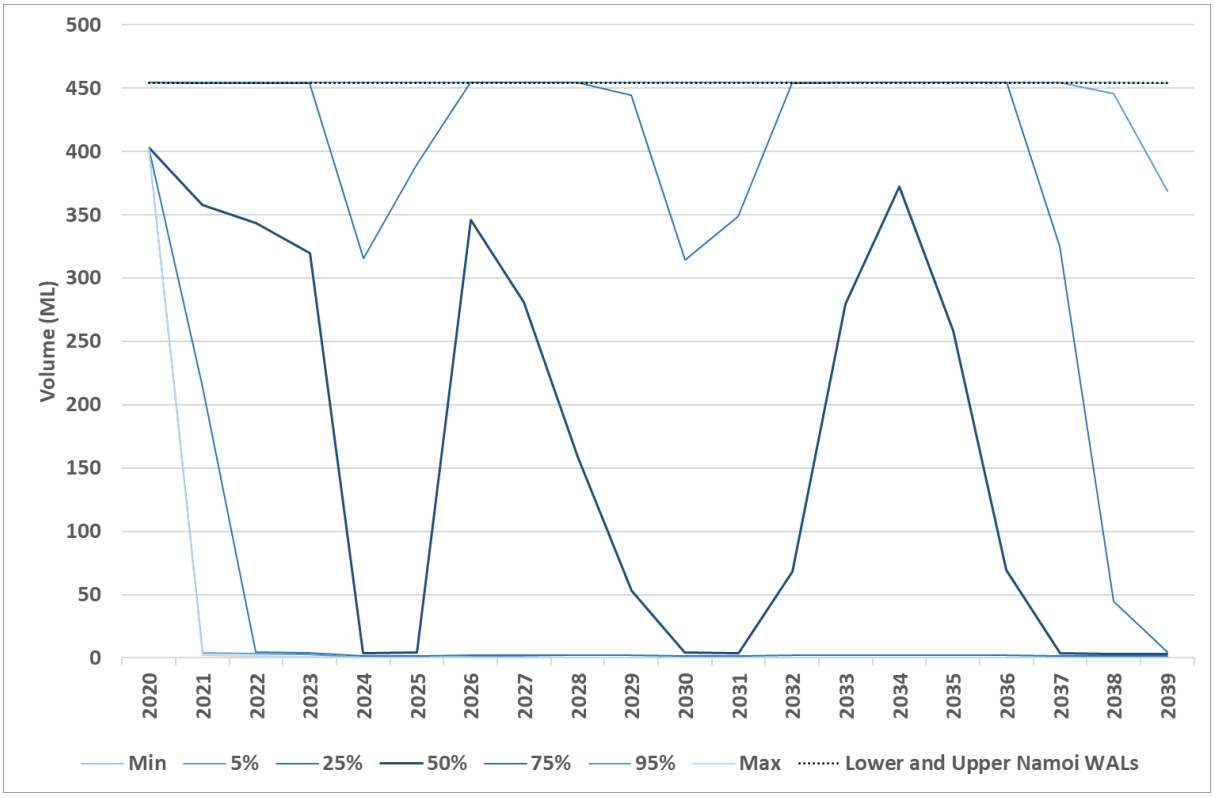

Figure 4.4: Modelled External Water Supply (Namoi River)

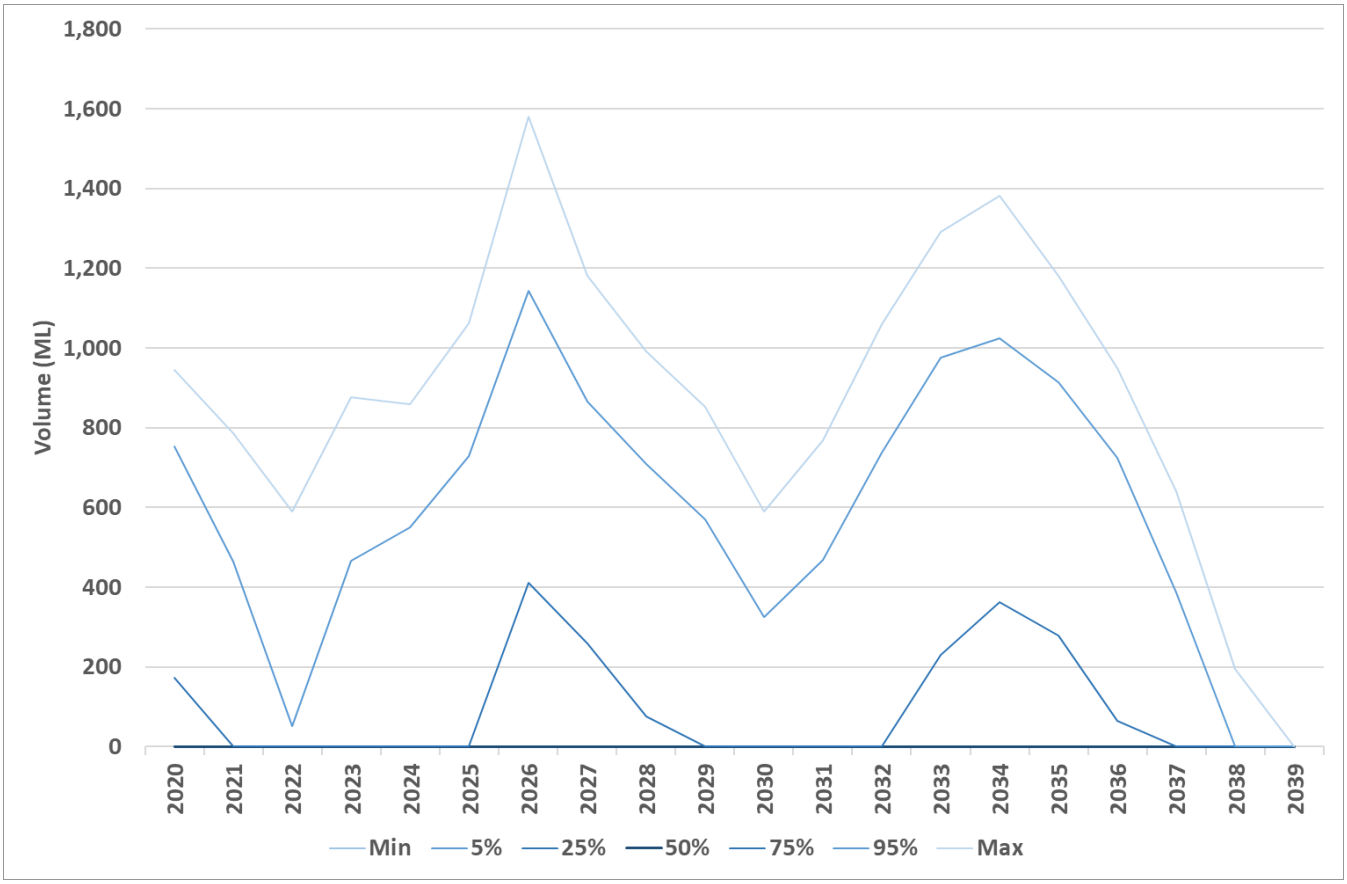

Figure 4.5: Modelled Additional Licensed Water Supply

5 SURFACE WATER IMPACTS AND MITIGATION MEASURES

5.1 CATCHMENT AREAS

As MOD 8 does not include changes to the total surface footprint of mining, no appreciable change to surrounding catchment areas (including cumulative impacts) is expected to occur because of the proposed changes to mining, or final landform (compared to the approved conceptual final landform).

Some minor changes to local catchments are expected, due to the temporary out of pit emplacement area; establishment of the Fauna Movement Crossing; and increased rehabilitation of overburden emplacement areas allowing for earlier release of these areas into the downstream environment. These changes are contained within the mining footprint and have been considered in the water balance modelling undertaken (Section 4).

The proposed conceptual final landform is considered to be generally consistent with the approved conceptual final landform, with the additional infilling of the mining area to reduce the surface area of the partially infilled final void and subsequently increase the surface area from the landform that will be free-draining compared with approved conceptual final landform (as required by SSD 09_0182).

5.2 FLOW REGIMES

The Groundwater Impact Assessment (AGE 2021) indicates that MOD 8 results in some increases to groundwater interception, largely as a result of the increase in mining depth and the extended mine life. However negligible impacts are anticipated to the surrounding watercourses as a result of this additional groundwater interception. Therefore, the potential for impacts to streamflow regimes (including cumulative impacts) are considered to be negligible, consistent with the approved operations.

5.3 FLOODING AND WATERCOURSE STABILITY

As MOD 8 does not include changes to the total extent of mining or significant changes to the approved water management system, the potential for changes in downstream flooding regimes and watercourse stability (including cumulative impacts) is considered negligible, consistent with the approved operations.

5.4 WATER QUALITY

As MOD 8 does not include changes to the approved water management system, the potential for changes to downstream water quality (including cumulative impacts) is considered minor, compared to the to the approved operations.

The WMS is designed to enable BCOPL to meet licence conditions within the requirements of the POEO Act, taking account of both historical and current water qualities in the surrounding watercourses, and current and future downstream water users. The risk of overflows during events that exceed the approved design criteria and potential impacts associated with overflows is currently managed by the WMP. No changes to the design criteria for water management infrastructure are proposed.

The WMP allows for the ongoing assessment of risk as mining operations progress, and the implementation of improvements and changes where required. The design strategy for the WMS (refer to Section 3) includes:

- Management (capture and storage) of mine water exposed to coal and/or coal processing for events up to and including the 1% AEP 72 hour storm event. Additionally, 1,000 ML of total freeboard is required to be maintained across all mine water storages at BCM.
- Management of runoff from disturbed areas, including overburden emplacement areas, based on the Blue Book requirements (Landcom, 2004 and DECC, 2008), including a series of dirty water catch drains and sediment dams to capture and manage sediment-laden runoff.
- Ongoing evaluation of the WMS adequacy based on the design criteria validated through water quality sampling.

The site Water Management Plan (BCOPL 2017) includes a description of erosion and sediment controls that are required to manage runoff from disturbed areas, including from on-site reject material stockpiles.

The EPL requires BCOPL to monitor for EC, nitrate, nitrogen (total), oil and grease, pH, phosphorus (total), reactive phosphorus, and TSS as soon as possible after discharge commences and, in any case, not more than 12 hours after a discharge event commences. A comparison of water quality results to ANZG (2018) guidelines for 95th percentile species protection for aquatic ecosystems should be undertaken within a suitable timeframe to allow for first flush spate events to have passed the monitoring location. The Geochemical Assessment, undertaken for MOD8 (RGS, 2021) indicates that surface runoff and seepage from overburden materials is likely to fall within the 95th percentile species protection range for aquatic ecosystems.

5.5 RIPARIAN AND ECOLOGICAL VALUES

As MOD 8 does not include changes to the total extent of mining or significant changes to the approved water management system, the potential for changes in downstream flow regimes, and therefore ecological conditions, is considered minor, compared to the approved operations.

5.6 WATER USERS

As MOD 8 does not include changes to the total extent of mining or significant changes to the approved water management system, the potential for changes in downstream flow regimes (including cumulative impacts), and therefore downstream water users, is considered minor, compared to the approved operations. Water balance modelling indicates that the current WALs remain sufficient to supply BCM, with the periodic purchase of additional water to continue as per current practice on site.

5.7 FINAL VOID

Groundwater modelling (AGE 2021) indicates that the long-term groundwater level within the vicinity of the final void will be below the finished level of the final void floor (i.e. 283 mAHD). Therefore, groundwater inflows into the final void will be negligible, and the void will likely provide additional groundwater recharge through the capture and infiltration of surface water. Modelling of the final void indicates that surface water will accumulate within the void following periods of high rainfall intensity or extended wet weather. This intercepted water will be retained and lost to evaporation and infiltration. Therefore, no final pit lake is expected (in accordance with the requirements of Schedule 3, condition 69, Table 16 of the current project approval).

5.8 SUMMARY OF PROPOSED MITIGATION MEASURES

In addition to the minor modifications of the existing approved WMS (refer to Section 3), erosion and sediment control will continue to be undertaken in accordance with the approved WMP, which will be reviewed and updated to ensure it is consistent with the operation of the mine associated with MOD 8. The approved WMP provides a framework for the management of erosion and sedimentation at BCM.

During operations, additional WMS components will be constructed as work progresses. The operational phase will involve the ongoing management of the WMS.

The objective of the approved WMP is to ensure that appropriate structures and programs of work are in place to:

- Identify activities that could cause erosion and generate sediment.
- Describe the location, function and capacity of erosion and sediment control structures required to minimise soil erosion and the potential for transport of sediment downstream.
- Ensure erosion and sediment control structures are appropriately maintained.
- Fulfil the statutory conditions of SSD 09_0182.
- Meet industry standards and best practice, specifically:
  - Landcom 2004. Managing Urban Stormwater – Soils and Construction, Volume 1, 4th Edition.
  - DECC 2008. Managing Urban Stormwater – Soils and Construction, Volume 2E – Mines and Quarries.

These objectives will continue to be applied for MOD8.

6 COMMONWEALTH SIGNIFICANT IMPACT GUIDELINES

A summary of the potential surface water impacts against the Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources (DoE 2013) is included in Table 6.1.

Table 6.1: Assessment Against Significant Impact Guidelines: Coal Seam Gas and Large Coal Mining Developments – Impacts on Water Resources

Aspect	Impact
Flow Regimes	The assessment indicates that MOD 8 will have minor to negligible impacts on flow regimes (Section 5.2) including flooding (Section 5.3), when compared to the existing Approved Operations. PB (2010) concluded that the operations would result in a reduction in flows reporting to the Namoi River (at Boggabri) of about 0.04% for median climatic conditions, which were not expected to result in appreciable environmental flows within the river. The assessment of potential impacts of flow regimes on riparian and ecological values is included in Section 5.5.
Recharge Rates; Aquifer Pressure or Pressure Relationships Between Aquifers; Groundwater Table Levels	Refer to Groundwater Impact Assessment (AGE 2021).
Groundwater/surface Water Interactions	Groundwater interactions with the surface water sources are discussed and assessed in the Groundwater Impact Assessment (AGE 2021). As described within Section 5.2, the Groundwater Impact Assessment (AGE 2021) determined that the potential for impacts to streamflow regimes (including cumulative impacts) are considered to be negligible, consistent with the approved operations. The surface water assessment indicates that the proposed conceptual final void includes an invert level above the estimated long-term recovery level of the regional groundwater. Therefore, interactions between surface and groundwater are expected to be limited to localised infiltration and groundwater recharge, with no pit lake expected within the conceptual final landform (Section 5.7).
River/floodplain Connectivity	MOD 8 is not expected to have an impact on river / floodplain connectivity as no changes are sought to the approved infrastructure located on floodplain areas.
Inter-aquifer Connectivity	Refer to Groundwater Impact Assessment (AGE 2021).
Coastal Processes	The site is located more than 270 km from coastal areas and will therefore have no impacts on coastal processes.
Impact on Water Users	The magnitude of impacts on water users are expected to be comparable to those for the approved operations, however, would continue for an additional 6 years (Section 5.6). All water take associated with MOD 8 will be licensed in accordance with the WM Act.
State Water Resource Plans	The surface water sources within and adjacent to the BCM are managed under the Namoi Unregulated WSP. In addition, water extraction from the Namoi River is managed under the Namoi Regulated WSP. Both WSPs are State Water Resource Plans and are governed under the WM Act. Water take for the BCM will continue to comply with the above listed WSPs and WM Act which are designed to provide for the sustainable use of NSW's water resources.

7 MANAGEMENT, MONITORING, LICENSING AND REPORTING

7.1 WATER MANAGEMENT PLAN AND MONITORING

The existing WMP includes details of erosion and sediment controls, surface water and groundwater monitoring programs, as well as a surface and groundwater response plan. The WMP includes specific monitoring for:

- Erosion and sediment control measures.
- Surface water quality monitoring.
- Stream health and channel stability monitoring.

The WMP will be reviewed and updated to include the WMS and water balance associated with MOD 8.

As MOD 8 is contained within the approved disturbance footprint, and results in impacts to the surrounding surface water environment that are considered consistent with the approved impacts, no proposed changes to the monitoring locations and metrics are considered necessary in response to MOD 8. It is noted, however, that the monitoring will be continued for the life of the project (i.e. to at least 2039) until the site is rehabilitated.

7.2 LICENSING REQUIREMENTS

7.2.1 Protection of the Environment Operations Act 1997

Licensing requirements for the operations under the POEO Act remain generally unchanged with MOD 8, except for a monitoring and potential discharge point from the proposed new sediment dam (Section 3.4.1).

7.2.2 Water Act 1912 and Water Management Act 2000

The WSP for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016 applies to water take from watercourses in the vicinity of the BCOPL. The operation of the WSP is governed by the WM Act.

7.2.3 Water Sharing Plan - During Operations

MOD 8 will not result in an increase in the capture/diversion of runoff take from clean catchment areas. Runoff from dirty and mine water catchments will be contained within the WMS to meet the requirements of the EPL. There are also no additional harvesting dams proposed as part of MOD 8 (it is noted that the proposed new sediment dam will capture dirty water runoff that would currently report to the pit). As such, the licensing regime for the Approved Operations during the operational stages in regard to surface water is not predicted to change as a result of MOD 8.

7.2.4 Water Sharing Plan - Final Landform

The proposed MOD 8 final landform is based on the objectives of the approved final landform, and includes improvements to the final voids (partial infilling to improve the area that is free-draining) and macro relief to manage surface water runoff generated on the overburden emplacement areas.

Consistent with the approved final landform, the proposed MOD 8 final landform includes a shallow final void that will capture surface water runoff. The captured surface water will be temporarily retained before being lost to the environment via infiltration, groundwater recharge, and evapotranspiration. No permanent water storage is expected within the final void. As a result, there are no significant changes to the WALs required to manage the surface water harvest associated with the proposed MOD 8 final landform, compared to the approved final landform.

7.3 REPORTING

A summary of surface water monitoring results will continue to be provided in the Annual Review, which will, at a minimum, include:

- A summary of monitoring results.
- An analysis of monitoring results against impact assessment criteria, historical monitoring results.

- Annual site water balance and comparison against predictions in the Modification Report.
- An identification of any trends in the monitoring results.
- Any non-compliances reported during the year and
- Actions taken to address any non-compliances.

In addition, the Annual Review is to include reporting on significant issues regarding the implementation of the WMP, including:

- The effectiveness of the erosion and sediment controls.
- Changes to the site water balance and
- Any identified issues or exceedances of trigger values.

The Annual Review will also document reviews and feedback relating to the maintenance and performance of the WMS.

8 REFERENCES

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WaterNSW, 2019, *Annual Operations Plan Namoi Valley 2019-20*

9 QUALIFICATIONS

a) In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

c) Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

   i) Additional sources of information not presently available (for whatever reason) are provided or become known to Engeny; or
   ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

d) Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the works, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works. All limitations of liability shall apply for the benefit of the employees, agents and representatives of Engeny to the same extent that they apply for the benefit of Engeny.

e) This document is for the use of the party to whom it is addressed and for no other persons. No responsibility is accepted to any third party for the whole or part of the contents of this Report.

f) If any claim or demand is made by any person against Engeny on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon the Report or information therein, Engeny will rely upon this provision as a defence to any such claim or demand.

g) This Report does not provide legal advice.

Appendix A:
Response to SEARs

Table A.1: Response to SEARs Requirements

	SEARs Comment	Response
13	**The Modification Report must include a detailed water assessment undertaken in accordance with the IESC Information Guidelines. The Modification Report should present sufficient evidence for independent verification of:** **• the processes of cause and effect between the project and water resource; and** **• the magnitude of the impacts on water resources.**	This assessment.
14	Sufficient information should be provided to consider the appropriateness of the underlying assumptions and conceptual models on which numerical models are based. An independent reader of the environmental assessment documents should be able to verify all significant conclusions made by the proponent.	Refer to Appendix B for full discussion on assumptions and conclusions in water balance modelling.
15	The Modification Report should provide the following information outlined in the IESC Information Guidelines: *A description of current regional and proposed impacts to water resources and water-dependent assets.*	Refer to Section 5
16	The water assessment should provide a regional overview of the project area including a description of the geological basin, coal resource, surface water catchments, groundwater systems, water-dependent assets, and current and reasonably foreseeable coal mining, CSG development and other water-intensive activities, including irrigation. This should include any relevant information generated by a bioregional assessment.	Overview of relevant information discussed broadly in Section 2 and specifically in Section 2.2
17	Provide descriptions of existing conditions, values and sensitivity to potential impacts.	Refer to: Water Quality - Section 2.3 WMS including imports and discharges – Section 3 Water balance existing conditions – Section 4
18	Provide conceptual and/or numerical modelling of potential impacts.	Refer to Section 4.2
19	Propose mitigation and management measures	Refer to Section 5 and Section 7
27	The Modification Report should include a cumulative impact assessment and consider all relevant past, present and reasonably foreseeable actions, including impacts from water-intensive activities other than mining and CSG, and programs and policies that are likely to impact water resources. Where impacts from a new project are considered small, these need to be considered with the impacts from existing development and the cumulative impact must be assessed to determine if a threshold of acceptable total impact may be crossed.	The proposed WMS footprint is generally consistent with the approved WMS. Similarly, the concept design of final void is generally consistent with the approved final landform. Therefore, it is considered unlikely that the proposed modification will appreciably alter the approved cumulative impacts associated with the Boggabri, Tarrawonga and Maules Creek mines.
28	The Modification Report should derive site-specific water quality guidelines and provide more information on how they plan to monitor impacts. For example, the parameters and frequency of monitoring should be detailed.	Refer to Section 2.3 and Section 5.4 for discussion on available data. Historical data inadequate to set site specific triggers so ANZECC triggers have been recommended until sufficient data becomes available.
29	Predictions of final void water quality and quantity.	Refer to Section 5.7
30	Discussion on re-equilibration of groundwater and eventual discharges to the environment.	Refer to Section 5.7

ENGENY
WATER MANAGEMENT

Appendix B:
Water Balance Report

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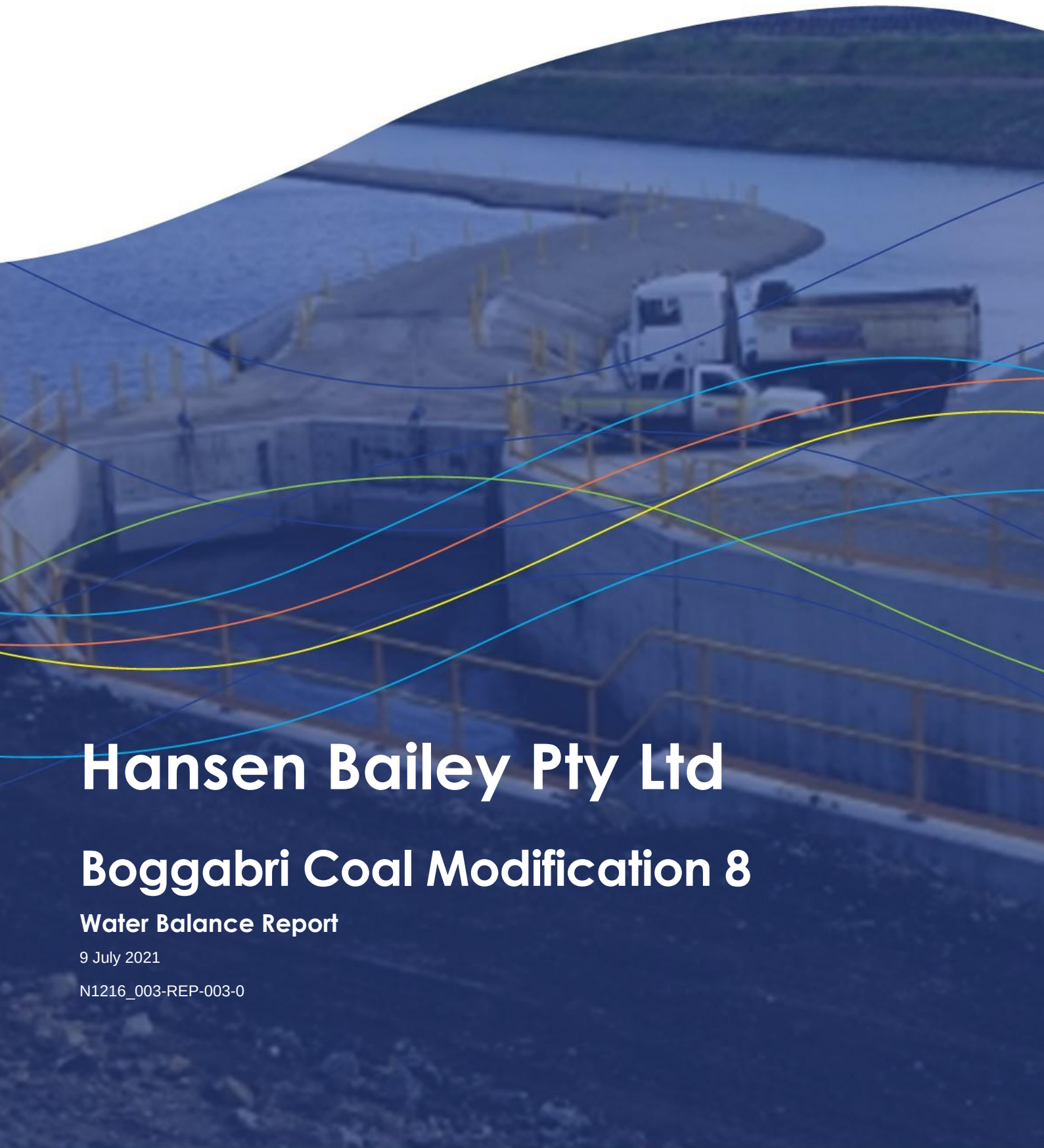
WATER MANAGEMENT

Hansen Bailey
ENVIRONMENTAL CONSULTANTS



Hansen Bailey Pty Ltd

Boggabri Coal Modification 8

Water Balance Report

9 July 2021

N1216_003-REP-003-0

Job no. and Project Name: N1216_003 Boggabri Coal Modification 8
Doc Path File: \\EGINCAPP01\Newcastle management$\Projects\N1200_Misc Clients\N1216_003 BCOPL MOD8 SWIA\07 Deliv\Docs\Report\N1216_003-REP-002-0-BCOP_MOD8_WBM_Report.docx

Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	2/07/2021	Client Issue	Michael Best	Susan Shield	Adam Wyatt	Susan Shield
1	9/7/21	Client Issue	Michael Best	Susan Shield	Adam Wyatt	Susan Shield
Signatures						

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1 INTRODUCTION

Boggabri Coal Operations Pty Limited (BCOPL) maintains an operational site water balance model for its Boggabri Coal Mine (BCM) which operates pursuant to Project Approval (PA) 09_0182 (as modified). The site water balance model was originally developed using the GoldSim software package which was originally developed as part of the Continuation of Boggabri Coal Mine Project Surface Water Assessment (WSP, 2010). The model was built to simulate the site water balance during the operations of the proposed mine plan for 1, 5 and 10 year horizons and estimate inflows, outflows and storage volumes.

A modification to PA 09_0182 granted in August 2016 resulted in the requirement (under Appendix 6A of PA 09_0182) to conduct additional water metering, estimates of losses from storages and an annual review of the water balance model against the observed water metering. A Site Water Balance (SWB) Report is prepared by BCOPL annually and includes the following:

A review of the model validation against observed storage levels, water imports, demands and discharges. Runoff parameters and transfer logic are adjusted if the validation is not found to be suitable.
A forecast simulation using the existing Mine Operating Plan (MOP). The forecast simulation is run for a total of 126 realizations to simulate demands, imports, and storage levels for a range of climate conditions.
Water infrastructure planning to satisfy the requirements of the predicted behaviour of the Water Management System (WMS) over the forecast period.

The most recent update of the SWB was undertaken for the 2019 calendar year (BCOPL, 2021). The SWB review for the 2020 calendar year is currently being undertaken by Engeny on behalf of BCOPL.

The existing model was used as a base for the Proposed Modification (MOD 8) and updated to reflect changes to the timing of the progression of the mine and landuse categories, and the staging of dams and other water infrastructure (refer to Section 2.1).

This report documents the SWB Modelling for MOD 8 and is intended to provide sufficient information to allow a suitably experienced mine water balance modeller to reconstruct the BCOPL Water Balance Model (WBM) to a reasonable degree of accuracy. The report is structured as follows:

Section 2 outlines the data used for both the base model and the updates for MOD 8.
Section 3 reviews the latest model validation undertaken in the SWB (Engeny, 2021).
Section 4 contains detailed results from the updated model as a result of MOD 8.

2 WATER BALANCE METHODOLOGY

2.1 INPUT DATA AND ASSUMPTIONS

The MOD 8 water balance model was built using the existing SWB model as a base with updates made to the following elements to reflect the mine plan changes sought by MOD 8:

- Catchments and landuse.
- Groundwater inflows.
- Production rates and coal handling and preparation plant (CHPP) supply.
- Operating rules.

Figure 2.1 shows the model schematic for the original approvals model for year 10 of the Project EA which has been reviewed and updated ten times since April 2012 (e.g. Figure 2.2 which shows the 2021 WMS from the 2019 SWB review (BCOPL, 2021)). Table 2.1 provides a summary of the model review history.

Table 2.1: Model Review and Validation History

Revision	Date
0	April 2012
1	September 2012
2	July 2013
3	October 2013
4	November 2013
5	February 2014
6	June 2015
7	September 2015
8	May 2017
9	April 2021

Figure 2.1 Boggabri Coal Approval Model Water Balance Schematic (Year 10) (PB, 2010)

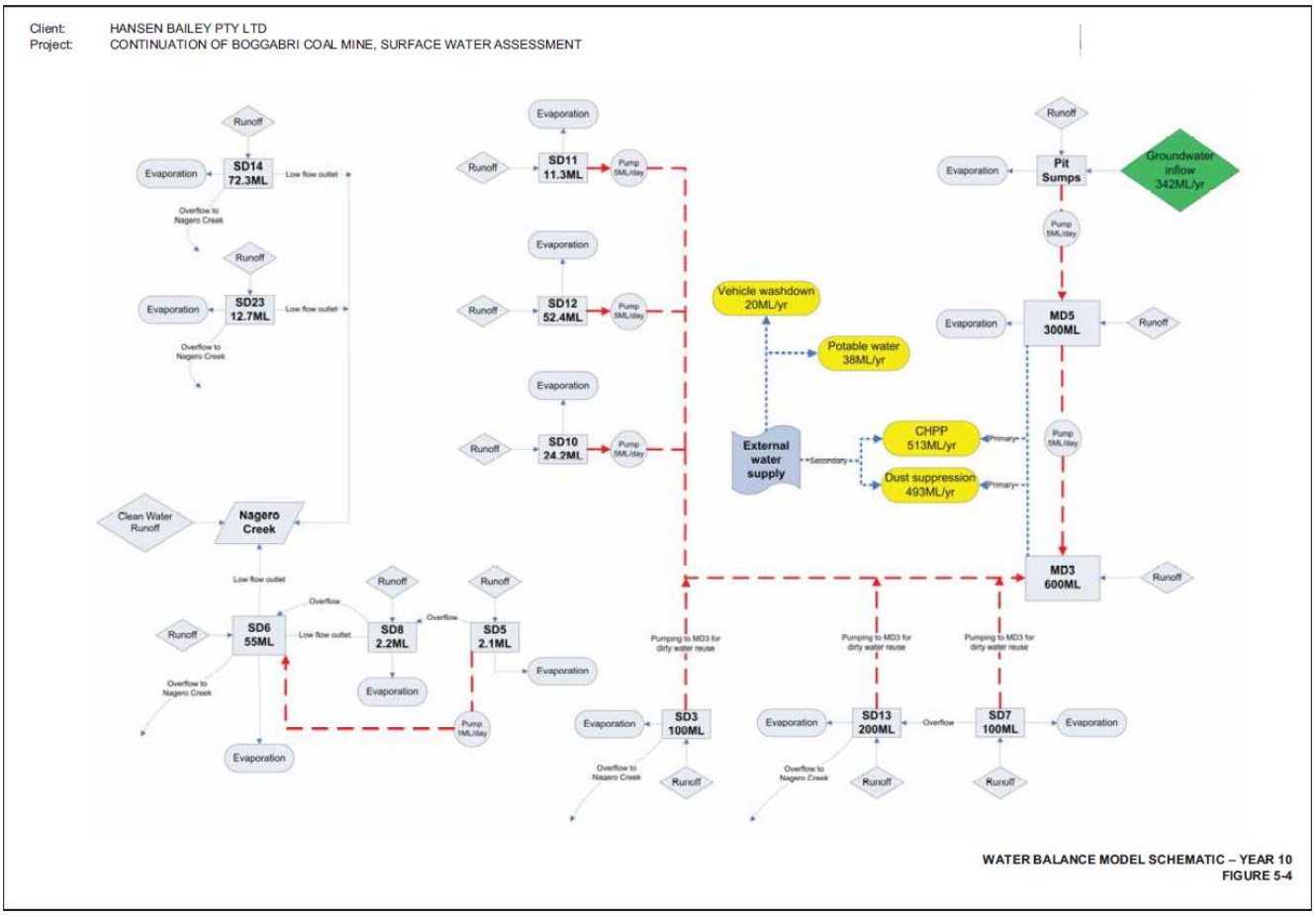
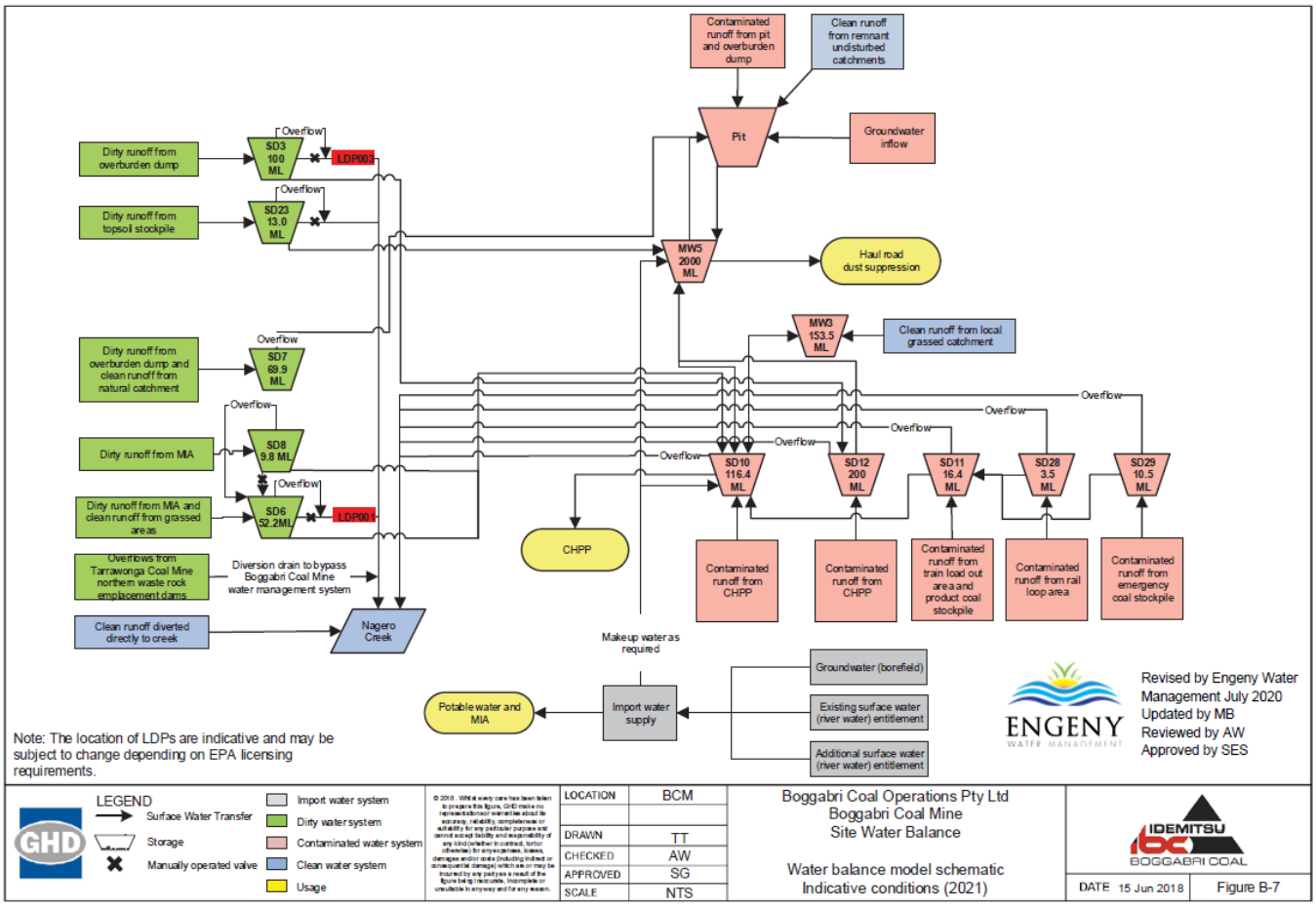


Figure 2.2 Boggabri Coal Revised Water Balance Model Schematic (Year 2021) (BCOPL, 2021)



2.1.1 Catchments

Catchment areas included in the water balance model for MOD 8 are provided in Table 2.2: The model includes all WMS storages as well as the clean Nagero Creek catchment to the gauge at SW1.

Table 2.2: Catchment Areas (ha)

		Conceptual Staged Mine Plan Year			
System	Storage	2021	2026	2031	2039
BCM mine water dams[1]	MW3	22	22	22	22
	MW5	15	15	2	2
	SD10	29	29	29	29
	SD11	5	5	5	5
	SD12	45	93	93	93
	SD28	3	3	3	3
	Pit	1548	1334	1278	1434
	Subtotal	*1667*	*1501*	*1432*	*1588*
BCM dirty water dams	SD3	254	23	23	23
	SD6	65	65	65	65
	SD7	249	0	0	0
	SD8	13	13	13	13
	SD19	0	0	0	0
	SD20	0	0	0	0
	SD21	0	0	0	0
	SD22	0	0	0	0
	SD23	34	34	34	34
	SD24	0	0	0	0
	Proposed Sediment Dam	-	42	-	-
	Subtotal	*615*	*177*	*135*	*135*
Rehabilitation runoff released directly to Nagero Creek		-	-	521	521
Undisturbed Nagero Creek catchment		1544	1544	1544	1387
Total		**3826**	**3222**	**3632**	**3631**

[1] Excludes the approved irrigation area draining to Bollol Creek catchment

2.1.2 Rainfall and Evaporation Data

BCOPL maintains a rainfall gauge on site with data available from 2013 to present. There are 2 operating Bureau of Meteorology (BoM) rainfall gauges within the vicinity of the Project area and several discontinued gauges. Table 2.3 summarises the available rainfall data for key rainfall gauges. Typical rainfall and evaporation rates are included in Figure 2.3 and Figure 2.4.

Table 2.3: Rainfall Gauges in the vicinity of BCM

Rainfall Gauge	Owner	Period of Record	Distance from Site
Site	BCOPL	8 years	-
Boggabri Post Office (055007)	BoM	137 years	15.1 km
Boggabri (Kanownda) (055076)	BoM	122 years (1899 - 2021)	12.8 km
Boggabri (Mayfield) (055033)	BoM	52 years (1934 – 1986)	8.7 km
Gunnedah Research Station (055024)	BoM	71 years (1948 - 2019)	42 km

For the purposes of the MOD 8 Surface Water Impact Assessment (SWIA), data from a SILO Data Drill (1889 to 2021) was used to represent the long term rainfall and evaporation data set, supplemented by the site rainfall data for the period 2013 to 2020. The SILO data drill is a derived data set from a combination of interpolated recorded data between weather stations and derived long-term average values. Due to poor distribution of evaporation monitoring stations near the BCM, there is a potential that the interpolated evaporation data at the location of BCM may be inaccurate. Therefore, the long-term pan evaporation derived from the SILO data drill has been compared against the average daily recorded data from the Gunnedah Research Station (055024) (nearest station available) to validate the SILO data, presented in Figure 2.4. The long-term average data from the SILO data drill matches well with the data recorded at Gunnedah Research Station (055024) for the period 1948 to 2019.

Figure 2.3: Daily Rainfall comparison (range and mean)

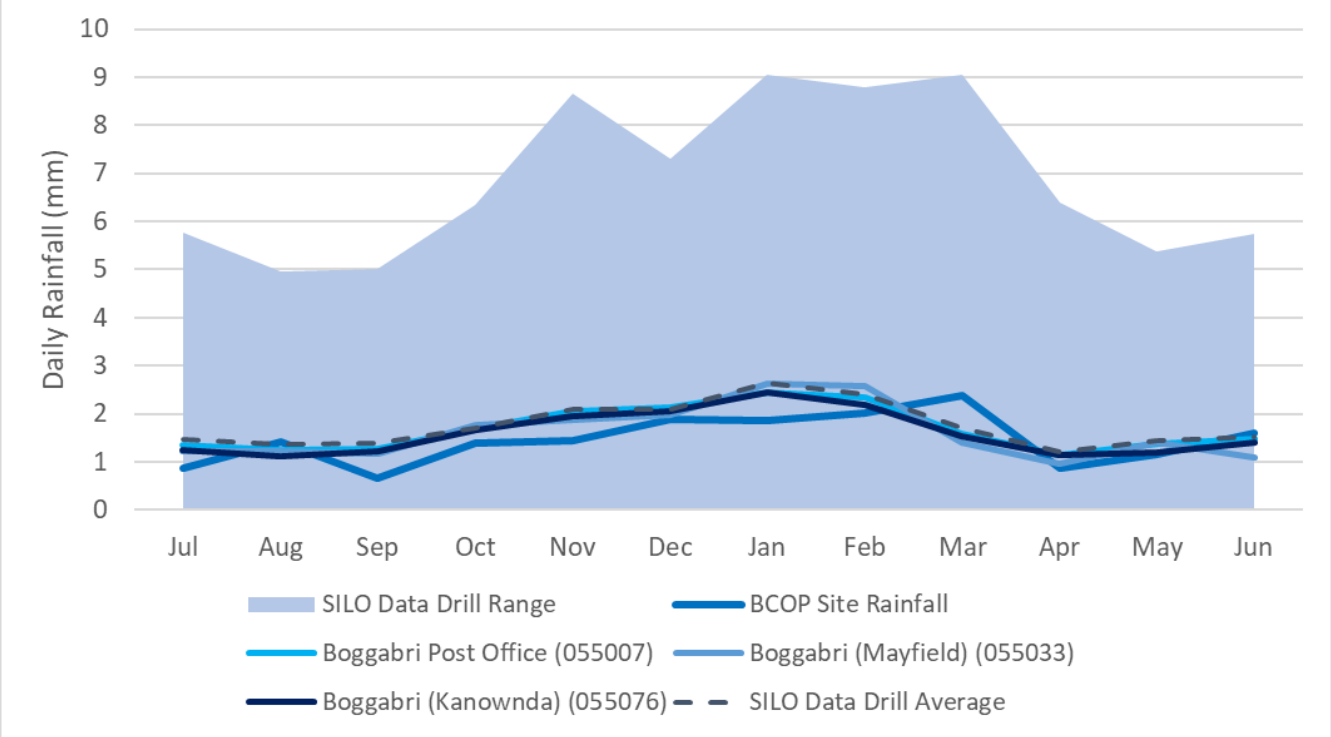
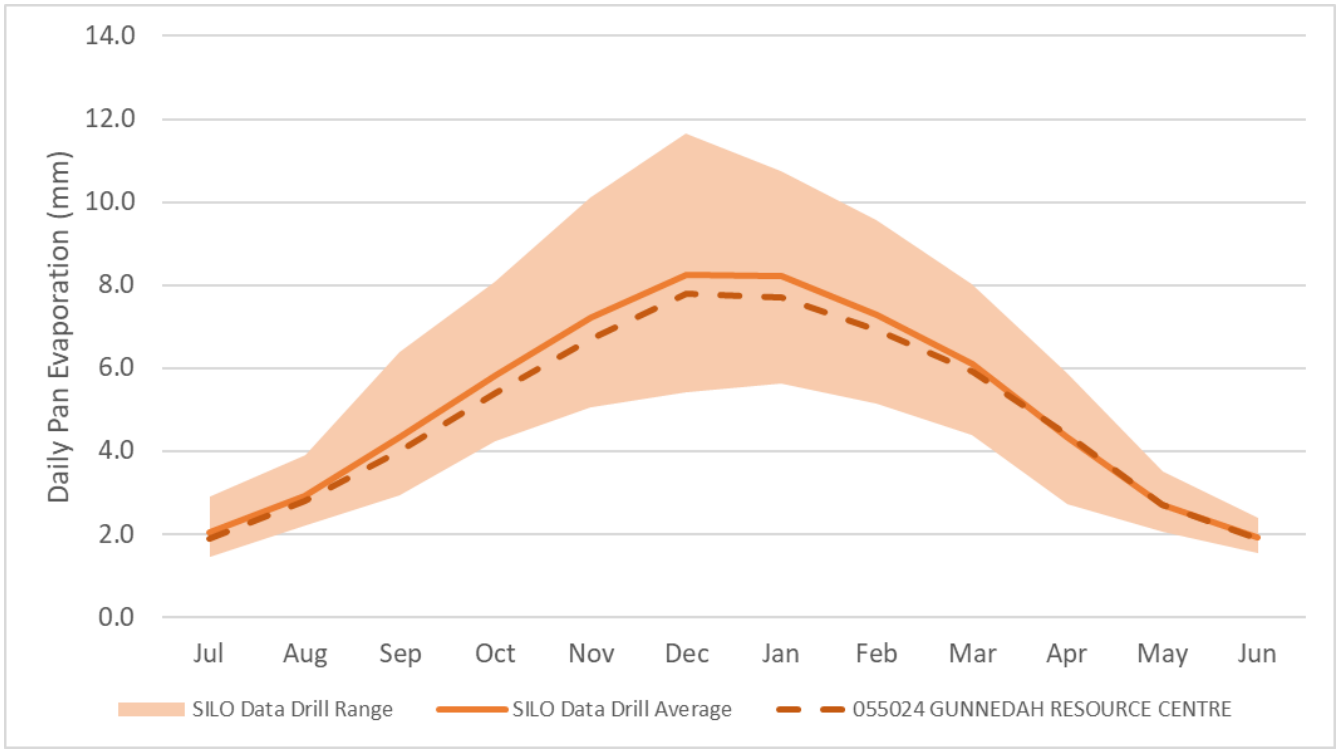


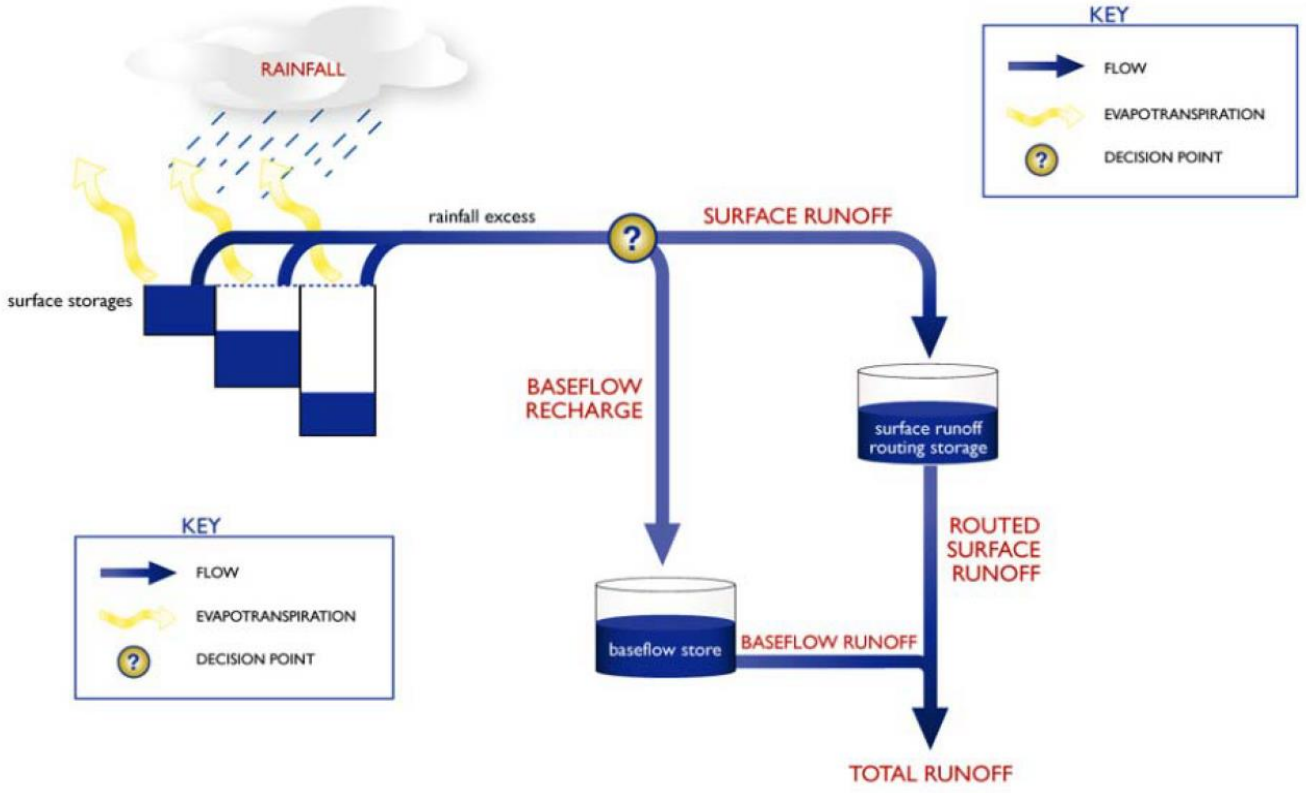
Figure 2.4: Daily Evaporation (range and mean)



2.1.3 Runoff Modelling

The site water balance model currently utilises the *Australian Water Balance Model* (AWBM: Boughton (1993)) to estimate the runoff response for the modelled catchment areas. 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 2.5 .

Figure 2.5 Schematic Layout of the AWBM Rainfall-Runoff Model (Chiew, 2004)



The input values for the AWBM model are reviewed in the annual validation (refer to Section 3). The latest values for the model are presented below in Table 2.4. Further discussion on historical AWBM parameters is included in Section 3.

Table 2.4: AWBM Parameters

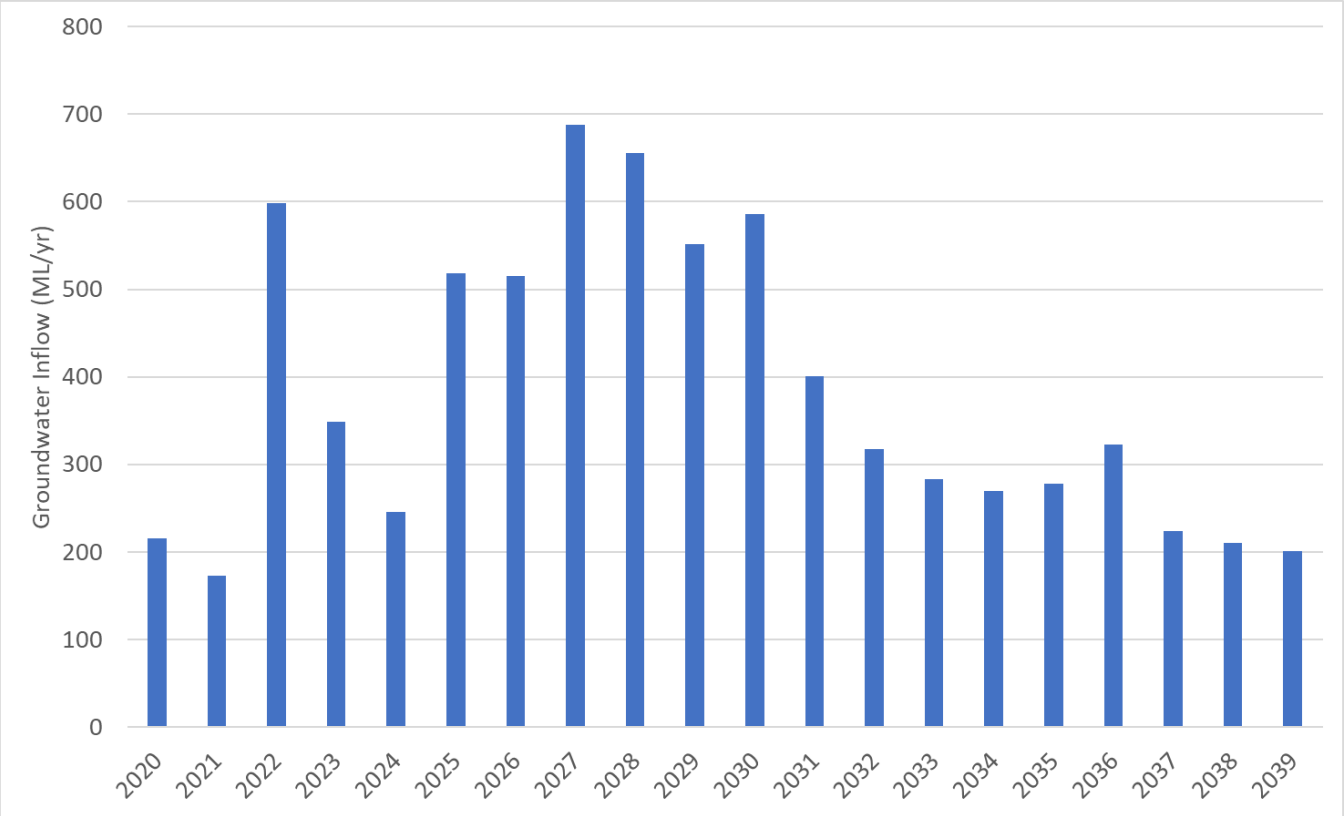
Parameter	Industrial and Hardstand	Open Cut Pit	Pre-strip	Rehabilitation	Overburden	Natural Catchment
Partial Area 1	0.134	0.2	0.134	0.134	0.3	0.134
Partial Area 2	0.433	0.2	0.433	0.433	0.3	0.433
Partial Area 3	0.433	0.6	0.433	0.433	0.4	0.433
Soil Store Depth 1	1.4	3.0	2.9	3.6	18.9	14.2
Soil Store Depth 2	14.4	44.1	29.4	36.4	37.8	145.2
Soil Store Depth 3	28.8	56.7	58.7	72.9	75.6	290.5
BFI	0	0	0.2	0.2	0.8	0.05
K_S	0	0	0	0	0	0
K_B	0	0.98	0.98	0.98	0.7	0.803

Runoff is modelled for all WMS storages as well the clean water catchment for Nagero Creek to the gauge at SW1. The WBM does not incorporate a runoff model for Bollol Creek.

2.1.4 Groundwater Inflows

Predicted groundwater inflows to the open cut were provided by the MOD 8 Groundwater Impact Assessment (AGE, 2021). The existing SWB model values were updated with the revised groundwater inflow predictions as shown below in Figure 2.6.

Figure 2.6: Modelled Groundwater Inflow (AGE, 2021)



2.1.5 External Water

BCOPL currently holds water access licences (WALs) for the Upper Namoi Zone 4 Namoi Valley Groundwater Source, the Upper Namoi Zone 11 Namoi Valley Groundwater Source and the Gunnedah-Oxley Basin. Details of these WALs are provided in Table 2.5.

Table 2.5: 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

Source	WAL category	WAL No.	Share (units)	Expiry	Current reliability (%)
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
Upper Namoi Zone 11 Groundwater source	Aquifer	WAL 42234	20	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**		

BCOPL currently holds general security and supplementary WALs for the Lower Namoi Regulated River Water Source. Details of these WALs are provided in Table 2.6.

Table 2.6: BCOPL WALs for Lower Namoi Regulated River Water Source

Source	WAL category	WAL No.	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 water balance model sources water imports when either MW5 or SD10 reach their low operating volume. Water is imported from the borefield first and, when either the licence allocation is exhausted or the import rate cannot match the CHPP demand, water is sourced from the Namoi River.

A separate model element provides water imports from an external supply not limited by licensing. This volume is tracked in the model as a shortfall in licence allocation and external supply and used to identify potential risk during dry periods.

2.1.6 Water Demands

Dust Suppression

For the purposes of the water balance analysis, it was assumed that dust suppression water will not be required on days with a total rainfall depth of more than 5 mm. Dust suppression rates are based on predicted haul road lengths, at an application rate estimated from historical usage (Figure 2.7). Predicted haul road lengths were supplied by BCOPL and total length is presented below in Figure 2.8.

Figure 2.7: Observed Water Usage for Dust Suppression of Haul Roads

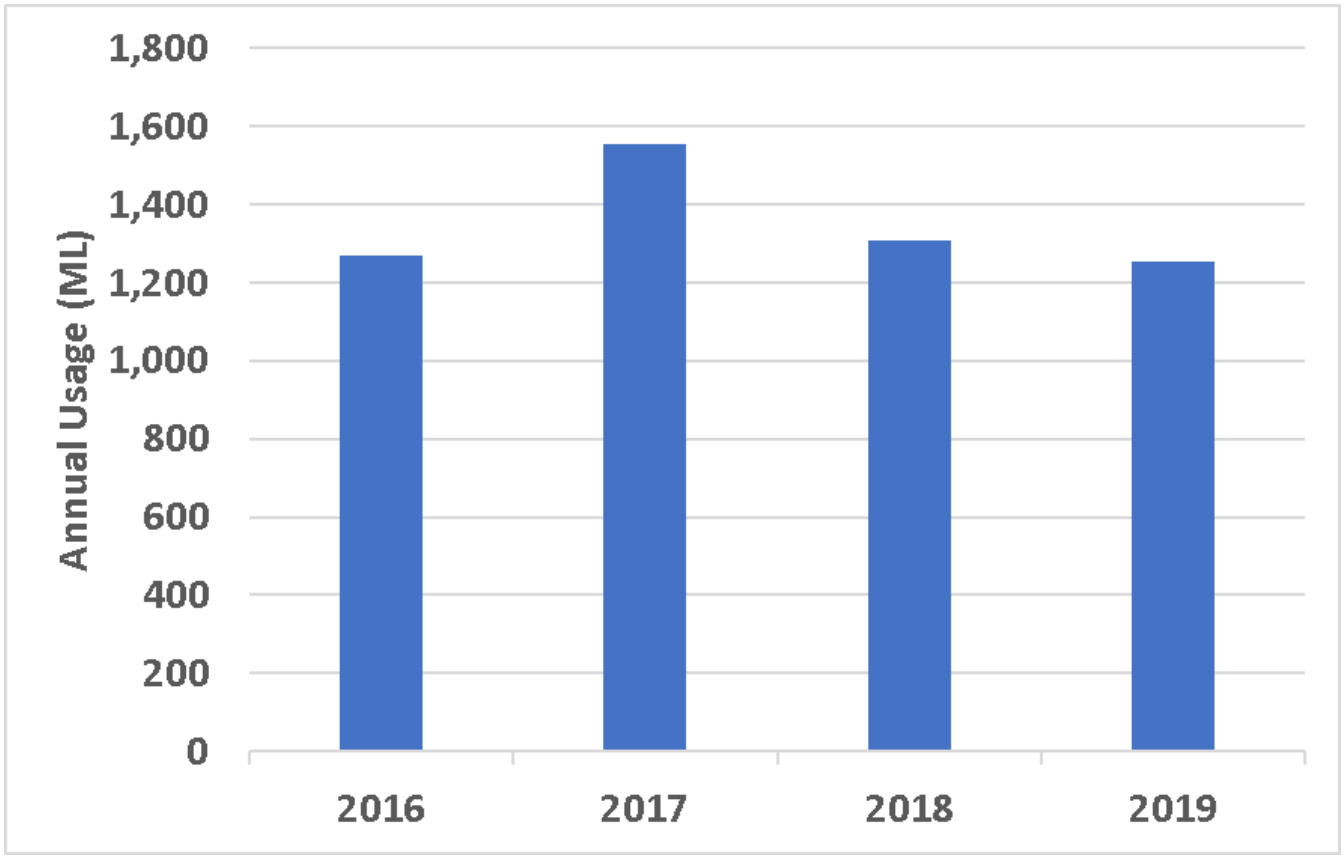
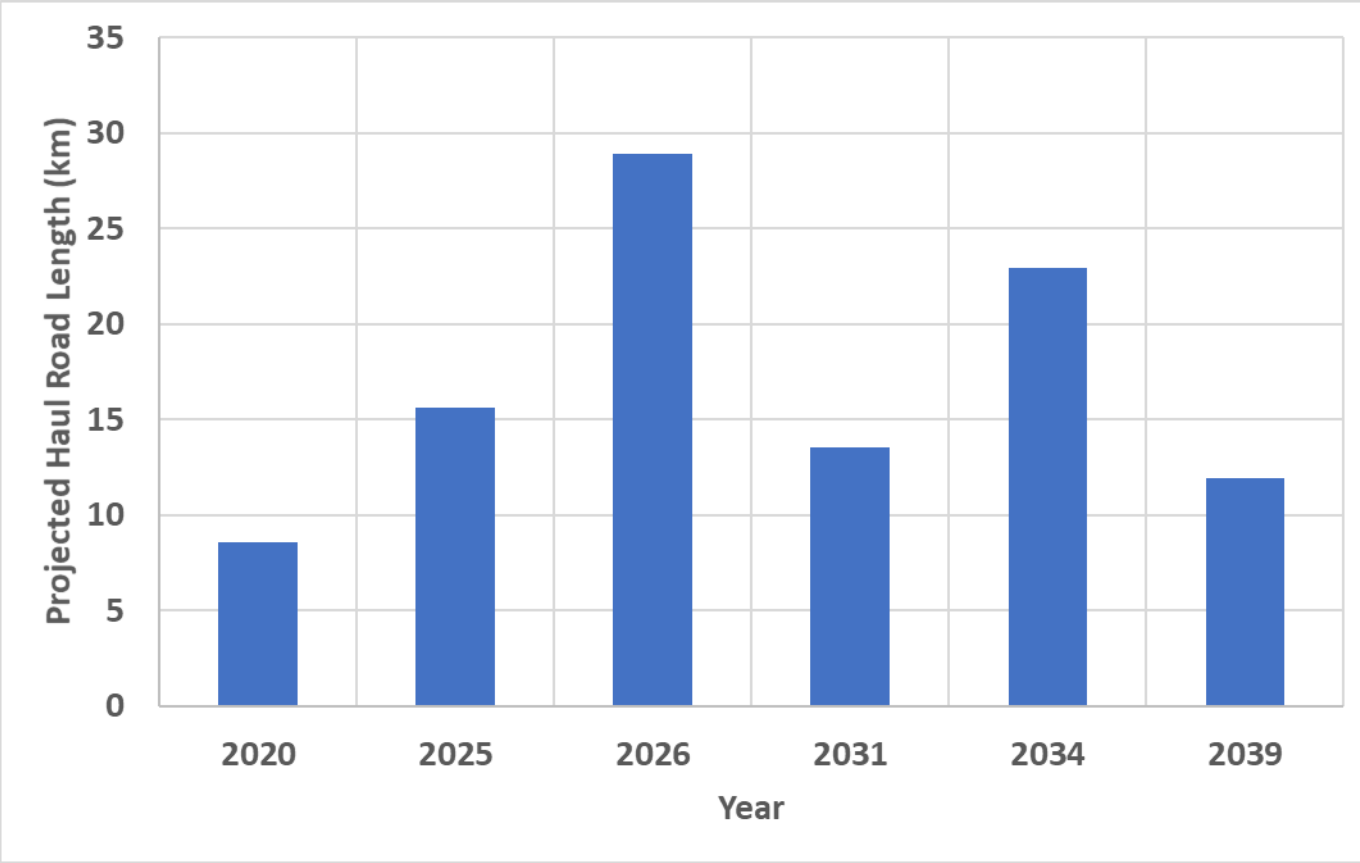


Figure 2.8: Predicted Haul Road Lengths



2.1.7 CHPP, Mining Infrastructure Area (MIA) & Potable Demands

The predicted water demands for the CHPP, MIA and potable uses are described in Table 2.7.These values are based on site estimates for existing demands. Average net water usage at the CHPP over the validation period (2016 to 2019) was determined to be 120 L/ Run of Mine (ROM) tonne from data provided by BCOPL. This net water usage rate was applied to the forecast production schedule provided by BCOPL to determine the predicted net water usage at the CHPP.

Table 2.7: Predicted Net CHPP Water Usage

Year	Predicted Net Water Usage (ML/day)
2021	2.710
2022	2.871
2023	2.871
2024	2.871
2025	2.871
2026	2.871
2027	2.871

2028	2.871
2029	2.871
2030	2.871
2031	2.871
2032	2.871
2033	2.871
2034	2.871
2035	2.871
2036	2.871
2037	2.209
2038	1.423
2039	1.063

Water is required for vehicle washdown in the Mining Infrastructure Area (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 Victoria Park and Lovton 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. BCOPL estimates the average daily usage for the MIA and potable water to be 1 ML/d.

2.1.8 Water Losses – Dam Seepage

Seepage from the dams is assumed to be negligible compared to open water evaporative losses and is not modelled in the water balance.

2.1.9 Operating Rules

The operating rules and operating storage volumes of major dams are outlined in the tables below. These rules are maintained in the assessment modelling until each dam is decommissioned. Note: HOV refers to high operating volume, LOV refers to low operating volume.

Table 2.8: Operating Rules

Pump / Valve	Pump rate (ML/day)	On trigger	Off trigger	Conditions
Dewater SD10 to 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 MW5 greater than HOV
Dewater SD10 to Pit	10.0	SD10 greater than HOV	SD10 less than HOV	MW3 greater than HOV MW5 greater than HOV
Dewater SD11 to SD10	2.0	SD11 greater than HOV	SD11 less than LOV	SD10 less than HOV

Pump / Valve	Pump rate (ML/day)	On trigger	Off trigger	Conditions
Dewater SD12 to 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 Pit to MW5	5.0 (10.0 if pit volume exceeds 200 ML)	Pit greater than HOV	Pit less than LOV	MW5 less than HOV
Makeup MW5 to SD10	5.0	SD10 less than LOV	SD10 greater than HOV	MW5 greater than LOV
Makeup MW3 to SD10	3.5	SD10 less than LOV or MW3 greater than HOV	SD10 greater than HOV or MW3 less than LOV	MW3 greater than LOV and SD10 less than HOV
Dewater SD3 to SD12	5.0	SD3 greater than HOV	SD3 less than LOV	SD12 less than HOV Not contaminated water excess
Dewater SD19 to 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 Not contaminated water excess
Dewater SD8 to SD6	1.0	SD8 greater than HOV	SD8 less than LOV	SD6 less than HOV 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 exceeds 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

Pump / Valve	Pump rate (ML/day)	On trigger	Off trigger	Conditions
Release CWDs to Creek (valve)		CWD greater than HOV	CWD less than LOV	

Table 2.9: Assumed Operating Volumes

Storage	LOV (ML)	HOV (ML)
MW3	5.0	131.0
MW5	600.0	1994.9
Pit sumps	5.0	10.0
SD10	19.4	61.7
SD6	17.4	18.4
SD23	3.2	4.2
SD3	33.3	34.3
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

3 WATER BALANCE MODEL VALIDATION

The validation for the BCM WBM is reviewed as a requirement under Appendix 6A of SSD 09_0182. The most recent validation was undertaken for the 2019 calendar year in the SWB Report (BCOPL, 2021). The followings model elements are reviewed and updated as necessary as part of the validation:

- Model operating logic.
- Storage data including operating volumes and capacities.
- AWBM runoff parameters.
- Groundwater and surface water licensed extraction volumes.
- Site demands including dust suppression, CHPP demand, MIA and potable demand.

A summary of the latest review of the WBM validation undertaken in the SWB Report (BCOPL, 2021) is presented below.

3.1 METHODOLOGY

The model was simulated from 1 January 2016 to 1 January 2020 using observed rainfall, water imports and water usage as inputs. The modelled water storage volume was compared to the observed water storage volume to confirm that the WBM is representative of the site observations. The input data used for the validation is summarised in Table 3.1.

Table 3.1: Validation Input Data

Data	Source	Notes
Dust suppression, potable usage, washdown, CHPP usage	BCOPL	Annual totals for 2016 to 2020. Groundwater extraction was assumed to include estimated pit inflows
Water volumes in mine water storages	BCOPL	Weekly surveyed volumes

Actual usages recorded by BCOPL for washdown and potable water and the CHPP were used in the validation simulation and are summarised in Table 3.2.

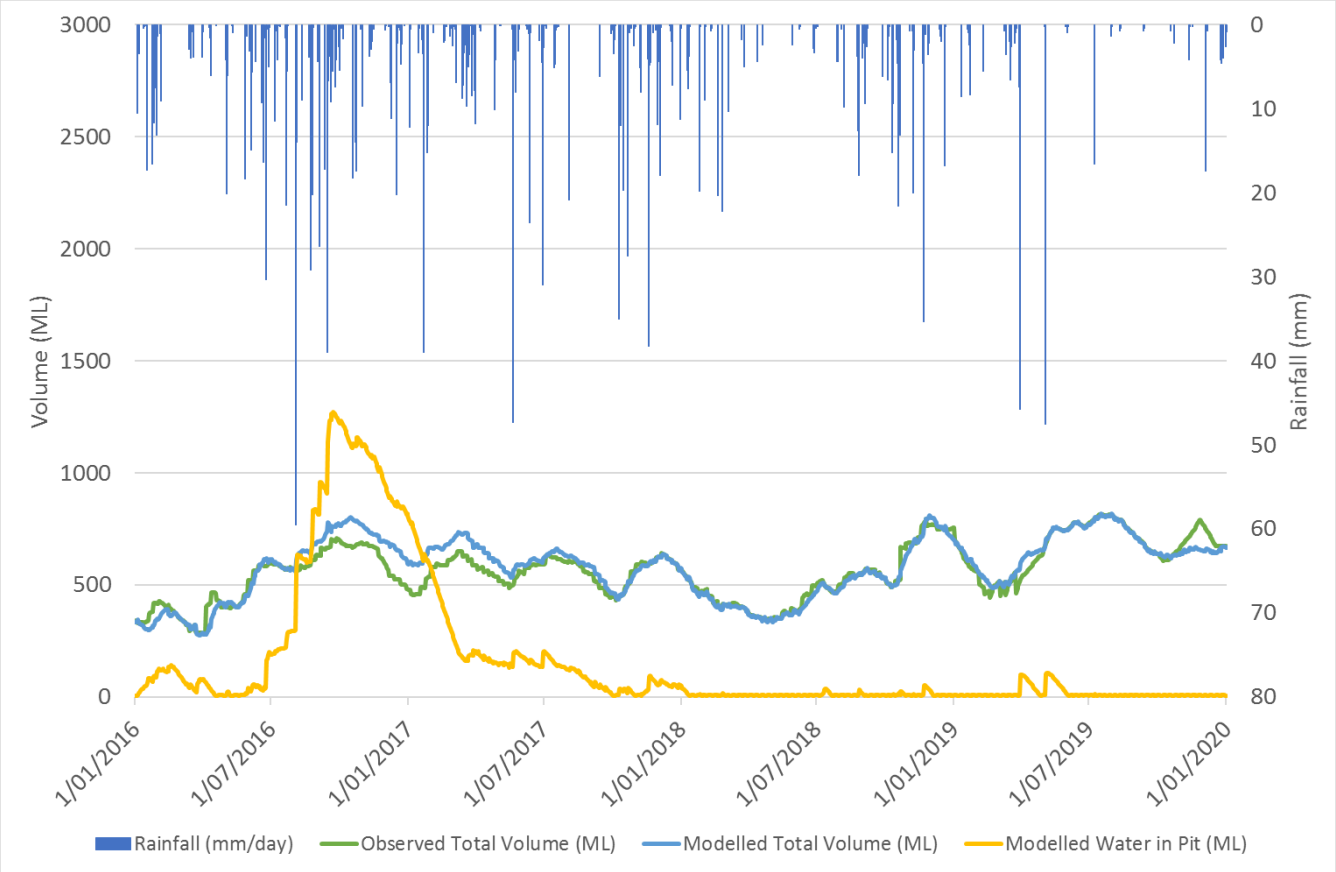
Table 3.2: Observed Water Usage

Water Usage	**Average observed by BCOP from 2016 to 2019**
CHPP net usage	120 L/ROM tonne
Washdown and Potable Usage	0.3 ML/day (110 ML/year)

3.2 RESULTS

Observed and modelled total site water volume from the annual WBM review is compared in Figure 3.1 below.

Figure 3.1: Total Site Water Inventory



The key outcomes from the 2019 WBM validation (BCOPL, 2021) were:

- Water storage operating logic was updated to match changes to how storages are managed on site.
- The extraction logic was updated to preference borewater over surface water extraction as is the practice on site.
- No changes to the AWBM parameters were required as the runoff model was considered to be operating acceptably.

It is noted that the AWBM parameters for the model have not been updated in any recent WBM review.

The SWB model validation exercise was considered to be suitable for the annual SWB review for the 2019 calendar year in accordance with the requirements of Appendix 6A of SSD 09_0182 and, as such, was considered suitable for use in the MOD 8 Surface Water Assessment (Engeny, 2021).

The SWB model review has been updated ten times since 2012, including three times since 2015, with updates to water management infrastructure and operating logic and a comparison of modelled verse observed water supply volumes. These reviews have meant the model has continued to provide a realistic representation of site WMS. Therefore, it was not considered to be necessary to undertake a sensitivity analysis on input data for the modelling for MOD 8.

4 WATER BALANCE MODEL RESULTS

4.1 OVERVIEW

The water balance model was updated to simulate the mining and coal handling characteristics because of MOD 8. The model considers existing and future operations and is used to estimate the likely water surplus/deficits and requirements into the future. The model allows detailed analysis, and considers:

- Direct rainfall onto dam/water storage surfaces.
- Water loss due to evaporation from water storages and pits.
- Runoff from natural, rehabilitated, and disturbed catchment areas.
- Groundwater inflow to open cut pits.
- Water lost to product coal through the CHPP and ROM coal through the crusher (based on projected production rates).
- Water used for on-site dust suppression (haul roads).
- External water supplies.
- Site discharges.

The assessment of the potential impacts of MOD 8 on the SWB is based on the outcomes of a GoldSim model. The model uses the SILO climate data for 126 years. The potential impacts of MOD 8 were assessed using 126 possible climatic sequences and as such assesses the water balance for many rainfall possibilities.

The predicted water balance for the Approved Operations at BCM is presented Table 4.1.

Table 4.1: Summary of Average Predicted Water Balance – Approved Operations

Water Balance Element	2021	2026	2031
Inflows (ML)			
Direct rainfall and runoff:			
Clean water (highwall) dams	0	12	55
Dirty water (sediment) dams	762	1,093	1,834
Mine water dams, MWDs and Pit	1,634	1,423	922
Groundwater make	329	377	319
Licensed imported water	1,211	581	838
Total inflows (ML)	3,936	3,486	3,968
Outflows (ML)			
Demands:			
Dust suppression	1,396	1,403	1,339
CHPP	1,252	1,249	1,249
MIA and potable water	365	364	364
Evaporation:			
Clean water (highwall) dams	-	2	17
Dirty water (sediment) dams	133	220	248

Water Balance Element	2021	2026	2031
Mine water dams, MWDs and Pit	388	365	334
Licensed discharges to Nagero Creek:			
Clean water (highwall) dam discharges	-	8	31
Dirty water (sediment) dam discharges	136	499	751
Dam overflows to Nagero Creek:			
Dirty water (sediment) dam overflows	131	123	216
Total Outflows (ML)	3,802	4,232	4,548
Change in storage (ML)	**134**	**-746**	**-580**

4.2 POTENTIAL IMPACTS WITH MOD 8

Table 4.2 presents a summary of the water balance results for BCM with MOD 8. The predicted water inventory is also shown on Figure 4.1.

Table 4.2: Summary of Average Predicted Water Balance – with MOD 8

Water Balance Element	2021	2026	2031	2039
Inflows (ML)				
Direct rainfall and runoff:				
Clean water dams	0	31	0	0
Dirty water (sediment) dams	680	333	330	334
Mine water dams, MWDs and Pit	1,429	1,272	1,266	1,616
Groundwater make	173	517	401	202
Licensed imported water	470	644	486	565
Total Inflows (ML)	**2,751**	**2,797**	**2,483**	**2,716**
Outflows (ML)				
Demands:				
Dust suppression	639	1,643	895	720
CHPP	989	1,048	1,040	393
MIA and potable water	365	365	362	365
Evaporation:				
Clean water (highwall) dams	0	1	0	-
Dirty water (sediment) dams	133	109	99	102
Mine water dams, MWDs and Pit	406	367	384	510

Water Balance Element	2021	2026	2031	2039
Licensed discharges to Nagero Creek:				
Clean water (highwall) dam discharges	-	24	0	-
Dirty water (sediment) dam discharges	175	44	50	68
Overflows to Nagero Creek:				
Dirty water (sediment) dam overflows	133	12	14	16
Total Outflows (ML)	2,841	3,613	2,844	2,173
Change in storage (ML)	**-90**	**-815**	**-361**	**543**

The water balance modelling indicates total water inventory (Figure 4.1) on site is primarily driven by groundwater inflows into the pit, and licensed imported water. However, the uncertainty in the modelled total water inventory (Figure 4.1) is largely a result of the range of climatic conditions (i.e. flood and drought: refer Section 2.1.2) that would alter the volume of surface water captured by the WMS.

The modelling indicates for MOD 8 a period of decline in total site water inventory prior to 2027 (Figure 4.1), due to reduced groundwater extraction between 2021 and 2024 when compared to the Approved Operations scenario (Figure 4.3). During this period, there is an increased risk of water shortage should prolonged or severe drought conditions occur. Under these conditions, site water inventories have the potential to drop below about 1,000 ML (Figure 4.1), requiring licenced Namoi River extractions to be maximised (Figure 4.3), and additional external water supplies may be required (Figure 4.5), in the form of temporary WALs (e.g. from Lake Keepit), consistent with existing operations.

During wet weather conditions, the water balance modelling indicates that the total site water inventory (Figure 4.1) remains within the target site-wide operating volumes for scenarios up to the 95th percentile climate scenario. Only extreme rainfall events are expected to result in an exceedance of the site wide target operating volumes. During these periods, mining operations are unlikely to be possible, allowing for the use of the pit as an emergency water storage (Figure 4.1).

The water balance modelling indicates that, for average conditions, MOD 8 will result in an increase in the water imported from the borefield after 2021, however this increase is not expected to result in the need to purchase any additional WALs, as the modelled imported water from the Lower Namoi River Regulated Water Source is reduced. The water balance modelling, for the 50th percentile modelled results, indicate that no additional WALs will be required to allow for the proposed minor increase in annual coal production rate from 8.6 to 9.1 Mtpa sought by MOD 8 (refer to Figure 4.5).

The water balance modelling indicates that the volume of uncontrolled discharges (overflows) of sediment-laden water from sediment dams is expected to reduce over time (Table 4.2), largely as a result of the rehabilitation of the waste rock emplacement areas and subsequent release of runoff to the downstream environment. The rehabilitation of the catchment areas reduces the overall volume of water intercepted by and managed within the dirty water management system (sediment dams). This reduction is considered a more realistic reflection of current site operations and rehabilitation strategies. It is noted that should runoff generated within the rehabilitated catchment area continue to be managed within the dirty water system, external water supplies (i.e. Namoi River extraction) would be reduced.

Figure 4.1: Predicted Water Storage Inventory

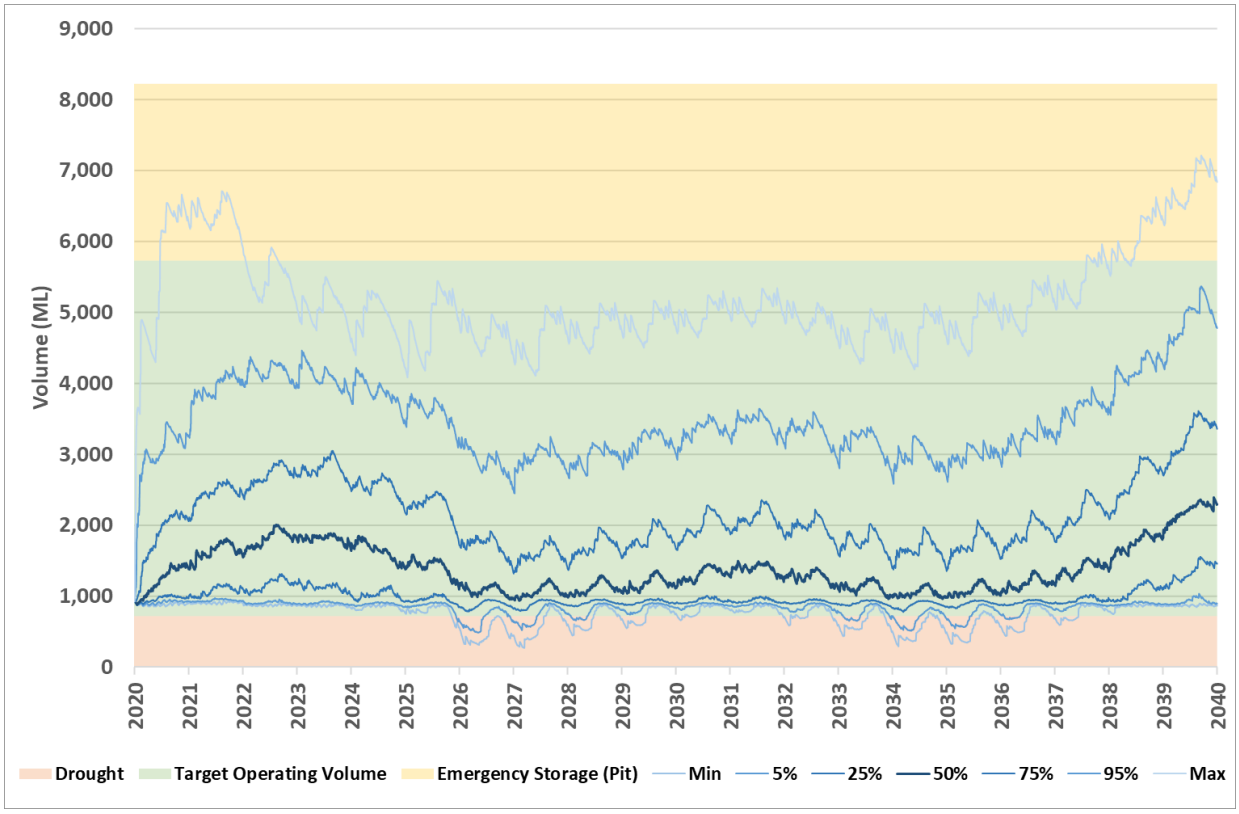
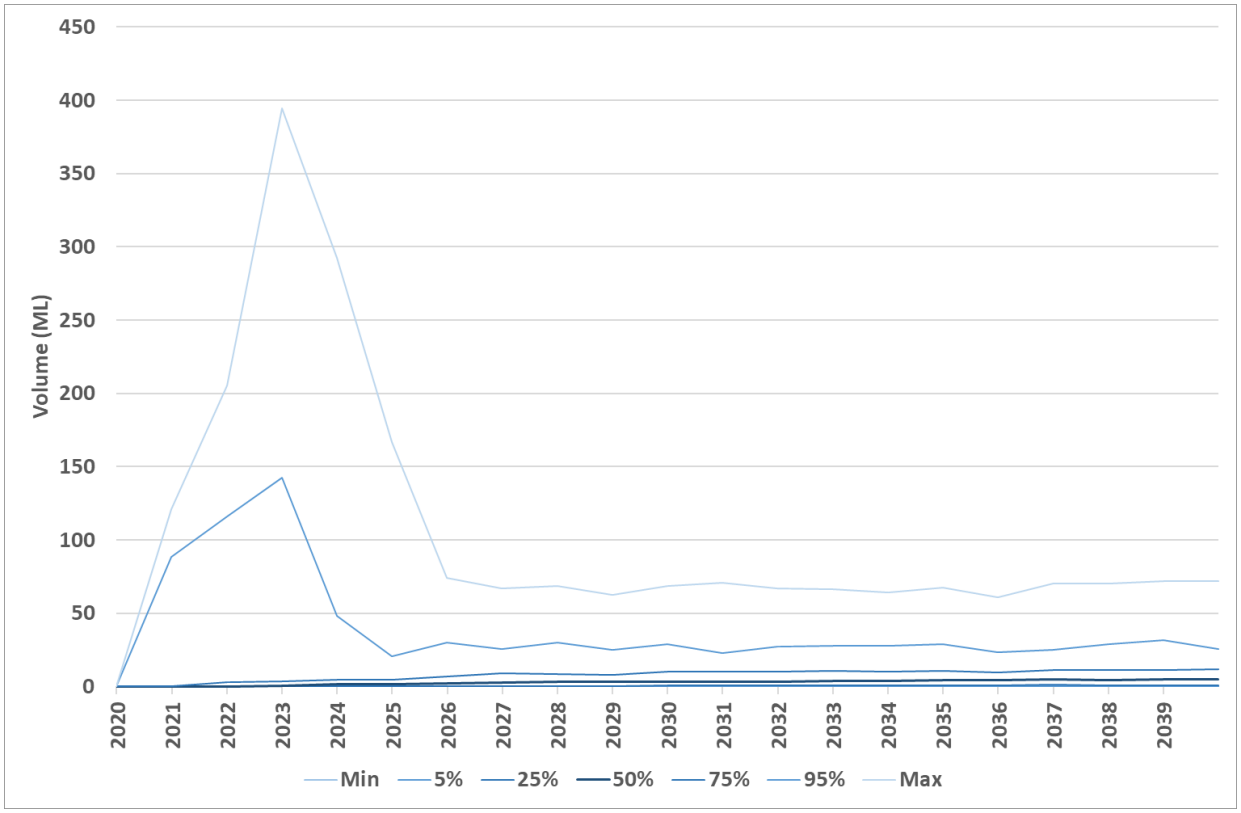
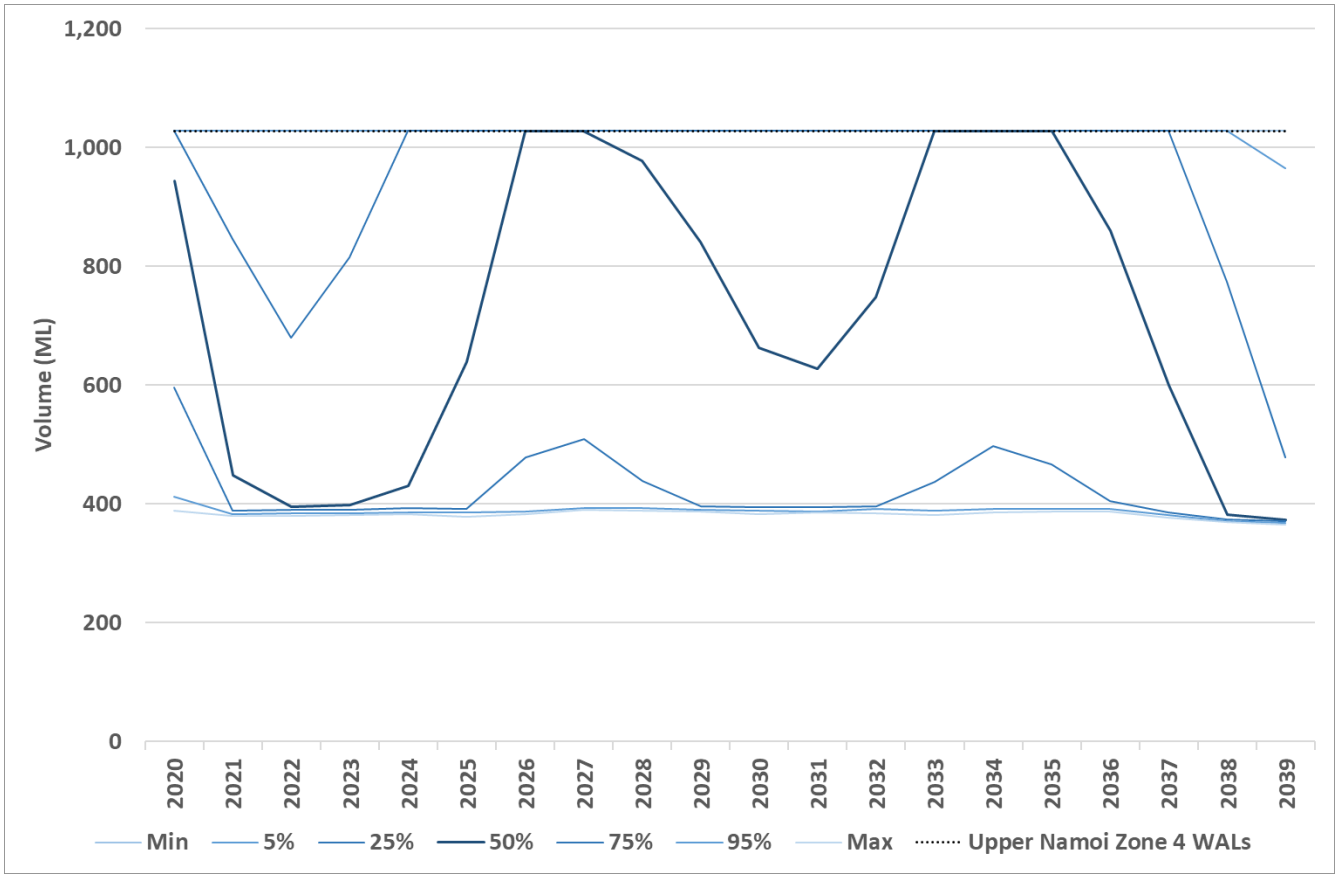


Figure 4.2: Modelled Dirty Water Overflows



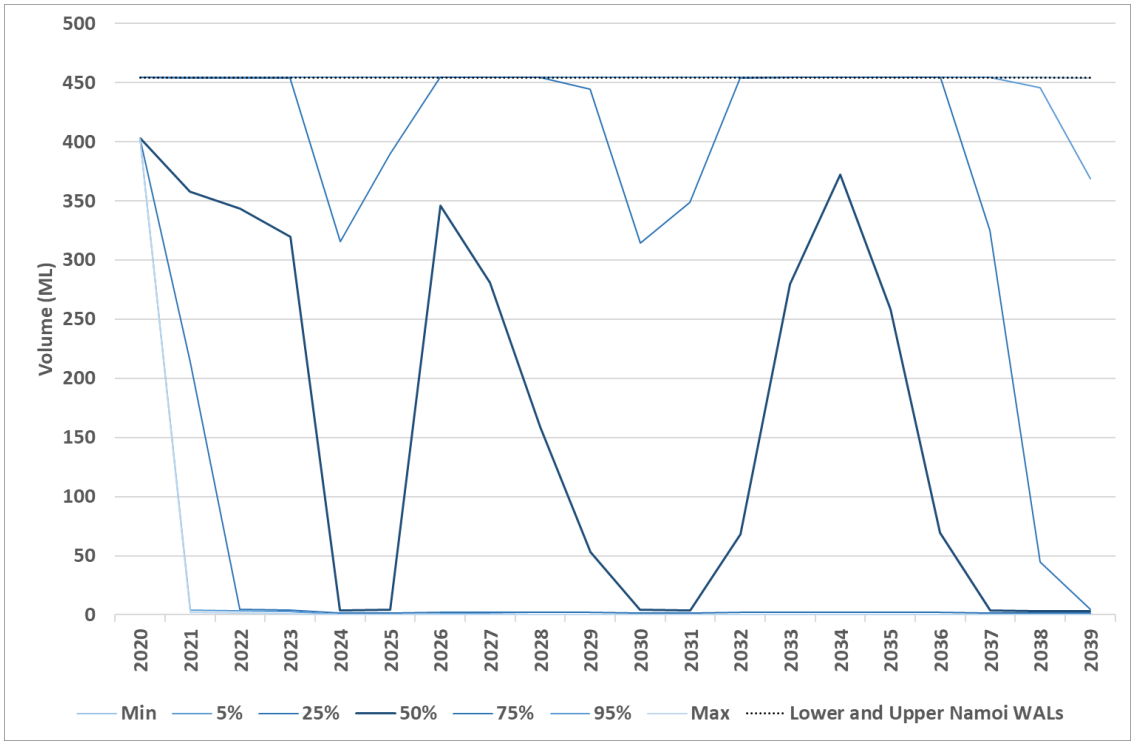
The predicted maximum dirty water overflow is 4 ML/year for the 50th percentile modelled results.

Figure 4.3: Total Modelled Groundwater Extraction (pit and borefield)



Predicted modelled groundwater extraction ranges from 373 ML/year to 1,028 ML/year for the 50th percentile modelled results. The maximum WAL entitlement of 1,028 ML for the alluvial borefield and incidental takes of groundwater from the alluvial as a result of mining activities was reached during 2026, 2027, 2033, 2034 and 2035 in the 50th percentile modelled results. It is noted that during the extreme dry conditions, all available groundwater WALs are utilised.

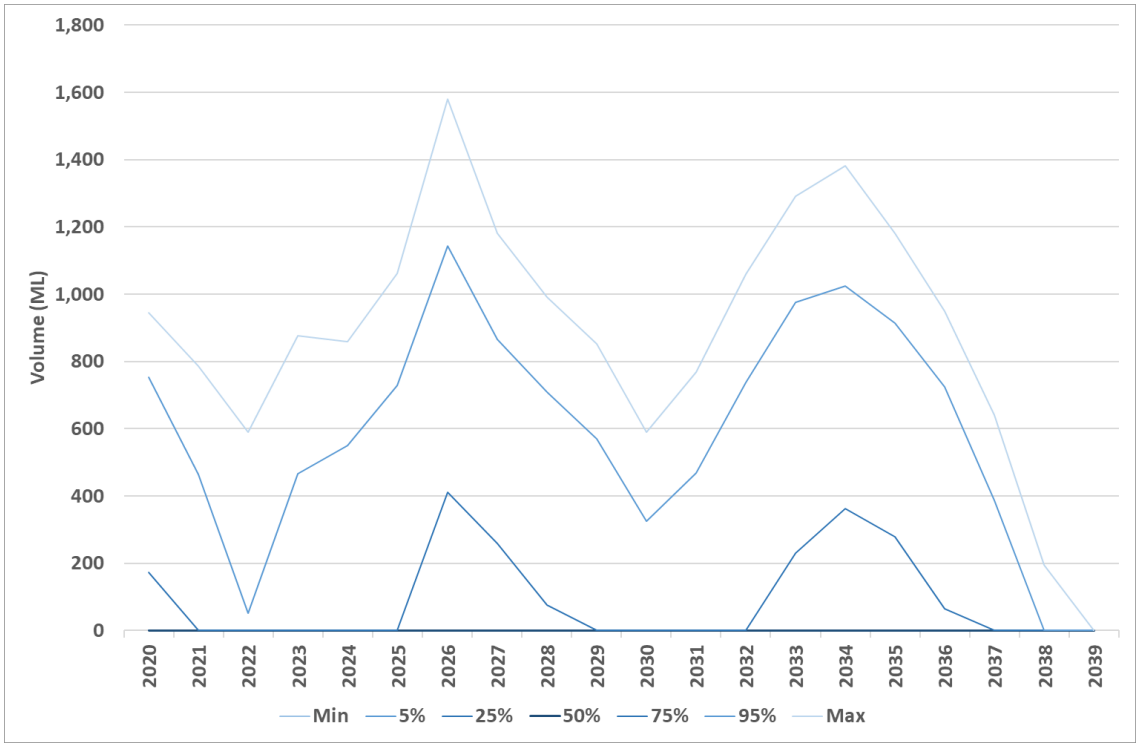
Figure 4.4: Modelled External Water Supply (Namoi River)



Predicted extraction from the Namoi River ranged from 3 ML/year to 403 ML/year for the 50th percentile modelled result. The maximum licensed extraction of 454.2 ML was not reached in the 50th percentile modelled result.

The modelled annual shortfall, where BCOPL are predicted to hold insufficient WALs to supply water to site operations, is presented in Figure 4.5. As discussed in Section 2.1.5, this volume is modelled as an additional external water source and the volume of water beyond the existing WALs held by BCOPL is estimated by the model on an annual basis. Water is assumed to be available as additional temporary licensed extraction from either surface water or bore water.

Figure 4.5: Modelled Additional Licensed Water Supply



No additional supply was required in the 50th percentile modelled event.

5 QUALIFICATIONS

a) In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

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g) This Report does not provide legal advice.

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