Narrabri Coal Mine

Brine Management and Beneficial Use Options Report

Narrabri Coal Operations Pty Ltd

Doc. Ref.: WHC-017-B3

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For and on behalf of **HydroBalance**
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1 Introduction

1.1 Background

The Narrabri Coal Operation (NCO) is an underground coal mining operation located approximately 28 kilometres (km) south-east of Narrabri and approximately 65 km north-west of Gunnedah in the Gunnedah Basin, New South Wales (NSW).

Narrabri Coal Operations Pty Ltd (NCOPL) currently has approval to extract 11 million tonnes of ROM coal from NCO per calendar year under Project Approval 08_0144.

1.2 Purpose and aim

HydroBalance has been commissioned to review and update the NCO Brine Management and Beneficial Use Report, developed by WRM Water & Environment on behalf of NCOPL in May 2019 (WRM, 2019).

Condition 21, Schedule 4 of the Project Approval 08_0144 states the following:

> *Every 5 years the Proponent shall engage suitably qualified experts approved by the Secretary to review brine management and beneficial use options for raffinate, brine and minewater produced by the project. The Proponent shall implement all reasonable and feasible recommendation of these reviews, to the satisfaction of the Secretary.*

For the purposes of this 5-yearly review, the report author, Matt Briody of HydroBalance, is considered a suitably qualified and experienced person and has been endorsed by the Planning Secretary (refer Appointment letter provided as Appendix B). In conducting the review, the suitably qualified person has undertaken an assessment of the (previous) 2019 report (WRM, 2019) and the status of recommendations; refer Section 3.

1.3 Report structure

The structure of this report is as follows:

- Section 2 list the available data and reports;
- Section 3 provides a summary of the WRM (2019) report recommendations and outlines actions taken by NCOPL to address them;
- Section 4 provides a summary of the available site water inventory data, including groundwater and brine generation and storage history;
- Section 5 summarise the brine management measures undertaken at NCO during the review period;
- Section 6 presents the proposed brine management strategy, including required upgrades to the NCO water management system and timing for construction of additional brine storages;
- Section 7 provides a summary of forecast modelling water balance modelling for NCO;
- Section 8 describes the beneficial use options for raffinate, brine and mine water produced by NCO;
- Section 9 details contingency measures for loss of brine management containment;
- Section 10 provides a summary of findings and recommendations for brine management at NCO;
- Section 11 is a detailed action plan to address the findings and recommendations of this report; and
- Section 12 is a list of references.

2 Available data

2.1 Previous studies and current reports

A number of previous studies were available for review as part of this study:

- Narrabri Coal Project (Stage 1) Surface Water Assessment (WRM, 2007);
- Narrabri Coal Hydrogeological Assessment (Aquaterra, 2009);
- Narrabri Coal Mine Stage 2 Longwall Project Surface Water Assessment (WRM, 2009); and
- Modification 5 Surface Water Assessment (WRM, 2015);
- Narrabri Mine Modification 5 Groundwater Assessment (Hydrosimulations, 2015);
- Narrabri Mine Water Management Plan (WRM, 2017);
- Preliminary assessment of beneficial use options for Narrabri Coal (WRM, 2018);
- Brine Management and Beneficial Use Options Report – Narrabri Mine (AECOM, 2017);
- Narrabri Coal Mine Brine Management and Beneficial Use Options Report (WRM, 2019);
- Narrabri Coal Rail Loop Dams Spillway Conveyance Capacity Assessment (WRM, 2019b);
- Narrabri Mine Water Management Plan (WHC, 2024); and
- Narrabri Coal Mine Groundwater Model Re-calibration (AGE, 2024).

2.2 Site water management and water quality data

A range of site water management data was provided by NCOPL, including:

- production data from the reverse osmosis (RO) and microfiltration (MF) plants from 2012 to 2024;
- detailed stage storage area relationships for all dams at the site;
- intermittent surveyed dam water levels from 2012 to 2024;
- ROM coal production records from 2010 to 2024, and the ROM coal production schedule for future years of mining;
- monthly surface water quality monitoring data for all dams at the site between 2009 and 2024;
- wet weather water quality monitoring data for the watercourses draining the mine site and the dams at the site; and
- details of water transfers and infrastructure changes between 2012 and 2024.

2.3 Predicted groundwater inflows

Predicted groundwater inflows for NCO were provided by AGE (2024).

3 Assessment of previous brine management reporting and recommendations

3.1 Previous reporting

NCOPL have completed two iterations of the *Brine Management and Beneficial Use Report* since 2017, to document and review the existing NCO brine management system and provide recommendations for future work. The reports completed to date include:

- *Brine Management and Beneficial Use Options Report – Narrabri Mine*, report prepared for AECOM, October 2017.
- *Narrabri Coal Mine Brine Management and Beneficial Use Options Report*, report prepared for WRM, May 2019.

The recommendations provided in these reports have been summarised in the sections below, as well as the actions taken by NCOPL to address the recommendations.

3.2 AECOM (2017) recommendations

The summary of the AECOM (2017) recommendations and NCOPL responses are summarised in Table 3.1. The AECOM (2017) recommendations were originally addressed in Section 3 of the WRM (2019) report. There are currently no outstanding recommendations from AECOM (2017).

Table 3.1 – Response to AECOM (2017) brine management action plan

Rec. no.	Target date	Recommended activity AECOM (2017)	NCOPL response (WRM,2019 – Section 3)
1	Completed	The Narrabri Mine WMP (WRM, 2017) is finalised	• The Narrabri Mine WMP (WRM, 2017) was reviewed by the NSW Natural Resources Access Register (NRAR), and comments were provided to NCOPL in 2018; and • An updated WMP (WRM, 2019a) has been produced to address the NRAR comments. *Note that the WMP has since been updated in 2024 by Onward Consulting (WHC, 2024); and is currently pending feedback from NSW DCCEEW.*
2	Completed	Continue ongoing monitoring of the site water balance and ensure the proposed infrastructure schedule, including water conditioning plant (WCP) capacity upgrades, installation of mechanical spray evaporators (if required) and construction of brine dam BR1 (if required) are conducted in a timely and effective manner.	• An updated WMP (WRM, 2019a) has been produced, incorporating all available water management system monitoring data; • A detailed water balance report (WRM, 2019c) has been produced including the following: ○ calibration of the site water balance model against available monitoring data; and ○ forecast water balance modelling of the water management system to

Rec. no.	Target date	Recommended activity AECOM (2017)	NCOPL response (WRM,2019 – Section 3)
			identify the timing of required upgrades and construction of brine dam BR1. *Note that the water balance modelling has since been updated in the latest WMP (WHC, 2024).*
3	Completed	• Conduct appropriate analysis to determine the capacity of existing HDPE overflow pipes; • Review the rail loop brine storage system with respect to: ○ Continued appropriateness of current system of potentially cascading overflows; ○ Conduct a revised consequence assessment (arising from the increased number of brine dams) resulting from embankment failure or failure to contain (overflow and seepage); and ○ Inform the Dam Safety Committee regarding the current and future change in use of the dam system. • Continue ongoing monitoring of site water balance and conduct assessment of off-site transfer options to ensure timely commencement of preferred option(s) when required.	• Feedback from the DSC was provided in December 2018, indicating that the cascading dams at NCO are prescribed as a single structure by the DSC ("Narrabri Coal Rail Loop Dams"), and that they have been assessed as having a significant consequence category. • A conveyance capacity assessment has been carried out for the HDPE overflow pipes, the findings of which have been summarised in WRM (2019) (refer Section 8).
4	Completed	Inform the Dam Safety Committee on mine water storage changes	NCOPL are communicating with the DSC to ensure all relevant reports and information on the mine water storages at NCO are available for review.

3.3 WRM (2019) recommendations

The summary of the WRM (2019) recommendations and NCOPL responses are summarised in Table 3.2. There are currently no outstanding recommendations from WRM (2019).

Table 3.2 – Response to WRM (2019) brine management action plan

Rec. no.	Target date	Recommended activity WRM (2019)	NCOPL response
1	Ongoing	Continue to monitor underground mine dewatering and water use at NCO	NCOPL actively monitor underground mine dewatering and water use over the 5-year period, as discussed in Section 4.7.

Rec. no.	Target date	Recommended activity WRM (2019)	NCOPL response
2	Ongoing	Track estimated extractions of groundwater and compared to modified groundwater inflows adopted for water balance modelling in this report. Flowmeter records for underground filtered water feed and boxcut dewatering should be compared on a weekly basis.	A comparison of the observed and the re-calibrated groundwater inflow rates is provided in Section 4.7. Totaliser readings for the key flowmeters have been regularly collected and are discussed in Section 4.7.
3	Ongoing	Track reclaim / saline and brine inventory. Dam water levels are currently surveyed once per month. Recommend frequency of surveys are increased to weekly.	Weekly water level surveys have been undertaken since January 2020 for all reclaim / brine dams. The recorded site inventory data is presented in Section 4.4.
4	May 2019	Commission update to and recalibration of groundwater modelling for NCO. Current groundwater estimates (Hydrosimulations, 2015) significantly overestimate actual groundwater extractions.	A re-calibration of the groundwater modelling for NCO was completed by AGE in 2024. A comparison of the observed and the re-calibrated groundwater inflow rates is provided in Section 4.7.
5	July 2019	Increase the capacity of the rail loop dam outlet pipes to increase the freeboard for Dam B2 and Dam D and prevent an overflow for Dam C. The following pipe upgrades are recommended in WRM (2019b): • Dam B2 - increase the minimum pipe diameter (internal) to 0.45 m • Dam C – duplicate existing 0.35 m (internal) pipe; and • Dam D – duplicate existing 0.45m (Internal) pipe.	A spillway pipe upgrade was completed in late 2019 which allows sufficient capacity to carry the 1 in 10,000 AEP. The upgrade works included the following: • Dam B2- two-pipe spillway comprising of the original 350mm inner diameter pipe and a second 500mm outer diameter pipe. • Dam C- two-pipe spillway comprising of the original 400mm inner diameter pipe and a second 500mm outer diameter pipe. • Dam D- two-pipe spillway comprising of the original 450mm inner diameter pipe and a second 500mm outer diameter pipe.
6	Optional	Provide infrastructure for use of brine in product and ROM stockpile sprays. A flowmeter should be installed to monitor usage volumes.	Infrastructure modifications allow for brine injection into stockpile sprays. A flowmeter has been installed to record the brine used in the brine injection system.
7	Optional	Commence design of BR1. Recommend design of BR1 is undertaken, with ability to be constructed as a staged storage. Volume of BR1 to be determined based on selected water management scenario.	Construction of BR1 was completed in November 2023. BR1 is currently in the process of being commissioned and is expected to be fully operational in September 2024. Further details regarding the configuration and operation of BR1 is presented in Section 5.3.

4 Site water inventory and history

4.1 Water management

The Water Management Plan (WMP) (WHC, 2024) sets out the key objectives and general operating rules of the site water management system at the NCO, including site demands and water sources.

4.2 Surface water types

For the purposes of site water management, the surface water generated at the NCO is divided into seven types based on water quality:

- 'Raw' – raw water imported to the NCO from external sources (e.g. Namoi River).
- 'Clean' – surface runoff from the NCO site areas where water quality is unaffected by mining operations. Clean water includes runoff from undisturbed areas and any fully rehabilitated areas.
- 'Filtered' – water treated by the RO or MF plants (raffinate), suitable for use in the underground workings or controlled release to the Namoi River in accordance with Condition 11, Schedule 4 of Project Approval (08_0144) (subject to a variation of EPL 12789).
- 'Disturbed runoff' – surface runoff water from the NCO site areas that are disturbed by mining operations. This runoff may contain silt and sediment, but does not contain other pollutants (e.g. chemicals, hydrocarbons). This water can be released from site in accordance with EPL 12789, if required.
- 'Reclaim' – surface water from NCO site areas affected by mining operations and potentially contain silt/sediment and other pollutants (e.g. chemicals and hydrocarbons). Reclaim water areas include sumps, coal stockpile areas, service dams and fuel storage areas. Reclaim water is managed to avoid its discharge from the NCO.
- 'Saline' – water pumped from the underground workings containing elevated concentrations of total dissolved solids (TDS).
- 'Brine' – waste or concentrate produced by the RO plant containing high concentrations of TDS.

4.3 Dams and infrastructure

Figure 4.1 shows the existing/approved dams at the NCO, and Table 4.1 provides a summary of the key characteristics of each dam.

Table 4.1 – Water storage details at NCO

Dam	Water type	Capacity (ML)	Catchment area (ha)
A1	Saline / Reclaim	142.9	3.6
A2	Saline / Reclaim	35.7	1.2
A3	Saline / Reclaim	37.8	1.2
B1	Filtered	39.2	1.0
B2	Brine	157.9	6.1
C	Brine	220.3	8.6
BR1	Brine	464.7	7.1
BR2[1]	Brine	528	-
BR3[1]	Brine	516	-
BR4[1]	Brine	501	-

Dam	Water type	Capacity (ML)	Catchment area (ha)
BR5[1]	Brine	499	-
BR6[1]	Brine	503	-
BR7[1]	Brine	502	-
BR8[1]	Brine	504	-
D	Raw	135.7	4.2
Containment Bund	Raw	40.1	10.6
SB1	Reclaim	24.3	15.8
SB2	Reclaim	42.3	8.2
SB3	Reclaim	27.8	23.3
SB4	Reclaim	26.3	12.2
SD1	Disturbed	7.3	41.6
SD2	Disturbed	53.6	35.7
SD3	Disturbed	5.9	28.8
SD4	Disturbed	34.6	6.6
SD6	Disturbed	10.3	8.2
SD7	Disturbed	12.0	18.3
SD8	Disturbed	7.1	3.0
SD9	Disturbed	8.9	9.2

[1] proposed water storage

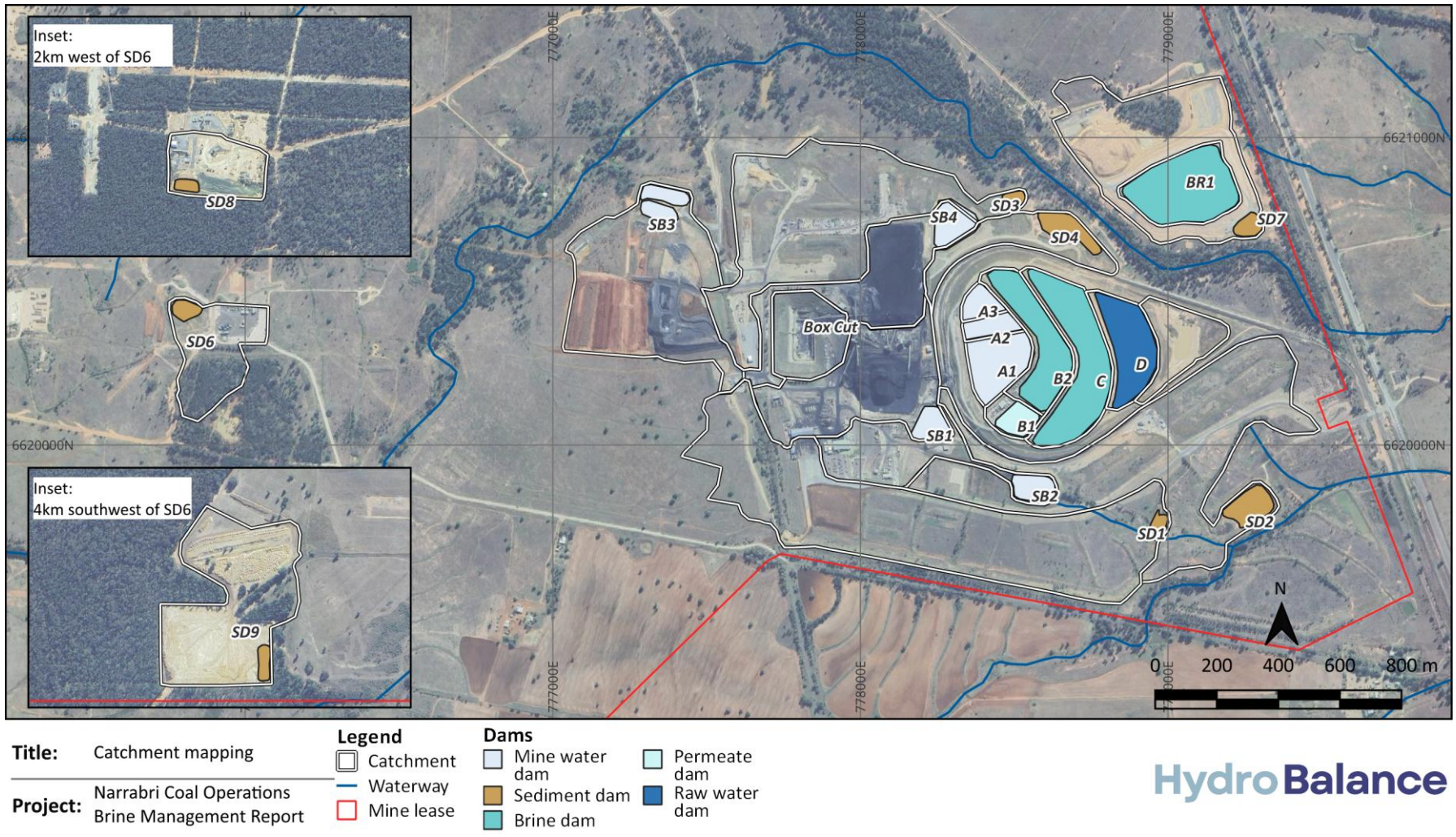

Figure 4.1 – Existing/approved dams and catchments

4.4 Recorded site inventory

Figure 4.2 shows the site water inventory history. At the time of reporting (July 2024), the total volume of each type of water stored at NCO in the rail loop dams is as follows:

- Reclaim and saline water: 204 ML (combined FSV of 216 ML in Dams A1, A2 and A3);
- Brine: 343 ML (combined FSV of 843 ML in Dams B2, C and BR1);
- Filtered water 28.0 ML (FSV of 39.2 ML in Dam B1); and
- Raw water: 61.7 ML (FSV of 135.7 ML in Dam D).

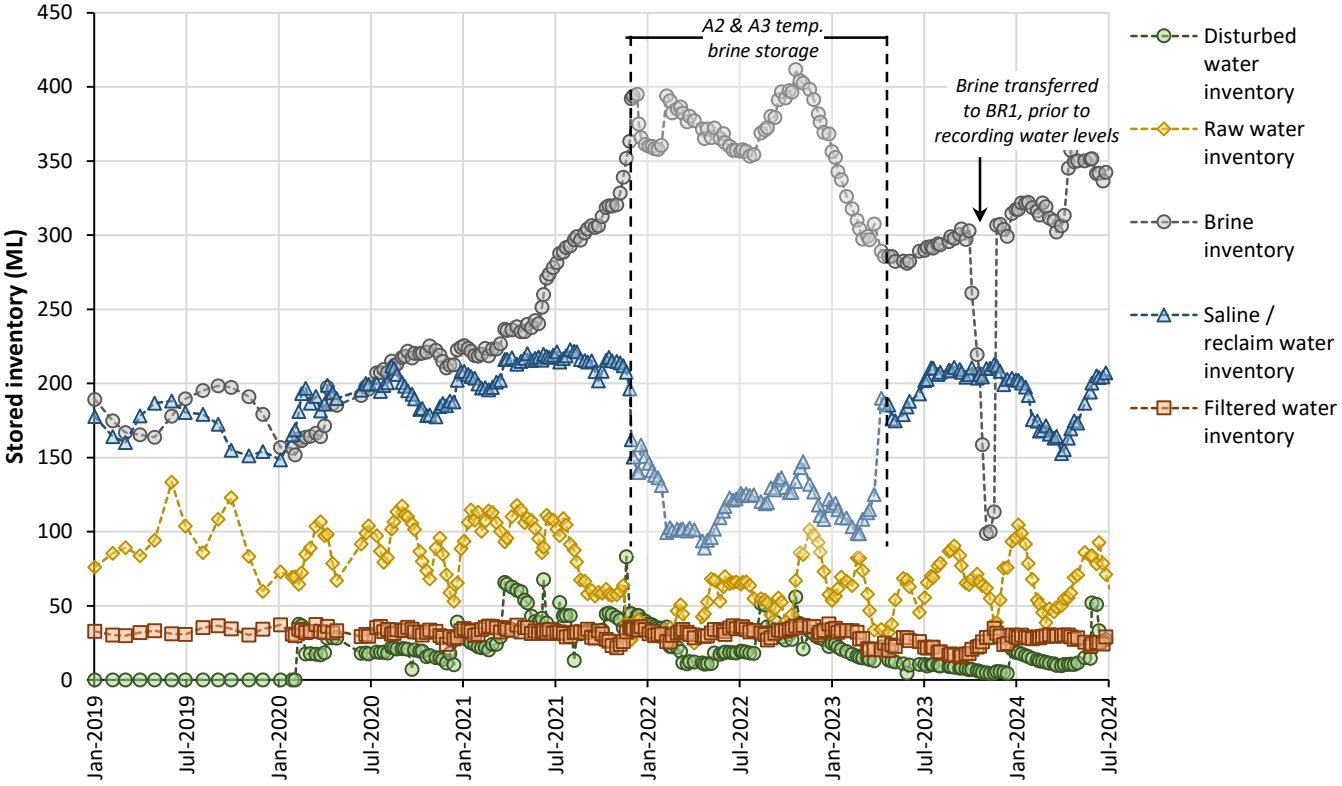

Figure 4.2 – Historical behaviour of site water inventory, January 2019 to July 2024

4.5 Site water management system

The operation of the existing/approved site water management system is shown schematically in Figure 4.3, and can be summarised as follows:

- Reclaim water is collected in SB1, SB2, SB3 and SB4. Water collected in these dams is pumped to A1 for reclaim use or treatment in the RO plant. Reclaim water is transferred from A1 to the reclaim water tanks at the box cut for use in the coal handling and preparation plant (CHPP), dust suppression (surface trucks and ROM and product coal stockpiles) and washdown bay.
- SB1 has a permanent automatic pump, but all other reclaim dams are dewatered as required using mobile diesel pumps. Any spills from SB1 drain to SB2. Some overflows from SB1 are to be expected, as it is undersized for the catchment area draining to it. SB2 was constructed to account for the lack of capacity in SB1. SB1 and SB2 are operated as a combined dam system with MOV held in SB2. Any spills from SB2 drain to SD1, which forms part of the disturbed runoff management system.
- Evaporation fans are operated on SB3 to minimise excess reclaim water onsite. The maximum feed rate to the fan is 0.5 ML/d, and will evaporate the feed at an efficiency of 60%.

- Underground process water and groundwater entering the underground workings are pumped to the box cut sump, then transferred to the A series dams for reclaim use or treatment in the RO plants.
- Demands for reclaim water at NCO are obtained from A1 (via the reclaim water tank at the box cut).
- Disturbed runoff is collected in sediment dams SD1, SD2, SD3, SD4, SD6, SD7, SD8 and SD9. Four of these dams (SD2, SD4, SD7, SD8 and SD9) are EPL 12789 surface water discharge points.
- There are two RO plants currently operating at the mine. Both RO plants source feed water from A1. The original RO plant at the mine (RO1) began operating in June 2012. The long-term average RO1 plant unit feed flowrate is approximately 0.43 ML/day which accounts for shutdowns and cleaning (based on available RO1 plant monitoring data recorded between 2022 and 2024). The RO1 plant product raffinate (clean) / concentrate (brine) split is approximately 70% / 30% respectively.
- The RO2 unit (also referred to as the IMS RO plant) was commissioned in August 2017. The long-term average RO2 plant unit feed flowrate is approximately 0.55 ML/day which accounts for shutdowns and cleaning (based on available RO2 plant monitoring data recorded between 2022 and 2024). The RO2 plant product raffinate (clean) / concentrate (brine) split is approximately 80% / 20% respectively.
- The combined maximum feed rate into RO1 and RO2 is 2.4 ML/d. To date, the RO plants have not been required to treat such a volume of water, hence the recorded site data giving a combined long term treatment capacity of 0.8 ML/day for the two plants.
- Brine from the RO plant is currently stored in dams C, B2 and BR1, but has also been stored in A2 and A3 in the past. Additional brine storages (BR2 to BR8) may be constructed to contain excess brine if and when they are required.
- Filtered water from the RO and MF plants is pumped into B1, and then transferred to the filter water storage tanks at the box cut, for use underground and for firewater purposes. Any filtered water in excess of the NCO requirements will be piped to the Namoi River for release in accordance with Condition 11, Schedule 4 of Project Approval (08_0144) (subject to a variation of EPL 12789).

4.6 Key historical changes to the site water management system

Figure 4.2 and Figure 4.4 show the historical behaviour of the site water management system, including site water inventory and recorded water usage and underground dewatering. Key operational changes in the water management system since operations commenced include:

- The CHPP was commissioned in August 2011 and commenced fulltime operation in mid-2012.
- Longwall mining commenced in October 2012 and the RO1 plant commenced operations in June 2012.
- A2 and A3 were used to store brine from the RO1 plant until July 2014, when lining of Dam C was completed, and it became the primary brine storage. The contents of A2 and A3 were transferred into Dam C in September 2014.
- Prior to January 2012 all gas drainage water was stored in B2. From January 2012 onwards gas drainage water has been deposited in A1 to A3.
- An additional package RO plant was operated between October 2013 and September 2014. The package RO plant treated water from A1, A2 and B2. Some of the brine stored in A2 and A3 was transferred into B2 for treatment using the package RO plant. This explains the decrease in brine inventory and increase in saline / reclaim inventory between September and November 2013.
- When the package RO plant had treated the water stored in B2 in November 2015, HDPE lining of B2 commenced, and was completed in August 2016.
- The RO2 plant was commissioned in August 2017 and includes its own pre-treatment systems.

- A rental RO was commissioned in November 2021 to draw water from B2, in order to manage high brine inventories onsite. The rental RO was operated in a 'brine squeeze' configuration to super concentrate the brine. The rental RO was decommissioned in March 2023, once the brine inventories had been sufficiently drawn down.
- Mechanical evaporators were obtained from NCO reclaim system and the nearby Tarrawonga Coal Mine and operated on B2 from December 2021, to enhance the super concentration of brine. The mechanical evaporators from Tarrawonga Coal Mine were returned in July 2022. The remaining mechanical evaporators were moved to SB3 in July 2023, to manage the reclaim inventories on site.
- A2 and A3 were temporarily used as brine storages from December 2021 for A2 and from February 2022 for A3. As a result of the temporary brine management measures implemented (i.e. operation of the rental RO and mechanical evaporators), the A2 and A3 dams were returned to reclaim dams by April 2023.
- BR1 was constructed in November 2023 as an additional brine storage. BR1 is currently in the process of being commissioned and is expected to be fully operational by September 2024.

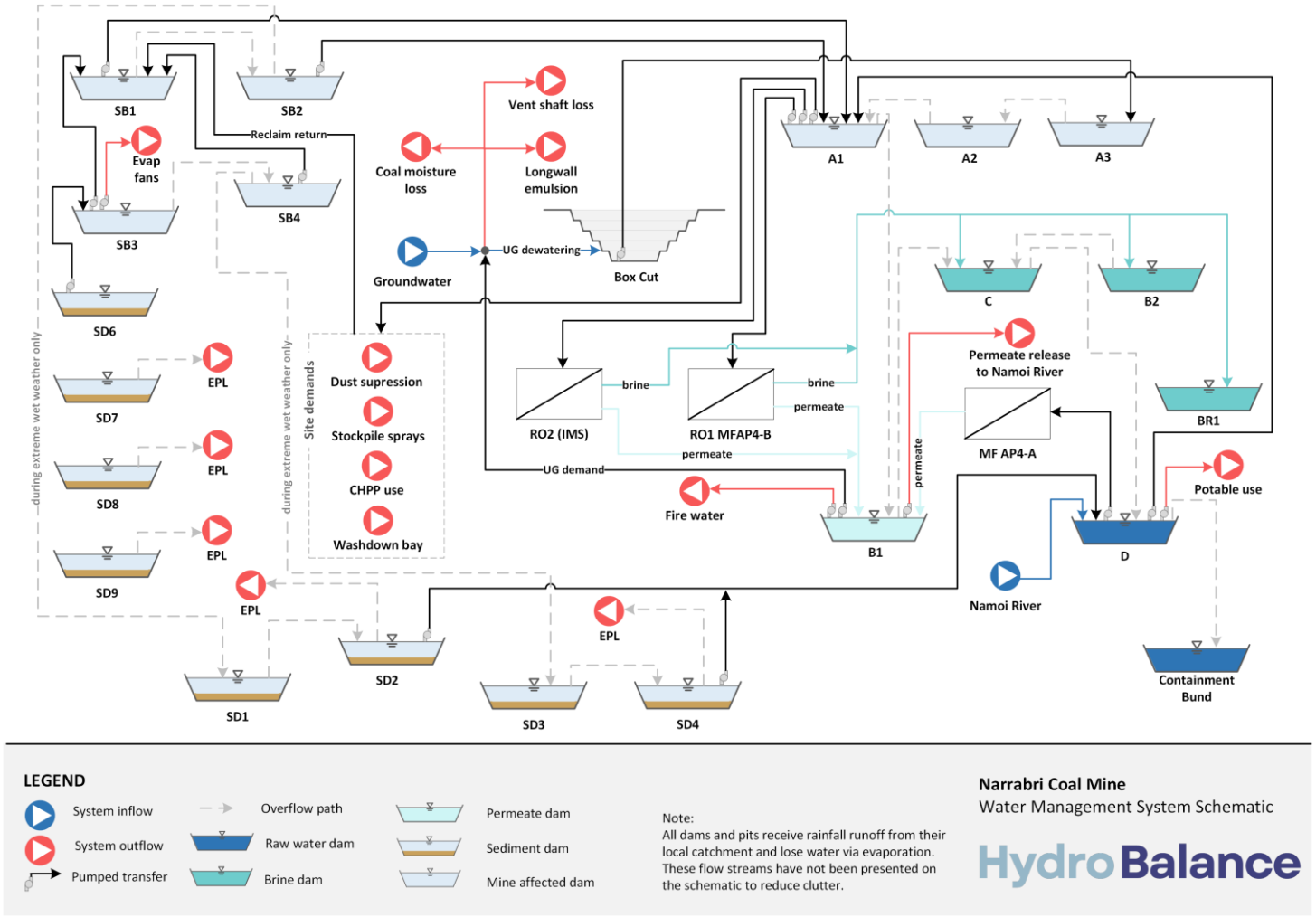

Figure 4.3 – Existing/approved site water management system schematic

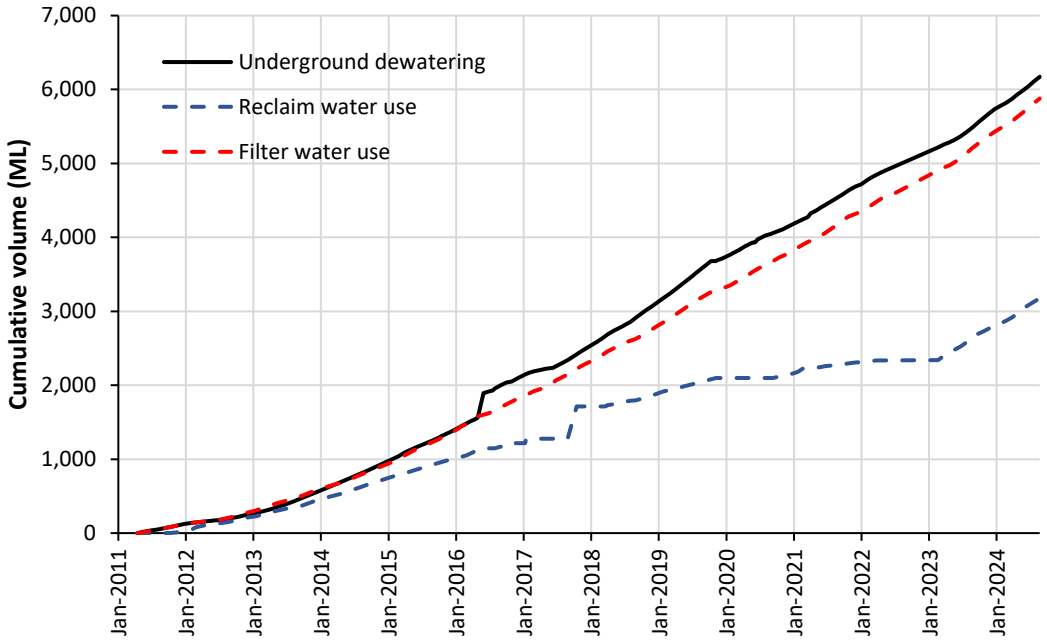

Figure 4.4 – Cumulative historical water consumption and underground dewatering, April 2011 to September 2024

4.7 Groundwater extraction

Groundwater is extracted via underground workings and via the gas drainage wells. Water pumped from underground into the boxcut sump is made up of both returned underground demand (underground equipment use, dust suppression etc) and groundwater inflows. The split between the two is important to calculate for both licensing and water management purposes.

To delineate the fractions of underground dewatering made up by return underground demand and groundwater inflows, the following assumptions were adopted based on discussions with NCOPL:

- Water enters the underground workings via:
  - underground filtered water demands (equipment use, dust suppression etc);
  - longwall emulsion; and
  - groundwater inflows.
- Water is lost from the underground workings via:
  - increase in coal moisture from in-situ to ROM;
  - vent humidity extraction; and
  - underground dewatering.

The underground mine filtered demand returning to the boxcut sump via underground dewatering is calculated as follows:

- Underground demand return = [underground filtered water demand + longwall emulsion] – [increase in coal moisture + vent humidity extraction].
- If the above result returns a negative number (i.e. losses exceed inflows) then there is no underground demand return for that day.
- The increase in coal moisture is based on an increase of 2% by mass from in-situ to ROM, and is estimated based on monthly ROM coal production totals provided by NCOPL.

- The vent humidity extraction is assumed to be 133 ML/yr (0.37 ML/day) based on calculations by NCOPL.

Groundwater inflow is unlikely to be lost to coal wetting or vent extraction. Therefore, all groundwater inflow would report to the boxcut sump via underground dewatering, and the estimated volume of groundwater inflow reporting the boxcut sump can be calculated as follows:

- Groundwater inflow = [Recorded boxcut flowmeter volume] – [Calculated underground demand return].

The total amount of groundwater extracted is then equal to the groundwater inflow plus the gas drainage extraction. Figure 4.5 shows a comparison between the groundwater inflow predictions from the *Narrabri Coal Mine Groundwater Model Re-calibration* report (AGE, 2024) and the estimated historical groundwater extraction at NCO since operations commenced.

Estimated actual extractions of groundwater followed a similar trend to the AGE (2024) estimated inflows between 2011 and 2019. The estimated actual extractions are between -55% below and +3% above the AGE (2024) estimated inflows during this period. The estimated actual extraction begins to deviate from the AGE (2024) estimated inflows from 2019, with the actual values appearing to progressively decrease between 2019 and 2024. This may be attributed to deviations from the actual and forecast ROM coal production over this period.

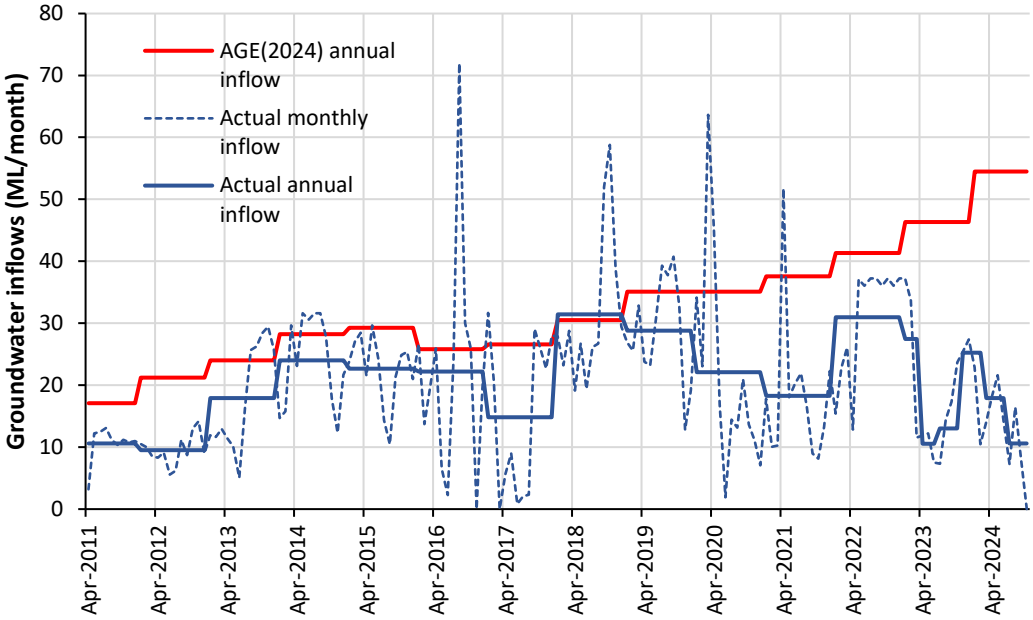

Figure 4.5 – Comparison of AGE 2024 re-calibrated groundwater inflow predictions and actual groundwater extractions

5 Brine management measures during the review period

5.1 System overview

The NCO brine management system currently includes three HDPE lined dams: B2, C and BR1. These dams manage and contain the brine generated by the two RO WTPs. The RO WTPs were continuously operated to manage underground dewatering inflows into the surface water management system. The brine dams are subject to climatic fluxes (i.e. inflows from rainfall, outflows from evaporation). Additional brine destruction measures were undertaken during the review period, to manage elevated brine inventories during prolonged wet weather conditions. The operation of the brine dams during the review period, including the additional brine destruction measures, are discussed in the follow section.

5.2 Recorded inventories and salinities

Figure 5.1, Figure 5.2 and Figure 5.3 shows the recorded inventories and salinities for B2, C and BR1, respectively.

These figures show that the brine inventories in B2 and C increased significantly between January 2020 and January 2023, due to the prolonged wet weather conditions at the site. The annual rainfall in 2020, 2021 and 2022 was 814 mm, 819 mm and 786 mm, respectively. These annual rainfall totals are 169 mm to 203 mm above the annual average rainfall for the site. Due to the increased brine inventories onsite, NCOPL undertook several measures to manage and mitigate potential risks:

- Commissioned a rental RO plant to super-concentrate the brine.
- Commissioned mechanical evaporators on B2, to enhance the brine evaporation.
- Temporarily converted A2 and A3 to brine water storages to increase the available brine capacity.

The brine inventories were returned to normal operational levels by April 2023, and the additional brine management measures were reversed or decommissioned.

BR1 was constructed in November 2023 as an additional brine storage. Routine leak detection monitoring identified a potential leak in the BR1, and the dam was subsequently taken offline for repairs in early 2024. BR1 will be available from September 2024, providing an additional 465 ML of additional brine storage.

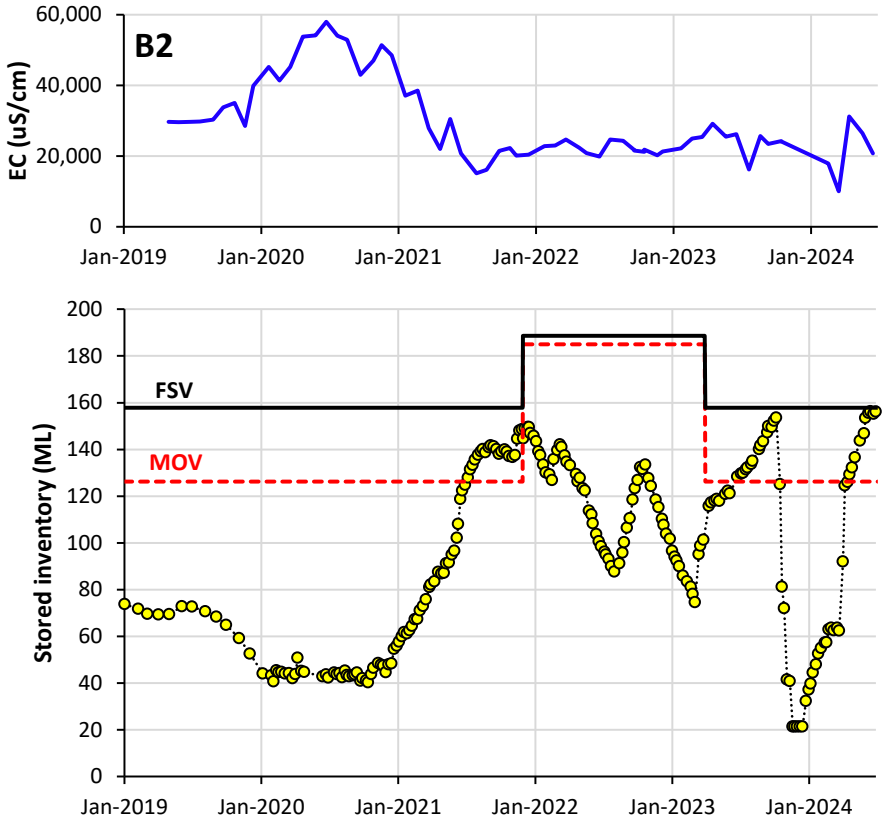

Figure 5.1 – Recorded B2 dam inventories and salinity

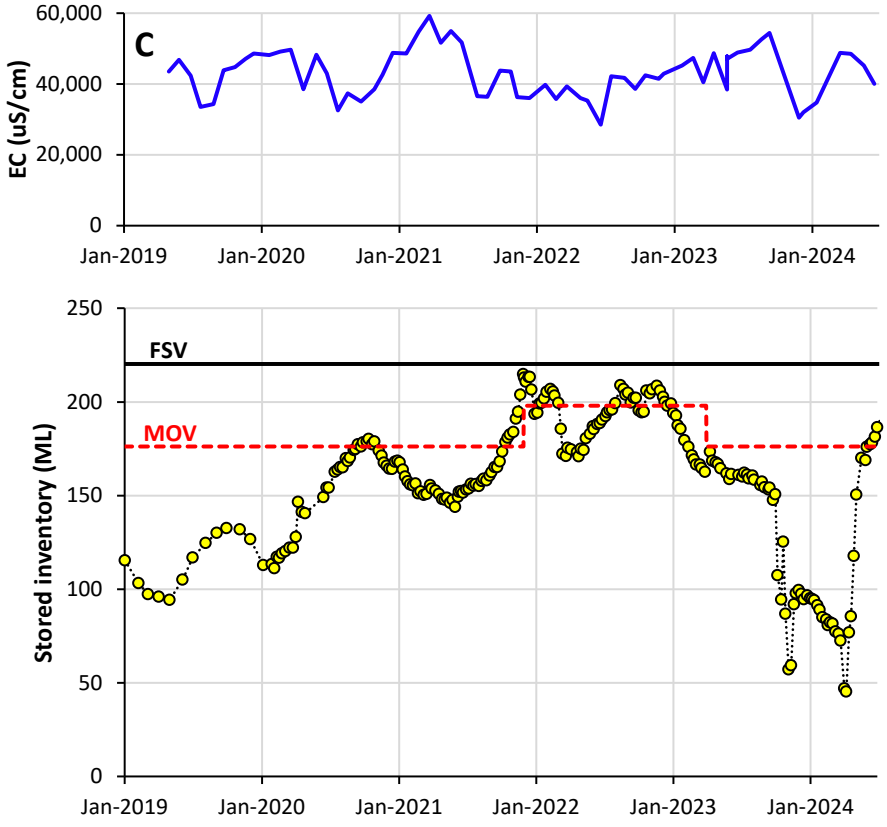

Figure 5.2 – Recorded C dam inventories and salinity

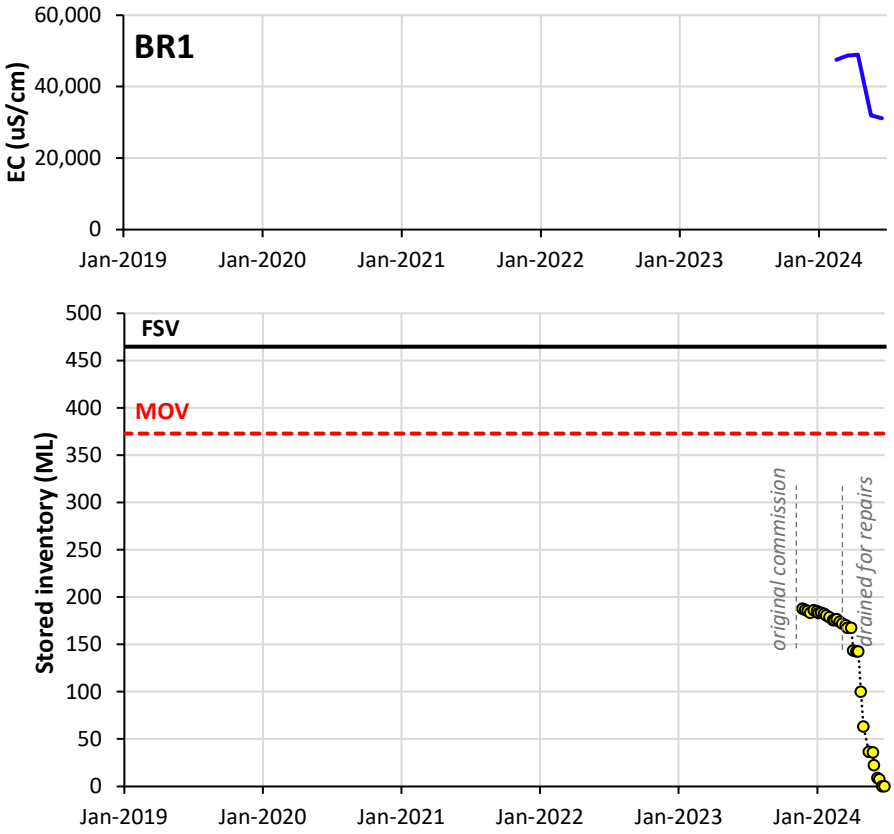

Figure 5.3 – Recorded BR1 dam inventories and salinity

5.3 Construction of BR1

BR1 was constructed in November 2023 as an additional brine storage. BR1 has an as-constructed capacity of 465 ML to the spillway and was lined with HDPE to the spillway level. The as-constructed stage-storage curve is shown in Figure 5.4.

BR1 was filled up to 187 ML in November 2023, however, routine leak detection monitoring identified a potential leak in the BR1, and the dam was subsequently taken offline for repairs in early 2024. BR1 is currently in the process of being commissioned and is expected to be fully operational by September 2024.

5.4 Annual brine dam inspection summary

The rail loop complex and BR1 were recently inspected by SLR in 2024 (SLR, 2024a; SLR, 2024b). The inspections generally found that the HDPE liners, embankments, pipework and signage were generally in good condition.

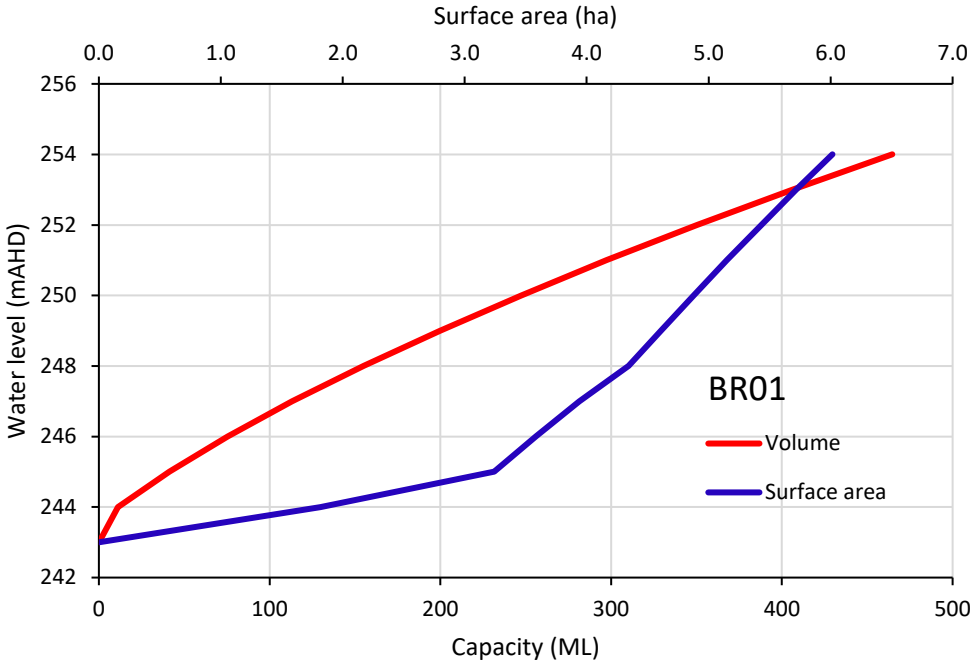

Figure 5.4 – As-constructed BR1 dam stage-storage curve

5.5 Water treatment plant operation for brine management

The two primary WTPs, RO1 and RO2, were operated during the review period to treat underground dewatering inflows into the surface water management system. The operation of RO1 and RO2 is described in Section 4.5.

An additional rental RO model was commissioned in November 2021 to reduce brine volumes on site. The plant was used to super concentrate the brine stored in B2 (along with brine produced by the permanent RO plants at NCO). The super concentrated brine was deposited in B2 and raffinate in B1. The rental RO module was operated as follows:

- Nominal feed rate 1.1 ML/day, which is capable of treating water with a total dissolved solids (TDS) concentration of up to 37,500 mg/L;
- The treatment efficiency was approximately 50%.

The rental RO module was decommissioned in March 2023, after brine inventories were recovered

5.6 Piped spillway upgrades

A conveyance capacity assessment was undertaken by WRM (2019b) to assess the hydraulic performance of the storages and piped spillways for the rail loop dams (A1, A2, A3, B1, B2, C and D) in 2019. The WRM assessment showed that Dam B2, Dam C and Dam D did not have sufficient freeboard for the 1 in 10,000 AEP event at the time of the assessment. Based on this, WRM (2019, 2019b) recommended that the capacity of the outlet pipes is upgraded to increase the freeboard for Dam B2 and Dam D and prevent an overflow for Dam C.

Following the WRM (2019b) assessment, the spillway pipe upgrades were completed in late 2019 which allows sufficient capacity to carry the 1 in 10,000 AEP. The upgrade works included the following:

- Dam B2- two-pipe spillway comprising of the original 350mm inner diameter pipe and a second 500 mm outer diameter pipe.
- Dam C- two-pipe spillway comprising of the original 400mm inner diameter pipe and a second 500 mm outer diameter pipe.

- Dam D- two-pipe spillway comprising of the original 450mm inner diameter pipe and a second 500 mm outer diameter pipe.

5.7 Mechanical evaporators

Mechanical evaporation fans were operated on B2 to reduce the volume of brine stored onsite between December 2021 and July 2023. The fans were estimated to have the following operational parameters:

- 0.5 ML/d feed rate per fan;
- 8 hours per day operation; and
- 50% average summer efficiency, 20% average winter efficiency.

The feed rates into the fans were not recorded over the period of their operation on B2, hence it is unknown how much brine water was evaporated using this strategy.

5.8 Liner maintenance and leak detection

NCOPL undertake weekly dam inspections to ensure the integrity of the low permeability layers lining the brine storage pond is maintained. These inspections are guided by the Operations, Maintenance and Surveillance Manual (SLR, 2024c) that form part of the site Dam Safety Management System. Routine inspections are documented in weekly inspection checklists and include, but are not limited to, the following aspects:

- general integrity of all embankments (e.g. observable deformation or settlement, etc).
- any visible damage to lining system.
- Indication of any seeps or expression of water downstream of any embankment.
- Water level within the storages.

Any corrective actions required are captured in the site maintenance system.

Leak detection is undertaken at 8 bores in the vicinity of the Rail Loop dams, and a further 5 wells located around BR1. Monitoring of groundwater levels and quality is undertaken quarterly in accordance with Environment Protection Licence. The monitoring results are reviewed by suitably qualified persons and reported in quarterly review reports. To date the results show there is no connectivity evident between the dam complex and groundwater system.

5.9 Algae management

The use of aerators to increase dissolved oxygen levels to inhibit algae growth is implemented in A1 and the brine dams B2, C and BR1.

When routine dam inspections indicate increased levels of algae growth are apparent, liquid copper-sulphate product is available for broadcast coverage over dams; this has been effectively applied to the surface of dams using water cart and sprinkler systems.

Algaecide injection into RO permeate discharge stream occurs for purpose of preventing algae growth in water used underground.

6 Potential brine management options

6.1 Overview

To ensure that adequate storage can be provided for brine at NCO, a brine management plan has been developed and validated using the site water balance model.

The brine management plan relies on two main objectives:

- Provision of adequate reverse osmosis treatment capacity at NCO to manage reclaim and saline water, and prevent dams A1, A2 and A3 overflowing and overwhelming the capacity of the downstream brine storage dams; and
- Provision of adequate storage capacity for brine to prevent overflows from the brine storage dams into the raw water Dam D, and into the receiving environment.

6.2 Reverse osmosis water treatment plant capacity

NCOPL have advised that, if necessary, additional RO treatment modules can be commissioned to increase the treatment feed rate and improve the treatment efficiency.

Forecast water balance modelling shows that the RO feed capacity would need to be upgraded to at least 3.5 ML/d prior to FY29 to manage the inventories onsite (see Section 7).

6.3 Super concentration of brine (brine squeeze)

IF a need arises to reduce the volume of brine stored at NCO, the existing brine could be super concentrated. Super concentration of brine has been undertaken at NCO in the past using a rental module between November 2021 and March 2023. The previous rental module was operated as follows (which could be replicated in future instances):

- Nominal feed rate 1.1 ML/day, which is capable of treating water with a total dissolved solids (TDS) concentration of up to 37,500 mg/L;
- The treatment efficiency was approximately 50%.
- The plant was used to super concentrate the brine stored in B2 (along with brine produced by the permanent RO plants at NCO). The super concentrated brine was deposited in B2 and raffinate in B1.

6.4 Construction of an additional brine dam

Forecast water balance modelling (refer Section 7) has shown that additional brine dams (BR2 to BR8) would not be required if the RO treatment capacity is upgraded prior to FY29.

While the construction of additional brine dams is not projected to be required prior to FY29, conceptual design work has been completed for the dams as a potential future contingency measure. The approved capacities for the potential additional brine dams are summarised in Table 6.1. The need, timing and required volume for the additional brine dams will be reassessed in future water balance assessments.

Table 6.1 – Additional brine dam approved capacities

Dam ID	Approved capacity (ML)	Recommended maximum operation volume (MOV) (ML)
BR2	528	415
BR3	516	400
BR4	501	382
BR5	499	376
BR6	503	407
BR7	502	403
BR8	504	382

6.5 Increase brine usage

Brine has previously been mixed with reclaim water at NCO for use in ROM and product coal stockpile dust suppression. Site water management infrastructure allows for the use of brine for coal stockpile dust suppression; with the use of brine or mine water decided based on monthly water balance reviews and operating rules.

6.6 Mechanical evaporators

Mechanical evaporators are used at site to help manage inventories post large rain events. Evaporators are either located on B2 or SB3.

The current use of mechanical evaporators is a viable strategy to manage reclaim inventories at NCO, which in turn reduces the volume of brine generation. Additional mechanical evaporators should be considered as contingency if problems or delays occur with the brine super concentration process, or construction of additional brine dams.

7 Water balance modelling

7.1 Overview

The GoldSim software was used to develop a detailed water balance model of the NCO site water management system. The configuration of the NCO site water balance model is described in detailed in the NCO Site Water Balance Model Update – March 2024 (WHC, 2024).

The site water balance model is calibrated annually against recorded inventory data from the NCO water management system. The calibrated model was used to undertake forecast water balance modelling for a number of different scenarios to inform the timing of required upgrades to the water management system and construction of additional brine dams.

In interpreting the results of the forecast water balance simulation, it should be noted that the results provide a statistical analysis of the water management system's performance over the forecast period, based on different climatic conditions.

- The 50th percentile probability represents the median results;
- The 10th and 1st percentile exceedance results represent dry and extremely dry conditions;
- The 90th and 99th percentile exceedance results represent wet and extremely wet conditions;
- There is a 80% chance that the result will fall within the 10th and 90th percentiles; and
- There is a 98% chance the result will fall between the 1st and 99th percentiles.

Importantly, a percentile trace shows the percentile chance of a particular value on each day, and does not represent continuous results from a single model realisation e.g. the 50th percentile trace does not represent the model time series for median climatic conditions.

Predicted 1st, 10th, 50th, 90th and 99th percentile inventory and overflow values are shown for a NCO water management system. The probability plots reflect the likelihood of the stored or overflow volume being at or above this value on any given day. For instance, 90% of stored volumes are expected to be at or below the 90th percentile value.

7.2 Model calibration

The water balance model was calibrated to match observed water levels in the NCO site water management system over the period between January 2021 to January 2024.

Figure 7.1 shows a comparison of predicted and observed site water inventories at the NCO over the calibration period.

The calibration results show that the water balance model adequately matches the trends in the observed data for site water inventories. The calibration is considered acceptable, particularly considering the complex nature of the NCO site water management system, and the numerous variations to the operation of the system during the calibration period.

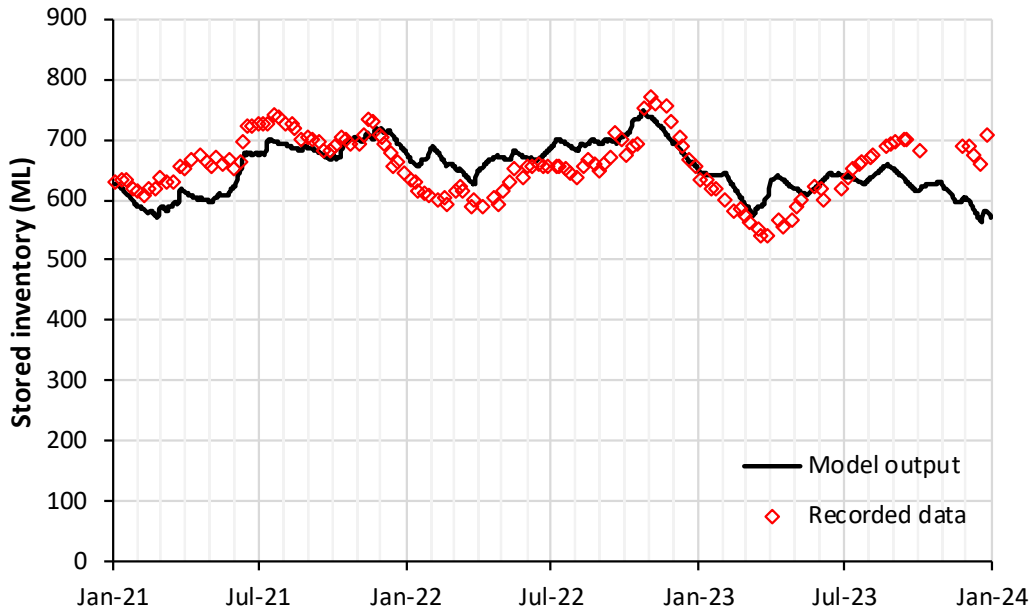

Figure 7.1 – Water balance model calibration results, total site water inventory

7.3 Forecast modelling methodology

The GoldSim water balance model was used to undertake a forecast simulation of the NCO site water balance under varying climatic conditions over the five-year period FY25 to FY29.

Climatic conditions were represented by extracting five-year periods of rainfall from the historical rainfall record which goes back to 1889. Each five-year climate sequence represented by the model is referred to as a "realisation". The first realisation used recorded rainfall data from 1889 to 1894. The second realisation used data from 1890 to 1895, and so on. The historical rainfall record (1889 to 2023) provides 130 realisations.

The water balance modelling assumes the operation of NCO water management system would remain relatively similar to the existing system described in Section 4.5, with the exception of the following key changes:

- The groundwater inflows will vary over time, based on the latest groundwater modelling report, prepared by AGE (2024).
- The RO will be upgraded prior to FY29, to a total combined feed capacity of 3.5 ML/d, including select upgrades to improve pre-treatment processes and a target brine concentration of around 25,000 mg/L TDS.
- The site water usage demands will vary according to the forecast ROM coal production rate, which peaks in FY27 at 7.51 Mtpa.

7.4 Water balance results summary

7.4.1 Release to the environment

The water balance model results show there is a less than 1% chance of an uncontrolled release (spill) to the environment occurring from the surface reclaim runoff dams SB2, SB3, SB4 for any of the modelled climatic conditions.

Sediment dams (SD1, SD2, SD3, SD4, SD7, SD8 and SD9) are generally well below the maximum storage volume of 260 ML. Controlled discharges are undertaken infrequently in accordance with the EPL 12789 conditions for wet weather discharges.

The water balance model predicts that the requirement for permeate release to Namoi River would increase over the simulation period and is highest in FY29 (up to 615 ML). The increase corresponds with the increased groundwater inflows.

No uncontrolled releases (spills) are predicted from the rail loop dams (Dams A1, A2, A3, B1, B2, C or D) for any of the modelled climatic conditions.

The water balance model result indicate that NCO would comply with the EPL release conditions in all modelled climatic conditions.

7.4.2 Brine management

The water balance model was used to investigate the need for, timing and volume of additional brine management measures at NCO. The modelled brine inventories over the FY25 to FY29 forecast period are presented in Figure 7.2. This figure shows that the brine inventory may reach the combined MOV by FY29 for extreme wet (1%ile) climatic conditions. Hence, it is considered unlikely that an additional brine management measures would be required prior to FY29, assuming that the RO is upgraded prior to FY29.

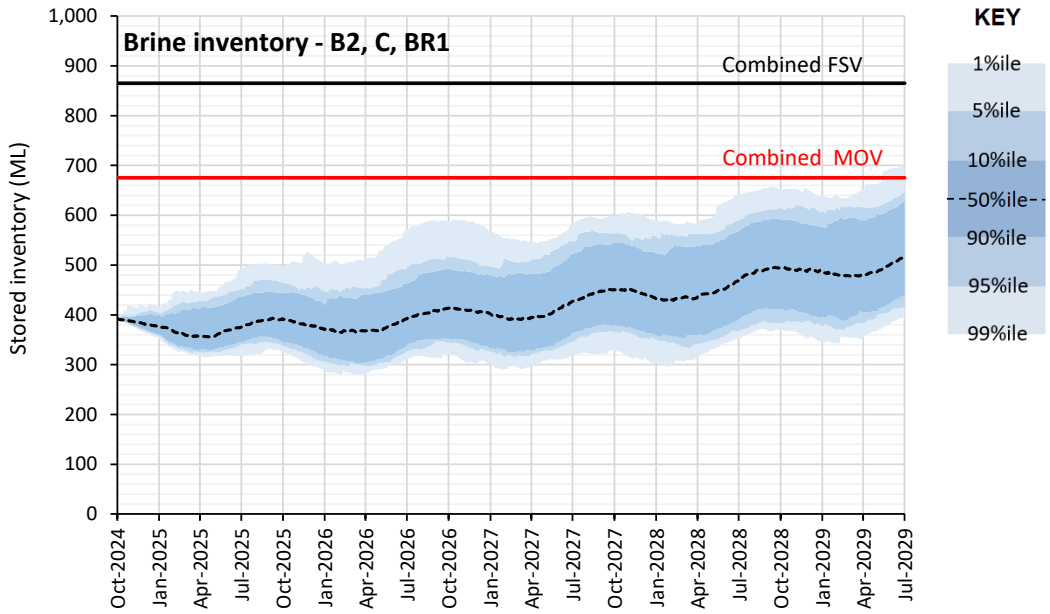

Figure 7.2 – Brine forecast modelling results

8 Beneficial use options

8.1 Overview

Condition 21 of the project approval 08_0144 states that NCOPL shall engage suitably qualified experts to review brine management and beneficial use options for raffinate, brine and mine water produced by the project.

NCOPL shall implement all reasonable and feasible recommendations of these reviews, to the satisfaction of the Secretary.

This section of the report reviews available beneficial use options for the available water streams at NCO. The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000) have been used a general guide to determine if the water streams at NCO are suitable for use in crop irrigation or stock watering.

8.2 Raffinate/filtered water

Filtered water from the RO and MF plants is currently pumped into B1, and then transferred to the filter water storage tanks at the box cut, for use underground and for firewater purposes.

Raffinate from the RO plants generally has an electrical conductivity (EC) of less than 800 µS/cm and a pH of between 8.0 and 9.0. This water is considered to be of good quality and is suitable for a range of uses, including crop irrigation or stock watering.

8.2.1 Onsite reuse

An underground filtered water demand of 0.064 kL/ROM tonne was calculated based on recorded underground filtered water use and ROM coal production since longwall mining commenced at the site.

Forecast water balance modelling of the ROM coal production schedule and adopted groundwater inflows to the underground mine, indicates that filtered water produced by the RO WTPs will exceed the filtered water demands. Hence, there is expected to be a surplus of filtered water onsite.

It is proposed to continue to prioritise the use of filtered water to supply underground mining demands at NCO.

8.2.2 Release to Namoi River

Filtered water stored in Dam B1 may be released to the Namoi River as required in accordance with Condition 11, Schedule 4 of Project Approval (08_0144). A licence variation to EPL 12789 was issued in 2024 to add NR1 (Namoi River pump) as a licenced discharge point, with appropriate concentration limits for TDS and pH to allow releases of treated mine water (filtered) water to the Namoi River. The management measures and controls are detailed in the site Water Management Plan- Raffinate Discharge Control and Monitoring Plan.

Forecast water balance modelling indicates that filtered water releases to the Namoi River may be required as early as FY25, based on the predicted groundwater inflow rates (AGE, 2024) which require treatment. However, the actual groundwater inflow rates estimated using recorded flowmeter data (see Section 4.7) is not currently in line with the trends observed in the AGE (2024) predictions, with the actual inflows being significantly lower than the modelled predictions. NCOPL should continue to monitor the actual estimated groundwater inflow rates, to determine the impact this may have on the timing of infrastructure commissioning.

8.2.3 Irrigation

WRM (2018) investigated the use of filtered water for irrigation on land owned by NCOPL, and also transfer of filtered water to third party.

The WRM (2018) study concluded that irrigation on land owned by NCOPL is potentially a viable option and that land and soil capability mapping suggests that there may be suitable land along the Kamilaroi Highway (on NCOPL land) that could be used for irrigation. However further work on the suitability to accept the treated water from an agronomist/soil scientist is required.

Forecast water balance modelling indicates that there may be a surplus filtered water at NCO, hence irrigation may be useful method for reducing stocks onsite.

8.3 Brine

The concentrated brine by-product of the RO plants is currently stored in dams C, B2 and BR1. The brine is evaporated in storage dams on site without releasing it to the environment.

Brine produced by the RO plants generally has EC of between 10,000 µS/cm and 25,000 µS/cm. This is considered highly saline water and would generally be expected to result in loss of production and a decline in animal condition and health if used for stock watering, and is also not suitable for irrigation of crops (ANZECC & ARMCANZ, 2000).

Therefore, there are limited options for beneficial use of the brine currently available at NCO due to the high EC of the water.

8.3.1 Reuse brine onsite

Brine has previously been mixed with reclaim water at NCO for use in ROM and product coal stockpile dust suppression, as per the recommendations of the WRM (2015) and WRM (2017a) studies. Site water management infrastructure allows for the use of brine for coal stockpile dust suppression; with the use of brine or mine water decided based on monthly water balance reviews and operating rules.

The water balance model shows the produced brine would be contained within the existing brine dams (B2, C and BR1) until at least FY29. However, the reuse of brine in product and ROM stockpile dust suppression sprays brine could be used to further reduce brine stocks and is considered to be one of the only beneficial uses available for brine at NCO.

8.3.2 Store and evaporate onsite

Brine is stored in dams C, B2 and BR1 and evaporated. The post-closure brine management process will involve reinjecting the brine into the mining void.

Future brine management strategies are as follows:

- Reuse of brine in product and ROM stockpile sprays;
- Super concentration (i.e. retreatment) of brine stored on site to increase brine salt concentrations, and reduce volume of brine; and
- Increase storage volume available for brine by constructing additional brine dams.

Forecast water balance modelling indicates that there is a 1% chance that the combined MOV for the existing brine dams would be exceeded by FY29. The combined FSV would not be exceeded for any climatic conditions assessed, prior to FY29.

Storage and evaporation of brine is considered to be the most appropriate beneficial use for this water stream at NCO at present, however NCO should continue to pursue other opportunities to potentially accelerate the reinjection of brine into the underground mine, or explore reinjection of brine at other locations.

8.4 Saline/reclaim/mine water

Water dewatered from the underground mine via the boxcut, and collected from the surface disturbance areas is pumped to Dam A1, A2 and A3 for settling, reuse and treatment via the RO WTPs.

Dewatering of the underground mine (comprising groundwater and recycling underground demand) is the primary source of the water stored in Dams A1, A2 and A3, along with the runoff from the disturbed catchment areas draining to SB1, SB2, SB3, and SB4.

The EC of water stored in Dam A1, A2 and A3 is generally between 4,000 µS/cm and 6,500 µS/cm, but can reach as high as 8,500 µS/cm. ANZECC & ARMCANZ (2000) indicates that this water would potentially result in loss of production and a decline in animal condition and health if used for stock watering for beef and dairy cattle, however sheep be able to tolerate this level of salinity.

8.4.1 Onsite reuse

Water stored in Dam A1, A2 and A3 is currently used to supply the following on-site demands at NCO:

- CHPP;
- Washdown Bay;
- Surface dust suppression; and
- ROM and product coal stockpile sprays.

The following is of note with regards to the available recorded data for these demands:

- The ROM and product coal stockpile sprays use about 0.33 ML/d;
- Surface dust suppression uses about 0.21 ML/d;
- ROM/product coal stockpile sprays and surface dust suppression only occur on non-rain days;
- The CHPP and washdown bay use about 0.039 kL per tonne of ROM coal produced;
- Approximately 22.5% of reclaim water use is recycled into the mine water management system (i.e. 77.5% of total demand is lost from the mine water management system.

The reuse of water dewatered from the underground, and runoff from surface disturbance areas is the most appropriate beneficial use for this water stream, and the reuse of this water is always prioritised at NCO. However, there are insufficient demands at NCO to reuse all of this water, and hence some of it must be treated for reuse as filtered water.

8.4.2 Treatment via reverse osmosis plants

RO water treatment plants are used to manage the difference between site demands and the volume of water dewatered from the underground and runoff from surface disturbance areas.

The stated capacity of the RO plants at NCO is 2.4 ML/day, and they produce a product split of about 75% raffinate and 25% brine. The treatment of water from Dam A1, A2 and A3 via RO treatment plants is an important aspect the NCO water management system, as it allows maximum reuse of site water by providing filtered water to supply underground mining demands.

Forecast water balance modelling, based on the predicted AGE (2024) groundwater inflows, indicates that additional RO treatment would be required by 2025. Ongoing treatment of mine water via RO to provide filtered water is considered a beneficial use for this water stream.

9 Contingency measures

9.1 Overview

This section of the report identifies contingency measures and for loss of brine containment at NCO. Loss of brine containment may occur in the following ways:

- Failure of brine storage dam HDPE liner (leak);
- Failure of brine storage dam (breach); and
- Overflow of brine storage dam.

Loss of brine containment may also occur via planned redundancy of brine storages. Based on forecast water balance modelling for NCO, it is not proposed to decommission any brine storage dams before completion of mining.

The Dam Safety Emergency Plan (DSEP) includes a series of Trigger Action Response Plans (TARPs) to manage the potential failure of the rail loop dams and BR1 (SLR, 2024). The TARPs have been reproduced in Appendix A. In addition to the DSEP TARPs, the following sections provide specific operational actions that could be undertaken to mitigate and manage potential brine dams failure.

9.2 Failure of brine storage dam HDPE liner

Brine storages should be inspected for damage to HDPE liners (at or above the water line) at regular intervals, ideally on a daily basis, and at least on a weekly basis. Leak detection bores are monitored on a regular basis, which will identify any damage to the HDPE liner below the water surface.

If monitoring data indicates that a brine storage dam is experiencing losses that exceed expected evaporation, an inspection of HDPE liners below the water line in the dam should be commissioned.

If the integrity of a HDPE liner is compromised, the following contingency plan should be implemented:

- Immediately pump the impacted brine down to provide 0.5 m of freeboard from the water surface to the damaged portion of the liner, and take sample of water from leaking storage.
    - Pump brine from impacted storage into other brine storage dams if capacity is available.
    - If insufficient capacity is available in other brine storages, brine should be pumped out of the impacted dam into the reclaim rail loop dams (Dam A1, A2 and A3).
- Repair the HDPE liner and test to confirm adequacy of the repair.
- Conduct visual inspections downslope of the liner damage to identify locations where seepage through the liner may be reporting to. Depending on the location of the damage to the liner, this may be along the rail loop, or on the embankment of a downslope (unlined) rail loop dam.
- If seepage has occurred into a down slope dam:
    - Immediately sample water in dam near seepage location and near dam outlet.
    - If possible, also obtain sample of seepage water.
    - Continue to monitor water quality in downslope dams on a daily basis, continuing for at least 7 days after the leaking dam has been pumped down.
    - Manage water levels in downslope dams as needed to prevent cascade overflows by pumping water back to other brine storages or reclaim rail loop dams.
- If seepage is occurring into the rail loop corridor:
    - Construct temporary sump to capture seepage flows.
    - Pump seepage flows back into mine water management system.

- Prevent seepage flows from reaching the release point dams outside of the rail loop.

9.3 Failure of brine storage dam

The likelihood of a piping or other embankment failure in the brine storage dams is considered low, but could conceivably occur. Brine storages should be inspected for erosion damage along embankment crests, and embankment batter slopes following rainfall events.

If a brine storage dam fails completely it is likely that brine would contaminate downslope dams within the rail loop (potentially Dams C and D), and potentially cause an overflow into the containment bund.

Should this occur, the following contingency plan should be followed:

- Cease underground mining and dewatering of the underground mine immediately.
- Cease pumping from surface disturbance area dams (SB1, SB2, SB3, SB4 and SD6) into the rail loop dams.
- Pump water from dams contaminated with brine into the rail loop reclaim dams (A1, A2 and A3), prioritise pumping of contaminated water from unlined dams (D and containment bund).
- If any of the brine dams suffer a failure, Dam A2 and Dam A3 should be used as a temporary brine storage until sufficient storage volume can be made available in the remaining brine dams.
- Seek approval from the regulator to make emergency releases of raffinate to the Namoi River as needed to dewater Dam B1, and to manage raffinate produced by RO treatment plants.

9.4 Overflow from brine storage dam

Operating rules have been defined for the rail loop storages to prevent overflows of saline and reclaim water or brine from contaminating the raw water Dam D during extended periods of wet weather.

The operating rules have been tested in the water balance model and result in a less than 1% chance of an overflow from Dam C into Dam D for all modelled scenarios. The operating rules are as follows:

- The RO plants operate to maintain the volume of water stored in Dam A1 between 50% (42.9 ML) and 70% (100.0 ML) of the dam capacity (142.9 ML).
- Pumping from SB1, SB2 and SD6 into Dam A1 ceases when the volume of water stored in Dam A1 is greater than MOV (114.3 ML);
- Pumping of brine into Dam B2 ceases when Dam B2 is at MOV (126.3 ML); and
- Pumping of brine into Dam C ceases when Dam C is at MOV (176.2 ML).

If the operating rules above are followed, an overflow could only occur from one of the brine storage dams due to an extended period of rainfall which would cause the dam to fill and overflow (water balance modelling indicates that there is less than a 1 % chance of this occurring). Overflow volumes for such an event are likely to be relatively small compared to the total volume of the dams. If such an overflow event occurs the following contingency plan should be followed:

- Monitor water quality in Dam D at least daily to determine if water in dam can still be used as raw water for potable and underground mining demands.
- Pump contaminated water from Dam D into the rail loop reclaim dams (A1, A2 and A3) for treatment via RO plants if necessary.
- Dilute the remaining water in Dam D with raw water from the Namoi River and bore as needed to improve water quality.

10 Summary of recommendations

10.1 Summary

This brine management plan and beneficial use report Condition 21, Schedule 4 of the Project Approval 08_0144, and provides the following:

- A detailed review of available data from the NCO mine water management system, including estimates of groundwater inflows to the underground mine, site water inventory and site water demands;
- Outcomes of updated forecast water balance modelling for NCO, which has been used to develop an action plan for required upgrades to the water management system, and upgrade of the RO plant feed capacity;
- A review of the current contingency measures as they relate to the Dam Safety Management System report; and
- Updated beneficial use options assessments for brine, raffinate and reclaim / saline / mine water.

Water balance modelling has identified that the RO feed capacity would need to be upgraded to at least 3.5 ML/d to manage the future groundwater inflows into the underground area. The water balance results also show that the brine inventory may reach the combined MOV by FY29 for extreme wet (1%ile) climatic conditions. Hence, it is considered unlikely that an additional brine dam would be required prior to FY29.

A review of available beneficial use options for the water streams at NCO have identified the following:

- Raffinate should continue to be reused to supply underground mine demands on site. Forecast water balance modelling indicates that filtered water releases to the Namoi River may be required as early as FY25, based on the predicted groundwater inflow rates (AGE, 2024) which require treatment. However, it should be noted that the actual groundwater inflow rates estimated using recorded flowmeter data (see Section 4.7) is not currently in line with the trends observed in the AGE (2024) predictions, with the actual inflows being significantly lower than the modelled predictions. NCOPL should continue to monitor the actual estimated groundwater inflow rates, to determine the impact this may have on the timing of infrastructure commissioning.
- The reuse of water dewatered from the underground (saline), and runoff from surface disturbance areas (reclaim) in the CHPP, wash down bay, stockpile sprays and for surface dust suppression is the most appropriate beneficial use for these water streams. However, there are insufficient demands at NCO to reuse all of this water, and hence some of it must be treated via RO for reuse as filtered water.
- Storage and evaporation of brine is the primary management strategy for this water stream at NCO. NCO have commissioned infrastructure to allow for the injection of brine water into the ROM stockpile sprays, to reduce the brine water stocks onsite, as a secondary management measure.

10.2 Recommendations

This report has identified there is some flexibility available at NCO with regards to brine management. The RO plant feed capacity requires upgrading prior to FY29 to maintain the water management system.

Based on the findings of this report the following key recommendations are made for the water and brine management system at NCO:

- Record current evaporation fan usage at SB3 and estimate efficiency. This will assist in determining the effectiveness of the fans, which can be applied to estimate the potential reduction in brine if required during emergency conditions where brine inventories are elevated for an extended period of time;

- Continue to monitor site water use, groundwater inflows and reclaim / saline and brine inventories (dam water levels);
- Prepare concept designs for the RO upgrades, including a commissioning schedules and appropriate trial periods.

11 Brine management action plan

Table 11.1 – Brine management action plan

Rec. no.	Date	Activity	Comments
1	Ongoing	Continue to monitor underground mine dewatering and water use at NCO	Current monitoring program is adequate.
2	Ongoing	Track estimated extractions of groundwater and compared to modified groundwater inflows adopted for water balance modelling in this report.	Flowmeter records for underground filtered water feed and boxcut dewatering should be compared on a weekly basis.
3	Ongoing	Track reclaim / saline and brine inventory.	Current monitoring program is adequate.
4	Optional	Monitor evaporation fan effectiveness.	Record current evaporation fan usage at SB3 and estimate efficiency. This will assist in determining the effectiveness of the fans, which can be applied to estimate the potential reduction in brine if required during emergency conditions where brine inventories are elevated for an extended period of time
5	Jul 2025	Commence design of RO upgrade.	Recommend design of RO upgrade is undertaken. Upgraded plant capacity to be determined based on water balance modelling outcomes.

12 References

AECOM, 2017	Brine Management and Beneficial Use Options Report – Narrabri Mine, Report prepared for NCOPL by AECOM, October 2017
AGE, 2024	'Narrabri Underground Mine Stage 2 – Revised Predicted Water Takes, AGE, March 2024.
ANZECC & ARMCANZ, 2000	Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment Control Council and Agricultural and Resource Management Council of Australia and New Zealand, October 2000
Aquaterra, 2009	Narrabri Coal Hydrogelogical Assessment, Report Prepared for Narrabri Coal Operations by Aquaterra Report No. S28B2/043 August 2009
Hydrosimulations, 2015	Narrabri Mine Modification 5 Groundwater Assessment, Report prepared by Hydrosimulations on behalf of Narrabri Coal Operations, August 2015
SLR, 2024a	Narrabri Coal Mine Rail Loop Dams Complex 2024 Annual Inspection, SLR Consulting Australia, August 2024
SLR, 2024b	Narrabri Coal Mine Brine Dam BR1 2024 Annual Inspection, SLR Consulting Australia, August 2024
SLR, 2024c	Narrabri Coal Operations Rail Loop Dams Complex and Brine Dam BR1, Operations, Maintenance and Surveillance Manual, SLR Consulting Australia, May 2024
WHC, 2024	NCO Site Water Balance Model Update – March 2024, Narrabri Coal Operations, 2024
WRM, 2007	Narrabri Coal Project Surface Water Assessment Specialist Consultant Studies Compendium Volume 1 Part 1. Report prepared for RW Corkery & Co. Pty Ltd on behalf of Narrabri Coal by WRM Water & Environment Pty Ltd, July 2007.
WRM, 2009	Narrabri Coal Mine Stage 2 Longwall Project Surface Water Assessment Specialist Consultant Studies Compendium Volume 1 Part 3. Report prepared for RW Corkery & Co. Pty Ltd on behalf of Narrabri Coal by WRM Water & Environment Pty Ltd, November 2009.
WRM, 2015	Narrabri Mine Modification 5 Environment Assessment – Surface Water Assessment. Report prepared for NCOPL by WRM Water & Environment Pty Ltd, August 2015
WRM, 2018	Preliminary assessment of beneficial use options for Narrabri Coal, Report prepared for NCOPL by WRM Water & Environment Pty Ltd, June 2018
WRM, 2019	Narrabri Coal Mine Brine Management and Beneficial Use Options Report, Report prepared for NCOPL by WRM Water & Environment Pty Ltd, May 2019
WRM, 2019b	Narrabri Coal Rail Loop Dams Spillway Conveyance Capacity Assessment, Report prepared for NCOPL by WRM Water & Environment Pty Ltd, January 2019

Appendix A. TARPS

Table A.1 – Earthquake TARP (SLR, 2024)

TARP level	Trigger	Actions
Normal operation	No seismic activity.	**Employees** • Abide by instruction of Supervisors and Managers. **Operators** • Routine Inspections • Notify the superintendent if unexpected vibrations occur. **Civil Infrastructure Coordinator** • Monitor for earthquakes
Level 1 (White)	One or more of the following: • Earthquake Magnitude >MM4 (within 300 km of the site). • Small (no significant) deformation or damage observed.	**Employees** • Be prepared to evacuate. **Operators** • Inspection to be undertaken within 24 hours of event. • Record and notify Civil Infrastructure Coordinator of any damage or changes in dam **Civil Infrastructure Coordinator** • Notify Dam Owner. • Conduct dam inspections between 1 hourly and 6 hourly as directed. • Lower water level if possible and appropriate. **Dam Owner (Surface Manager)** ACTIVATE WHITE ALERT • Implement DSEP, including notification protocols. • Inspection to be undertaken within 24 hours of event. • Carry out Risk Assessment and implement controls • Inform the Dams Engineer of event and inspection observations. • If deemed appropriate, arrange for a controlled drawdown. • Notify Mine Manager of change in TARP Level. • Notify internal WHC Stakeholders. **Dams Engineer** • Review provided data. • Undertake inspection as required. • Advise on remediation and controls.
Level 2 (Amber)	Significant deformation or other structural damage noted that has likely diminished the integrity of the dam.	**Employees** • Evacuate and adhere to exclusion zone(s). **Operators**

TARP level	Trigger	Actions
		• Support Civil Infrastructure Coordinator. **Civil Infrastructure Coordinator** • Implement exclusion zone as directed. • Monitor dam from safe monitoring point. • Notify and assist the Dam Owner. **Dam Owner (Surface Manager)** ACTIVATE AMBER ALERT • Implement DSEP, including notification protocols. • Establish exclusion zone around dam infrastructure • Carry out Risk Assessment and implement controls. • Inform the Dams Engineer of inspection observations. • Notify Mine Manager of change in TARP Level. • If failure imminent, activate Seepage and Structural Failure TARP **Environment Manager** • Notification to Environmental Protection Agency if required. **Statutory Mine Manager** • Notify to activate IMT if required. • Review the situation with staff. • Ensure TARP actions are being followed. • Manage notification to internal WHC stakeholders. **Dams Engineer** • Review provided data. • Undertake inspection as required. • Advise on remediation and controls.
Level 3 (Red)	Failure imminent or occurred.	**Employees** • Return to work as instructed by Supervisors. **Operators** • Return to work as instructed by Supervisors. • Resume routine inspections. **Civil Infrastructure Coordinator** • Implement recovery / repair activities as advised. **Dam Owner (Surface Manager)** ACTIVATE RED ALERT • Implement DSEP, including notification protocols. • Implement recovery / repair activities in conjunction with Dams Engineer. **Environment Manager**

TARP level	Trigger	Actions
		• Notification to Environmental Protection Agency if required **Statutory Mine Manager** • Activate IMT. • Manage notification to internal WHC stakeholders. • On approval, authorise return to work. **Dams Engineer** • Undertake inspection. • Advise on recovery / repair activities

Table A.2 – Overtopping TARP (SLR, 2024)

TARP level	Trigger	Actions
Normal operation	Water below Maximum Operating Level (MOL). Scheduled inspection, monitoring and remediation is occurring as per OMS.	**Employees** • Abide by instruction of Supervisors and Managers. **Operators** • Routine Inspections as per OMS • Notify the Civil Infrastructure Coordinator of unusual occurrences. **Civil Infrastructure Coordinator** • Collate routine inspections and monitoring data. **Environment Manager** • Engage Dams Engineer for Annual Inspections.
Level 1 (White)	One or more of the following: • Water level flowing through spillway s (excluding A1 - A2 - A3). • ≥100mm rainfall in 1 hour (~1% AEP). • ≥550mm rainfall in 3 days (~1% AEP). • Waves, generated over long periods of wind, above spillway level.	**Employees** • Be prepared to evacuate. **Operators** • Barricade and avoid areas of flooding. • Notify the Civil Infrastructure Coordinator **Civil Infrastructure Coordinator** • Notify Dam Owner. • Conduct dam inspections between 1 hourly and 6 hourly and track rate of rise as directed. • Review weather forecast • Lower water level if possible. **Dam Owner (Surface Manager)** ACTIVATE WHITE ALERT • Implement DSEP, including notification protocols. • Instruct dam inspections to increase to between 1 hourly and 6 hourly • Notify Mine Manager of change in TARP Level • Notify Dams Engineer. • Carry out Risk Assessment and implement controls. • Activate emergency drawdown if required. • If damage to infrastructure is imminent / occurred, activate Structural Failure TARP. • Notify internal WHC Stakeholders. **Environmental Manager** • Assist Dam Owner. **Dams Engineer** • Undertake inspection as required.

TARP level	Trigger	Actions
Level 2 (Amber)	One or more of the following: • Water level overtopping crest. • Spillway blockage. • Waves, generated over long periods of wind, breaching embankment upstream face.	**Employees** • Evacuate and adhere to exclusion zone(s). **Operators** • Support Civil Infrastructure Coordinator. **Civil Infrastructure Coordinator** • Implement exclusion zone as directed. • Monitor dam from safe monitoring point. • Notify and assist the Dam Owner. **Dam Owner (Surface Manager)** ACTIVATE AMBER ALERT • Implement DSEP, including notification protocols. • Establish exclusion zone around dam infrastructure • Review weather forecast • Monitor dam from safe monitoring point. • Activate emergency drawdown if required. • Carry out Risk Assessment and implement controls. • Notify Dams Engineer • Notify Mine Manager of change in TARP Level. • If damage to infrastructure is imminent / occurred, activate Seepage and Structural Failure TARP. **Environment Manager** • Assist Dam Owner • Notification to Environmental Protection Agency if required. **Statutory Mine Manager** • Notify to activate IMT if required. • Review the situation with staff. • Ensure TARP actions are being followed. • Manage notification to internal WHC stakeholders. **Dams Engineer** • Undertake inspection as required
Level 3 (Red)	Failure imminent or in progress.	**Employees** • Return to work as instructed by Supervisors. **Operators** • Return to work as instructed by Supervisors. • Resume routine inspections. **Civil Infrastructure Coordinator** • Implement recovery / repair activities as advised.

TARP level	Trigger	Actions
		Dam Owner (Surface Manager) ACTIVATE RED ALERT • Implement DSEP, including notification protocols. • Implement recovery / repair activities in conjunction with Dams Engineer. • Notify internal WHC stakeholders **Environment Manager** • Assist Dam Owner • Notification to Environmental Protection Agency if required **Statutory Mine Manager** • Activate IMT. • Manage notification to internal WHC stakeholders. • On approval, authorise return to work. **Dams Engineer** • Advise on recovery / repair activities

Table A.3 – Seepage and Structural Failure TARP (SLR, 2024)

TARP level	Trigger	Actions
Normal operation	• No seepage at Rail Loop Dams. • Seepage at BR01 seepage sump of normal rate and clarity. • No signs of embankment instability. • No movement/settlement detected in survey monitoring. • No unusual water quality or levels recorded in relevant piezometers. Scheduled inspection, monitoring and remediation is occurring as per OMS.	**Employees** • Abide by instruction of Supervisors and Managers. **Operators** • Routine Inspections • Notify the superintendent if unexpected seepage or structural failure identified. **Civil Infrastructure Coordinator** • Collate routine inspections and monitoring data.
Level 1 (White)	One or more of the following: • Seepage flow noted through Rail Loop or BR01 embankments, becoming cloudy. • Increase in seepage water in BR01 seepage sump. • Increase or acceleration of movement/settlement detected by survey. • Tension cracks forming at crest slope >15 mm. • Differential settlement >15 mm observed. • For potential human interference (i.e. terrorism or sabotage) refer *Flowchart Figure 9 Emergency Response Procedure – Structural Damage in the Dam Safety Emergency Plan*.	**Employees** • Be prepared to evacuate. **Operators** • Barricade and avoid areas of seepage and/or structure failure. • Notify the Civil Infrastructure Coordinator **Civil Infrastructure Coordinator** • Notify Dam Owner. • Conduct dam inspections between 1 hourly and 6 as directed. • Lower water level if possible and appropriate. **Dam Owner (Surface Manager)** ACTIVATE WHITE ALERT • Implement DSEP, including notification protocols. • Instruct dam inspections to increase to between 1 hourly and 6 hourly • Notify Mine Manager of change in TARP Level • Notify Dams Engineer. • Carry out Risk Assessment and implement controls. • Notify internal WHC Stakeholders. **Dams Engineer** • Review provided data.

TARP level	Trigger	Actions
		• Undertake inspection as required. • Advise on remediation and controls.
Level 2 (Amber)	One or more of the following: • Seepage flow through Rail Loop or BR01 embankments increasing significantly or becoming uncontrolled. • Significant increase in the rate of pumping from BR01 seepage sumps. • Excessive loss from the storage. • Whirlpools observed. • Slope failure observed or appears imminent • Tension cracking, deformation, increased settlement or unravelling of batter slope observed which may indicate deep seated instability.	**Employees** • Evacuate and adhere to exclusion zone(s). **Operators** • Support Civil Infrastructure Coordinator. **Civil Infrastructure Coordinator** • Implement exclusion zone as directed. • Monitor dam from safe monitoring point. • Notify and assist the Dam Owner. **Dam Owner (Surface Manager)** ACTIVATE AMBER ALERT • Implement DSEP, including notification protocols. • Establish exclusion zone around dam infrastructure • Inform Dams Engineer of inspection observations. • Monitor dam from safe monitoring point. • Activate emergency drawdown if required. • Carry out Risk Assessment and implement controls. • Notify Mine Manager of change in TARP Level. **Environment Manager** • Notification to Environmental Protection Agency if required. **Statutory Mine Manager** • Notify to activate IMT if required. • Review the situation with staff. • Ensure TARP actions are being followed. • Manage notification to internal WHC stakeholders. **Dams Engineer** • Review provided data. • Undertake inspection as required. • Advise on remediation and controls.
Level 3 (Red)	Failure imminent or occurred.	**Employees** • Return to work as instructed by Supervisors. **Operators** • Return to work as instructed by Supervisors. • Resume routine inspections. **Civil Infrastructure Coordinator** • Implement recovery / repair activities as advised.

TARP level	Trigger	Actions
		Dam Owner (Surface Manager) ACTIVATE RED ALERT • Implement DSEP, including notification protocols. • Implement recovery / repair activities in conjunction with Dams Engineer. **Environment Manager** • Notification to Environmental Protection Agency if required **Statutory Mine Manager** • Activate IMT. • Manage notification to internal WHC stakeholders. • On approval, authorise return to work. **Dams Engineer** • Undertake inspection • Advise on recovery / repair activities

Appendix B. Appointment of Experts Letter

Department of Planning, Housing & Infrastructure

Our ref: MP08_0144-PA-65

Mr Brent Baker
Environmental Manager
Narrabri Coal Operations Pty Ltd

20/05/2024

Subject: Appointment of Matt Briody as Principal Engineer

Dear Mr Baker,

I refer to your request for the Planning Secretary's approval of Matt Briody of HydroBalance to review the brine management and beneficial use options of the brine as required by Schedule 4, Condition 21 of MP08_0144-PA-65.

The Department has reviewed the nomination/s and information you have provided and is satisfied that Mr Briody is suitably qualified and experienced. Accordingly, as nominee of the Planning Secretary, I approve his appointment.

If you wish to discuss the matter further, please contact Rose-Anne Hawkeswood on 02 9274 6324.

Yours sincerely

Stephen O'Donoghue
Director
Resource Assessments
As nominee of the Planning Secretary