Greater Brockman Operations

Detailed water balance assessment

Prepared for Rio Tinto Iron Ore
March 2021

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Detailed water balance assessment

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Executive Summary

Rio Tinto Iron Ore (RTIO) is proposing to develop the Greater Brockman Operations (GBO) Proposal (the proposal) in the Pilbara region of Western Australia. The proposal is required to sustain operations across the Brockman Syncline, comprising the hubs of Brockman Syncline 4 and Brockman 2 / Nammuldi. Planning studies for the proposal indicated a high-level risk in water management with respect to the project water balance. GBO hubs at Brockman 2 Nammuldi (B2N) and Brockman Syncline 4 (BS4) currently have surplus groundwater to needs. Each hub has specific EPA Act approval within Ministerial Statements with respect to disposal of surplus water that may limit future expansion of dewatering to facilitate the mine plans.

Individual deposit scale water balances have been created for all the deposits included within the GBO Pre Feasibility Study level mine plans. These deposit-level balances were integrated to sub hub-level water balances for Silvergrass East (SGE) and Brockman Syncline 1 (BS1); and then to hub level balances (for B2N and BS4) to determine whether sufficient water was available for processing and dust suppression, and the volume and timing of surplus water and/or deficits.

The following water transfer links between deposits and hubs were simulated:3

- B2N hub to receive deposit level balance estimates from Nammuldi Lens/BS2/SGE/BS2ED/BS3 Extension. Nammuldi includes Lens AB, CD, EF and G and BS3 Extension includes Brokenwood, Sandelford, Diesel, MM-J and Creekside; and

- BS4 hub to receive deposit level water balance estimates for BS4, BS3, BS1 (East and West), BSSM and BSMN.

Predicted surplus mine water, net of deposit and hub demands, can be managed up to the capacity of existing water management infrastructure. The existing options included in the GBO water balance assessment to manage predicted B2N hub and BS4 hub surplus water include:

- the water transfer pipeline linking SGE deposits to the B2N hub;

- the Nammuldi Agricultural Project (NAP), located at the B2N hub;

- the Duck Creek discharge, also located at the B2N hub; and

- the Boolgeeda Creek discharge, located at the BS4 hub.

The assessment of alternative and new surplus water management options (ie MAR schemes, discharge to pit, increase creek discharge limits, inter-hub transfers or alternative NAP scheme operational options) are beyond the scope of this assessment.

Given the existing surplus water management infrastructure capacity (ie with no additional surplus water management options) the water balance forecasts indicate;

- that monthly discharges to Duck Creek are likely required at rates up to 38.0 ML/d for the 2022 to 2024 period and is predicted to potentially reduce to a maximum rate of approximately 10 to 15 ML/d for intermittent periods over the 2024 to 2027 period. From 2028 onwards predicted B2N hub surplus water can be fully managed through the NAP (as shown in Figure 6.1).

- for the no BS1 crusher scenario additional surplus water management options are required above the current discharge limit to Boolgeeda Creek (17.5 ML/d) at varying rates between 2024 and 2036. A maximum hub water surplus of approximately 30.0 ML/d is predicted in 2025 (ie 12.5 ML/d higher than the Boolgeeda Creek discharge limit).

- the BS1 crush and convey scenario includes an additional 3.5 ML/d deposit water demand, therefore under this scenario the utilisation of the Boolgeeda Creek discharge is reduced and the unmanaged surplus at BS4 (ie the surplus in excess of the Boolgeeda Creek discharge constraint) is potentially limited to the 2024 to 2025 period to a maximum rate of 9.2 ML/d.

- The NAP scheme demand assumed a 902 ha (19 pivot) irrigation scheme. Whilst the scheme is approved for up to 2500 ha (Ministerial Statement No 925) the water balance would suggest expansion of the NAP is probably not warranted.

- Water deficits are predicted towards the end of the PFS mine plan at both B2N and BS4; however these are likely artefacts of the battery limits with respect to the mine plan provided; whereas in reality other satellite deposits may be developed with further dewatering demand that can met these deficits.

- Water deficits are predicted at the SGE deposit from 2041, as mining of SGE ceases in 2040, and the Silvergrass MAR demand is assumed to continue post-SGE deposit mining at the final rate of 5.61 ML/d. Potential options to transfer water from B2N hub to SGE to supplement the post-mining MAR requirements could, based on the current water balance forecast, be constrained by a predicted B2N hub deficit beyond 2041.

The water balances provided for the GBO are based on a range of underlying assumptions that require review and validation as the project progresses through RTIO's study phases. The following key items should be addressed to increase confidence, and reduce uncertainty, in the water balance forecasts and assessment of water surplus and/or deficit management options:

- The NAP scheme water use estimates should be validated against a longer historic water use than the 2019 data to confirm assumptions and remove any 2019 climate bias;

- Flow meters should be reviewed and validated to ensure (as far as practicable) that meters are operable and data is being captured at every water use point across hubs and deposits as required;

- Reconciliation of current impacts and volumes discharged to Boolgeeda Creek is required to determine whether the predicted BS4 hub discharge falls within current approved impacts;

- A detailed review and assessment process should be undertaken to better understand the potential scale and nature (and potential implications) of uncertainty inherent in numerical groundwater modelling predictions of dewatering abstractions.

- Alternative water management options will require further works to determine their feasibility and overall efficacy on predicted hub water balances.

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1 Introduction

The Greater Brockman Operations (GBO) consists of Brockman Syncline 4 (BS4), comprising a 46 Mtpa dry plant, and Brockman 2/Nammuldi (B2N) Operations comprising a 43 Mtpa wet plant and two 10 Mtpa high grade dry plants. BS4 operates separately from B2N and is located approximately 35 kilometres (km) to the south. Silvergrass East functions as a satellite operation to B2N, with its own 20 Mtpa primary crusher located approximately 9 km from B2N. It is linked to B2N by an overland conveyor and water conveyance infrastructure. There are other satellite deposits that occur around the syncline that will feed tonnes to either BS4 or B2N for the life of mine (LoM).

Dewatering is currently required across the GBO to access below water table (BWT) ore and further dewatering will be required at various satellite deposits. Abstracted groundwater is preferentially used for mineral ore processing, dust suppression and potable water supply. However dewatering requirements to access the ore bodies exceeds project demand. The B2N wet plant process facilities include a waste fines storage facility (WFSF), with a decant system, located between B2N and SGE. The decant return water is part of a closed loop system with the B2N wet process plant.

Existing surplus water management options for the GBO comprises the following:

- Surplus water from the B2N/SGE dewatering borefields is utilised by the Nammuldi Agricultural Pivots (NAP). If the NAP scheme cannot utilise all the surplus water available on any given day the excess water is discharged to Duck Creek. Approval to discharge surplus water to Duck Creek is predicated on meeting water quality criteria (as defined by Ministerial Statement (MS) 925 Condition 7-3).

- Surplus water from the BS4 dewatering borefields is discharged to Boolgeeda Creek. Approval to discharge to Boolgeeda Creek is limited by a maximum wetting front condition limited to an extent of 37 km from the discharge point during dry conditions (as defined under MS 1000). The Part V licence for discharge limits this to 6.4 gigalitres per annum (GL/a).

Development of further BWT deposits are included in the Greater Brockman development pathway. A Rio Tinto Iron Ore (RTIO) risk assessment identified Class IV (HIGH) risks for the GBO expansion with respect to water management at the Order of Magnitude (OoM) study. In 2018 a Brockman 2 Nammuldi Regional OoM study and a Greater Brockman Syncline 4 Regional OoM study presented a “hub” wide water balance assessment, for each area assessed in the respective study. These studies recommended developing a GBO-wide water balance with more detail on individual development areas to be completed prior to a Prefeasibility Study (PFS) for relevant deposits, and also to define a water management approach to support the Brockman Syncline approval.

The water balance has focused on forecasts of dewatering profiles and future water supply and demand requirements at the deposit scale; as well as options for surplus water management beyond integration with the current systems. The intent of the water balance is to support a broader GBO water management strategy given the geographic spread of deposits and to develop a hierarchy of use aligned with regulatory expectations. The strategic nature of the water balance assessment supports the process of identifying water management risks across the GBO development plan, based on existing water management strategy and options, and providing detail on the estimated timing and magnitude of surplus water management options and requirements.

This report presents the updated GBO water balance given updated estimates of dewatering requirements, process plant and dust suppression water demand at the deposit scale and NAP scheme seasonal utilisation. Satellite deposits with predicted surplus or deficit water balances are highlighted, and potential water management options are provided. The water balances are developed based on the mine plans provided by RTIO as detailed in Section 2.2.

2 Background

2.1 Locations and mine nomenclature

The following nomenclature definitions have been adopted for the GBO mine operations consisting of hubs, deposits, pits and stages for interpreting mine plan water balances.

A hub is defined by the location of ore processing facilities including plant(s) and train load out facilities. GBO has been split into two operational hubs, BS4 and B2N.

The BS4 hub currently consists of the following infrastructure with associated water demand:

- ~46 Mtpa dry plant (Calibre, 2018a);
- train load out (TLO);
- Boolgeeda Airport;
- BS4 / Nammuldi mine village; and
- mine administration and maintenance buildings.

The B2N hub currently consists of the following infrastructure with associated water demand:

- ~43 Mtpa Nammuldi wet plant and associated WFSF;
- 10 Mtpa Brockman 2 dry plant (Calibre, 2018b);
- 10 Mtpa CSI dry plant (Calibre, 2018b);
- B2N TLO;
- B2 and Jerriwah mine villages;
- mine administration and maintenance buildings, and
- NAP scheme.

A deposit is defined as representing a geographical area with naturally occurring accumulations of minerals of sufficient size and concentration to represent economic value. A deposit may comprise of multiple pit shells with the ore either sent to a primary crushing plant or haul road to a hub. Thus, multiple deposits can contribute ore to a hub. Currently Silvergrass East (SGE) is the only satellite deposit that comprises a primary crusher. The 20 Mtpa SGE primary crusher is linked back to B2N hub via a conveyor to provide ore feed to the Nammuldi wet plant

(13-15 Mtpa) with ~5 Mtpa diverted as dry feed. A second satellite deposit, Brockman Syncline 1, is proposed to have its own 25 Mtpa crusher and conveyance to provide feed ore to BS4 hub.

Pit shells are defined as representing the design mine pit void used to calculate total material movement per bench elevation. Pit shells are often split into Stages (or sub pits) within mine plans with the stages representing pit wall cutbacks. Several pit shells may be associated with a deposit.

For this assessment water balances are aggregated and calculated at the deposit scale with balances resolved individually to determine the surplus water available to contribute to either BS4 or B2N hub level balances.

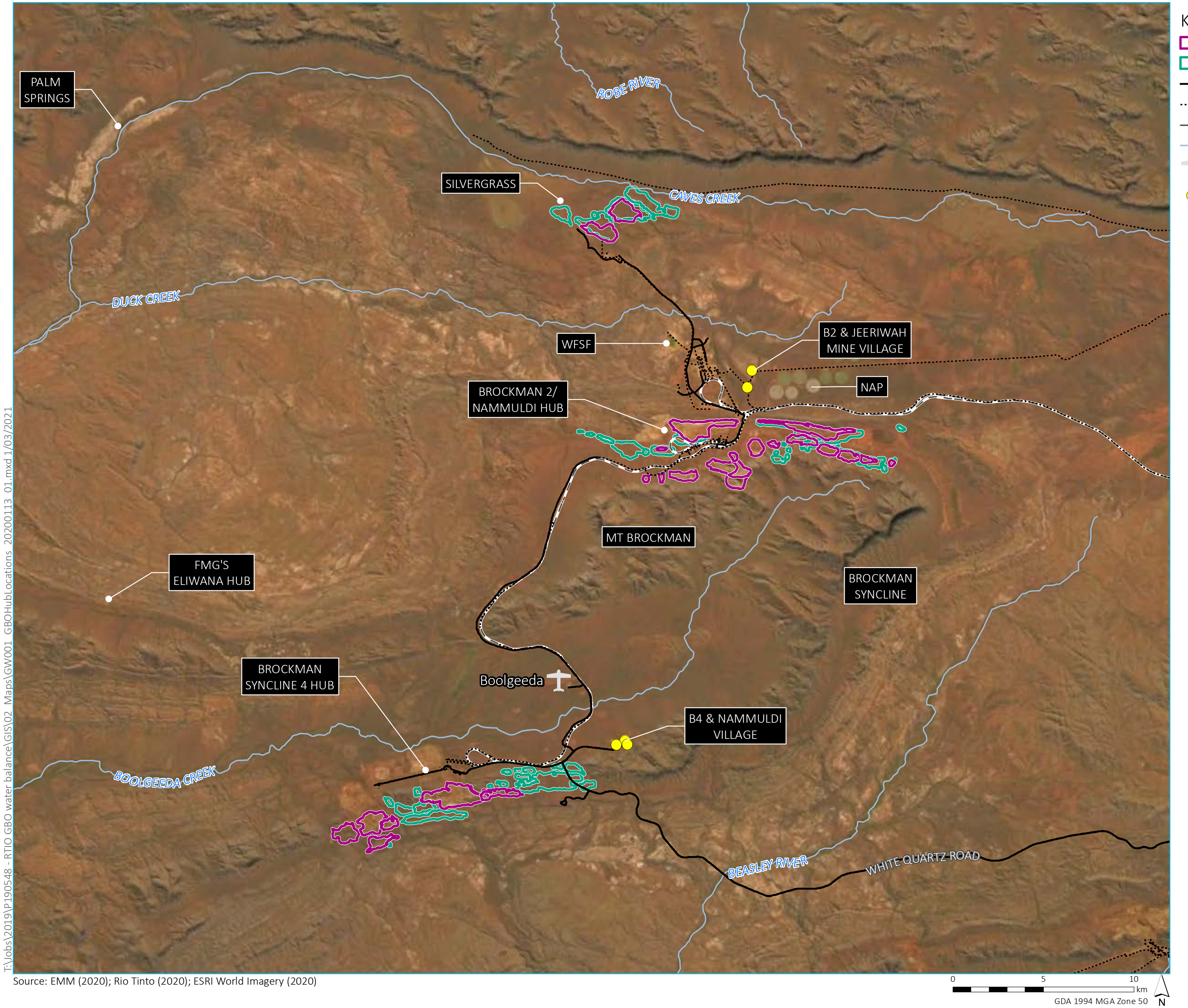
In this manner the deposit scale balances are rolled up within hub scale water balances and account for all operating infrastructure demands and dust suppression needs to estimate future water surplus or deficits at the hub level.

The following geographical descriptions are applied consistent with mine plan allocations for the deposits. GBO includes all operations and satellite deposits associated on the Brockman Syncline and immediate Hamersley Group deposits located to the north of the Brockman Syncline along Caves Creek (Figure 2.1).

The BS4 hub comprises the BS4 plant operations and deposits, mine village, airport and train loadout; and all satellite deposits located on the southern limb of the syncline from BS4 in the west to BS3 (Figure 2.2). Brockman Syncline 1 (BS1) has been included in BS4 hub mine plans for processing through the BS4 high grade plant, but geographically sits on the northern limb of the Brockman Syncline west of B2N (Figure 2.2). The destination hub for some deposits may vary as the study advances and optimisation of mine plans occur.

The B2N hub comprises the Brockman 2 Nammuldi mine operations and deposits, SGE and all other satellite deposits located on the northern limb of the Brockman Syncline from Nammuldi Lens AB in the west to MMJ and Creekside around the northern tip of the syncline; and deposits located to the north of the Brockman Syncline along Caves Creek (Figure 2.3). The NAP is located near the B2N hub and comprises 19 pivots for use of surplus dewatering water for irrigation.

Deposits and pits associated with B2N and BS4 are presented in more detail in Section 3.2.1 and Section 3.2.2 respectively.

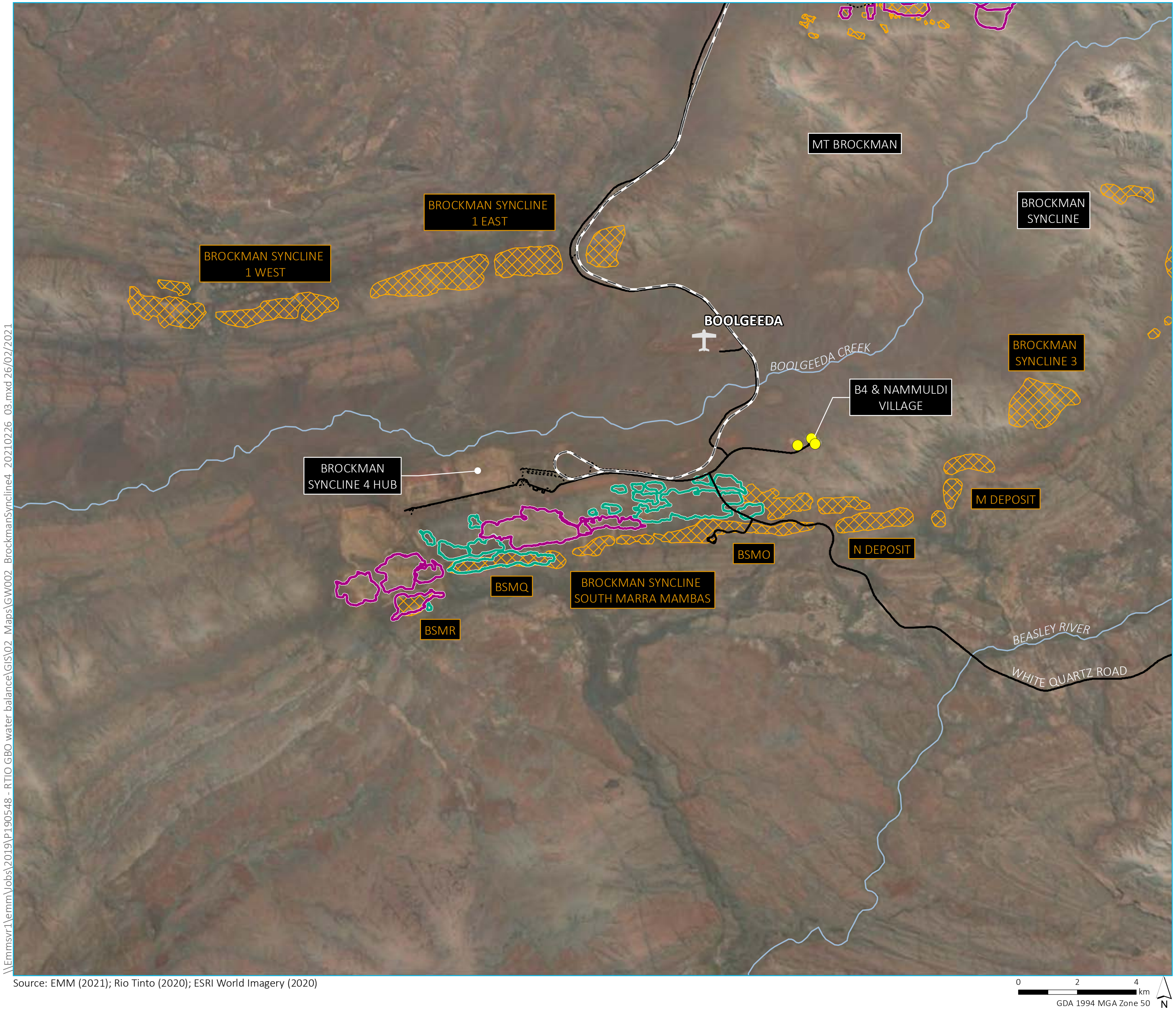


Source: EMM (2020); Rio Tinto (2020); ESRI World Imagery (2020)

Greater Brockman Operations hub locations

Rio Tinto Greater Brockman Operations
Water balance assessment
Figure 2.1

EMM creating opportunities



KEY
- Approved pit
- LOM approved pit
- Greater Brockman Operations proposed pit
- Sealed road
- Unsealed road
- Rail
- Major watercourses
- Airfields
- Mining camp

Source: EMM (2021); Rio Tinto (2020); ESRI World Imagery (2020)

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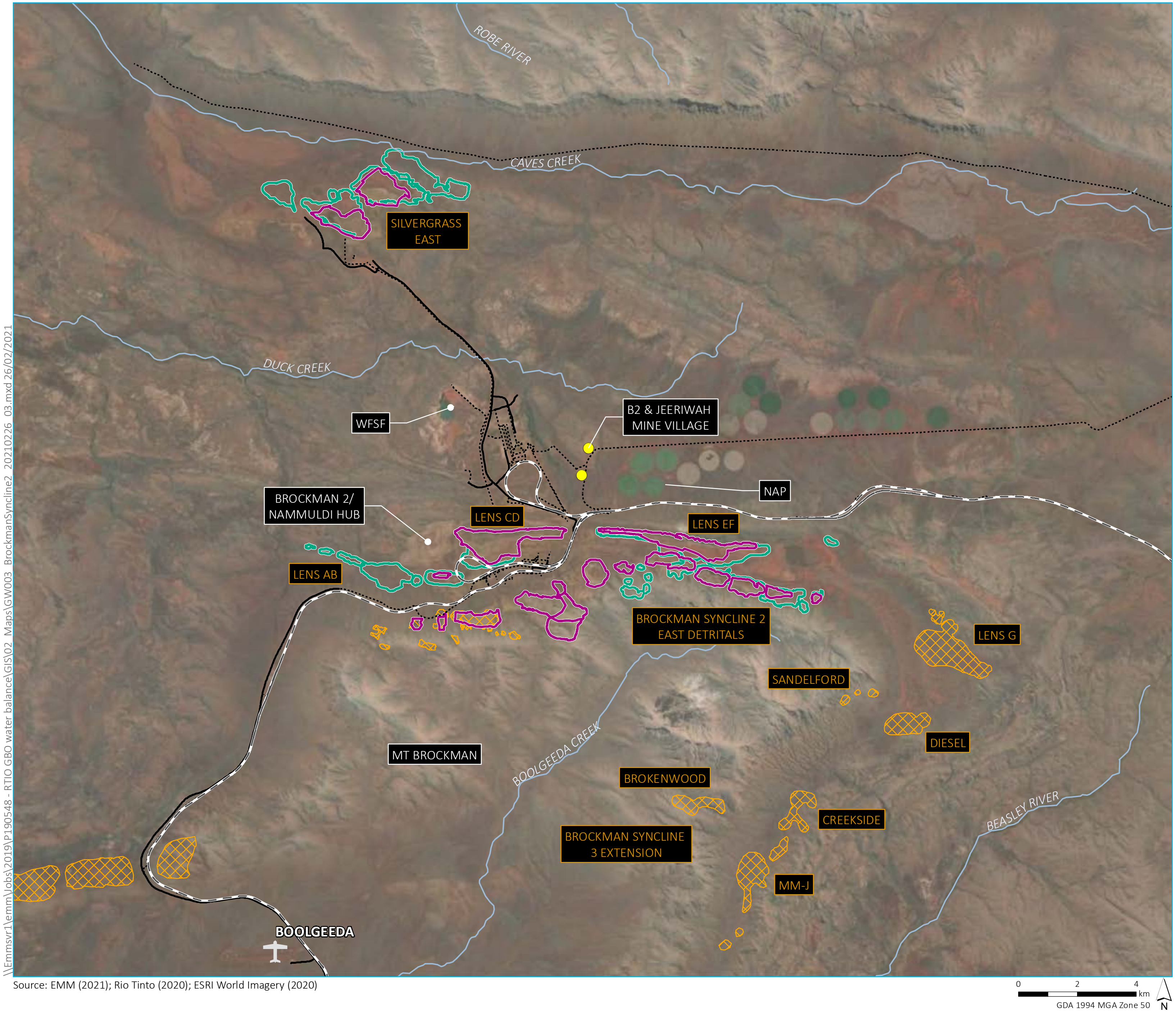
Brockman Syncline 4 deposit locations

Rio Tinto Greater Brockman Operations
Water balance assessment
Figure 2.2

EMM creating opportunities



Source: EMM (2021); Rio Tinto (2020); ESRI World Imagery (2020)

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Brockman Syncline 2 Nammuldi hub and potential satellite deposits

Rio Tinto Greater Brockman Operations
Water balance assessment
Figure 2.3

EMM creating opportunities

2.2 Greater Brockman Operations project

Options for GBO development are being refined via RTIO Study process comprising concept level through to Implementation. GBO project is currently at the Pre-feasibility (PFS) level of study. The following documents have been reviewed to understand the development options;

- Greater Brockman Syncline 4 OoM Basis of Design (BoD) (Calibre, 2018a); and
- Brockman 2 Nammuldi Regional OoM BoD (Calibre, 2018b).

The Greater BS4 OoM BoD study comprises two main objectives:

- to optimise the development sequence of new deposits to sustain BS4 at ~46 Mtpa; and
- to test expansion options, including revising wet processing assumptions.

The BS4 expansion involved a number of plant type options for additional ore processing of between 15 and 30 Mtpa supported by a new rail loop and train load out facility.

The B2N Regional OoM BoD study comprised the following objectives:

- to identify the optimal deposit development strategy to meet business wide system production of 380 Mtpa; and
- to provide business optionality to sustain the existing combined dry plant capacity of 20 Mtpa at Brockman 2 and CSI plants (10 Mtpa + 10 Mtpa).

The B2N expansion options involved a number of plant type options for additional ore processing of between 20 and 25 Mtpa supported by a new rail loop and train load out facility at the undeveloped Nammuldi Lens G deposit.

The BoD documents for Greater BS4 and B2N Regional OoM's included provision for the construction of primary crushing facilities at the deposits of BS1, Brockman Syncline 3 (BS3), and Brockman Syncline 3 Extension (BS3 Ext) / Lens G. Primary crushed ore would be sent from these deposits via overland conveyors to the ore processing facilities at either BS4 or B2N hubs for secondary processing. For the water balance assessment a 'crush and convey' scenario, including a primary crusher water demand at the deposit level, has only been defined for the SGE and BS1 deposits (BS1 East and BS1 West combined – refer to Section 2.3).

2.3 Water balance assessment approach

Water balance cases for each deposit have been developed based on the requirement to sustain current cumulative production. The water balances are developed for the 24-year period from 2022 to 2045 inclusive, as defined by the mine plans and available dewatering forecasts. The GBO water balance has been developed using the Goldsim modelling software which provides a robust approach to structure and links relevant input data, defines relevant water balance calculations and operational constraints, and undertake the assessment of relevant water management measures and options. Model dashboards have been included in the water balance model to allow RTIO to efficiently assess surplus and deficit outcomes given water management options.

The assessment outlined in this report has been constrained to the review and definition of hub level water balances for the BS4 and B2N hubs only, including the influence of defined scenarios on the respective hub balances. Potential water management options and measures to manage predicted water surplus (or deficit) conditions, defined by the final hub water balances, are to be addressed separately by RTIO.

For this assessment water balances are aggregated and calculated from the deposit scale with balances resolved individually to determine the surplus water available to contribute to either the BS4 or B2N hub level balances. In this manner the following assessment steps are accounted for in the balancing process:

- Firstly, the deposit scale balances are calculated accounting for local dust suppression water requirements,
- Secondly, deposit level water balances are rolled up within a sub-hub level balance accounting any specific operating infrastructure demands, ie primary processing, and water supply inputs that may occur at the level below the hub balance; and
- Finally, sub-hub water balances are aggregated up to hub level water balances, accounting for hub level water demands and water supply as well as options to combine sub-hub balances through existing water transfer pipelines, to estimate future water surplus or deficits at the hub level.

It should be noted that SGE represents the only specific (existing) sub-hub deposits for the purpose of the GBO water balance assessment, due to the presence of primary processing (primary crusher) water demands at the deposit level. In addition, to maintain groundwater dependent ecosystems at Palm Springs groundwater flow will require supplementation during operations and into closure (refer to Section 3.4.3iii). BS1 deposit sub-hub level water balance scenarios are also included (as potential future operational scenarios) to provide flexibility to review the influence of including or excluding a primary processing option at the deposit.

This process of progressive and scaled water balance estimation is broadly summarised in Figure 2.4.

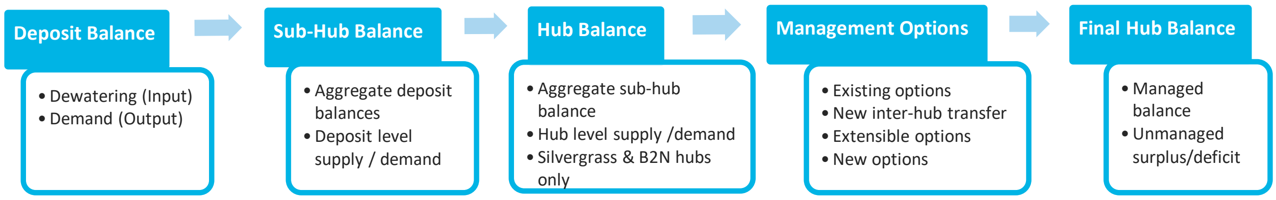

Figure 2.4 Water balance assessment hierarchy

3 Data sources

3.1 Overview

The following data and information have been adopted for the development of GBO deposit and hub level water balances:

- Mine plans used to develop estimates of dust suppression demand and inform dewatering estimates are summarised in Section 3.2;
- Water supply data sources, including dewatering estimates and other mine water supplies, are summarised in Section 3.3;
- Data and assumptions used to develop deposit and hub level estimates of process and non-process water demands are summarised in Section 3.4; and
- Information and assumptions associated with the definition of existing surplus water management infrastructure and options are summarised in Section 3.5

3.2 Mine plans

Mine plans provide detail of the future schedule of pit operations, total material movement and rate of vertical advance, for the given version of the mine plan. As such they determine where and when dewatering is required and where water demand is required for determining future site water balance forecasts. Deposit level estimates of dust suppression demand (refer to Section 3.4.2) are estimated directly from total material movement rates taken from the mine plans.

Two mine plans are relevant to the GBO water balance for the hubs detailed in this assessment and these plans and the source mine plan file (provided by RTIO) are summarised in Table 3.1 below. The mine plans include deposits, pit shells and pit stages with a corresponding schedule of when and how much total material is to be mined from each bench elevation in a stage. The mine plan data commence from 2022 in annual increments and information has been collated for the relevant deposits to the end of 2045. A summary of total deposit material movement forecasts for each of the three hubs is presented in Figure 3.1

Table 3.1 GBO mine plans

Hub	Mine plan source filename
Brockman 4	BS1_END_PFS_01E_Bench_Progression.xlsx
Brockman 2 Nammuldi (includes SGE)	NAM_LOM_TMM_15-2-21

It should be noted that mine plans represent a snapshot of material movement across the hub deposits at the time of the mine plan development, which may vary between different mine plan versions. Therefore, changes to either mine plan may invalidate assumptions used in developing and assessing the individual deposit scale water balances.

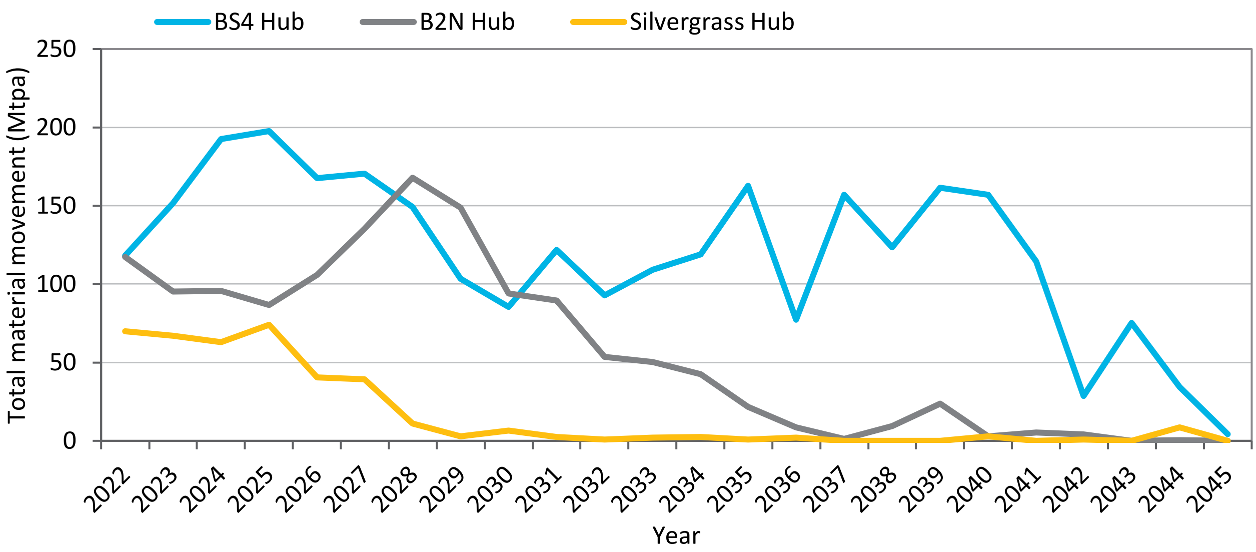

Figure 3.1 Hub level total material movement forecasts

3.2.1 B2N hub

There are eight deposits included within the B2N hub comprising Nammuldi Lens CD, EF, AB and G, Brockman 2 (BS2), Brockman 2 East Detritals (B2ED) and BS3 Ext. There is a single Silvergrass hub deposit, namely Silvergrass East (SGE), included in the Nammuldi mine plan. These eight deposits comprise of 23 pits and 59 stages.

All deposits have a BWT component except for BS2 which does not include a dewatering forecast. A summary of the B2N hub deposits and pits, including the Silvergrass deposit, is provided in Table 3.2, including the estimated BWT period, from dewatering estimates, or an indication that the pit development and mining is fully above water table (AWT) and therefore does not contribute dewatering volumes to the balance.

Other satellite deposits are not included within the current Part IV proposal and have not been included in this water balance. Where the mine plan forecast extends beyond 2045 the material movement tonnes and dewatering forecasts have not been considered for the development of water balance forecasts.

Table 3.2 B2N and Silvergrass hub deposit and pit summary

Deposit	Pits	Stages	Mining from	Mining to	BWT from	BWT to
B2ED	5	9	2022	2029	2022	2025
BS2 [1]	3	9	2027	2034	AWT	AWT
BS3 EXT	5	5	2025	2041	2023	2041
Lens AB	2	6	2022	2043	2022	2028
Lens CD	1	3	2022	2036	2022	2036
Lens EF [2]	1	10	2022	2044	2022	2045
Lens G	1	2	2025	2035	2023	2033
SGE	5	15	2022	2040 [3]	2022	2040

[1] All mining assumed to be AWT

[2] Lens EF includes mining beyond 2045

[3] mining at Silvergrass assumed to finish in 2040, although mine plan include small material movements beyond 2040

3.2.2 BS4 hub

There are six deposits included within the BS4 hub comprising BS1 East (BS1E), BS1 West (BS1W), BS3, BS4, Brockman Syncline Marra Mambas (BSMM) and Brockman Syncline M and N (BSMN). According to the BS4 mine plan, these six deposits comprise 39 pits and 107 stages. Every deposit of the BS4 hub has a BWT component. A summary of the BS4 hub deposits and pits is provided in Table 3.3.

Table 3.3 BS4 hub deposit and pit summary

Deposit	Pits	Stages	Mining from	Mining to	BWT from	BWT to
BS1E	3	17	2025	2044	2024	2044
BS1W	2	18	2030	2045	2031	2045
BS3	2	3	2030	2044	2041	2044
BS4	20	47	2022	2045	2022	2045
BSMM	6	11	2022	2045	2022	2044
BSMN	6	11	2027	2040	2031	2044

3.3 Water supply

3.3.1 Water quality assumptions

A review of potential water quality requirements for water management has not been included as a component of this water balance assessment. Groundwater quality is largely consistent across the Brockman Syncline with fresh to brackish (600–1400 milligrams per litre (mg/L) Total Dissolved Solids (TDS)).

It is therefore assumed that water quality across all deposits is of suitable quality for the respective water uses and demands including mineral processing, dust suppression and potable supply. Potable supply demand for mine camps and administration buildings requires further investigation to ensure suitable dewatering bores can be quarantined to provide secure and reliable future potable water supply requirements of sufficient quality.

The water balance further assumes that dewatering from the BWT deposits will not be impacted by acid mine drainage (AMD) influences on groundwater systems over time. It is noted that potentially acid forming (PAF) material has been documented at Lens CD (Strategen, 2012) and the BS4 pits (RTIO, 2014).

3.3.2 Dewatering

Water supply for mineral processing and dust suppression is often integrated with dewatering requirements, or if dewatering is insufficient to meet demand, supplemental water will be sourced from dedicated water supply borefields. The use of dewatering for water supply mitigates potential impacts from unnecessary groundwater extraction and drawdown; reduces or removes capital costs of developing alternative supply borefields and decreases requirements to manage and dispose of surplus water.

Dewatering estimates for each deposit included in the Greater Brockman Syncline were derived from deterministic numerical groundwater models conducted by RPS and RTIO internal WRE team. A summary of the dewatering data sources provided for the water balance assessment and allocation of respective deposit (and pit) level dewatering estimates defined in each model are summarised in Table 3.4. Total hub level dewatering estimates, for deposits detailed in Table 3.4, are presented in Figure 3.2.

Two scenarios have been provided for BS1 East and BS1 West, referred to as homogenous and heterogeneous model scenarios (as shown in Figure 3.2), which incorporate the influence of alternative assumptions for modelled hydraulic conductivity. For developing the water balance assessments presented in this report, only the heterogenous BS1 (East and West) deposit dewatering estimates have been adopted.

The heterogeneous dewatering estimates represent a more conservative estimate in terms of total abstractions over the forecast period (ie 7% higher volume than the total homogenous dewatering volume estimate). As shown in Figure 3.2, at the BS4 hub level, total annual dewatering volumes are approximately equivalent for the predicted peak BS1 dewatering period (2022 to 2025), with the BS1 heterogeneous dewatering scenario resulting in marginally lower hub level dewatering estimates (1.5 to 3.0 ML/d lower) for the 2026 to 2036 period and higher hub level dewatering estimates (2.0 to 4.0 ML/d) for the 2037 to 2045 period.

RTIO have advised that numerical modelling for Silvergrass dewatering estimates includes a predicted managed aquifer recharge (MAR) rate, currently being investigated as an option in relation to recovery of groundwater during operations and post closure. This SGE MAR rate varies annually with an average rate of 4.88 ML/d for the groundwater modelling period of 2020 to 2040, ranging from a minimum rate of 3.69 ML/d (2025) to a maximum of 5.61 ML/d (2040). For completeness in the water balance assessment process the modelled MAR rate has been included as a water demand/requirement in the calculation of the Silvergrass water balance to the end of the simulation period (2045). It is most likely this demand will continue beyond cessation of dewatering at SGE as the water table recovers at SGE pits, but the extent of drawdown expands in area.

Table 3.4 GBO numerical model and deposit dewatering summary

Model	Filename	Hub/Deposits	Deposits
RPS Brockman Syncline groundwater model	PT03 - BSYNC_pitinflows_RTIO_Mining_Case.xlsx	B2N	• BS2ED (Pit 8) [1] • BS3 Ext (Creekside and MMJ only)
		BS4	• BS3
RTIO direct input	Input_Data_GBO_BS1_BS4.xlsx	BS4	• BS1W [2] • BS1E [2] • BS4 • BSMM • BSMN
Nammuldi numerical model	NAM_PRED_DRAIN_WELL.xlsx	B2N	• BS3 EXT (DSL) [1] • Lens AB • Lens CD • Lens EF • Lens G
Silvergrass numerical model	SGE_Dewatering and MAR.xlsx	Silvergrass	• SGE [3]

[1] Pit level dewatering estimates combined to provide BS3 EXT deposit dewatering estimate.
[2] includes BS1W and BS1E homogenous and heterogeneous model run scenarios.
[3] includes predicted annual MAR rates– refer to Section 3.4.3iii.

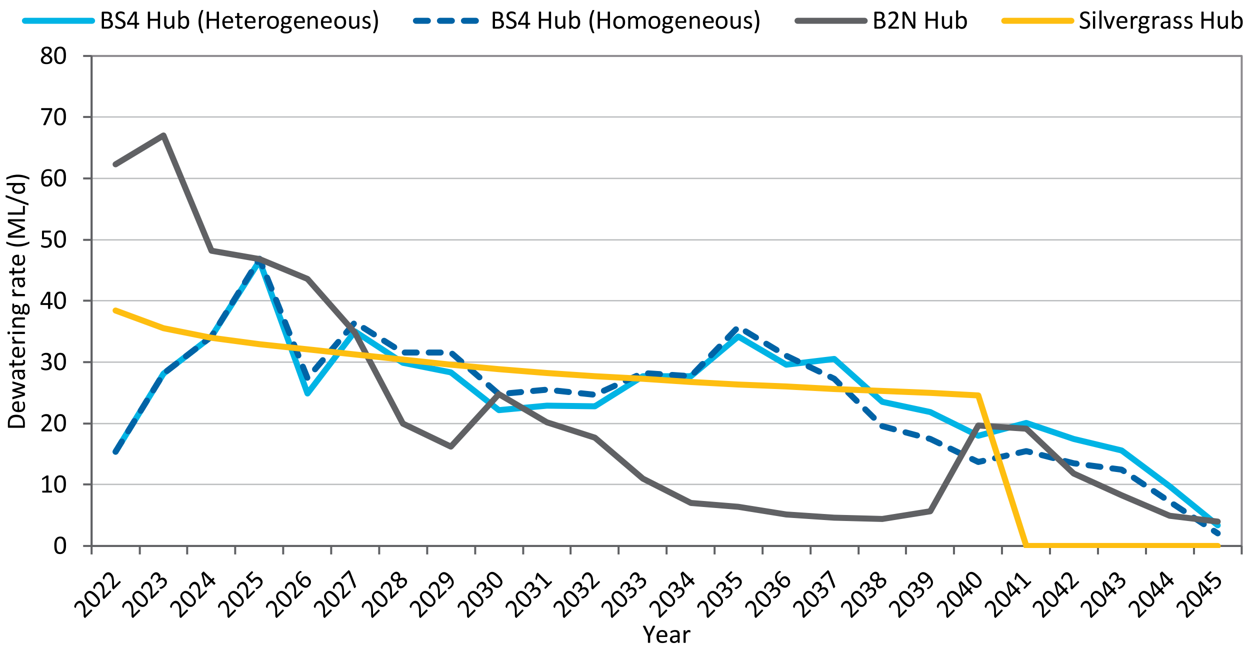

Figure 3.2 Hub level total dewatering estimates

3.3.3 Waste fine storage facility decant

The Nammuldi waste fine storage facility (WFSF) represents a closed water return system with the Nammuldi wet plant. Saturated waste fines from the wet plant are disposed to the facility and water released from the deposited slurry that ponds on the surface is returned to the plant via a decant pumping system. The total decant available is based on the wet plant feed tonnes, operating days, moisture lost to saleable ore product (SOP) and the solids and moisture content in the tailings.

An average daily WFSF decant return in the order of 238.6 m^3/h (5.72 ML/d) has been estimated by RTIO. This water input is included at a constant rate over the model period (2022 to 2045) in the water supply available for B2N hub.

3.3.4 Potable supply - Southern Strike Valley and Eastern Potable borefield

During the 2004/05 BS4 PFS and Feasibility Study (FS) a potential deficit in process water supply from dewatering to meet demand was identified. Consequently, the Southern Strike Valley (SSV) borefield and an Eastern Potable borefield (EPB) were established to supply water to BS4 above that expected from the dewatering estimates required to meet the mine plan. Both borefields had the added advantage of providing early dewatering of some of the Brockman pits and supporting information on groundwater behaviour for improving conceptual understanding. Historic water use from these two sources is provided in Figure 3.3. Mean annual abstraction from these two supply borefields from 2010 to 2018 is around 3 ML/d (1.1 GL).

This supply will be assumed available at BS4, if required, prior to BS4 deposit Pit 18 commencing mining and dewatering. An alternative potable water supply will be required once Pit 18 commences mining. Potable water demand, for both BS4 and B2N hubs are included in hub water demand estimates (refer to Section 3.4.3i), therefore it is assumed that a potable water supply option will be identified from future dewatering schemes.

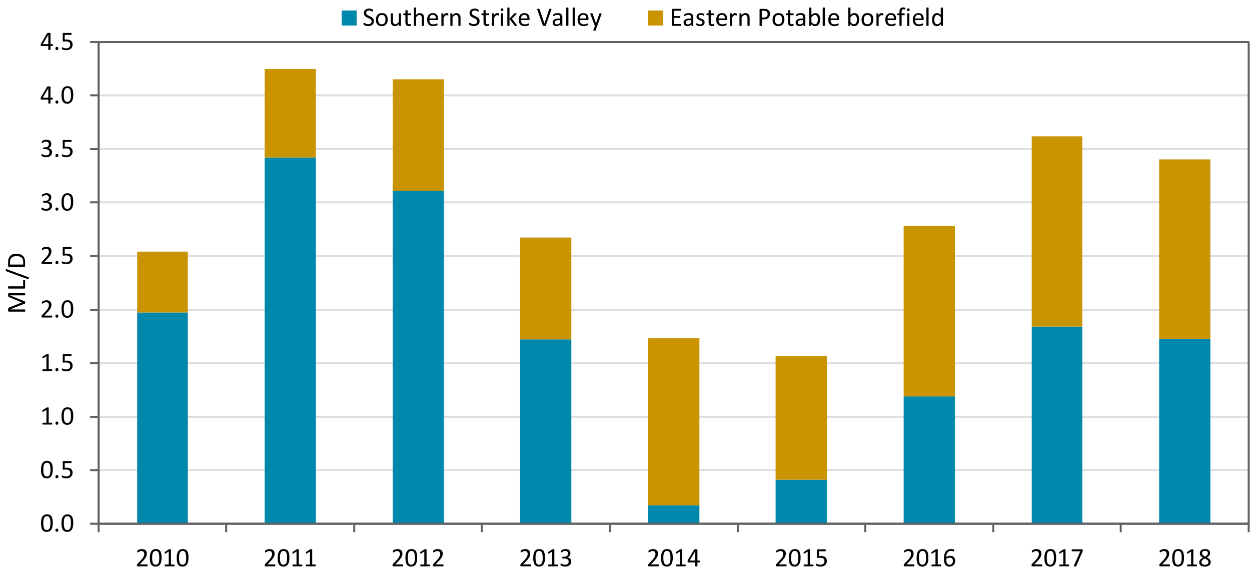

Figure 3.3 Historic water supply to BS4 hub

3.4 Demand assumptions

3.4.1 Overview

Water demands are defined at different levels of the water balance assessment, which are primarily related to the assumed location and nature of the water requirement, namely:

- Deposit level demand, summarised in Section 3.4.2, assumed to be dominantly related to dust suppression water use; and
- Hub level demand, summarised in Section 3.4.3, including wet/dry processing plant, camp potable, central facilities potable and other hub level water demand.

Other water demands accounted for in the GBO water balance include:

- An optional BS1 crusher demand (summarised in Section 0) to be applied to the balance of the BS1E and BS1W deposits; and
- A predicted MAR demand (summarised in Section 3.4.3ii) to be applied to the Silvergrass hub.

3.4.2 Deposit demand

i Dust suppression

Dust suppression water use at deposits is assumed to be a direct function of material movement at the deposit. Estimates of dust suppression water use over the forecast period can therefore be calculated using mine plan outputs of total material movement for individual deposits (refer to Section 3.2).

Historically, dust suppression demand has been based on an assumed water use factor of 17.3 L/T across all hubs. A review of annual mined tonnes and metered dust suppression water use has been undertaken by RTIO for the period 2014 to 2020 for the BS4 hub and a more limited period of January 2020 to September 2020 for the B2N hub. Dust suppression water use factors estimated for deposits within the two hubs are presented in Table 3.5. For the water balance assessment, the previous dust suppression water use estimate of 17.3 L/T has been adopted for the SGE deposit demand. A summary of deposit dust suppression water demand estimates totalled to a hub level are presented in Figure 3.4.

Table 3.5 Dust suppression water use factors

Hub	Dust suppression water use factor (L/T)
B2N	16.87
BS4	22.23
Silvergrass	17.30

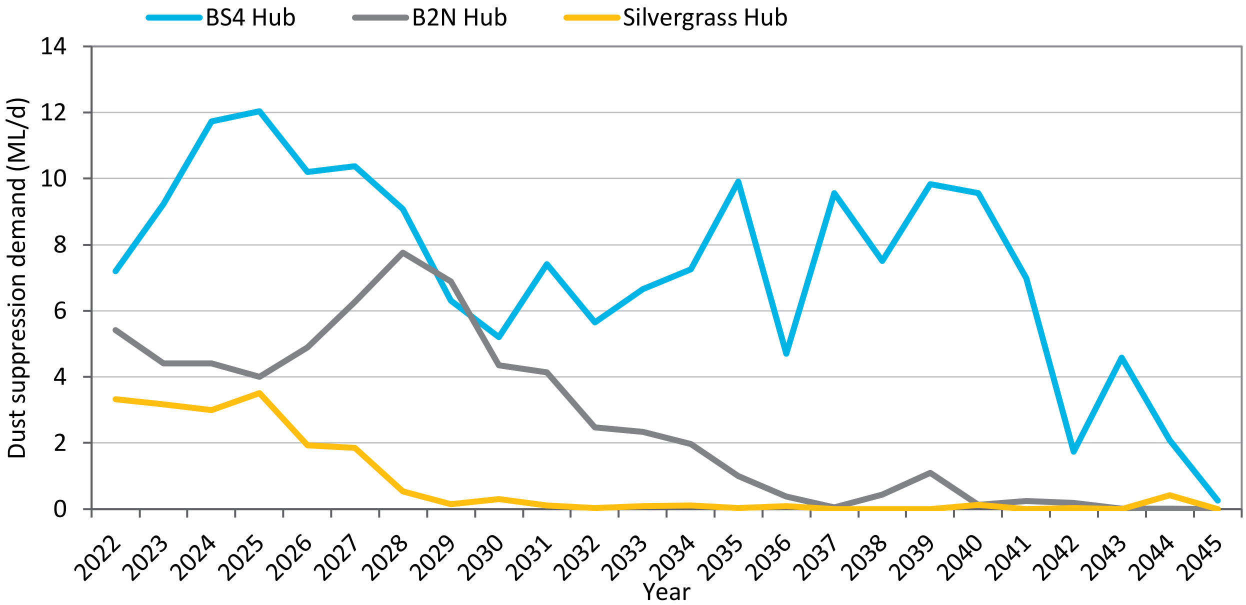

Figure 3.4 Hub level total deposit dust suppression demand estimates

ii BS1 crusher demand

A BS1 crusher demand (for crush and convey scenarios) of 3.5 ML/d is assumed to be applicable to BS1 East and BS1 West deposits and is applied at a constant water use rate only used when material movements occur (ie from 2025 onwards). BS1 East and BS1 West deposit level water balances are combined to a total BS1EW balance for the calculation of a total deposit level water balance under the crush and convey scenario.

3.4.3 Hub demand

i B2N and BS4 processing and non-processing demand

Hub level water demands for B2N and BS4 have been estimated by RTIO based on a review of monthly metered water usage for the period January 2020 to October 2020. Daily hub water demands for B2N and BS4 hubs, including metered water uses included in the analysis, are summarised in Table 3.6.

For both the B2N and BS4 hubs, the fixed plant represents the dominant water use; accounting for approximately 98% and 57% of total water use, excluding dust suppression, at the B2N and BS4 hubs respectively.

The updated water demand estimates for the B2N and BS4 hubs represent a significant demand reduction to the assumed hub demands defined for the previous GBO water balance assessment (EMM 2020). B2N demand is reduced from 25.57 ML/d to 15.57 ML/d (a 57% reduction) and BS4 demand is reduced from 9.97 ML/d to 4.24 ML/d (a 39% reduction). These reductions are likely a reflection of the inclusion of dust suppression in the hub level metered water use data adopted in the previous assessment (EMM 2020) whereas the updated demand analysis provides a more reliable estimate of metered dust suppression specific water demand to be applied at the deposit level (refer to Section Table 3.5 above).

Table 3.6 Hub water demand estimates

Hub	Hub water demand (ML/d)	Demand sources
B2N	15.57	Fixed plant (Nammuldi wet plant) and potable water use
BS4	4.24	Fixed plant (BS4 dry plant), camp potable, central facilities potable and other metered water use.

Daily estimates of hub level water demand have been adopted at a constant rate over the 2022 to 2045 water balance forecast period.

ii Silvergrass hub processing and non-processing demand

No updated analysis of Silvergrass hub water demand have been provided by RTIO, therefore hub water demand estimates are based on the analysis and review of metered water used undertaken for the previous GBO water balance assessment (EMM 2020). A primary crusher and conveyor located at the SGE deposit requires its own site water demand sourced from SGE dewatering.

The assumptions for processing and non-processing infrastructure hub water demand at Silvergrass are based on the analysis of 2019 metered water use provided in Table 3.2. Water stands at SGE pit 2 and SGE pit 1 are currently not metered. Consistent with the B2N and BS4 hub demand detailed above, Silvergrass hub water demand of 8.46 ML/d is applied at a constant rate over the 2022 to 2045 water balance forecast period.

Table 3.7 SGE 2019 water use

Purpose	Flowmeter	GL/a	ML/d
SGE primary crusher (20Mtpa)	FM18SILV0004, FM18SILV0005, FM18SILV0006, FM18SILV0007	1.89	5.18
SGE admin and water stand	FM18SILV0001, FM18SILV0002, FM18SILV0003	1.20	3.28
	Total	3.09	8.46

iii Silvergrass MAR demand

Commitments have been made under the EPA Act to back fill SGE pits to above pre-mining water table levels to enable groundwater throughflow and prevent permanent groundwater sinks from forming, as well as to assist gradual recovery of the aquifer. Current investigations into options to assist quicker recovery of the aquifer via MAR are ongoing and as such a predicted MAR rate has been explicitly included in the numerical modelling of SGE dewatering estimates (summarised in Section 3.3.2).

This SGE MAR rate (presented in Figure 3.5) varies annually with an average rate of 4.88 ML/d for the groundwater modelling period of 2020 to 2040, ranging from a minimum rate of 3.69 ML/d (2025) to a maximum of 5.61 ML/d (2040). The annual estimates have been included in the SGE deposing level balance and continuing at the final rate (5.61 ML/d – as shown as a dashed line in Figure 3.5) after mining activities at SGE cease from 2041 onwards (based on dewatering and mine plan forecasts).

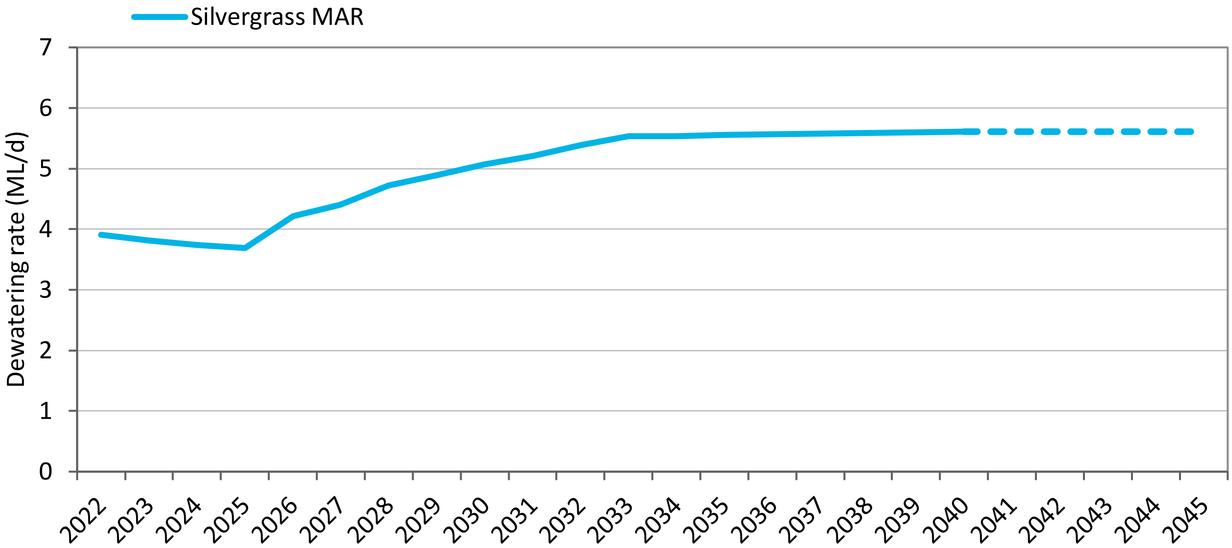

Figure 3.5 SGE MAR rate from numerical model

3.5 Surplus water management options

3.5.1 Overview

Surplus mine water, net of deposit and hub demands, can be managed through existing water management measures across the GBO which include:

- the water transfer pipeline linking SGE deposits to the B2N hub, summarised in Section 3.5.2
- the Nammuldi Agricultural Project (NAP), located at the B2N hub, summarised in Section 3.5.3;
- the Duck Creek discharge, also located at the B2N hub, described in Section 3.5.4; and
- the Boolgeeda Creek discharge, located at the BS4 hub, described in Section 3.5.5.

3.5.2 Silvergrass deposits to B2N hub transfer

A water transfer pipeline has been established linking the Silvergrass hub to B2N hub enabling surplus water from the Silvergrass deposit(s) to be managed through the Nammuldi surplus water management options. For the water balance assessment the maximum capacity of the transfer is limited to 35 ML/d.

3.5.3 Nammuldi Agricultural Project (NAP) scheme

The NAP utilises B2N surplus mine water to irrigate crops (902 ha), supplying high quality fodder to the Pilbara pastoral industry. Locally produced fodder provides pastoral stations with affordable and reliable supplies during periods of drought and reduces pressure on sensitive rangeland areas, improving biodiversity and overall health of these areas without affecting cattle production. No significant water storages are associated with the NAP to mitigate potential variability in water supply and/or irrigation water requirements.

It is noted that while creek discharge options represent a direct disposal option for surplus mine water management (to the environment), whereas the management of surplus mine water through the NAP has primarily been established as an integrated water management scheme to both reduce creek discharge and provide additional social, economic and environmental benefits. Surplus water use through the scheme is often referred to as a demand, however, additional NAP water requirements, in addition to available surplus mine water, is not sourced or extracted to satisfy predicted (of forecasted) NAP water deficits.

The estimation of monthly NAP water use was undertaken in 2015. The water uses estimates considered the following conditions:

- 902 ha of crop under irrigation;
- monthly evapotranspiration rate in millimetres per day (mm/d);
- crop growth rate (9 kilograms per millimetre (kg/mm));
- number of harvests per month per growth rate;
- days lost to harvest and rainfall when pivots are inoperable; and
- a maximum irrigation rate per day of 12.5 mm (112.75 ML/d for 902 ha).

The 2015 estimate is compared to the measured 2019 NAP water use in Figure 3.6. In 2019 the number of hectares under irrigation ranged from a minimum of 520 (11 pivots) up to 884 (19 pivots). The irrigation rate varied between a peak of 7.6 mm/d down to 4.4 mm/d. A comparison of the estimated use with the 2019 demand indicates that:

- the demand is less than estimated (~160.6 GL/a actual versus 177.5 GL/a estimated);
- the 2015 estimated use was over predicted in summer but significantly under predicted in winter;
- peak monthly water use of ~46 ML/d coincided with the maximum number of pivots in October, however the same number of pivots were in use in November, but water use was ~39 ML/d; and
- the natural variability in crop water use is heavily dependent on prevailing climatic conditions and operational factors.

The observed differences between NAP water use estimates and measured water use, and the inherent variability in water use, highlight the difficulty in estimating the water use (or demand) from the scheme in the future and the inherent risks in understanding the greater water balance for estimating surplus volumes.

Regardless, the NAP scheme is approved for a significantly greater irrigation area, as such the scheme is amenable to using more irrigation water than the actual or estimated per month use provided in Figure 3.6, contingent on the economics of expanding and operating the scheme; and marketing the produce.

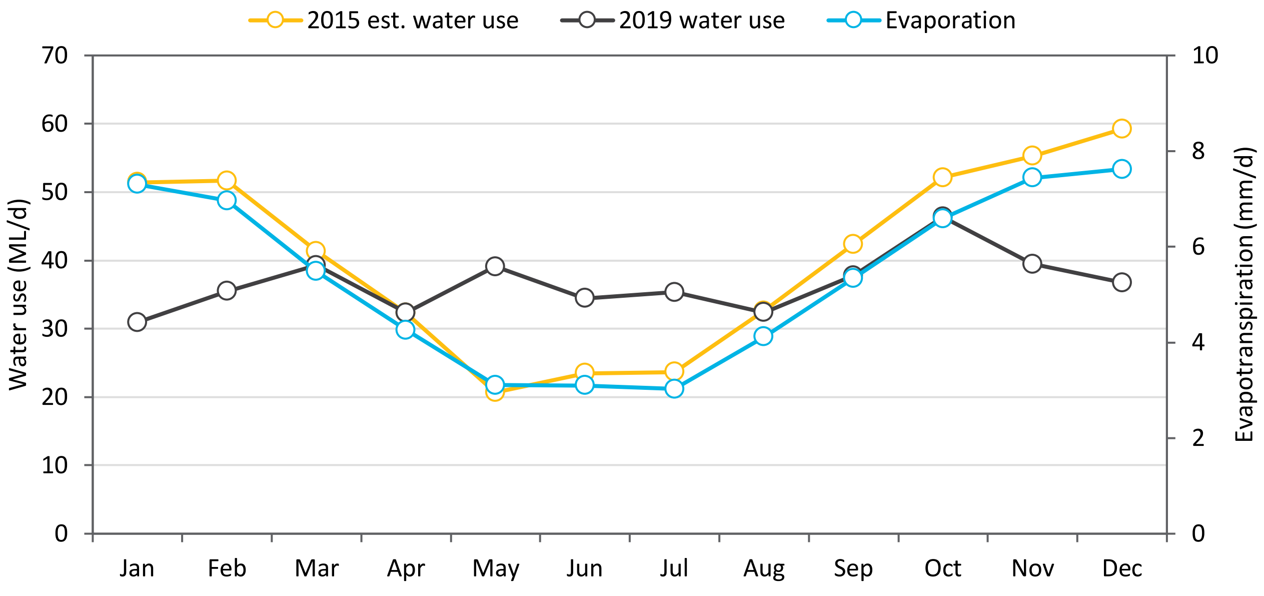

Figure 3.6 NAP scheme 2019 use versus 2015 estimated monthly water use and evapotranspiration.

3.5.4 Duck Creek

B2N hub surplus water in excess of processing and non-processing demands and NAP water requirements is discharged to a tributary of Duck Creek, before flowing into Duck Creek. Approval to discharge surplus water to Duck Creek is predicated on meeting water quality criteria (as defined by MS 925 Condition 7-3). Daily discharge is metered (flowmeter DP13NAM001) and presented from January 2018 to January 2020 in Figure 3.7. Over the two-year period daily discharge varied between zero and a maximum of 34.4 ML/d; mean daily discharge was 14.6 ML/d (5.3 GL/a). The variability in daily discharge is primarily a function of the variability in NAP water use when pivots are not operating for harvesting or owing to antecedent or prevailing rainfall.

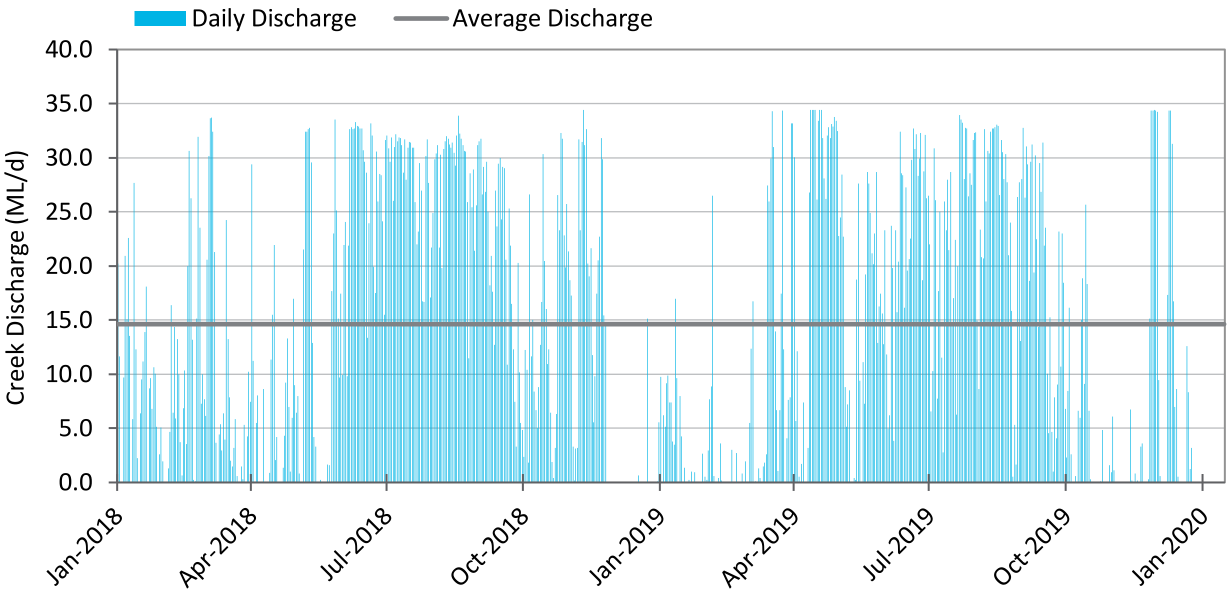

Figure 3.7 Metered discharge to Duck Creek (Jan 2018 to Jan 2020)

3.5.5 Boolgeeda Creek

At BS4 hub, surplus water is discharged to Boolgeeda Creek and is metered daily (DP15BS4001). Approval to discharge to Boolgeeda Creek is limited by a maximum wetting front condition limited to an extent of 37 km from the discharge point during dry conditions (as defined under MS 1000). The Part V licence for discharge limits this to 6.4 GL/a. Daily discharge is metered and presented from February 2016 when discharge commenced to August 2019 in Figure 3.8. Over this period daily discharge varied between zero and a maximum of 12.4 ML/d; mean daily discharge was 4.0 ML/d (1.5 GL/a).

The GBO water balance assessment applies the currently approved Boolgeeda Creek discharge limit of 17.5 ML/d.

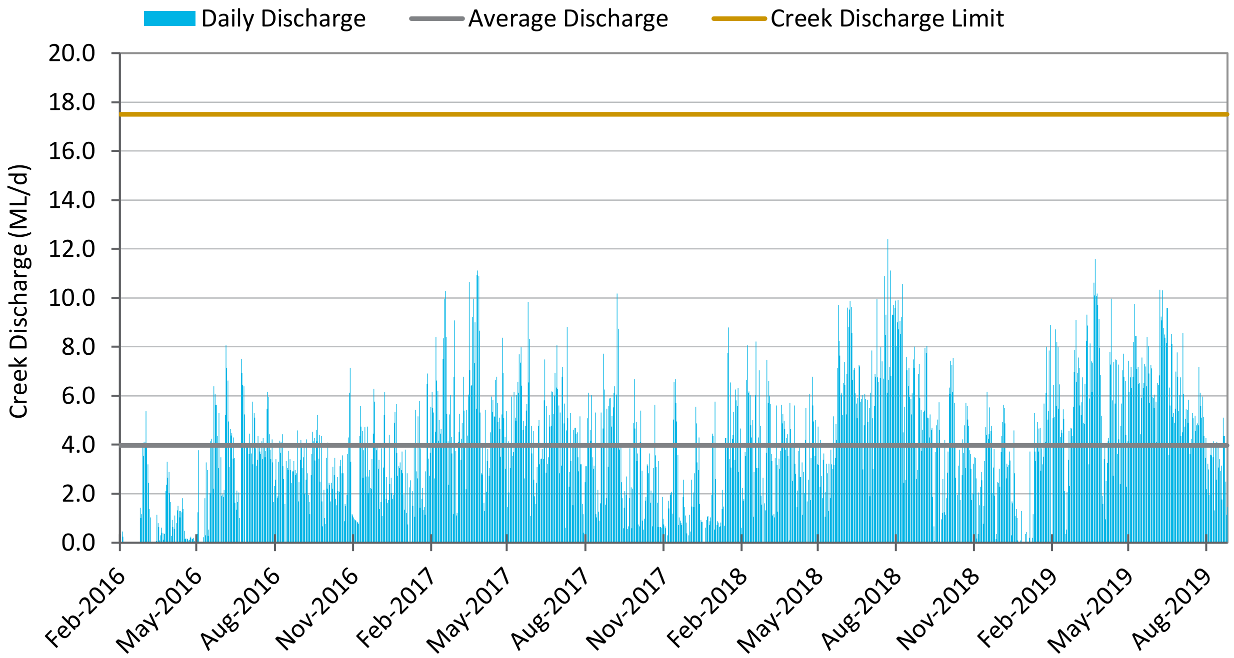

Figure 3.8 Metered discharge to Boolgeeda Creek (Feb 2016 – Aug 2019)

4 Deposit balances

4.1 Overview

Deposit scale water balances have been determined for each deposit to understand the surplus water that is available after dust suppression and deposit scale water demands have been accounted for. The surplus water from each deposit is the water available to be transferred to a processing hub.

As detailed in Section 3.3.2, deposit scale water balances are derived from BWT dewatering requirements less the dust suppression, and additional process and non-process infrastructure demands, where relevant, at each deposit. Additional deposit water balance assessments including process and non-process water demands are presented for the BS1 and SGE deposits only.

Deposit water balances are presented for the following hubs;

- BS4 hub deposit balances are summarised in Section 4.2
- B2N hub deposit balances are summarised in Section 4.3; including Silvergrass East (SGE) deposit balances summarised in Section 4.3.8.

4.2 BS4 hub deposits

4.2.1 Brockman Syncline 1 (BS1)

BS1 deposits have been sub-divided to BS1 East and BS1 West deposit based on available mine plan and dewatering forecast information (refer to Section 3). BS1 deposits comprise BWT BIF on the northern limb of the Brockman Syncline to the far west of Lens AB. The assumption is that the BIF ore would be similar in characteristics to BS4 ore and will be processed at the BS4 hub.

As described in Section 0, two scenarios are defined for the combined BS1 East and BS1 West deposit level water balances;

- Scenario 1 - deposit water balance assumes no primary crusher infrastructure is required at BS1; and
- Scenario 2 - a crush and convey water balance scenario with a crusher demand assumed to be applicable to BS1 East and BS1 West deposits and is applied at a constant water use rate only when material movements occur (ie from 2025 onwards).

i BS1 East

The predicted BS1 East water balance is presented in Figure 4.1. The deposit water balance shows a predicted water surplus from the start of dewatering in 2024 with dust suppression demand increasing from 2025 as TMM increases. The surplus water forecast peaks at 11.3 ML/d in 2025 and progressively reduces through the mine life of the deposit through to 2044. Minor water deficits, with estimated dust suppression demand slightly exceeding dewatering supply, are predicted up to 0.2 ML/d in 2040 and 2042.

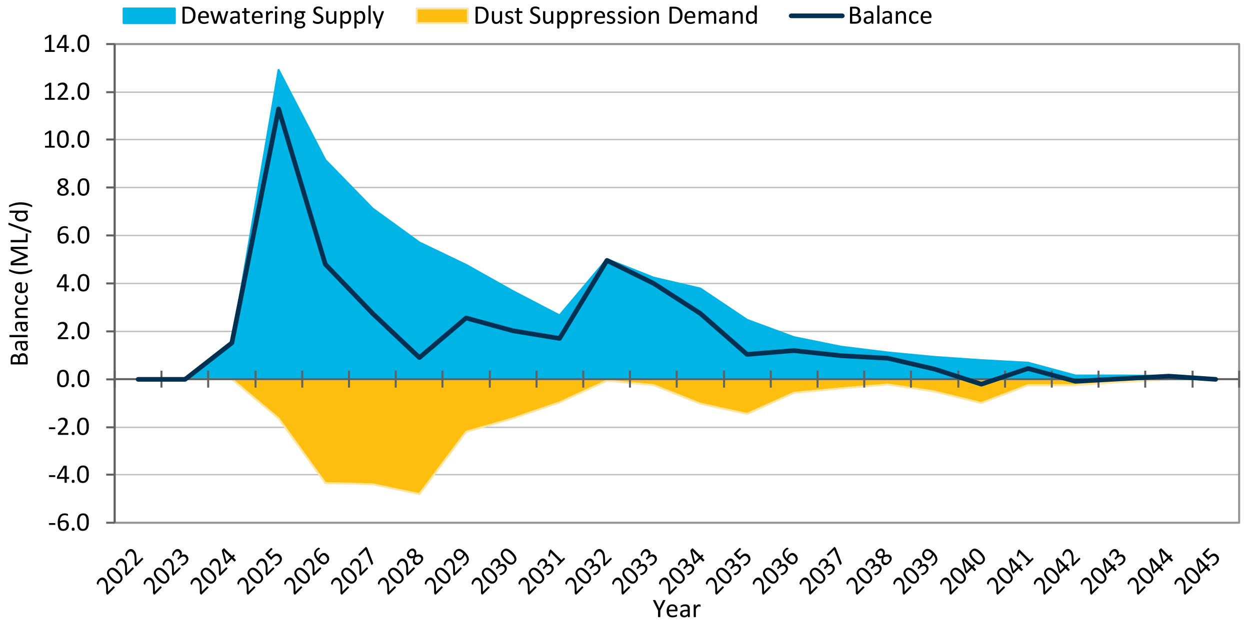

Figure 4.1 BS1 East deposit water balance

ii BS1 West

The predicted BS1 West water balance is presented in Figure 4.2. The deposit water balance profile shows TMM data and dust suppression demand at BS1 West starting from 2030, a year before dewatering estimates begin, resulting in a minor deposit water deficit of approximately 0.2 ML/d. A consistent water surplus is predicted for the period 2031 to 2045 peaking at 9.4 ML/d in 2037 reducing progressively to approximately 1.5 ML/d at the end of the forecast period (2045).

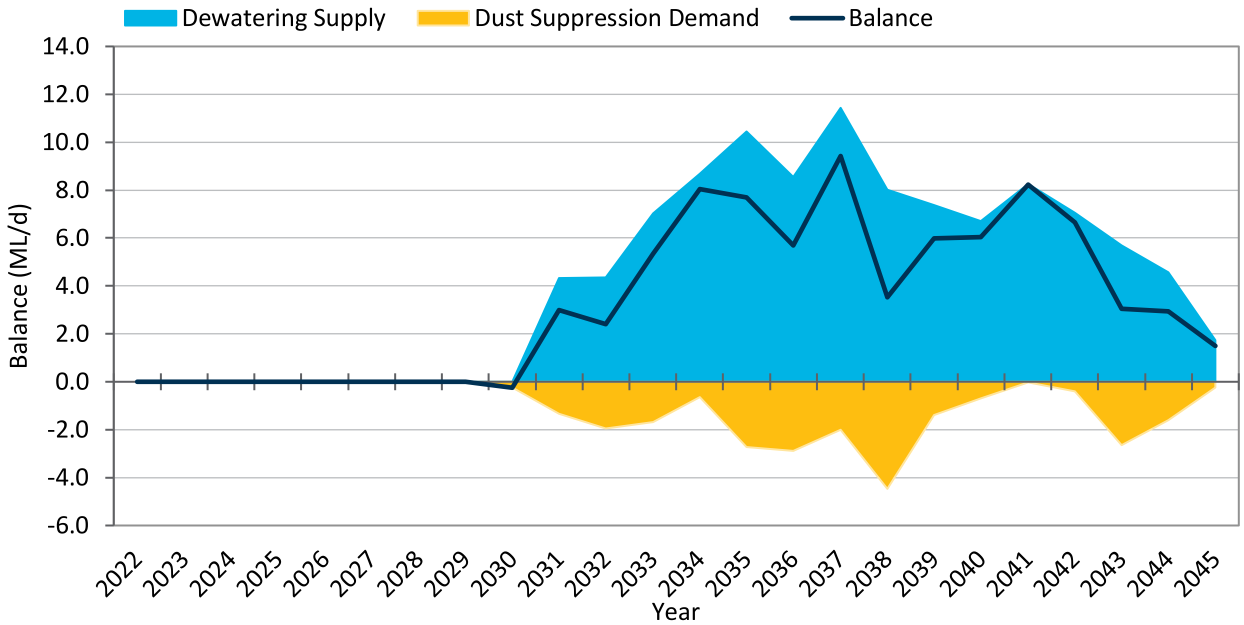

Figure 4.2 BS1 West deposit water balance

iii BS1 Total

The total forecast water balance for the combined BS1 East and BS1 West deposits is presented in Figure 4.3, including the influence of the BS1 crusher water demand scenario. The baseline BS1 water balance estimates a water surplus over the mine life of the deposits with water surpluses in excess of 10 ML/d indicated in 2025, 2034 and 2037. Predicted water surplus for the deposits is much lower, approximately 2.0 ML/d, between 2027 and 2029 as BS1 East dewatering is reducing and BS1 West dewatering is initiated from 2031.

For the crush and convey BS1 water balance scenario a constant deposit water demand of 3.5 ML/d is applied from 2025 through to 2045. The forecasted water balance presented in Figure 4.3 highlights potential water deficits, of up to approximately 2.0 ML/d, for the periods 2027 to 2030 and 2043 to 2045.

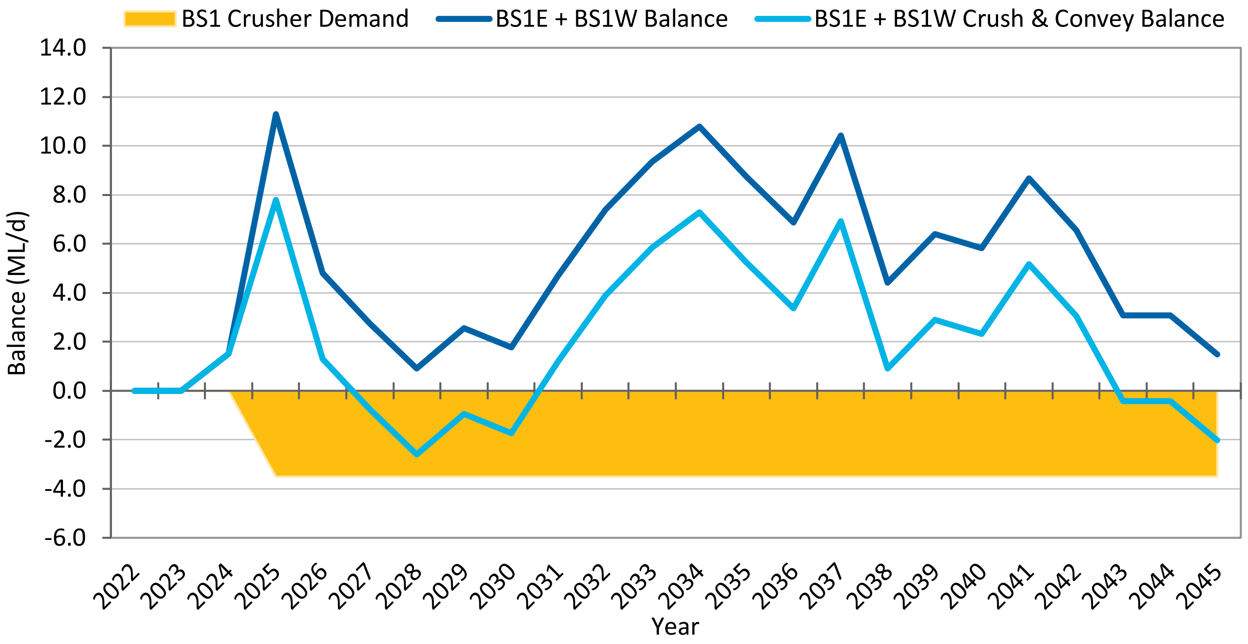

Figure 4.3 BS1 East and BS1 West total deposit water balance crush and convey scenario

4.2.2 Brockman Syncline 3 (BS3)

The BS3 water balance is provided in Figure 4.4. The estimated dewatering supply for the deposit commencing from 2041 is negligible (ie less than 1.0 ML/d). Forecast dust suppression water demand estimates from deposit TMM indicate deficits in water supply at the deposit occur from 2030 through to 2040, with deposit water demands exceeding water supply for the entire mining period with the exception of 2042. Maximum deposit water deficits, potentially required to be satisfied from alternative water sources, of up to 5.0 ML/d are predicted in 2045.

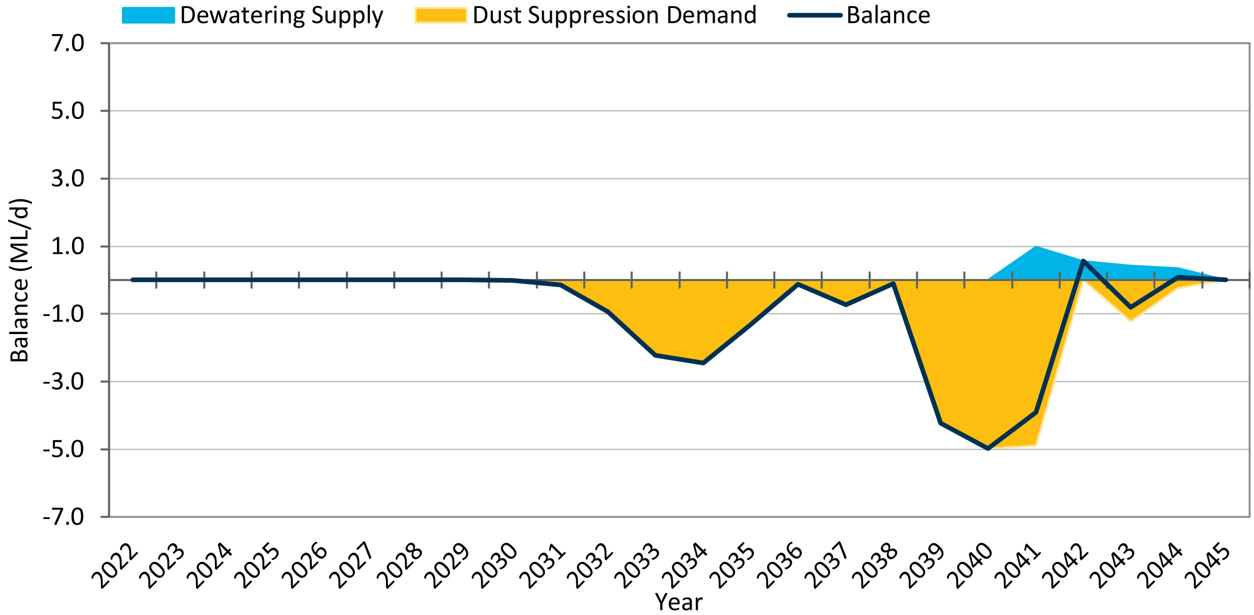

Figure 4.4 BS3 deposit water balance

4.2.3 Brockman Syncline 4 (BS4)

The predicted BS4 deposit water balance is presented in Figure 4.5 showing estimated water surplus anticipated to peak at 21.2 ML/d in 2024 with a second surplus peaking at 20.0 ML/d in 2027. The predicted water surplus reduces rapidly over the period to 2031 and is consistently in a state of lower surplus (ranging from 1 ML/d to 3 ML/d) over the remaining mining period to 2045. A very minor water deficit is predicted in 2039 due to an increase in TMM and dust suppression water demand.

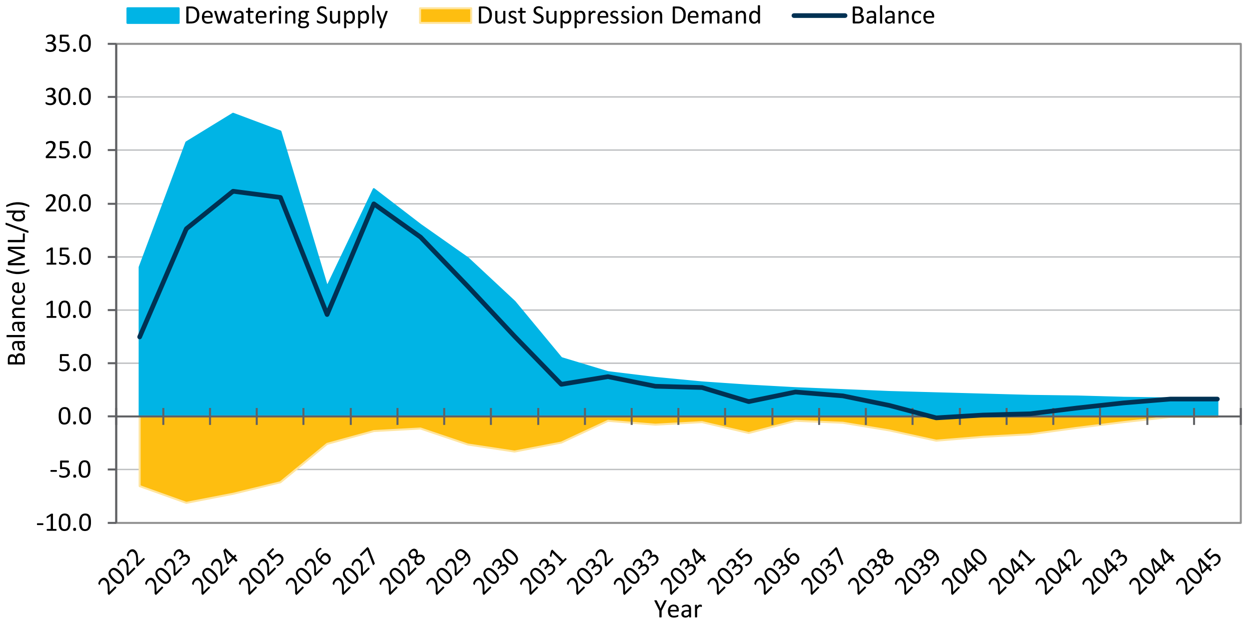

Figure 4.5 BS4 deposit water balance

4.2.4 Brockman Syncline South Marra Mambas (BSMM)

The predicted BSMM deposit water balance is presented in Figure 4.6, and indicates the deposit includes substantial BWT pits with significant dewatering expected given hydrogeological investigations to date. Deposit dewatering is forecasted to be required from 2022 through to 2044 with a maximum dewatering rate (of up to 11.0 ML/d) predicted in 2035. In contrast dust suppression water demand for the BSMM deposit is predicted to peak at approximately 4.5 ML/d in 2024 and reduce to an insignificant level from 2036 onwards. A very minor deposit water deficit (less than 0.2 ML/d is predicted in 2024). The deposit water balance generates a water surplus above 4.0 ML/d for the 2028 to 2043 period with a maximum estimated water surplus of 9.5 ML/d between 2035 and 2037.

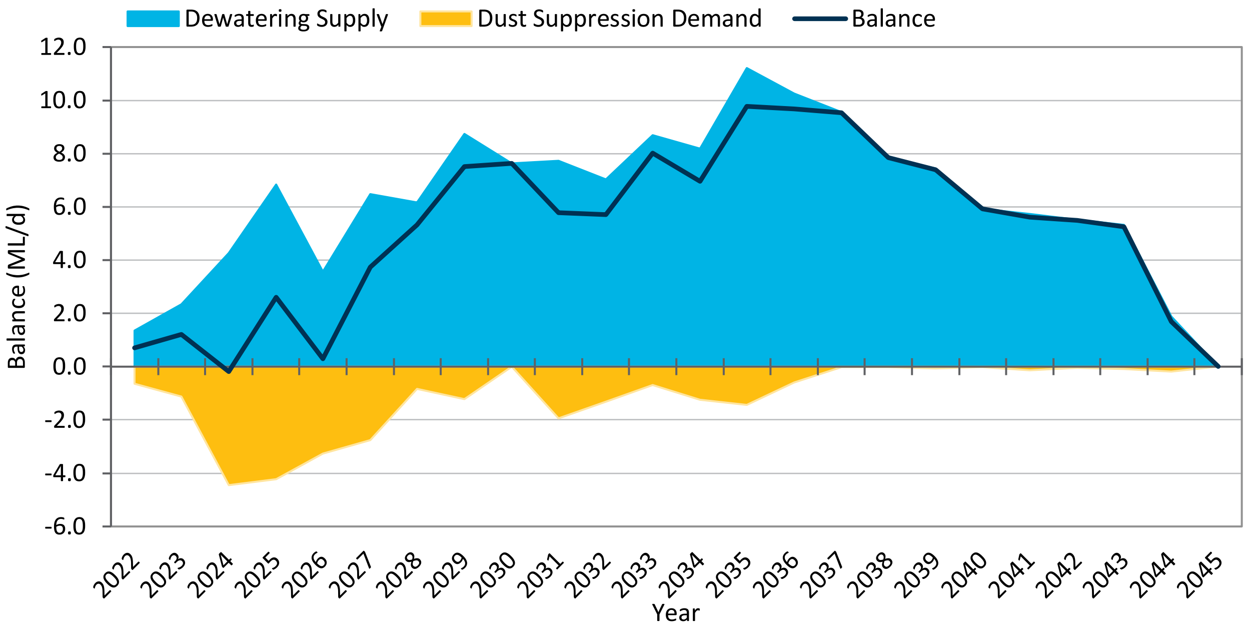

Figure 4.6 BSMM deposit water balance

4.2.5 Brockman Marra Mamba M and N Deposits (BSMN)

The BSMN deposit water balance is presented in Figure 4.7 and indicates an initial period of water deficit, in the region of 2.0 ML/d for 2027 and 2028, where dust suppression water requirements occur prior to dewatering starting in 2031. From 2031 onwards the deposit water balance is in surplus through to 2044. Peak water surplus in the order of 6.0 ML/d is predicted 2035.

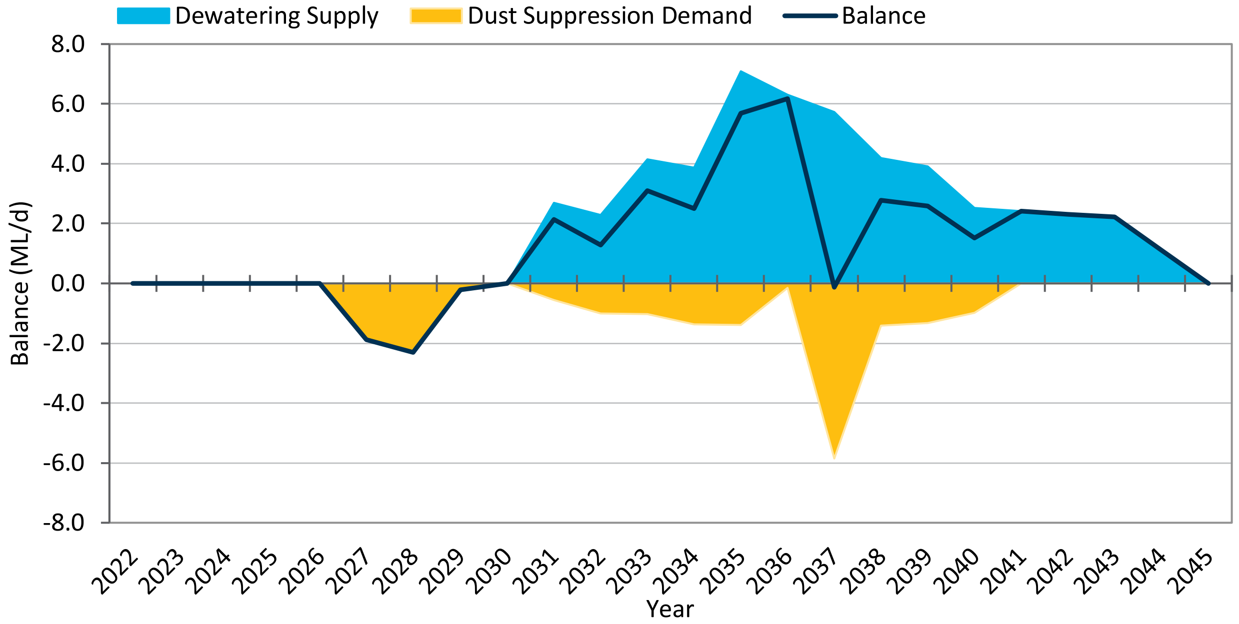

Figure 4.7 BSMN deposit water balance

4.3 B2N hub deposits

4.3.1 Brockman Syncline 2 East Detritals (BS2ED)

The BS2ED comprise Pits 8 to 13 on the southern side of the northern limb of the Brockman Syncline. The deposit consists of detrital and bedded Brockman Iron Formation (BIF). Local geological structure, dewatering from multiple deposits and groundwater level responses have been reviewed by Latscha (2017). Whilst some pits at BS2ED are isolated (Pit 8), others have had groundwater levels respond to dewatering from the nearby Nammuldi Lens CD or EF. As such the available groundwater from dewatering at these deposits may be impacted by dewatering activity at other deposits.

The only water demand for these deposits is for local dust suppression of the pits and haul roads, estimated from deposit material movements and assumed dust suppression demand factors (refer to Section 3.4.2i. It is assumed, as for all deposits, that dust suppression water demand is sourced locally from dewatering bores.

The water balance for the BS2ED deposits is presented in Figure 4.8. The BS2ED deposits are predicted to oscillate between water deficit and surplus over the period of deposit mining between 2022 and 2029. However, the predicted annual demand and surplus are generally very small relative to other deposits (ie in the order of 0.6 ML/d or less).

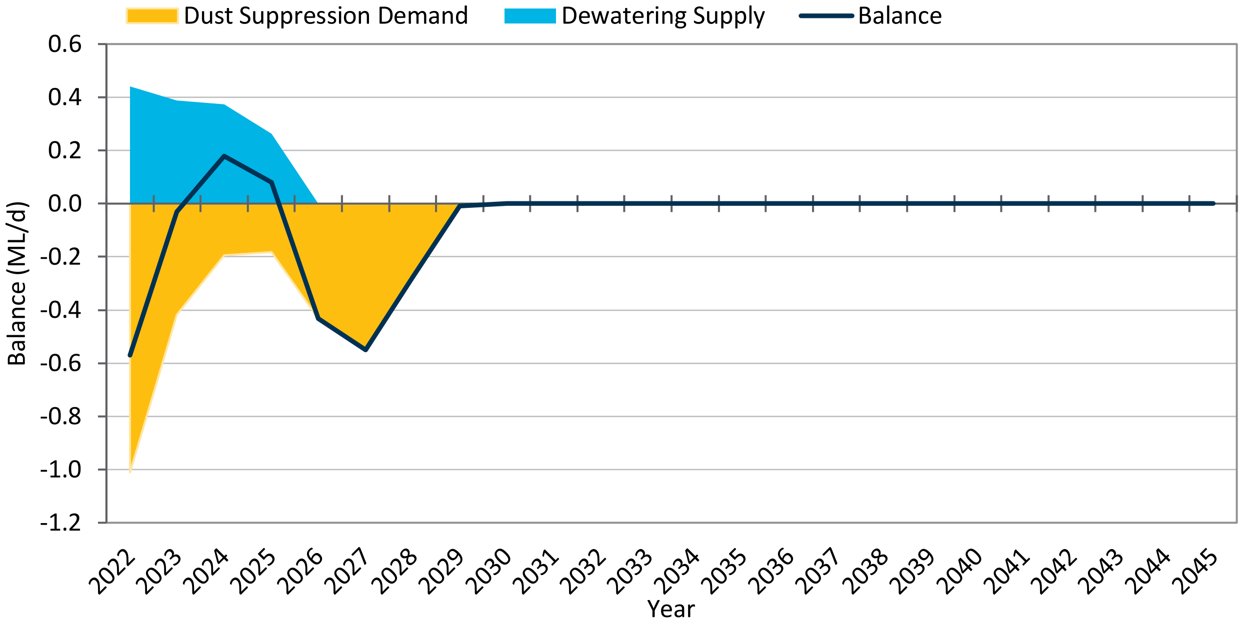

Figure 4.8 BS2ED deposit water balance

4.3.2 Brockman Syncline 2 (BS2)

The water balance for the BS2 deposit is presented in Figure 4.9 and highlights that the deposit is located mainly above AWT and no dewatering has been estimated from the groundwater model at BS2 (refer to Table 3.1 and Table 3.2). Therefore, very small water deficits of less than 0.3 ML/d are predicted through the deposit mining period (2027 to 2034) based on estimated water requirements to satisfy deposit dust suppression water demand.

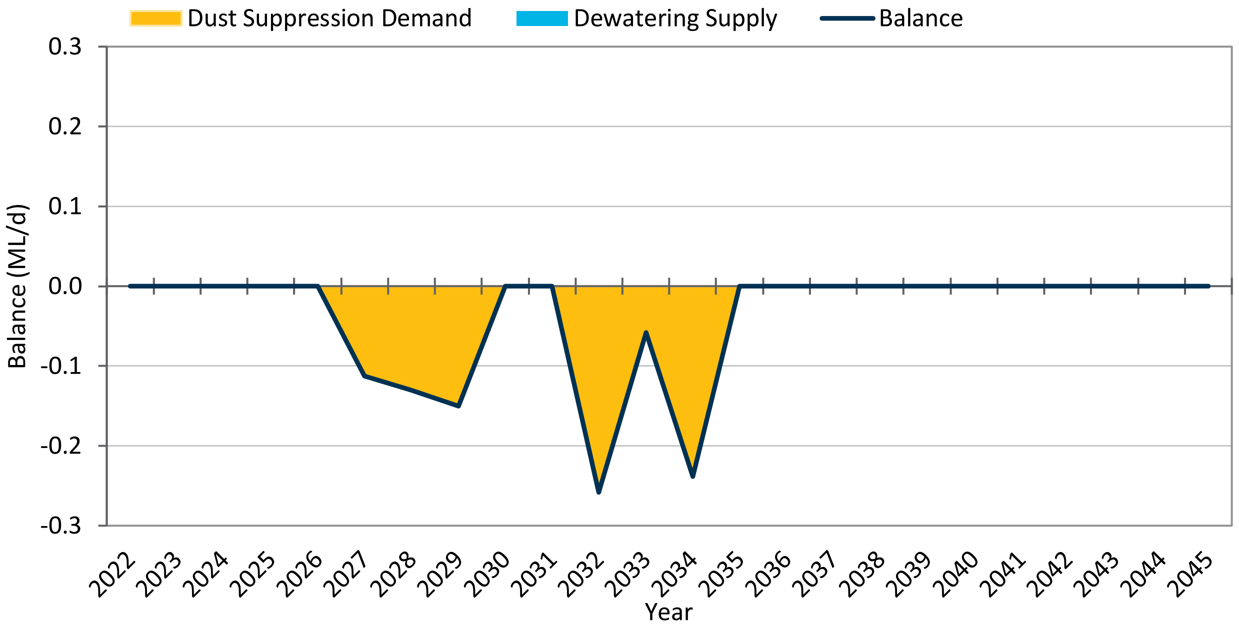

Figure 4.9 BS2 deposit water balance

4.3.3 Brockman Syncline 3 Extension

The water balance for the BS3 Ext deposits is presented in Figure 4.10 and indicates a highly variable water balance to be managed over the mining period from 2022 through to 2042. Notable increases in dewatering estimates are observed in 2030, up to 12 ML/d, and 2040, up to 15.0 ML/d, resulting in predicted water surplus of a similar magnitude as dust suppression water demand is relatively low. Dewatering is not predicted to be required between 2033 and 2038 resulting in minor water deficits for the period of up to 0.5 ML/d.

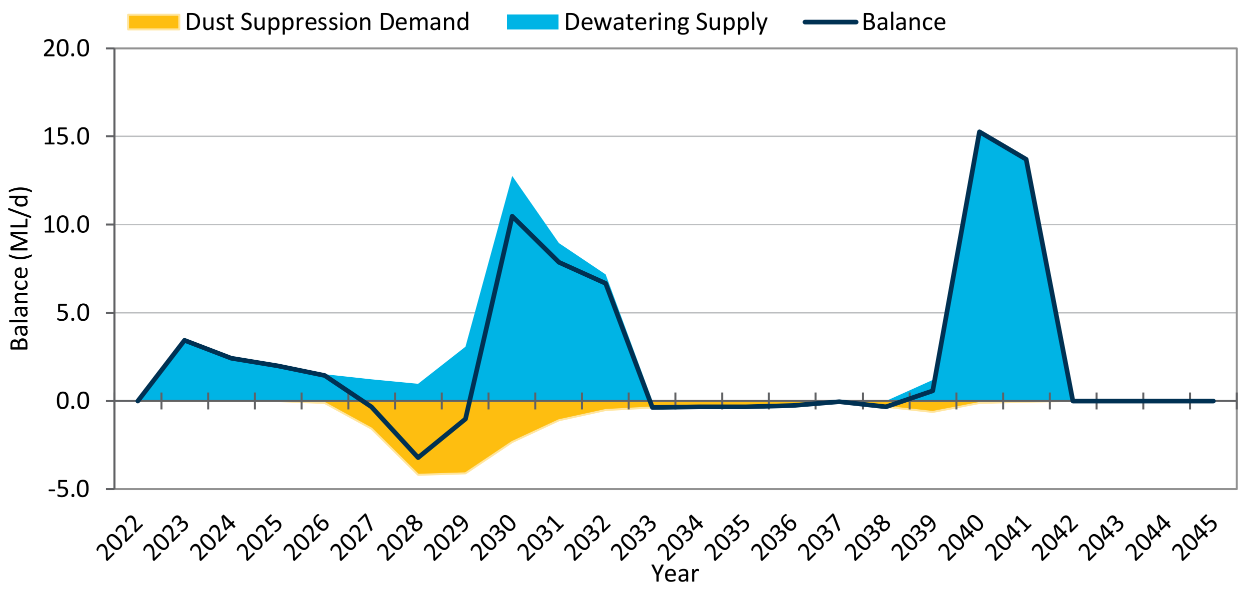

Figure 4.10 BS3 Ext deposit water balance

4.3.4 Lens AB

The water balance for the Lens AB deposit is presented in Figure 4.11. The predicted water balance presents significant dewatering driven water surplus between 2022 and 2027 of up to 17 ML/d and consistently above 12 ML/d over the six-year period. Dewatering ceases from 2029 onwards although dust suppression water requirements are predicted to continue, albeit at a very low demand level of up to 0.7 ML/d, and result in very slight deposit level water deficits through to 2043.

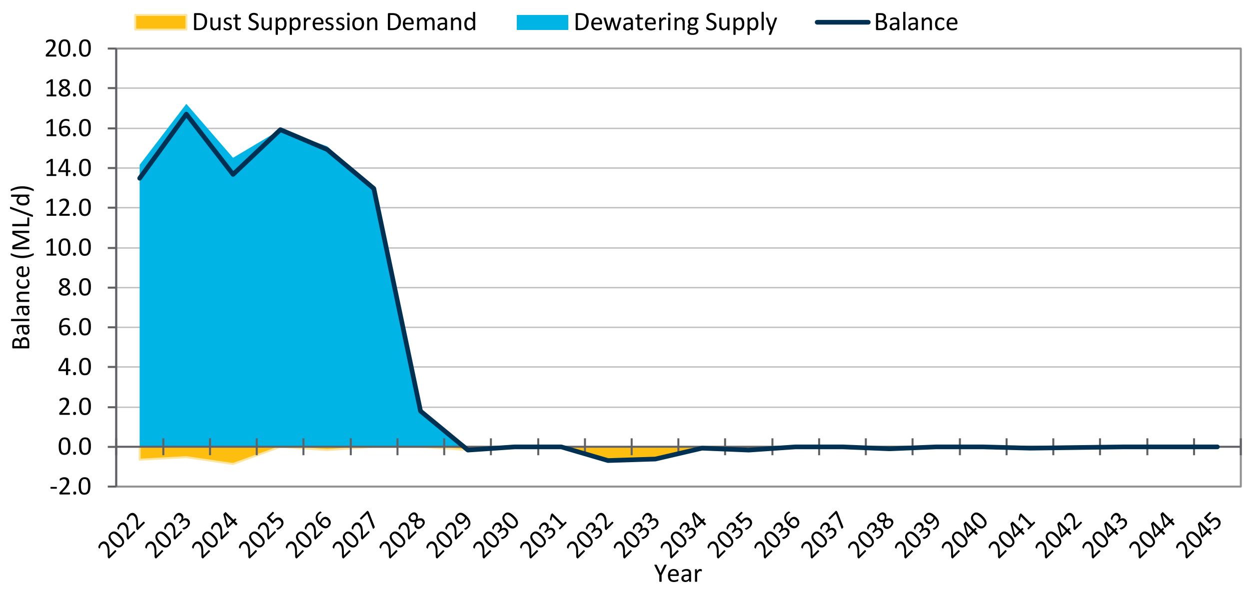

Figure 4.11 Lens AB deposit water balance

4.3.5 Lens CD

The water balance for the Lens CD deposit is presented in Figure 4.12 and indicates a predicted water surplus over the deposit mining period from 2022 to 2036. Estimated dust suppression water demand requirements are relatively low, ie predominantly less than 1.5 ML/d, compared to the predicted deposit dewatering rates which are consistently above 4.0 ML/d and peak at approximately 12.0 ML/d in 2026.

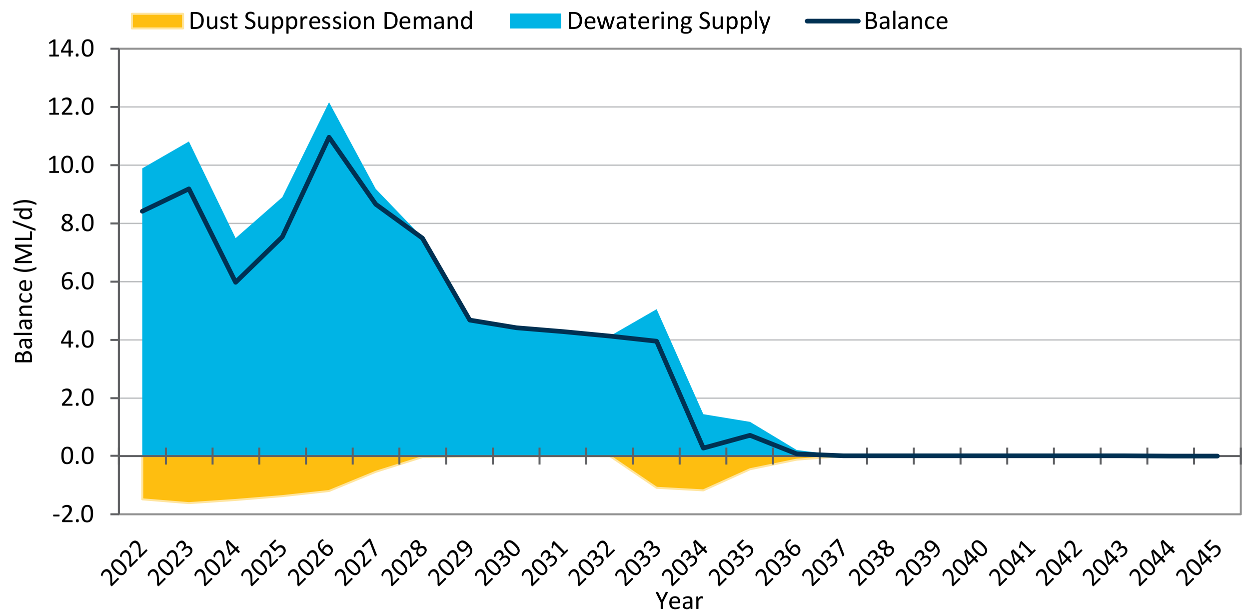

Figure 4.12 Lens CD deposit water balance

4.3.6 Lens EF

The water balance for the Lens EF deposit is presented in Figure 4.13 and shows a predicted deposit water surplus over the entire forecast period (2022 to 2045). Very high predicted dewatering estimates, particularly in the early years of the forecast period (up to 37 ML/d), and low dust suppression water requirements (up to 2.3 ML/d) result in a predicted water surplus in excess of 5.0 ML/d for almost all years.

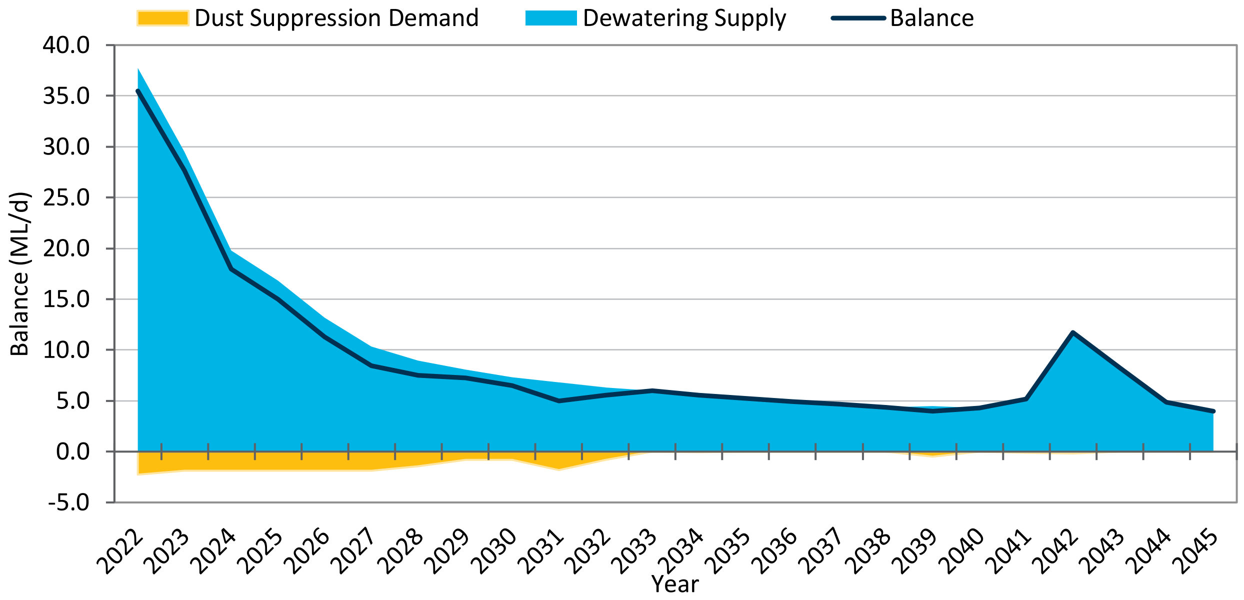

Figure 4.13 Lens EF deposit water balance

4.3.7 Lens G

The water balance for the Lens G deposit is presented in Figure 4.14. The predicted deposit water balance shows a peaky water balance forecast with a maximum estimated water surplus of 5.6 ML/d in 2023 (before dust suppression water demand requirements are predicted to start) which reduces as dewatering rates drop off through to 2033. Dust suppression water demand from 2025 is predicted to increase up to a maximum demand of 1.7 ML/d from 2027 through to 2029. Between 2027 and 2035 a deposit water deficit of up to 1.2 ML/d is predicted as dust suppression demand increases relative to prevailing dewatering rate estimates.

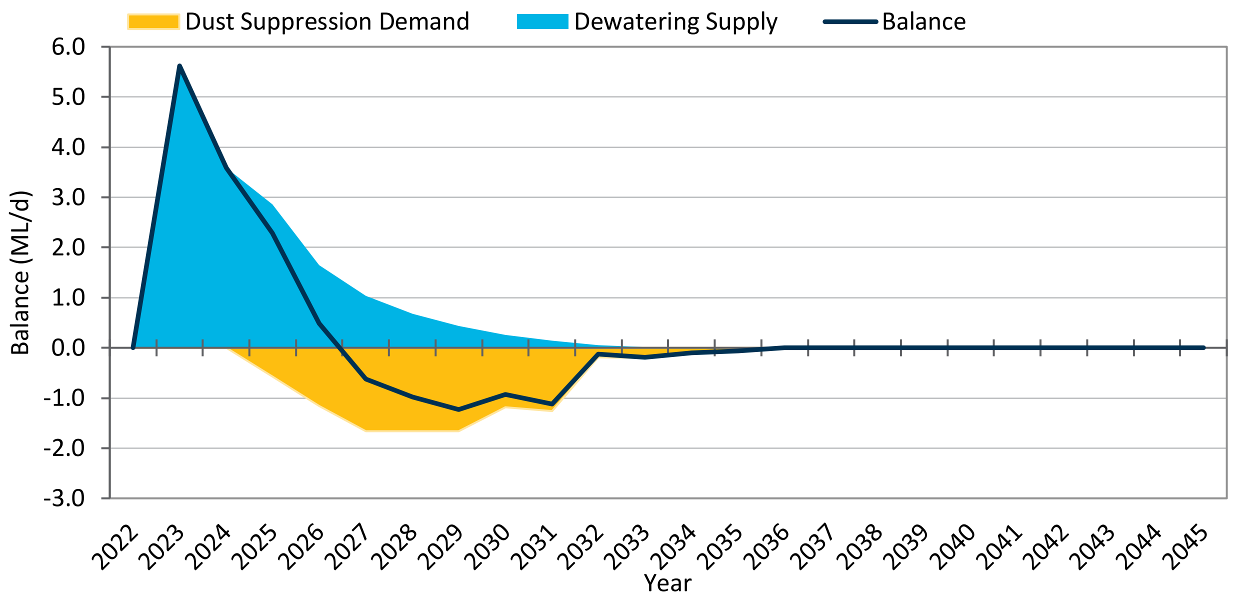

Figure 4.14 Lens G deposit water balance

4.3.8 SGE

i SGE deposit balance

The water balance for the SGE deposit is presented in Figure 4.15 and highlights that SGE represents one of the larger dewatering sites at the GBO and consists of multiple BWT deposits. SGE dewatering is estimated to generate up to 38.4 ML/d in 2022 and progressively reduces through to 2040, down to a minimum dewatering rate of 24.6 ML/d. SGE deposit dust suppression water demand is estimated to be up to 3.5 ML/d during the early period of the forecast, between 2022 and 2025 and reducing to a low water demand requirement, of less than 0.2 ML/d, from 2029 onwards. The forecasted deposit water balance surplus is, therefore, of a comparable magnitude to dewatering estimates, ie maximum predicted surplus of 35.0 ML/d in 2022 reducing to 24.5 ML/d in 2040.

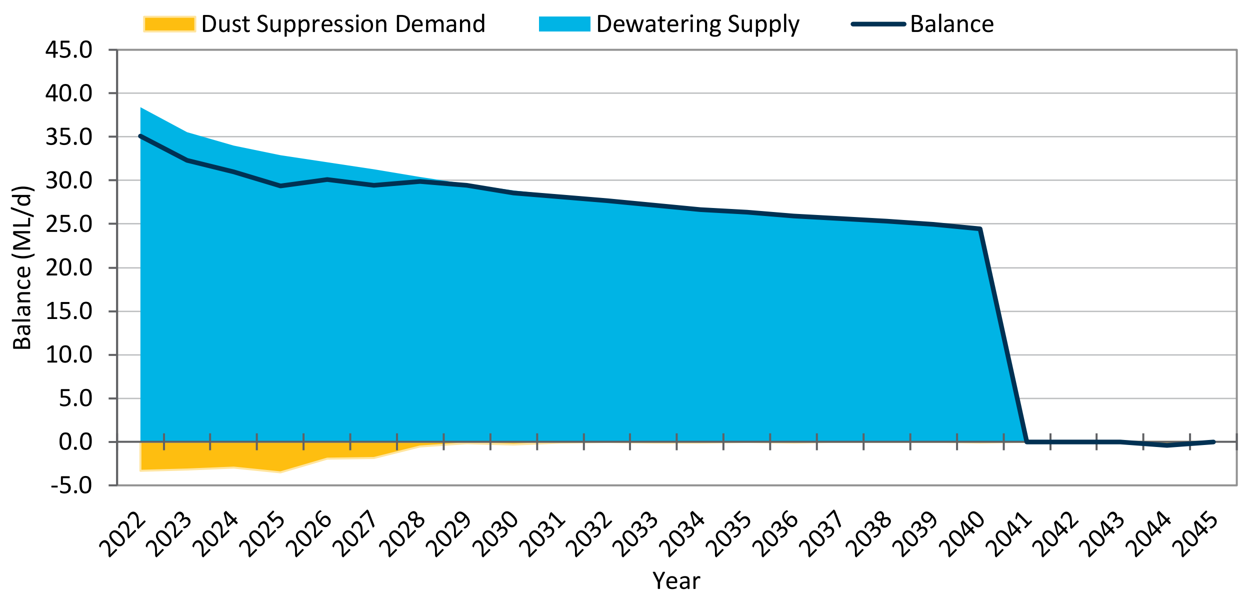

Figure 4.15 SGE deposit water balance

ii SGE final balance

The deposit water balance presented above in Figure 4.15 includes dust suppression water demand estimates only, however, the Silvergrass deposits have their own deposit specific water demands in addition to dust suppression (similar to the BS1 crush and convey scenario presented in 4.2.1iii). The other SGE specific processing and non-processing water demand include;

- water demand requirements for the primary crusher and conveyor (summarised in Section 3.4.3ii); and
- allowance for MAR to assist with aquifer recovery both during operations and post closure.

Due to the geographical location relative to other deposits and the absence of a direct water transfer to Silvergrass from other deposits/hubs these demands are assumed (based on existing water infrastructure constraints) to be satisfied by local deposit water surplus.

The final SGE water balance accounting for all deposit water demands (dust suppression, processing, and MAR requirements) is presented in Figure 4.16. SGE processing water demand is applied at a rate of 8.46 ML/d through the period of SGE deposit mining (up to 2040) and when combined with the MAR demand requirement (of up to 5.6 ML/d), total deposit water demand, in addition to dust suppression demand, ranges between 12.2 ML/d (in 2024) up to 14.1 ML/d (in 2040).

Post SGE mining, the environmental water requirement through the MAR scheme is assumed to be 5.61 ML/d through to the end of the forecast period but will likely continue over the long-term to assist with recovery of the deep aquifer drawdown resulting from dewatering of SGE. Post SGE deposit mining, from 2041 onwards, the SGE water balance indicates a water deficit of 5.61 ML/d required to maintain the MAR scheme operation in the absence of the dewatering water supply. It should be noted that minor deposit water deficits of up to 0.4 ML/d are generated by small material movements included in the mine plan post-2040, although SGE deposit mining is assumed to cease in 2040 for the purpose of the water balance assessment.

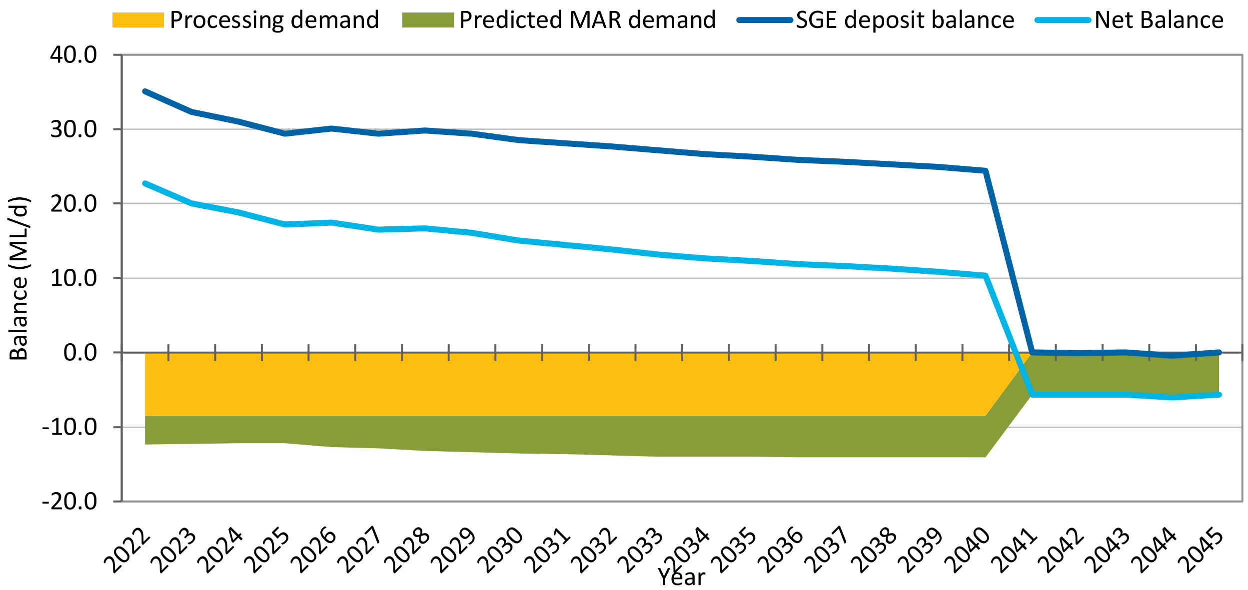

Figure 4.16 SGE total deposit water balance, including processing and MAR demands

5 Hub balances

5.1 Principles for water management

The hub level water resource management principles adopted for determining the best approaches for the management of surplus water and mitigation of water deficits are:

- water management must facilitate forecasted production targets;
- water use must be efficient and follow a hierarchy of use to avoid waste; and
- impacts to natural ecological processes and biodiversity of water dependent ecosystems (riparian environments) are to be minimised to mitigate risk.

The water management options do not consider costs (capex and opex) at this stage and focus solely on efficient water use and management as the priority aligned with the Office of EPA expectations for inland waters.

5.2 BS4 hub balance

BS4 hub level water balance forecasts have been estimated based on summation of deposit level water balances (detailed in Section 4.2) and integration of hub level processing and non-processing water demands and additional hub level water supply inputs, where relevant. BS4 hub deposit water balances are presented in Figure 5.1 for the no BS1 crusher scenario and in Figure 5.2 for the BS1 crush and convey scenario. These two water balance scenarios are combined with the BS4 hub processing water demand in Figure 5.3 to provide a final hub level water balance forecast.

The final BS4 hub water balances show the following:

- Both the no BS1 crusher and BS1 crush and convey scenarios predict a water surplus at the BS4 hub from 2022 through to 2044.
- The no BS1 crusher scenario predicts a hub level water surplus in excess of 10.0 ML/d from 2024 through to 2038 with a maximum predicted water surplus of 30.2 ML/d in 2025. A minor water deficit of 1.1 ML/d is predicted at the very end of the forecast period in 2045.
- Applying the BS1 crush and convey scenario, with additional processing demand at the BS1 deposits, reduces the predicted hub water surplus with the water balance predicted to be consistently above 7.0 ML/d through to 2038. However, the BS4 hub balance is predicted to be close to a deficit condition in 2040 and enters a water deficit condition a year earlier than the no BS1 crusher scenario in 2044.

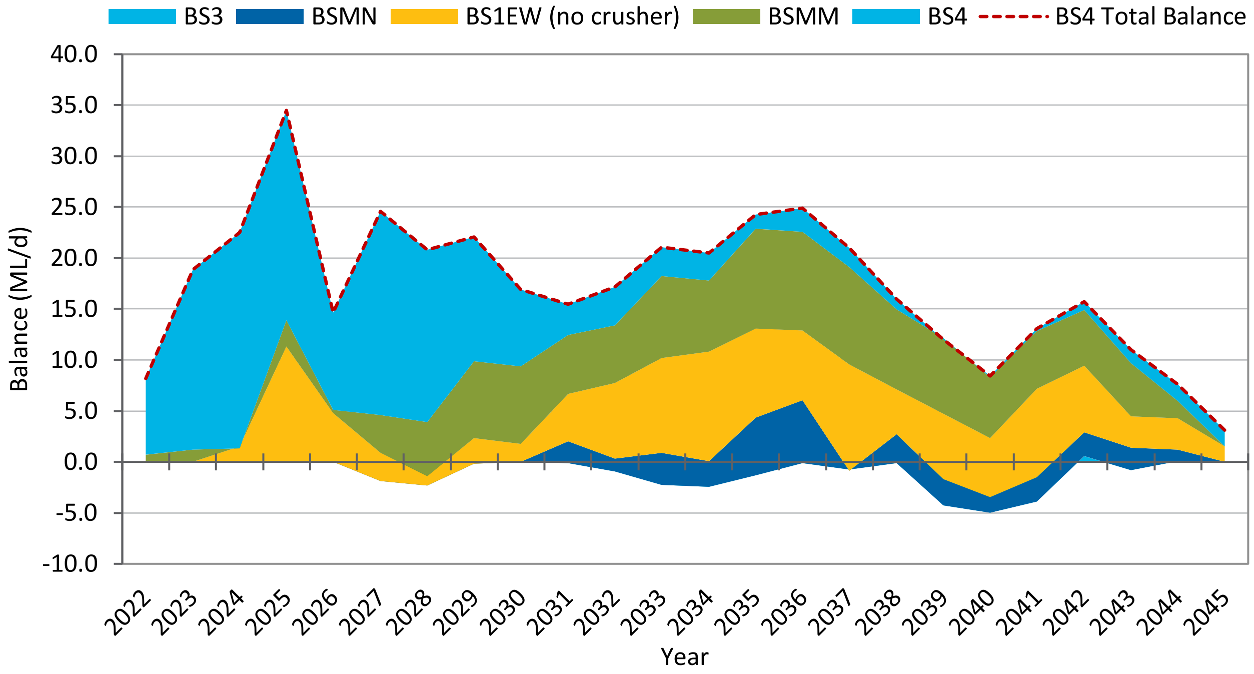

Figure 5.1 BS4 hub total deposit water balance summary – no BS1 crusher scenario

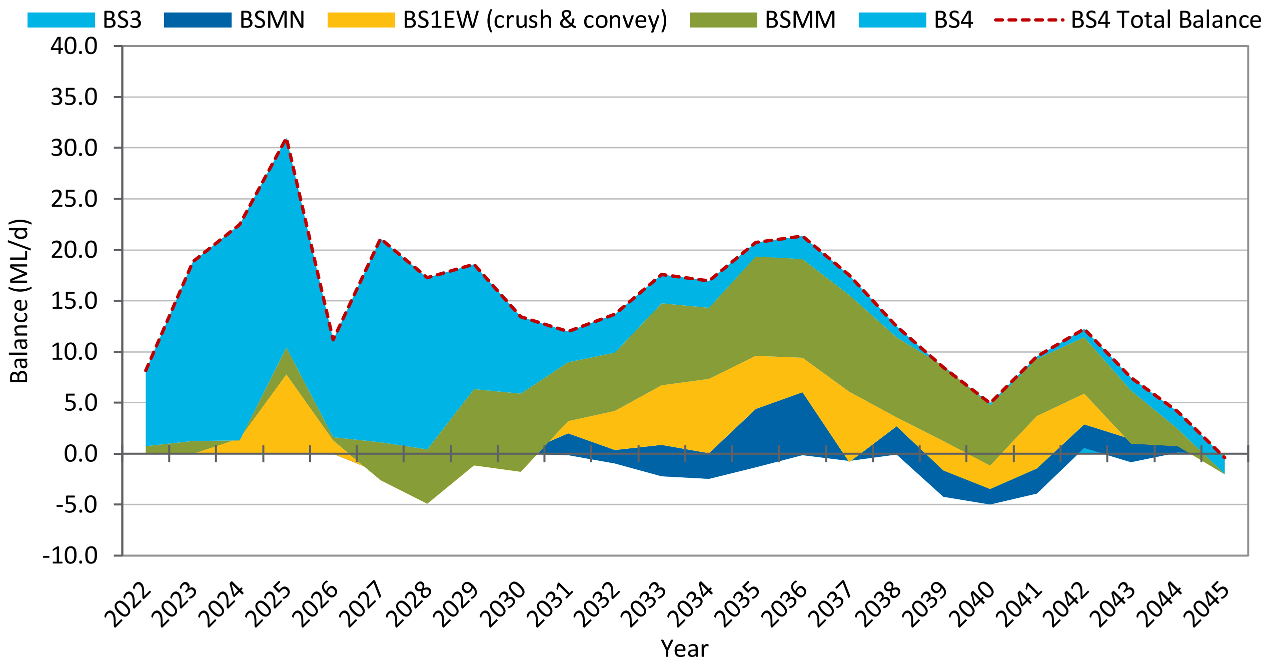

Figure 5.2 BS4 hub total deposit water balance summary – BS1 crush and convey scenario

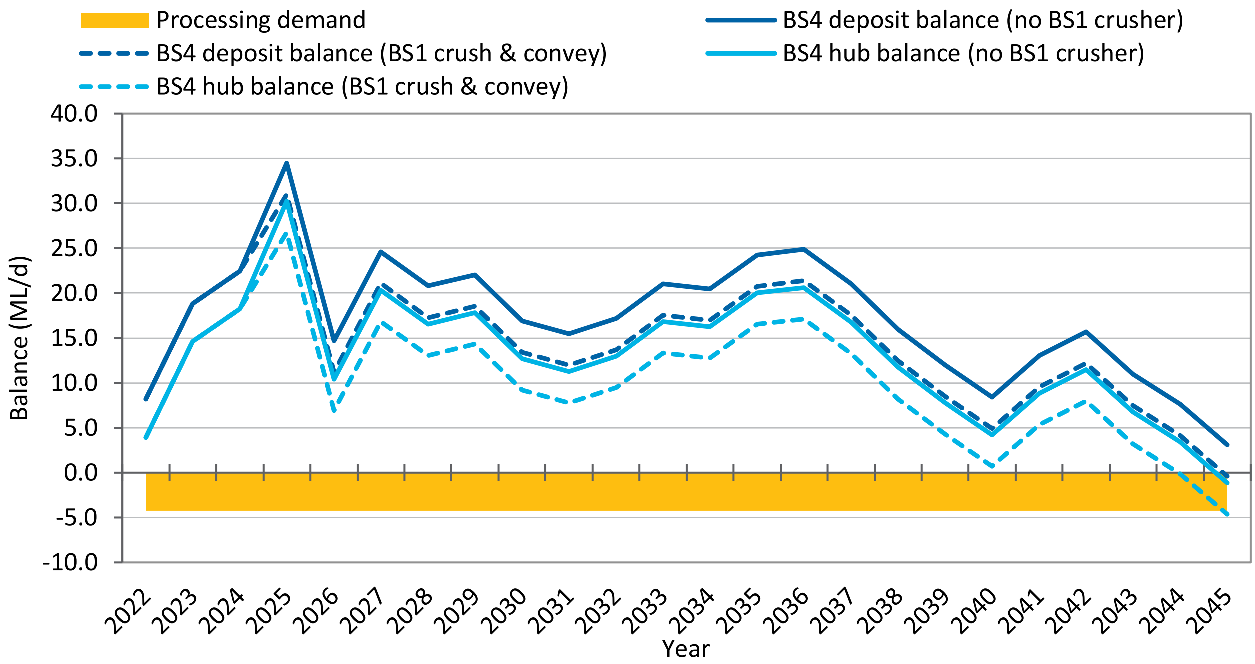

Figure 5.3 Final BS4 hub water balance (incl. BS1 crusher scenarios)

5.3 B2N hub balance

B2N hub level water balance forecasts have been estimated based on summation of deposit level water balances (detailed in Section 4.3), and integration of hub level processing and non-processing water demands and additional hub level water supply inputs, where relevant.

All deposit water balances contributing to the B2N hub water balance are presented in Figure 5.4, excluding SGE deposit surplus, whereas Figure 5.5 includes the SGE deposit surplus. The final SGE deposit water balance is presented in Section 4.3.8. The water transfer pipeline linking SGE deposits to the B2N hub has an assumed 35.0 ML/d capacity (refer to Section 3.5.2), therefore all the SGE water surplus can be transferred to the B2N hub. It should be noted that Figure 5.5 also presents the final post-transfer water balance for the SGE deposit showing a 5.61 ML/d post-mining deficit. At this stage the deficit remains at the SGE deposit as the SGE to B2N hub transfer is assumed to be one-way at this stage.

The final hub balance, accounting for hub level processing water demands and water supply (WFSF decant) are presented excluding the SGE surplus transfer in Figure 5.6 and including the SGE surplus transfer in Figure 5.7. The final B2N hub water balances show the following:

- Excluding the SGE surplus transfer the B2N hub is predicted have a significant initial water surplus (in excess of 50 ML/d) which progressively reduces over the 2023 to 2031 period before experiencing a period of water deficit of between 5.0 ML/d and 6.0 ML/d for the period 2034 to 2039 and again in 2043 to 2045.

- Including the SGE surplus in the B2N hub balance results in a significant increase in the predicted B2N hub water surplus and removes the predicted water deficit condition until 2043. The forecasted water balances for the two cases, including and excluding SGE deposit surplus, are the same from 2041 onwards as mining of SGE ceases in 2040.

- Potential options to transfer water from B2N hub to SGE to supplement the post-mining MAR requirements (5.61 ML/d) could only be effective in 2041 (with a B2N hub surplus of 9.0 ML/d) as beyond that point the B2N hub is also precited to be in water deficit.

- Additional water supply, ie new deposit dewatering, transfer between hubs or new supply borefield sources, are predicted to be required to supplement forecasted water deficits at the B2N hub from 2043 and at the SGE deposit from 2041.

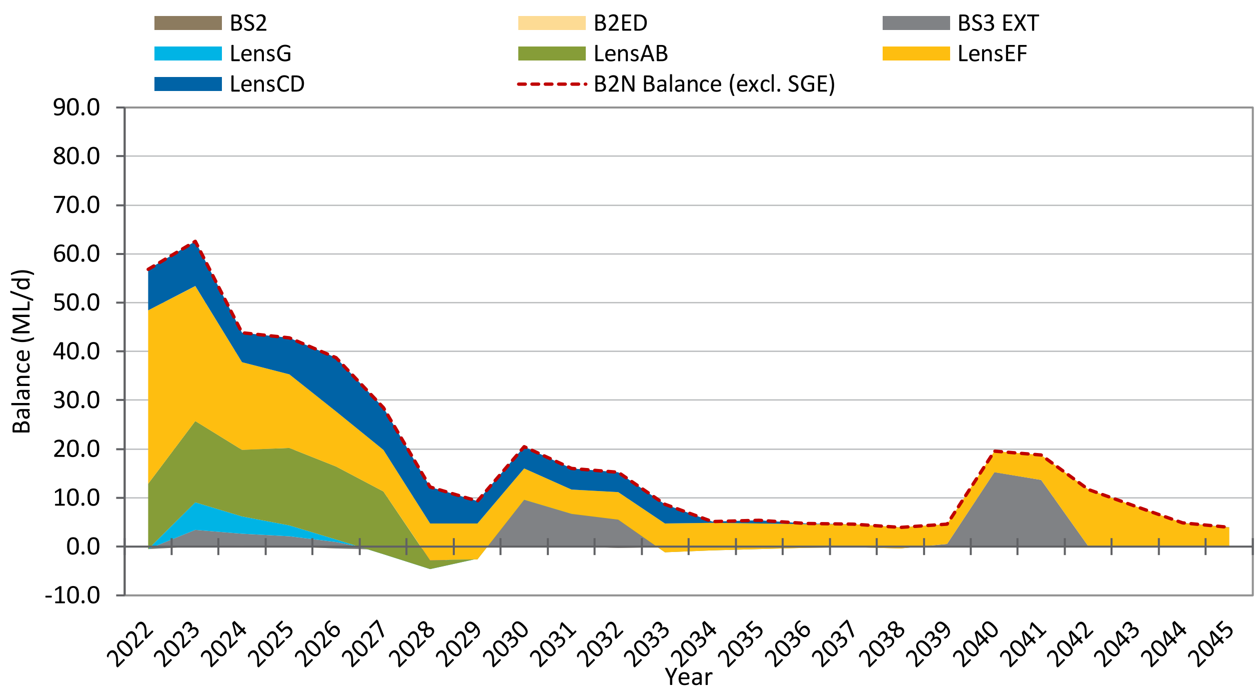

Figure 5.4 B2N total deposit water balance (excl. SGE surplus)

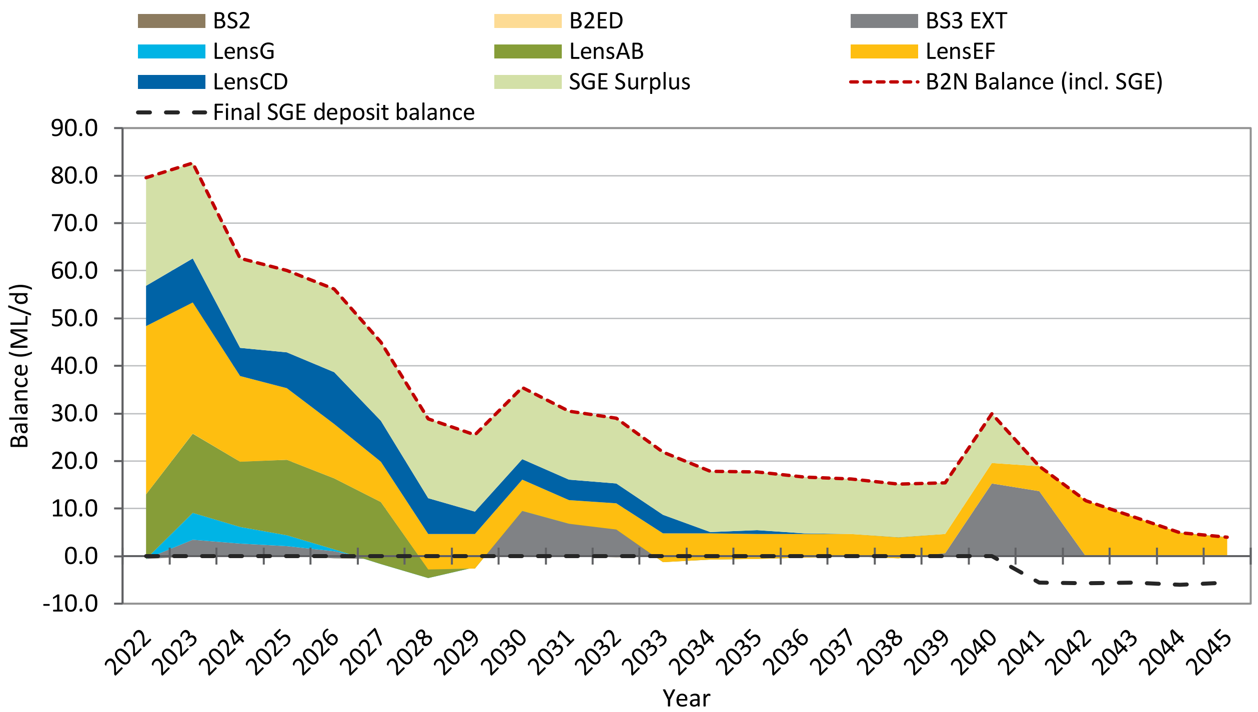

Figure 5.5 B2N total deposit water balance (incl. SGE surplus)

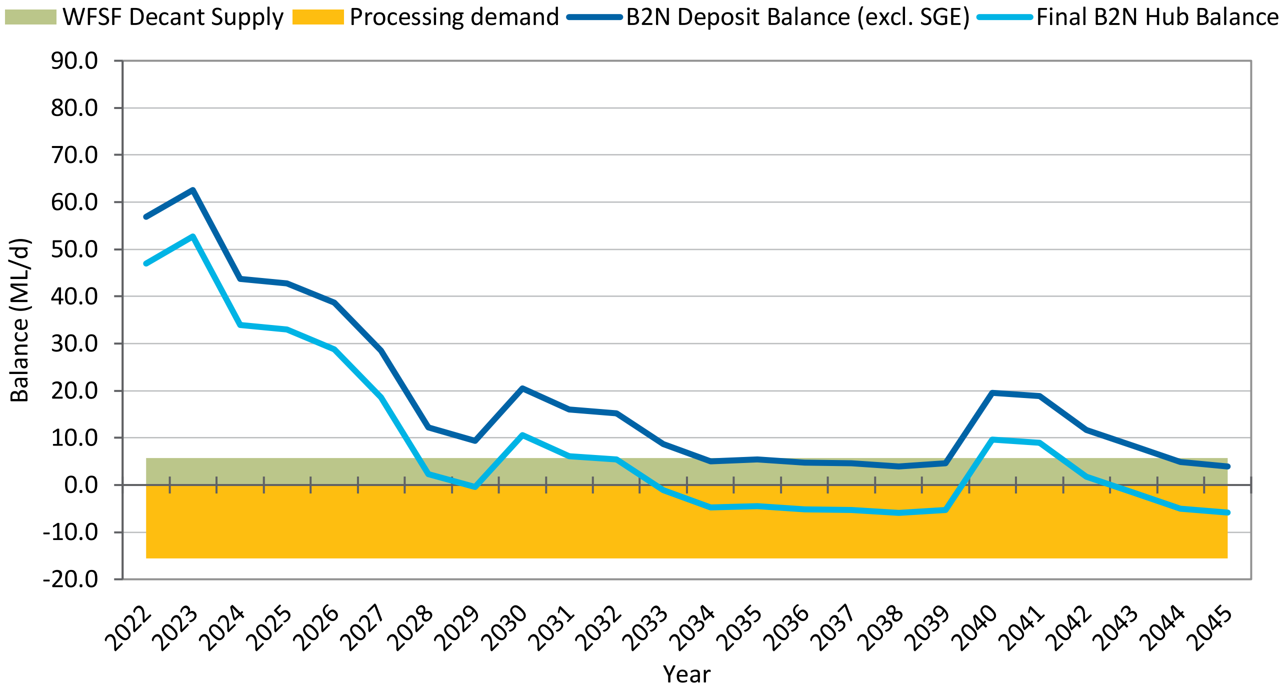

Figure 5.6 Final B2N hub water balance (excl. SGE surplus)

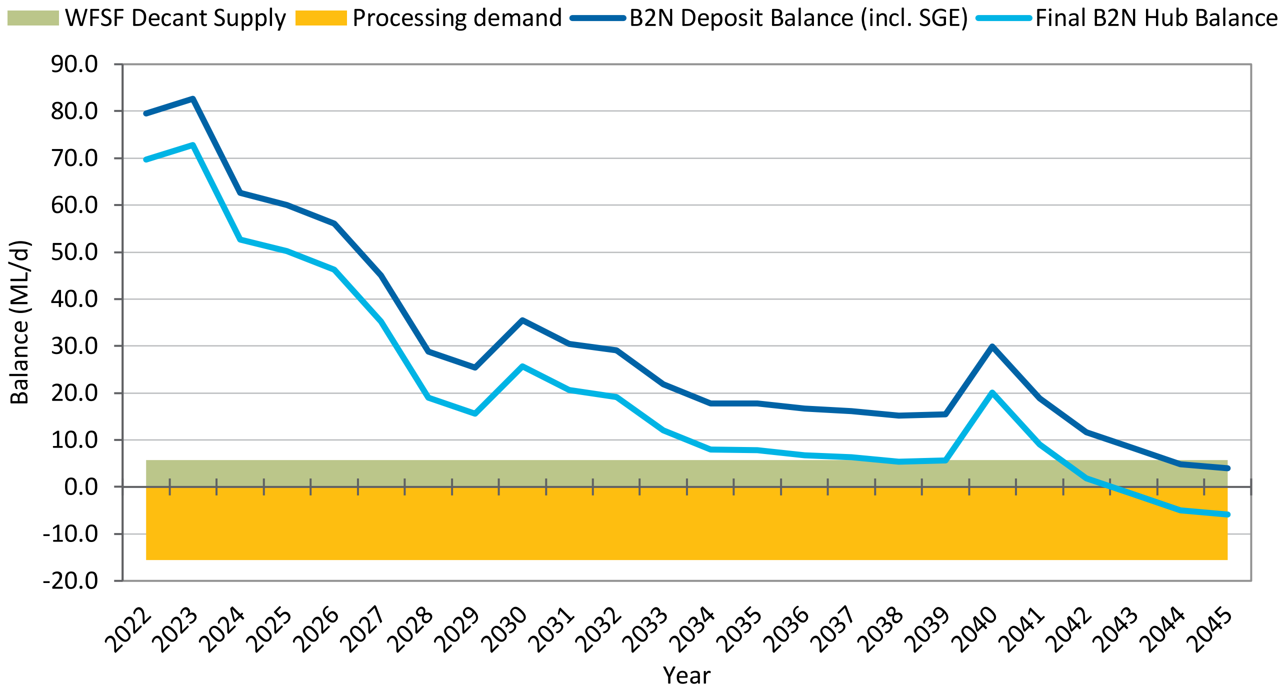

Figure 5.7 Final B2N hub water balance (incl. SGE surplus)

6 Surplus water management

6.1 Overview

The following sections provide a summary of the potential options to manage predicted B2N hub and BS4 hub surplus through the existing surplus water management options (described in Section 3.5). The assessment of alternative and new surplus water management options (ie MAR schemes, discharge to pit, increase creek discharge limits, inter-hub transfers or alternative NAP scheme operational options) are beyond the scope of this assessment.

6.2 B2N hub water management options

6.2.1 NAP water use and Duck Creek discharge

The NAP scheme is designed for managing surplus water through irrigated agriculture by use of pivots and as detailed in Section 3.5.3 the NAP provides integrated benefits with respect to reducing reliance on creek discharge as a surplus water management option and provides additional social, economic and environmental benefits. The NAP scheme water supply infrastructure is linked to the B2N hub only.

A monthly NAP water demand profile has been derived based on NAP historic water use in 2019 (Section 3.5.3) and scaled up to an assumed 902 ha irrigated area. This demand profile is used for the entire forecast period, ie assuming the objective of fully utilising a 902 ha scheme. The potential NAP utilisation of the predicted B2N hub surplus, including SGE deposit surplus transferred to the B2N hub as presented in Figure 5.5, is presented in Figure 6.1. The forecasted NAP demand deficit is also presented.

The B2N hub water balance forecasts indicate that, based on a 902 ha NAP scheme, there is potentially only sufficient surplus water generated across the B2N hub to be fully utilised at the NAP for the years 2022 and 2023. This hub surplus (in excess of estimated NAP demand) is reflected in the predicted Duck Creek discharge described below and presented in Figure 6.2. As surplus water estimates decrease from 2024 the scheme can only intermittently be fully utilised during the year, ie only during the low water demand months during the summer (ie November to February). NAP scheme demand deficit increases significantly from 2028 onwards.

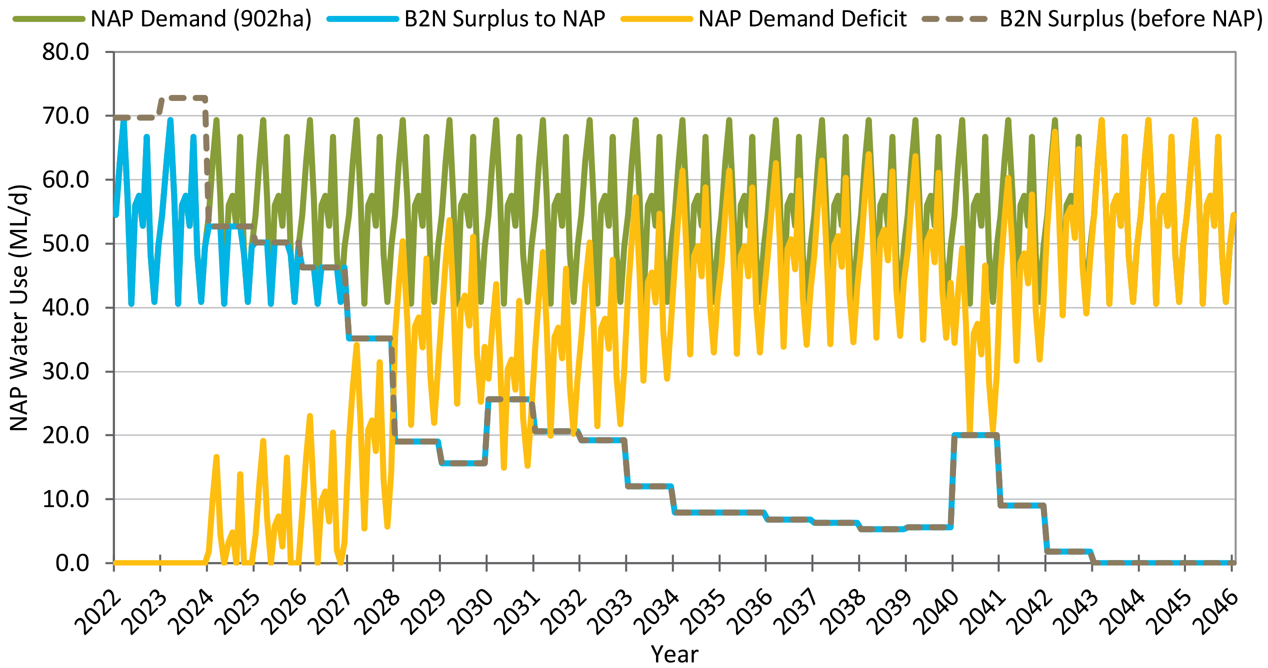

Figure 6.1 NAP scheme water balances for 902 ha

It is noted that for most of the forecast period there is insufficient surplus volume to support full utilisation of a 902 ha scheme (as indicated by the progressively increasing NAP demand deficit in Figure 6.1). Conversely, a 902 ha scheme effectively mitigates the requirement for surplus discharge to Duck Creek (refer to Figure 6.2) to short periods, ie the current NAP scheme size is fit for purpose for the predicted B2N hub water surplus.

The periods and estimated average surplus water rates that would require discharge to Duck Creek, or some alternative surplus water management option, are presented in Figure 6.2. This surplus discharge to the creek represents surplus water for the B2N hub which is in excess of the assumed monthly NAP water demand. The water balance forecasts indicate that monthly discharges to Duck Creek, or to one or a combination of alternative surplus water management options, are likely to be required at rates up to 32.0 ML/d for the 2022 to 2024 period. Surplus water management requirements potentially reduce to a maximum rate of approximately 5 to 12 ML/d for intermittent periods over the 2024 to 2026 period. From 2027 onwards predicted B2N hub surplus water can be fully managed through the NAP (as shown in Figure 6.1).

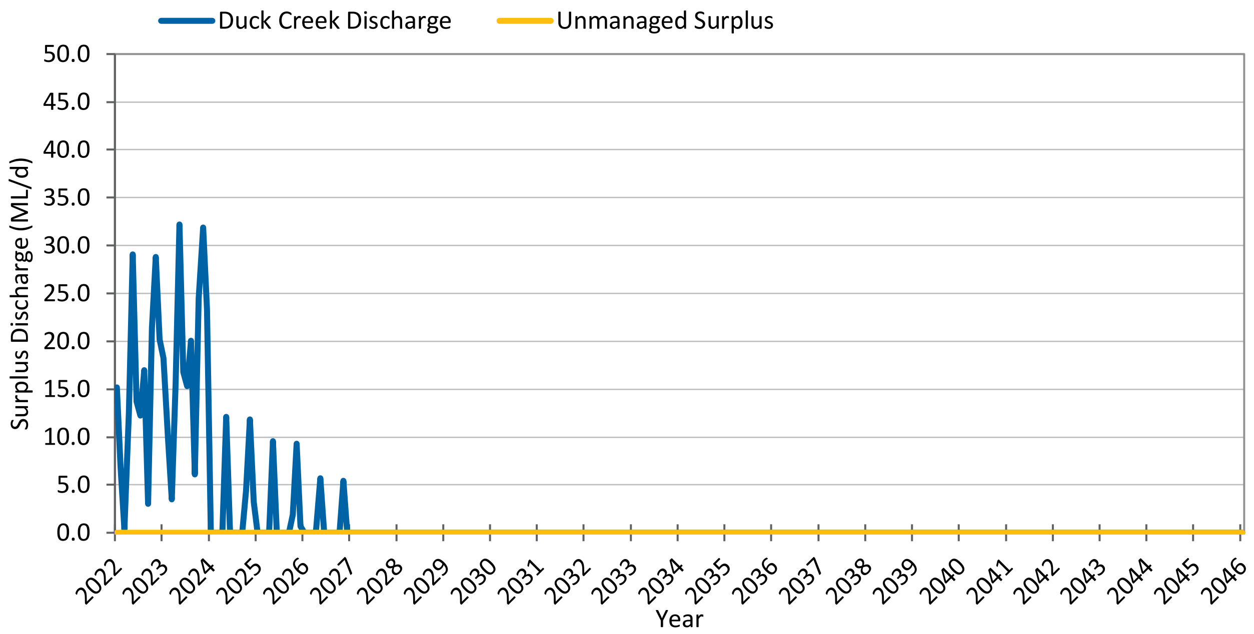

Figure 6.2 Duck Creek discharge - Surplus volume in excess of current NAP scheme (902 ha).

6.2.2 B2N deficit summary

The B2N hub water balance estimates presented in Section 5.3 indicates that B2N will potentially enter a period of water deficit from 2043 onwards. Predicted water deficits for the B2N hub are presented in Figure 6.3 showing potential deficits required to be managed through alternative water supply sources of more than 5.0 ML/d in the last year of the water balance forecast period (2045). As detailed in Section 5.3 forecasted water deficits are predicted at the SGE deposit from 2041, as mining of SGE ceases in 2040, and the Silvergrass MAR demand (described in Section 3.4.3iii) is assumed to continue post-SGE deposit mining. The predicted SGE deposit water deficit at the final rate of 5.61 ML/d is shown in Figure 6.4.

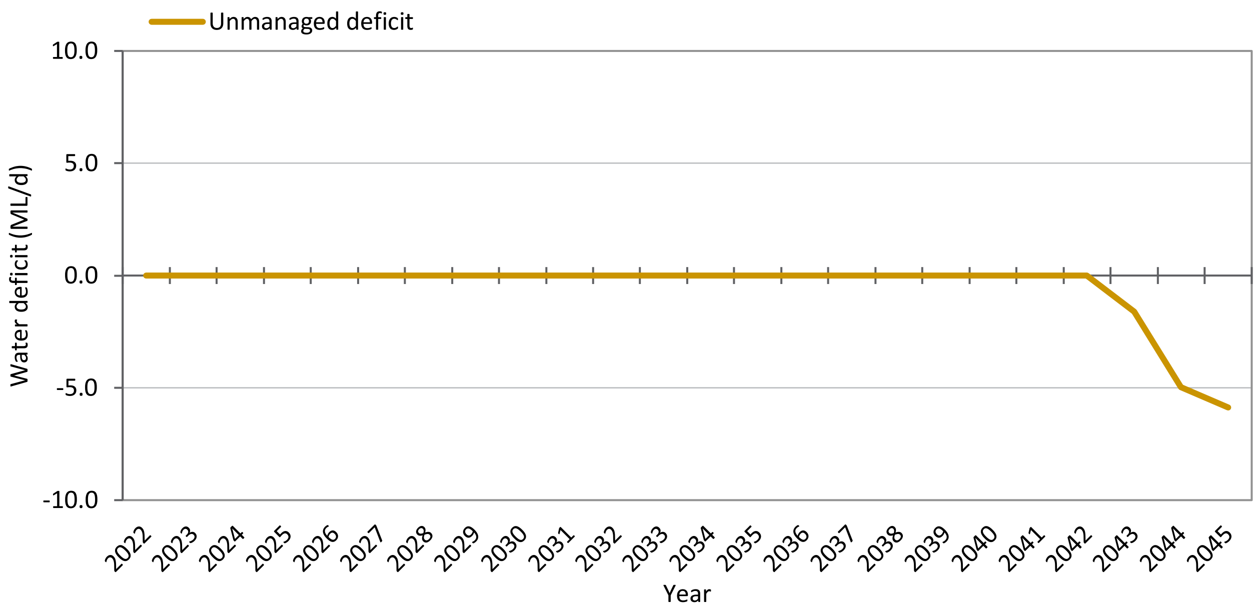

Figure 6.3 B2N hub predicted water deficit

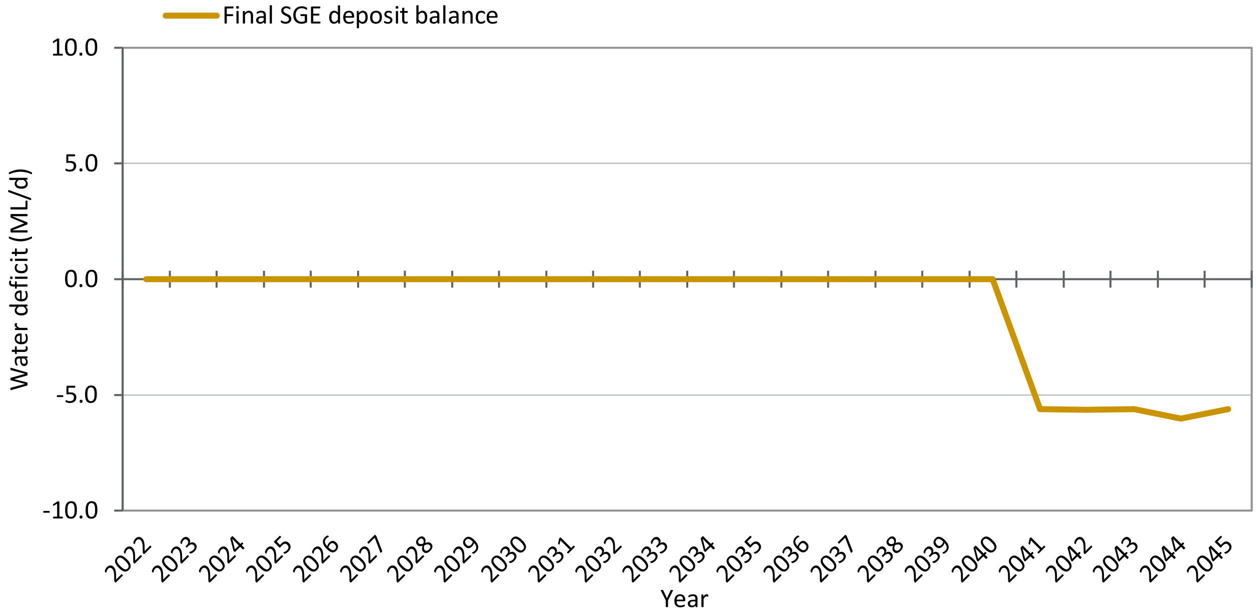

Figure 6.4 SGE deposit predicted water deficit

6.3 BS4 hub water management options

6.3.1 Boolgeeda Creek discharge

Controlled discharge of surplus water from BS4 hub is released to Boolgeeda Creek. The limiting factor controlling the volume to be released is contingent on the extent of the wetting front under dry conditions of no more than 37 km from the licensed discharge point. RTIO currently equate 37 km discharge limit to approximately 17.5 ML/d. Predicted BS4 hub surplus water discharge requirements to Boolgeeda Creek for the 'no BS1 deposit crusher scenario' and the 'BS1 crush and convey scenario' are presented in Figure 6.5 and Figure 6.6 respectively. These model results also present the predicted unmanaged water surplus, ie the BS4 hub surplus required for management above the current creek discharge licence limit.

Both BS4 hub water balance scenarios predict that Boolgeeda Creek discharge is required to manage surplus water consistently over the forecast period. For the no BS1 crusher scenario additional surplus water management options are predicted to be required at varying rates between 2024 and 2036, with a maximum predicted rate of 12.7 ML/d in 2025. The BS1 crush and convey scenario includes an additional 3.5 ML/d deposit water demand, therefore under this scenario the utilisation of the Boolgeeda Creek discharge is reduced, and the unmanaged surplus is potentially limited to the 2024 to 2025 period to a maximum rate of 9.2 ML/d.

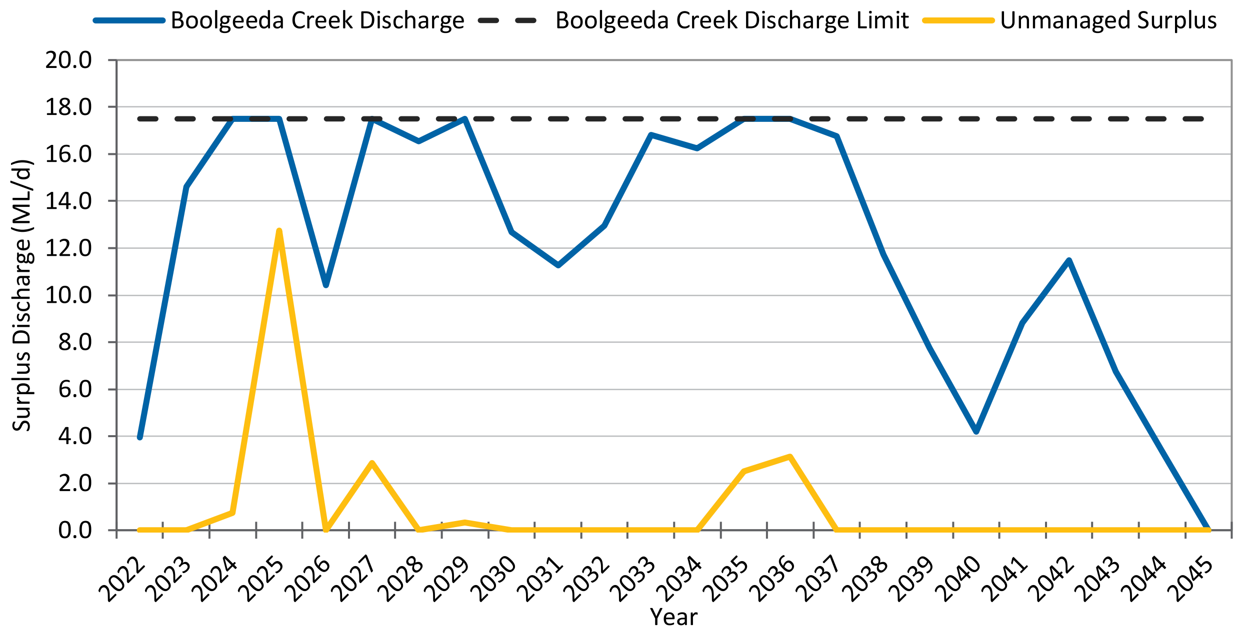

Figure 6.5 Boolgeeda Creek discharge and unmanaged surplus summary – no BS1 crusher scenario

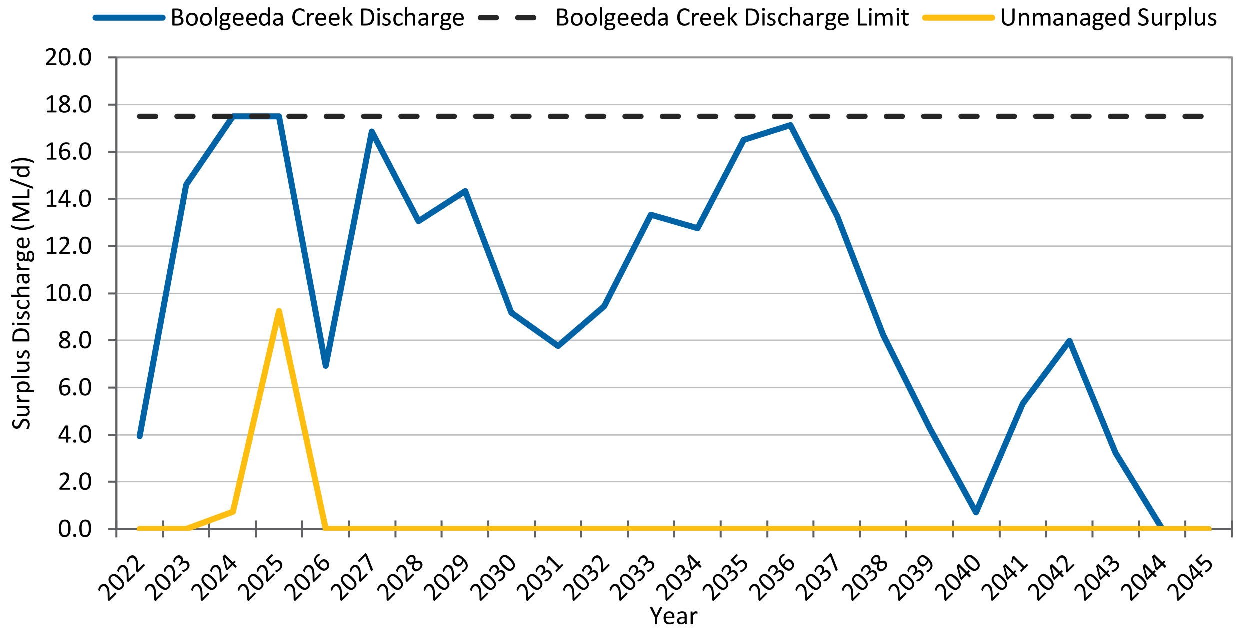

Figure 6.6 Boolgeeda Creek discharge and unmanaged surplus summary – BS1 crush and convey scenario

6.3.2 BS4 deficit summary

The BS4 hub water balance estimates presented in Section 5.2 indicate that a very slight hub level water deficit is predicted for the BS4 hub at the very end of the forecast period. Predicted water deficits for the 'no BS1 deposit crusher scenario' and the 'BS1 crush and convey scenario' are presented in Figure 6.7 showing deficits of approximately 1.5 ML/d and 5.0 ML/d respectively in 2045.

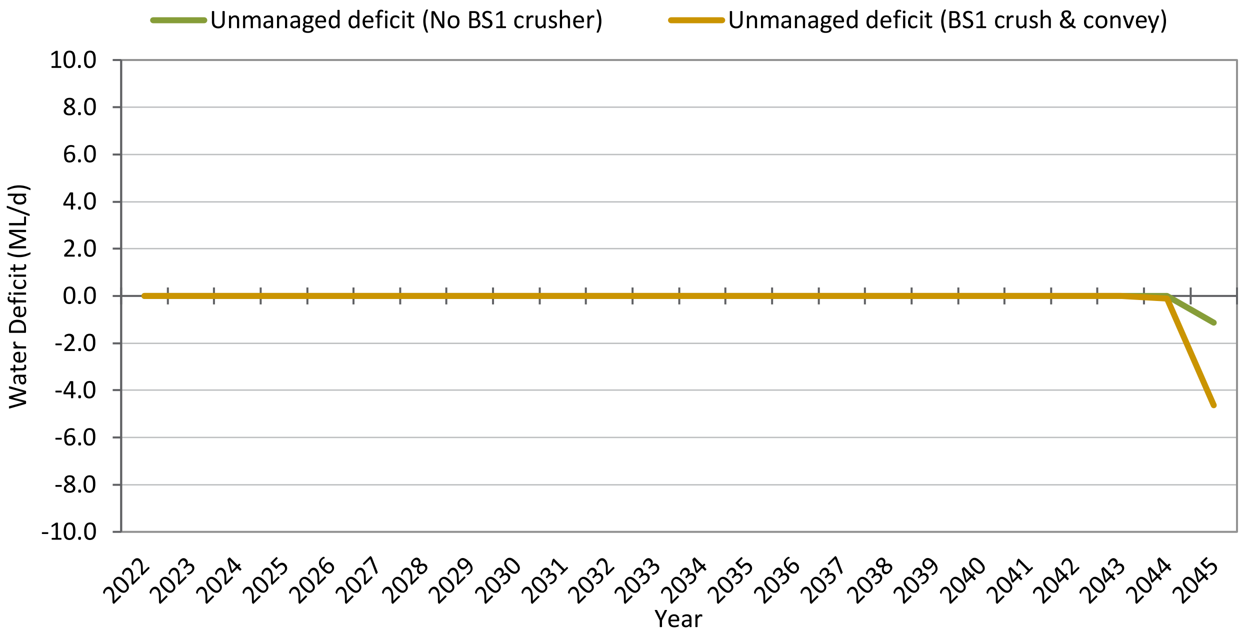

Figure 6.7 BS4 hub predicted water deficit

6.4 Alternative water management options

Alternative water management options that may be developed to reduce surplus water discharge to Boolgeeda and/or Duck Creek catchments comprise the following:

- injection to a suitable aquifer (MAR schemes);
- discharge to disused (or closed) mine voids for accelerated groundwater level recovery;
- supply to a third party; and/or
- ring main options (eg link BS4 to B2N, or BS1 to both B2N and BS4, or both) with and without expansion of the NAP scheme.

Injection of water into the ground requires amenable characteristics such as permeable aquifer conditions, significant depth to water (storage space), compatible groundwater quality and tenure access. Knowledge of the Brockman region would suggest that optimal injection locations are likely limited to Caves Creek catchment east of SGE, with no obvious locations in proximity to the southern Brockman Syncline limb. Further investigation and assessment of impacts and feasibility is required for the implementation of an injection scheme. Until a suitable area can be identified this option appears limited by technical feasibility and potentially capital if the nearest feasible location is a considerable distance (eg Southern Fortescue Borefield, ~100km from BS4 hub)

Discharge to mine voids would be feasible where there is no hydraulic connection between mine voids still being dewatered and those undergoing groundwater recovery via surplus discharge. Further studies would be required to identify the schedule of available pits, their hydraulic characteristics and void water balances for understanding available storage, total volume and timing that surplus water could be discharged for. Potentially, some BS4 BIF pits could be used for storing surplus water whilst dewatering of the BSSM MMIF pits was ongoing.

Supply to a third party is likely limited to competitor's with operations of similar scale and operating under a potential water deficit situation comparable to the surplus water volume that is required to be managed. FMG's Eliwana hub and Flying Fish deposits may be in water deficit and represent a potential third-party demand. FMG's Solomon hub further east of Tom Price railway currently operates multiple supply borefields in the northern part of the Southern Fortescue valley. Government approval may be readily provided given the potential environmental benefits, however commercial and indemnity negotiations could prove protracted with respect to a "no liability" supply contract to a third party.

The NAP scheme water balance assumed 902 ha under irrigation. Concentration of surplus water to B2N hub from BS4 could be managed via increasing the current area under irrigation to match predicted surplus volumes as near as practical. However, the NAP scheme is weather sensitive and seasonal, as such even by expanding the scheme there would be periods when substantial surplus water would be discharged to Duck Creek. At 902 ha there are periods when all the surplus water from B2N and BS4 would be insufficient to meet the NAP demand. Any expansion of the scheme to use more surplus water would have significant periods of redundancy when pivots were not in use.

A "ring main" would provide infrastructure that could facilitate greater water management system integration. It is noted that a "Boolgeeda Borefield" pipeline linking the area south of Lens AB to BS4 was approved as part of the 2006 Brockman Syncline 4 Ministerial Statement 717 in 2006. Whilst the time limit of approval to commence a pipeline has lapsed, it suggests approval for a pipeline is possible. A pipeline that connects BS4 and B2N hub could transfer the surplus BS4 water to B2N hub initially to manage the volume in excess of the discharge limit to Boolgeeda Creek (or the entire surplus volume).

Further work is required to demonstrate the benefits of alternative water management options and understand capital costs and environmental benefits or mitigations affected by each option. To this end RTIO can use the GoldSim GBO model to test options and alternative scenarios as the PFS progresses to subsequent study levels. The links between satellite deposits and hubs can readily be investigated, with consideration of the existing approved surplus water discharge constraints, using the GBO GoldSim model.

The GBO Goldsim water balance model includes additional, high-level, functionality to assess potential alternate water management schemes in conjunction with existing management measure. A summary of water management option functionality available in the water balance model structure for the two hubs and the Silvergrass deposits are summarised in Table 6.1

Table 6.1 GBO Goldsim water management options

BS4 Hub	B2N Hub	Silvergrass Deposits
Pit disposal	Pit disposal	MAR scheme
MAR scheme	MAR scheme	Increased transfer pipeline (SGE to B2N hub)
Increase Boolgeeda Creek discharge limit	Alternative NAP operation	
Inter-hub transfer (BS4 hub to B2N hub)		

7 Discussion

7.1 Conclusions

Individual deposit scale water balances have been created for all the deposits included within the Greater Brockman Operations PFS level mine plans. These deposit-level balances were integrated to sub hub-level water balances (for SGE and BS1); and then to hub level balances (for B2N and BS4) to determine whether sufficient water was available for processing and dust suppression, and the volume and timing of surplus water and/or deficits.

The following water transfer links between deposits and hubs were simulated:

- B2N hub to receive Nammuldi Lens/BS2/SGE/BS2ED/BS3 Extension. Nammuldi includes Lens AB, CD, EF and G and BS3 Extension includes Brokenwood, Sandelford, Diesel, MM-J and Creekside; and
- BS4 hub to receive BS4, BS3, BS1 (East and West), BSSM and BSMN.

Given the existing installed infrastructure capacity (ie with no additional surplus water management options) the water balance forecasts indicate;

- that monthly discharges to Duck Creek are likely required at rates up to 32.0 ML/d for the 2022 to 2024 period and is predicted to potentially reduce to a maximum rate of approximately 5 to 12 ML/d for intermittent periods over the 2024 to 2026 period. From 2027 onwards predicted B2N hub surplus water can be fully managed through the NAP (as shown in Figure 6.1).
- for the no BS1 crusher scenario additional surplus water management options are required above the current discharge limit to Boolgeeda Creek (17.5 ML/d) at varying rates between 2024 and 2036. A maximum hub water surplus of approximately 30.0 ML/d is predicted in 2025 (ie 12.5 ML/d higher than the Boolgeeda Creek discharge limit as shown in Figure 6.5).
- the BS1 crush and convey scenario includes an additional 3.5 ML/d deposit water demand, therefore under this scenario the utilisation of the Boolgeeda Creek discharge is reduced and the unmanaged surplus at BS4 (ie the surplus in excess of the Boolgeeda Creek discharge constraint) is potentially limited to the 2024 to 2025 period to a maximum rate of 9.2 ML/d (as shown in Figure 6.6).
- The NAP scheme demand assumed a 902 ha (19 pivot) irrigation scheme. Whilst the scheme is approved for up to 2500 ha (Ministerial Statement No 925) the water balance would suggest expansion of the NAP is probably not warranted.
- Water deficits are predicted towards the end of the PFS mine plan atB2N, BS4 and SGE; however, these are likely artefacts of the battery limits with respect to the mine plan provided; whereas in reality other satellite deposits may be developed with further dewatering demand that can met these deficits.
- Water deficits are predicted at the SGE deposit from 2041, as mining of SGE ceases in 2040, and the demand for sustaining groundwater throughflow to downstream environmental receptors will continue post-SGE deposit mining at the final rate of 5.61 ML/d. Potential options to transfer water from B2N hub to SGE to supplement the post-mining MAR requirements could, based on the current water balance forecast, be constrained by a predicted B2N hub deficit beyond 2041.

Glossary

AMD	Acid mine drainage
ANFO	Ammonium nitrate fuel oil
AWT	Above the water table
BAU	Business as usual
BIF	Brockman Iron Formation
BoD	Basis of design study
BWT	Below water table
CAPEX	Capital expenditure
CSI	Crushing Services International
EPB	Eastern Potable Borefield
FS	Feasibility Study
GBO	Greater Brockman Operations
LoM	Life of mine
MAR	Managed Aquifer Recharge
MMIF	Marra Mamba Iron Formation
MS	Ministerial Statement
Mtpa	Million tonnes per annum
NAP	Nammuldi Agricultural Project
OoM	Order of Magnitude Study
OPEX	Operating expenditure
PAF	Potentially acid forming
PFS	Prefeasibility study
SSV	Southern Strike Valley borefield
TDS	Total Dissolved Solids
TLO	Train load out
TMM	Total material movement
WFSF	Waste fines storage facility
m AHD	metres Australian Height Datum
m^3	Cubic metre of water (1000 Litres of water)
kL	Kilolitre (1000 Litres of water)
ML	Megalitre (1000 kL of water)
GL	Gigalitre (1000 ML of water)
ha	Hectare (10,000m^2)

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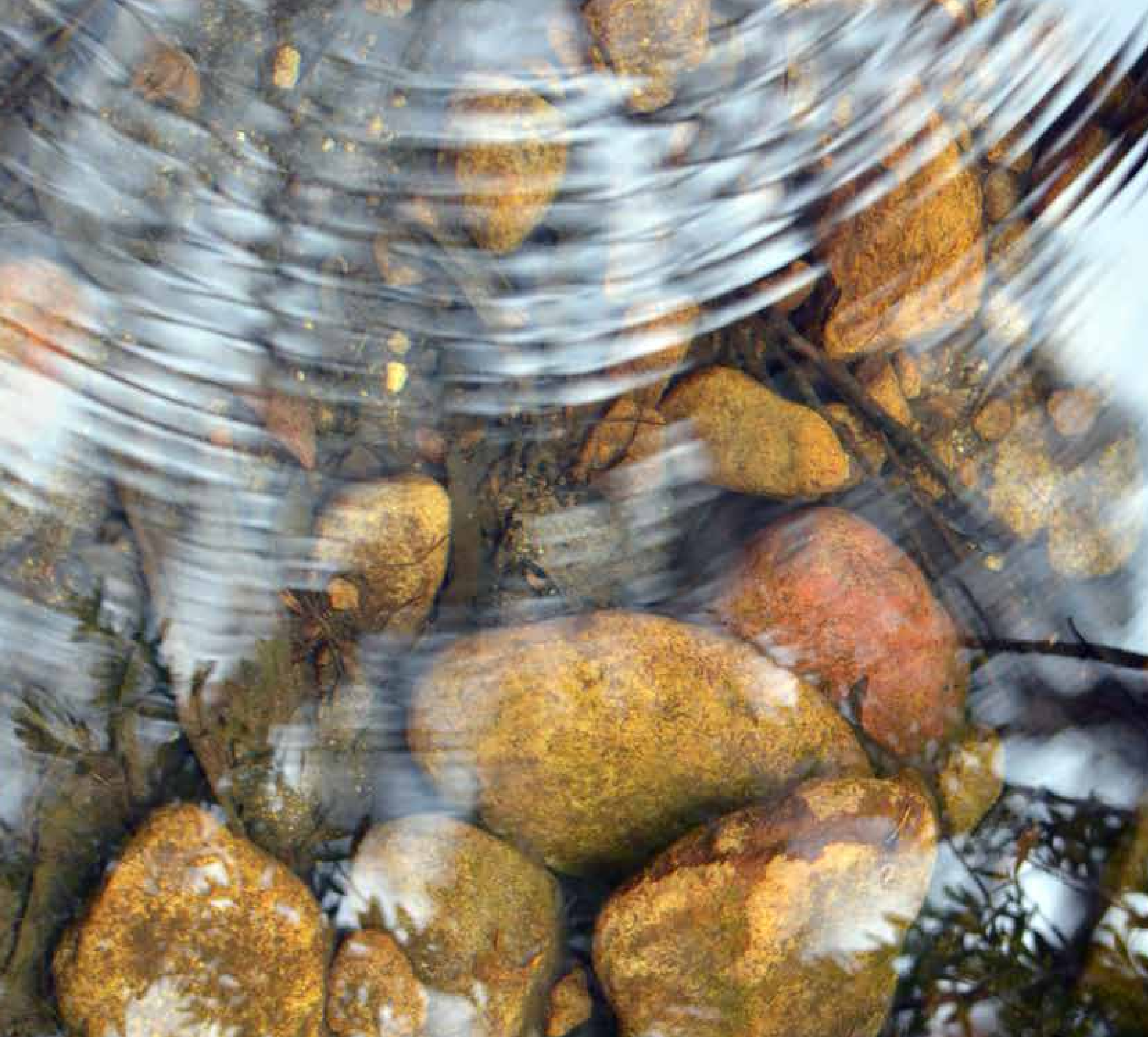

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