Technical Memorandum

Date	25 November 2022
To	WAIO Environment Approvals
From	Water Planning – Stewardship and Approvals
CC	Superintendent Environmental Approvals
Subject	Western Ridge: Ophthalmia Dam surplus water impact assessment update

1 Purpose

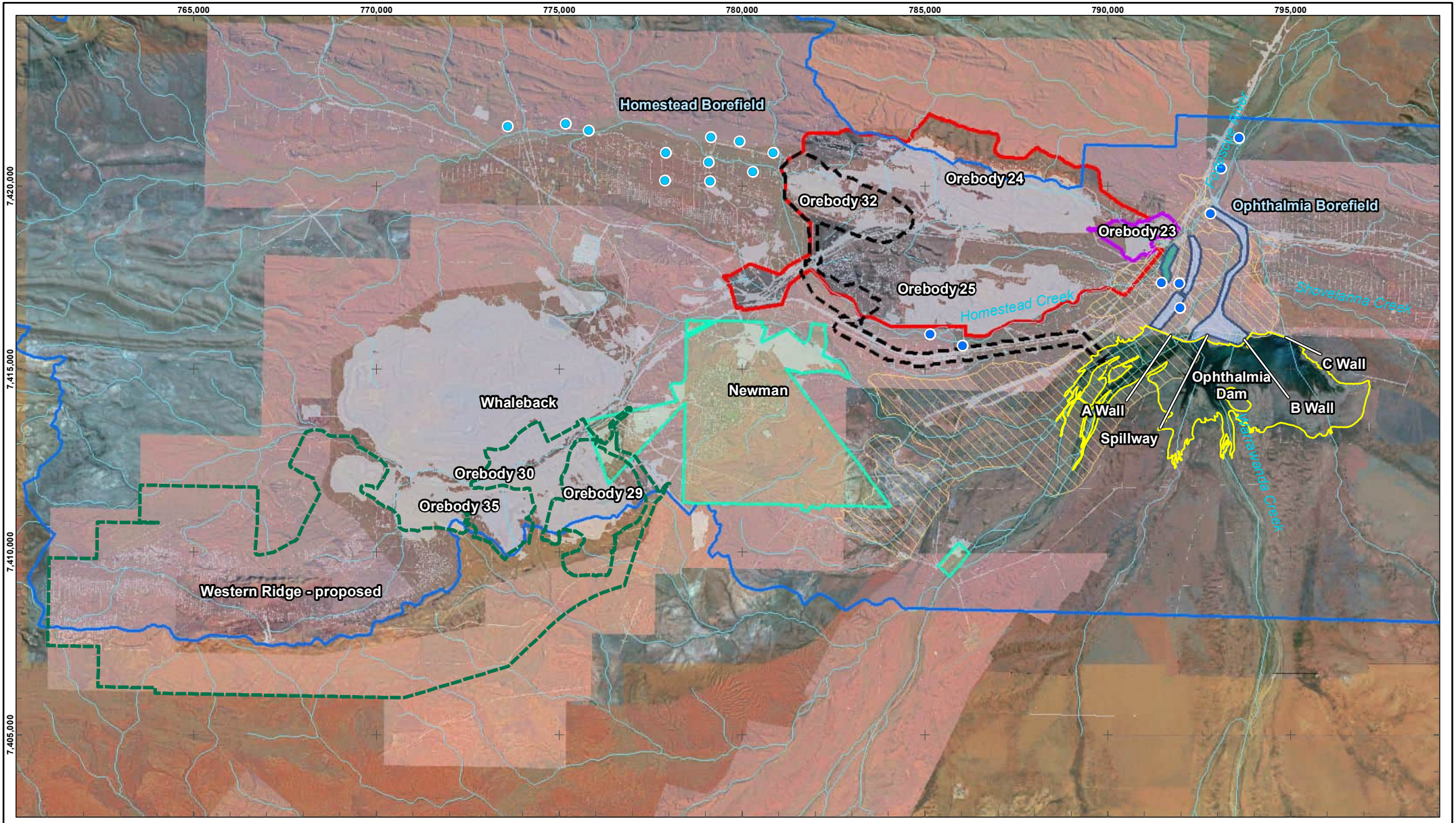
To update the Ophthalmia Dam surplus water impact assessment undertaken for the Orebody 32 Below Water Table Proposal (OB32 BWT Proposal) (BHP 2022a), to include information and predictions for the additional surplus mine dewater from the Western Ridge Proposal (BHP 2022b).

2 Existing environment and environmental values

The Ophthalmia Dam system is located to the northeast of Western Ridge (Figure 1). The Eastern Pilbara Hub Water Balance report (EMM 2020) describes the Ophthalmia Dam system in detail. Ophthalmia Dam is located within the Priority 1 Public Drinking Water Source Area of the Newman Water Reserve. Groundwater is currently sourced from the BHP operated Ophthalmia and Homestead borefields for the Newman town water supply. The Ophthalmia Dam system partially overlies the Ethel Gorge aquifer system which supports the Ethel Gorge aquifer Stygobiont community Threatened Ecological Community (Ethel Gorge TEC). The Ophthalmia Dam system continues to maintain water levels within the Ethel Gorge aquifer system to support the Ethel Gorge TEC and provides a location for the discharge of surplus water from BHP mines in the Eastern Pilbara Hub (currently Eastern Ridge, Orebody 29/30/35, Jimblebar and Orebody 31) (BHP 2022a).

As for the OB32 BWT Proposal, the main water-related environmental values that may be impacted by the addition of surplus water discharge to Ophthalmia Dam from the Western Ridge Proposal (Figure 1) are:

- local groundwater resource in the Newman Water Reserve, used for town water supply
- Fortescue River and tributaries
- Ethel Gorge aquifer (and TEC).



- Orebody 32 BWT proposed Development Envelope
- Western Ridge proposed Development Envelope
- Ophthalmia Dam full supply level
- Infiltration basin
- Recharge pond
- Indicative Cleared Area as at 15 February 2022
- Newman Drinking Water Reserve P1
- Newman Drinking Water Reserve P3
- Watercourses
- Homestead Borefield bores
- Ophthalmia Borefield bores
- Eastern Ridge MS1037 Development Envelope
- Orebody 23 MS478 Development Envelope
- Ethel Gorge Threatened Ecological Community

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WESTERN RIDGE

Local context

PLANNING & STANDARDS - IRON ORE

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3 Surplus water regulation and management

The impact assessment undertaken for the OB32 BWT Proposal (BHP 2022a; Appendix A) outlines the environmental regulation for the operation of the Ophthalmia Dam system and the discharge of surplus water from BHP mines to Ophthalmia Dam. There has been no change to the approved discharge rates to the Ophthalmia Dam under Part IV and Part V of the *Environmental Protection Act 1986* (EP Act) since the impact assessment for the OB32 BWT Proposal was finalised in August 2022.

BHP manages the potential impacts to the environment from the discharge of surplus water to the Ophthalmia Dam system from its approved mines primarily through its *Eastern Pilbara Water Resource Management Plan* (EPWRMP) (Revision 6.0, BHP 2018). BHP proposes to manage the potential impacts to the Ethel Gorge aquifer from additional surplus water discharge from the Western Ridge Proposal, in accordance with the current management approach in the EPWRMP and has updated the EPWRMP (Version 6.3) to include the Western Ridge Proposal (BHP 2022c).

4 Historical and recent water balance

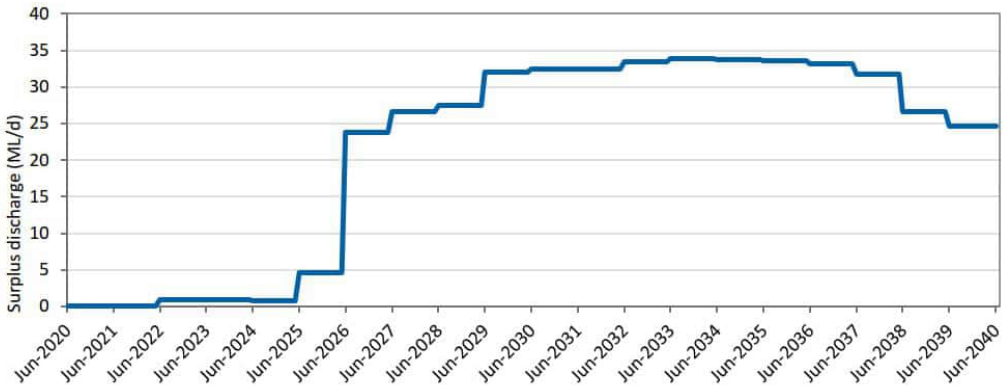
The impact assessment for the OB32 BWT Proposal (BHP 2022a) provides historical and recent data (up to mid-2022) for the following:

- storage and inundation conditions (low and high) for Ophthalmia Dam and provides continuous plots of dam storage and Fortescue River flow for each water year (September - August) since 1982 following construction of the dam in 1981
- Ophthalmia Dam observed salinity
- recent actual discharge rates from BHP mines to Ophthalmia Dam and a comparison to approved discharge rates
- releases of water from Ophthalmia Dam to the Fortescue River
- Ethel Gorge aquifer observed groundwater levels and groundwater salinity.

5 Forecast water balance

Figure 2 shows the estimate of forecast surplus water discharge rates to Ophthalmia Dam from the Western Ridge Proposal (EMM 2021; Appendix B). The forecast maximum rate of discharge of surplus water from Western Ridge to Ophthalmia Dam is 34 ML/d (13 GL/a rounded to the nearest GL/a), which is conservative as it assumes there is no mine water use demand (i.e. 0 ML/d). The actual discharge rates will depend on the mine plan and the variability in dewatering rates, and the forecast rates presented in Figure 2 are for assessment purposes only.

Table 1 summarises the approved and proposed (OB32 BWT and Western Ridge) discharge rates to Ophthalmia Dam.



Source: EMM (2021), Figure 2.2

Figure 2: Forecast Western Ridge discharge rates to Ophthalmia Dam

Table 1: Approved and proposed discharge to Ophthalmia Dam

Mine hub	Mine	Surplus discharge to Ophthalmia Dam (GL/a)	Approved or proposed
Newman	Eastern Ridge operations (OB23, OB24, OB25, OB25 West)	19	Approved
	Orebody 29/30/35	8	Approved
	OB32 BWT	21.9	Proposed
	Western Ridge	13	Proposed
Jimblebar	Jimblebar	32.625	Approved
	Orebody 31		
	Total	**94.525**	

Figure 3 shows the 2020 estimate of the total forecast surplus water discharge rate to the Ophthalmia Dam system from all BHP mines that are approved to discharge surplus water into Ophthalmia Dam (including discharge to the recharge ponds): Eastern Ridge operations (Eastern Ridge mine and OB23), Whaleback operations (Orebody 29/30/35) and Jimblebar operations (Jimblebar and Orebody 31), and the proposed discharge from OB32 BWT and Western Ridge.

The forecast additional discharge from Western Ridge increases the estimated peak total discharge rate marginally by approximately 5 ML/d from 155 ML/d to 160 ML/d (Figure 3) and the peak discharge years remain between 2022 and 2026 for the total forecast surplus discharge from all BHP mines. The estimated peak total discharge rate (160 ML/d) shown on Figure 3 is lower than the equivalent average daily total surplus discharge rate for all approved and proposed projects (259 ML/d) based on 94.525 GL/a in Table 1. As discussed in BHP 2022a, only a portion of the approved rate is discharged to the Ophthalmia Dam system because the licensed rate is an annual peak rate that allows for fluctuations in dewatering rates during the year. The total forecast peak daily rate (160 ML/d) as a percentage of the total average approved and proposed rate (259 ML/d) is 62%, which is higher than the total actual recent discharge rate as a percentage of the approved rate (41%) (BHP 2022a). The total recent discharge rates (BHP 2022a) and estimated forecast discharge rates to Ophthalmia Dam are used in the Western Ridge water balance modelling (Section 6).

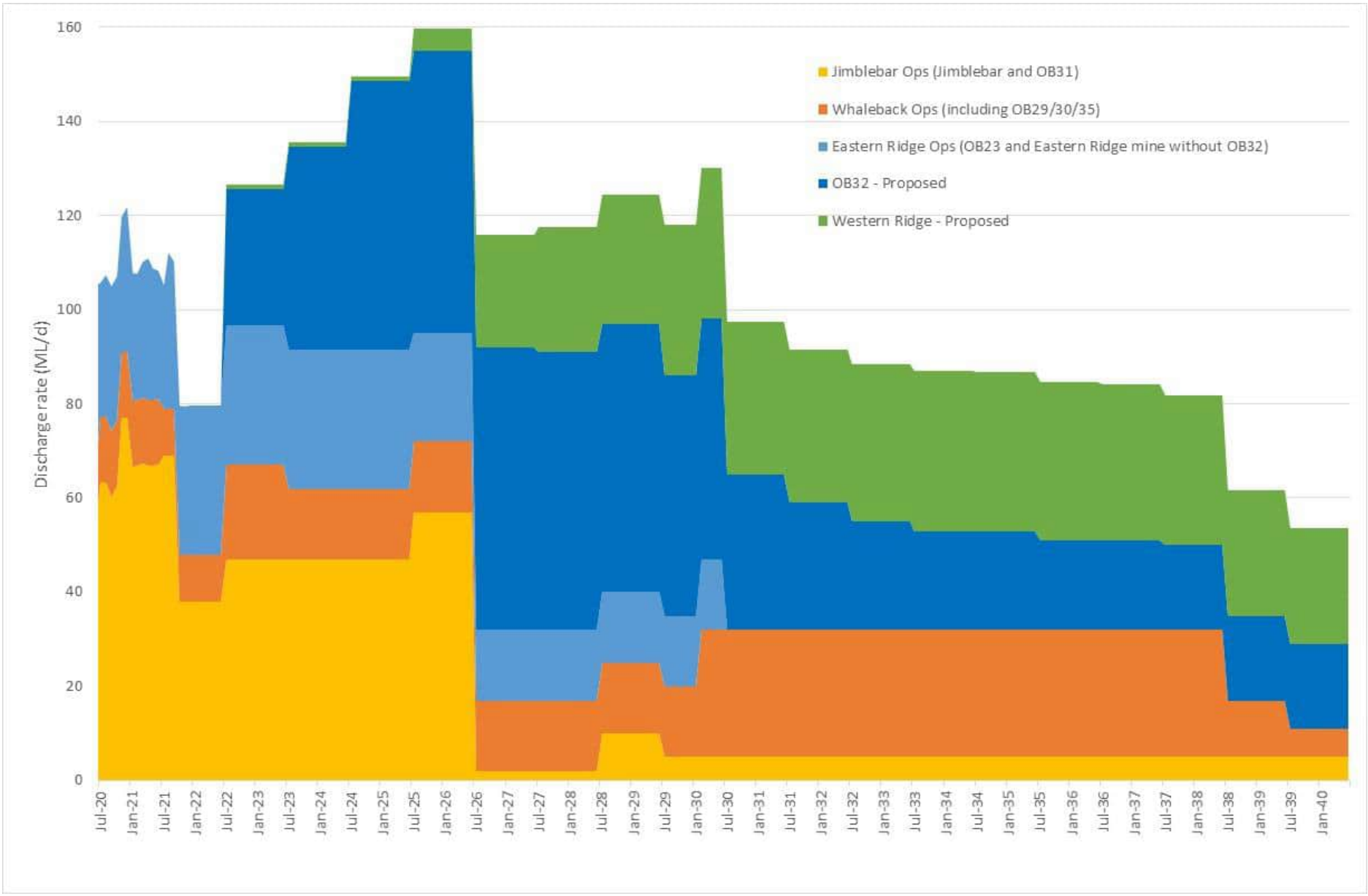


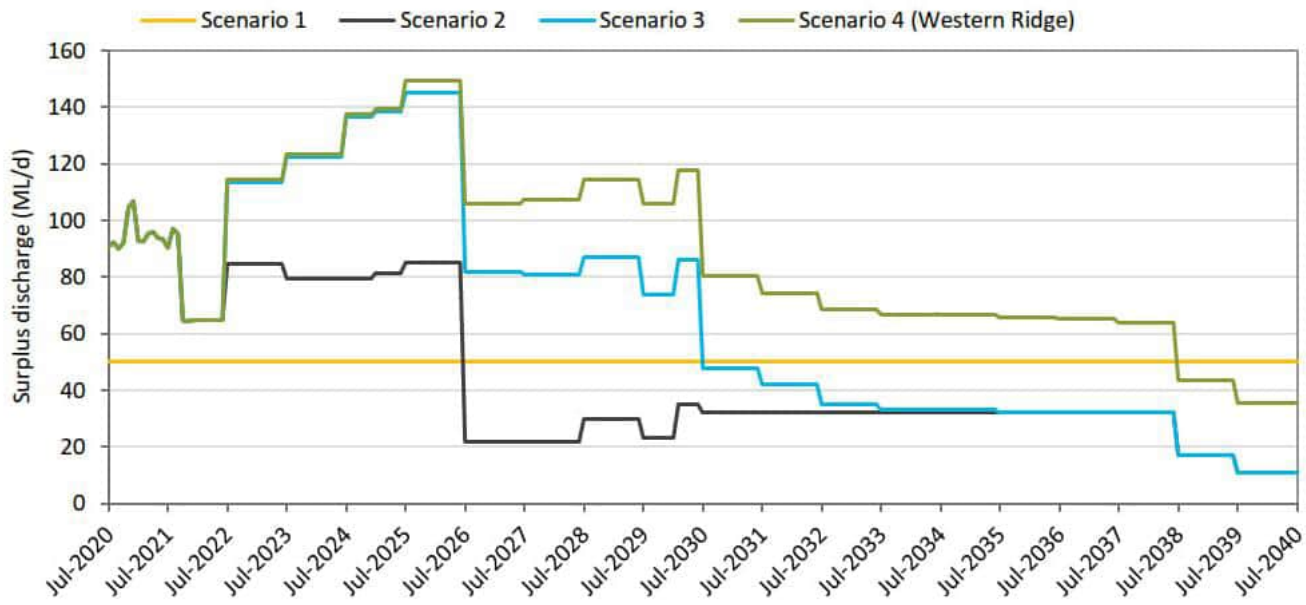
Figure 3: Forecast discharge rates to Ophthalmia Dam system - All BHP mines

6 Water balance model and scenarios

BHP commissioned EMM in 2021 to update the water balance review and hydrological assessment of the Ophthalmia Dam and downstream Ethel Gorge aquifer system undertaken by EMM in 2020 using the Eastern Pilbara Hub (EPH) integrated water balance model (EMM 2020).

The 2021 water balance modelling assessment considered the additional contribution of surplus water from the Western Ridge Proposal (Scenario 4) relative to Scenarios 1 to 3 modelled in the 2020 study (Figure 4) (EMM 2021). As discussed in BHP 2022a, the discharge rates for Scenarios 2 and 3 (and 4) represent the discharge to Ophthalmia Dam only (i.e. excludes the forecast discharge rate to the recharge ponds from Eastern Ridge).

Detail on the water balance model and Scenarios 1 to 3 is provided in EMM (2020) and summarised in BHP 2022a. Scenario 4 adds the forecast surplus water from Western Ridge to Scenario 3 (which applies the total forecast surplus discharge rate from approved operations and the OB32 BWT Proposal).



Source: EMM (2021), Figure 2.1

Figure 4: Surplus water discharge scenarios

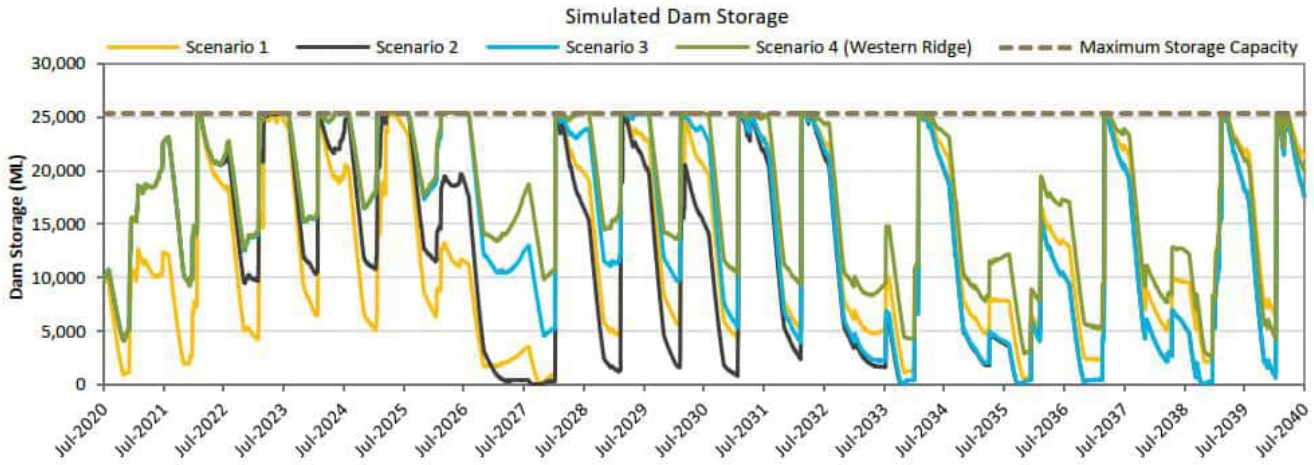
7 Western Ridge assessment

The water balance assessment for Western Ridge focuses on the modelled contribution of Western Ridge surplus water discharge to Ophthalmia Dam (Scenario 4 as described in Section 6). The results of the modelling (EMM 2021) are summarised in Sections 7.1 and 7.2. Because the modelling was undertaken in 2020 and 2021 and assumed that discharge from OB32 BWT and Western Ridge starts in 2022 (see Figure 2 and Figure 4), the dates discussed in the following assessment are for comparative purposes only.

7.1 Ophthalmia Dam water balance

7.1.1 Dam storage and inundation

Figure 5 shows the simulated (predicted) dam storage for the model run for the 'average' hydrology (streamflow) scenario, with a 3-month controlled release each year (model run 13) (EMM 2021). Figure 5 shows that dam storage is predicted to be higher with the contribution of surplus water from Western Ridge (Scenario 4 compared to Scenario 3) for longer periods, particularly between 2027 and 2032.



Source: EMM (2021), Figure 3.1

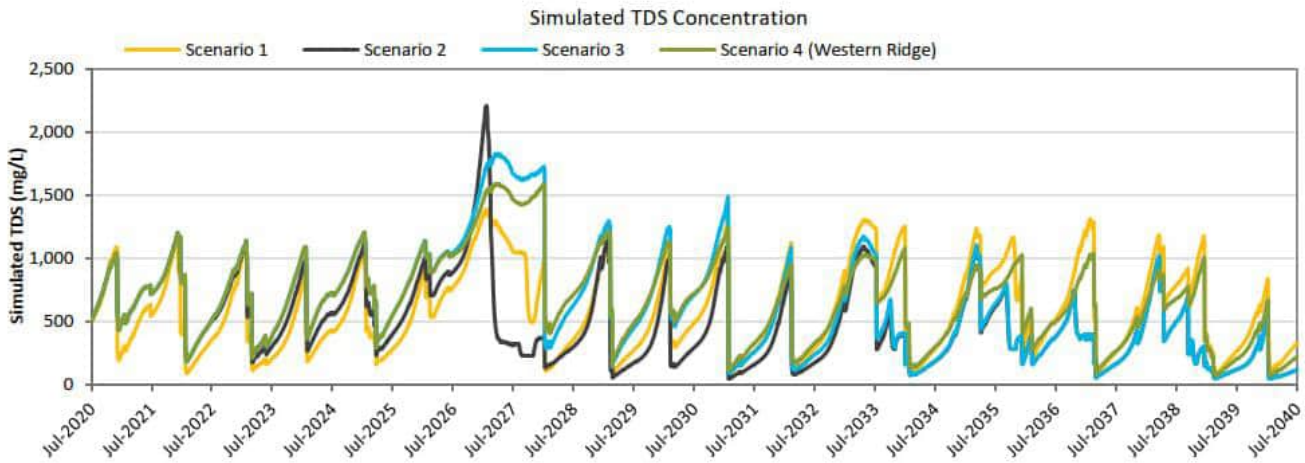
Figure 5: Predicted dam storage

As discussed in BHP 2022a (Section 4.1), the maximum inundation area is controlled by the maximum operating storage capacity of the dam. As for the OB32 BWT Proposal, the Western Ridge Proposal will not result in a change to the storage capacity of Ophthalmia Dam, so there will be no change to the maximum inundation area. Figure 5 shows that there will still be the seasonal change in storage, however, dam storage will be relatively higher from the contribution of surplus water from Western Ridge. During periods where dam storage is predicted to be higher from the contribution of surplus water from Western Ridge (Scenario 4 compared to Scenario 3), the inundation extent is similar to historical inundation in wet years (BHP 2022a; Section 4.1).

As discussed above, the predictions are for the 'average' hydrology (streamflow) scenario. BHP also notes that the calibration shows that the model simulation has over-estimated the volume of water in the dam compared to the measured volume of water in the dam (EMM 2020; Figure 4.6). The actual dam storage will depend on catchment and climate conditions and actual discharge rates to the dam. Figure 3 shows that forecast discharge including discharge from OB32 and Western Ridge will be lower than recent historical discharge except for between 2022 to 2030. Therefore, when the discharge is similar or lower than recent historical discharge rates, the pattern of inundation (change in extent and duration) is not expected to change compared to recent historical inundation.

7.1.2 Dam salinity

There is the potential for the salt load in the dam to increase from increased discharge as the salinity of the discharge water from all BHP mines is higher than rainfall salinity. Figure 6 shows the predicted Ophthalmia Dam salinity for model run 13. The plot shows that the seasonal freshening will still occur. The predicted peak salinity (TDS) for the contribution of surplus water from Western Ridge (Scenario 4) is generally less than 1,100 mg/L for most years but is as high as approximately 1,500 mg/L during the peak discharge years around 2026. The predicted dam salinity for Scenario 4 remains within the range of observed dam salinity (BHP 2022a; Figure 9).



Source: EMM (2021), Figure 3.1

Figure 6: Predicted dam salinity

7.2 Groundwater criteria assessment

Figure 7 to Figure 10 show the predicted groundwater levels and groundwater salinity in the Ethel Gorge aquifer for model run 13. The model outputs are shown for model zones 2 to 5, as the EPWRMP Ethel Gorge Primary Habitat Monitoring Zone (Monitoring Zone 1) extends across these four zones of the model (BHP 2022a; Figure 3, Section 6.2.1).

7.2.1 Groundwater levels

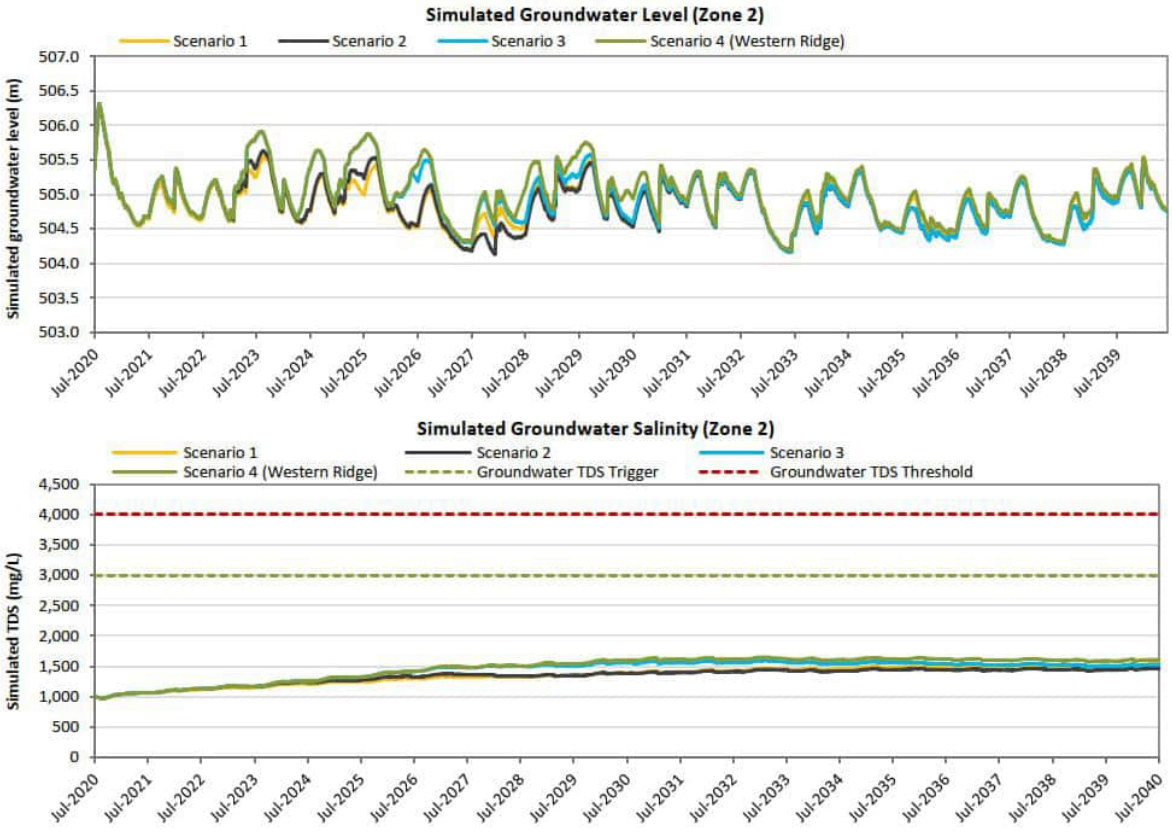
Figure 7 to Figure 10 indicate that predicted groundwater levels in the Ethel Gorge aquifer are higher with the contribution of surplus water from Western Ridge (Scenario 4 compared to Scenario 3) from 2026 to 2030, due to the high forecast discharge rates from Western Ridge from 2026 (up to approximately 0.3 m higher within any of the model zones). The reduction in surplus discharge rates from 2030 onwards is reflected by similar predicted groundwater levels for Scenarios 2, 3 and 4 from 2030 onwards (EMM 2021). The modelled groundwater levels for Scenario 4 (representing the cumulative discharge scenario) remain within the range of observed groundwater levels in the Ethel Gorge aquifer (BHP 2022a; Figure 8).

The cumulative increase in average groundwater levels as a result of surplus water discharge is predicted to be in the order of less than 0.5 to 1 m. This is within the predicted natural range of groundwater variability and is within the EPWRMP criteria (EMM 2021), i.e. below the groundwater level change trigger of less than 4 m/year or total change of 6 m (BHP 2022a; Table 2).

7.2.2 Groundwater salinity

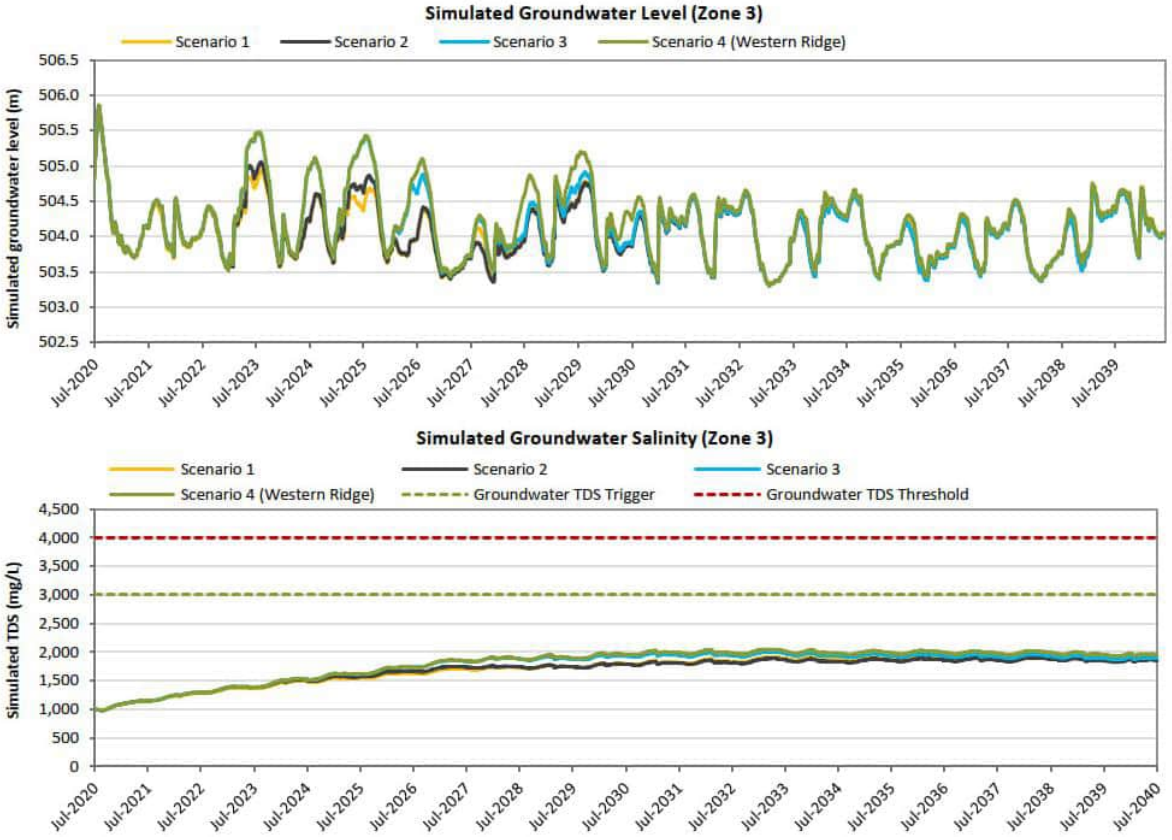
Figure 7 to Figure 10 indicate that the higher surplus water discharge rates from the addition of surplus water from Western Ridge (Scenario 4) indicates a potentially marginally higher groundwater salinity relative to Scenario 3 over the 20-year simulation period. However, there is a high level of uncertainty relating to these predictions with considerable natural variability (spatially and temporally) in groundwater quality (EMM 2021).

The modelled groundwater salinity for Western Ridge (Scenario 4) remains at or below approximately 2,000 mg/L, within the range of observed groundwater salinity in the Ethel Gorge aquifer (BHP 2022a; Figure 9) and is within the EPWRMP criteria (EMM 2021), i.e. below the groundwater salinity trigger of less than 3,000 mg/L TDS (BHP 2022a; Table 2).



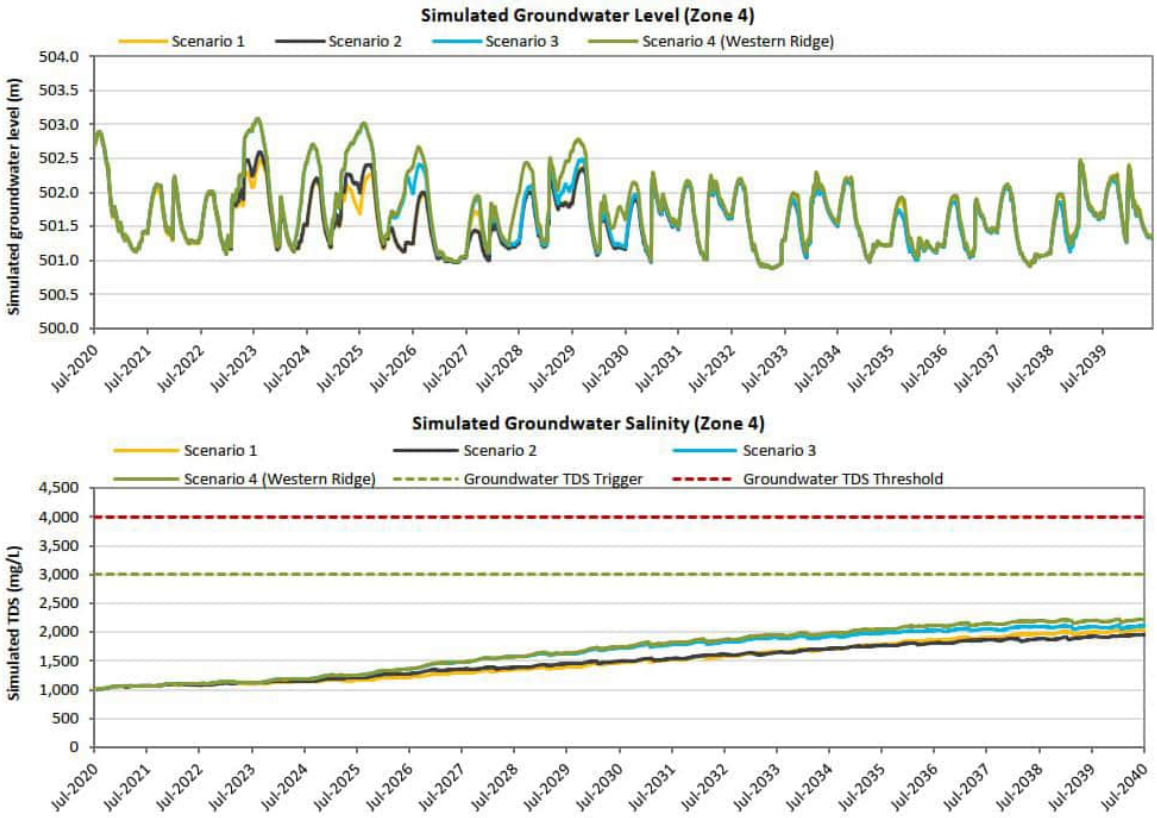
Source: EMM (2021), Figure 3.4

Figure 7: Predicted Ethel Gorge aquifer groundwater levels and salinity - Model zone 2



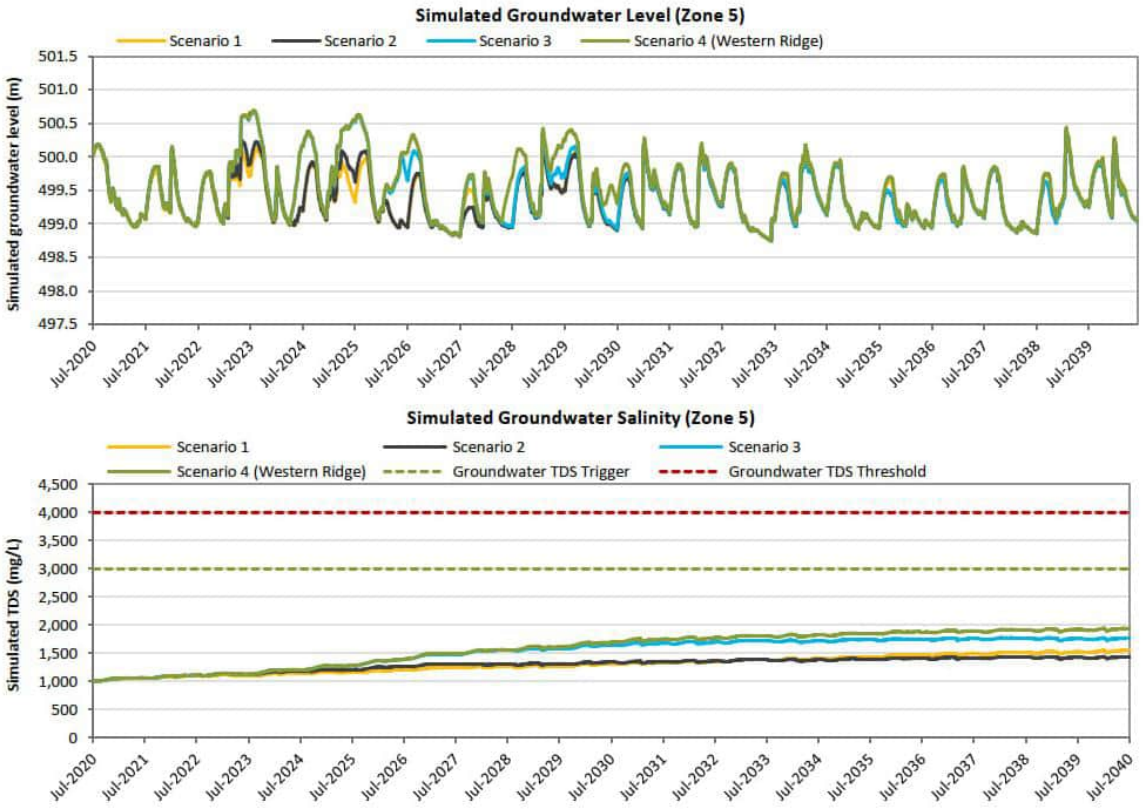
Source: EMM (2021), Figure 3.5

Figure 8: Predicted Ethel Gorge aquifer groundwater levels and salinity - Model zone 3



Source: EMM (2021), Figure 3.6

Figure 9: Predicted Ethel Gorge aquifer groundwater levels and salinity - Model zone 4



Source: EMM (2021), Figure 3.7

Figure 10: Predicted Ethel Gorge aquifer groundwater levels and salinity - Model zone 5

7.3 Conclusions

As discussed in BHP 2022a, The EPH water balance model (EMM 2020) produced simulated dam water balance results that closely match observed Ophthalmia Dam water levels and quality (TDS concentrations) leading to a high level of confidence in the Ophthalmia Dam water balance predictions.

Evaluation of the potential hydrological changes from the addition of the discharge of surplus water from the Western Ridge Proposal to Ophthalmia Dam (up to 34 ML/d or 12.41 GL/a) indicates that groundwater and salinity will remain within the range of observed levels. Predictions show that none of the EPWRMP groundwater level or groundwater salinity triggers or thresholds are exceeded for any of the hydrological scenarios over the 20-year simulation period, assuming a 3-month controlled release period. A controlled release of up to 3 months total in the dry season is consistent with the response actions outlined in the EPWRMP (BHP 2018).

As discussed in BHP 2022a, modelling scenarios undertaken to assess the theoretical capacity of Ophthalmia Dam indicate that the potential maximum capacity of the dam to manage surplus water via infiltration, evaporation and controlled discharge, without overtopping of the dam during the dry season, is approximately 115 ML/d without any controlled discharge and potentially up to 135 ML/d with a 3-month annual controlled discharge (EMM 2020). This is lower than the estimated peak discharge rate from all approved operations, plus the OB32 BWT and Western Ridge proposals (150 ML/d). The OB32 BWT modelling undertaken in 2020 indicated that it is possible that the capacity of Ophthalmia Dam may be reached during the estimated peak discharge years (for approximately 2 years between 2024 and 2026). The addition of surplus water from Western Ridge increases the peak discharge rate marginally from 145 ML/d to 150 ML/d but does not increase the duration that the dam capacity may be exceeded. Potential management options are discussed in Section 8.

There is no change to the storage capacity so there will be no change to the maximum inundation area. The pattern of inundation (change in extent and duration) is expected to be within historical variation and during peak discharge years, the inundation extent and duration may be more similar to historical wet years.

8 Surplus water management requirements

As discussed in Section 8, model predictions indicate that the groundwater level and salinity criteria in the EPWRMP will continue to be met if surplus water discharge to Ophthalmia Dam is increased due to the contribution from the Western Ridge Proposal. Therefore, BHP proposes to manage the additional surplus water discharge from the Western Ridge Proposal in accordance with current groundwater level and groundwater salinity criteria (triggers and thresholds) in the EPWRMP.

If future detailed surplus water forecasts indicate that the capacity of Ophthalmia Dam could be reached, BHP will manage the surplus discharge volumes from its operations and the operation of the dam to avoid overtopping of the dam spillway and uncontrolled surface flows to the Fortescue River in the dry season. Management options to limit releases to the Fortescue River in the dry season include the management measures and controls outlined in the EPWRMP, e.g. release water from the dam during wet season flow events or alter the surplus water discharge regime (amount of water discharged) from its eastern mines to the Ophthalmia Dam system. BHP is also reviewing the operation of the dam to manage the dam at higher water levels (within the existing storage capacity), to minimise planned releases to the Fortescue River.

As communicated to the DWER-EPA Services, BHP is also implementing and investigating alternative surplus water management options for its Eastern Pilbara mines, including managed aquifer recharge (MAR) and creek discharge in the catchment, to minimise risk to operations and alleviate dependency on the dam. This includes implementing the Caramulla surplus water scheme (MAR and creek discharge) and investigating alternative surplus water options as part of its Eastern Pilbara Regional Surplus Water study.

Future surplus water management may also depend on future climate and the management of the dam itself. A wetter or drier climate may require regular more frequent or longer duration releases from the dam, to maintain groundwater levels and salinity in the Ethel Gorge TEC and/or seasonal flows to the Fortescue River.

Changes may also be required to meet contemporary dam engineering and safety standards (noting that Ophthalmia Dam was constructed in the 1980s). BHP will assess the potential environmental impacts of any proposed major changes, including if changes are required to the EPWRMP.

9 References

BHP (2018) *Eastern Pilbara Water Resource Management Plan*, Version 6.0, April 2018.

BHP (2022a) *Orebody 32 below water table: Ophthalmia Dam surplus water impact assessment*. August 2022.

BHP (2022b) *Newman Hub (Western Ridge) Derived Proposal Request Ministerial Statement 1105*. Draft November 2022.

BHP (2022c) *Eastern Pilbara Water Resource Management Plan*, Version 6.3, Draft October 2022.

EMM (2020) *Eastern Pilbara Hub Water Balance: Integrated water balance model review and Ophthalmia Dam water management capacity scenarios*. Report prepared for BHP.

EMM (2021) *Western Ridge Mine - Water Balance Modelling Assessment*. March 2021. Report prepared for BHP.

10 Appendices

Appendix A: *Orebody 32 below water table: Ophthalmia Dam surplus water impact assessment*. Separate document.

Appendix B: *Western Ridge Mine - Water Balance Modelling Assessment*. Separate document.