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Memorandum

20 May 2024

Subject: **Eastern Pilbara Hub Water Balance - 2024 Forecast Surplus Discharge Assessment**
Attention: **James Jordan – Superintendent Newman Hydrogeology (BHP)**

1 Introduction

1.1 Background

The Eastern Pilbara Surplus Water Strategy has been developed to support the sustainable management of surplus mine water discharge from local BHP mining operations in the Eastern Pilbara region of Western Australia. The strategy is supported by water balance modelling which enhances BHP's understanding of local surface and hydrogeological responses to various management scenarios, particularly relating to the discharge of surplus mine water and controlled discharges from Ophthalmia Dam.

Since 2020, EMM Consulting (EMM) have undertaken several projects for BHP using the Ophthalmia Dam GoldSim Water Balance Model. This includes model calibration work, sensitivity testing and predictive model runs to support Part IV Environmental Approvals for OB32 BWT, Western Ridge and Jimblebar to discharge surplus mine water to Ophthalmia.

The Mine Dewatering Plan for the Newman West Marra Mamba Iron Formation deposits (OB29/30/35) requires an increase to the current 5C Groundwater Licence to enable planned below water table (BWT) mining. This will trigger the requirement for a Part IV Environmental Approval to cover the additional groundwater abstraction and resultant additional surplus water discharge to Ophthalmia Dam.

1.2 Project objectives

BHP propose to update the predicted surplus discharge scenarios previously assessed to reflect proposed dewatering rates from OB32, Western Ridge and Jimblebar plus the additional surplus water from Whaleback, which includes OB29/30/35. This surplus mine discharge scenario is known as *2024 Forecast Surplus Discharge*. The purpose of this assessment is to:

- Apply the recommended hydraulic conductivity (K) from the 2022 sensitivity analysis (EMM, 2022); and
- Update the water balance with the 2024 Forecast Surplus Discharge scenario to demonstrate the response of Ophthalmia Dam and the associated groundwater levels and salinity.

2 Model parameters

2.1 Updates

2.1.1 Hydraulic Conductivity

The mean hydraulic conductivity of the groundwater modelling components was changed from 7 m/d to 49 m/d. For comparative purposes, results are presented for both 7m/day and 49 m/day.

2.1.2 Surplus water discharge

The 2024 Forecast Surplus Discharge adopted for the Jimblebar, Whaleback, Western Ridge and Eastern Ridge mining operations in the water balance assessment is presented in Figure 2.1 below. The cumulative forecast surplus discharge is presented in Figure A.1.

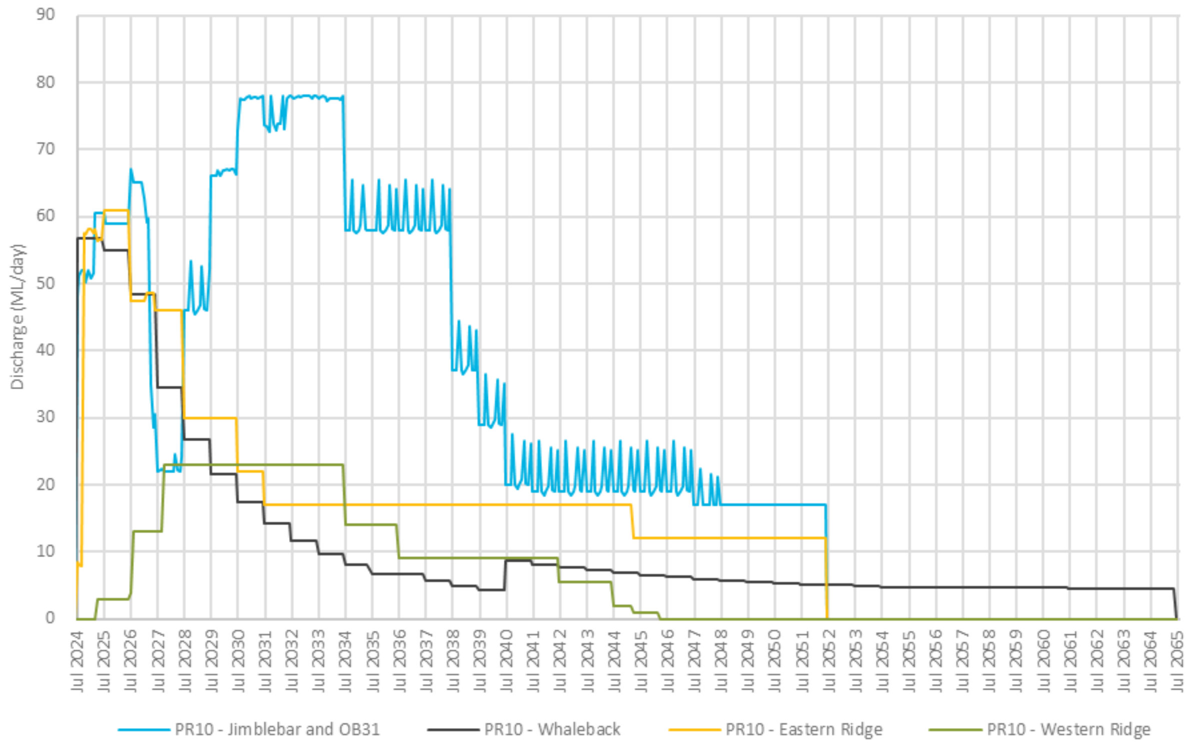

Figure 2.1 2024 Forecast Surplus Discharge PR10

2.2 Overview of applied parameters

The parameters applied to the modelling assessments are presented in Table 2.1 below. The justification and background on the parameters and modelling approaches is documented in *Eastern Pilbara Hub Water Balance – Integrated water balance model review and Ophthalmia Dam water management capacity scenarios* (EMM, 2020).

Table 2.1 Water balance model parameters for 2024 assessment

Parameter (units)	Value	Comment
Global settings and data		
Simulation dates	July 2024 to June 2065	
Climate data (includes daily rainfall, pan evaporation and MLake evaporation)	20-year average climatic conditions (2001 to 2020 SILO historical data)	Looped to achieve 41-year simulation timeframe.
Ophthalmia Dam parameters		
Dam seepage rate	Non-linear area-based seepage function	As per EMM (2020)
Catchment inflow factor	1.0	As per EMM (2020)
Stage-area-volume relationship	Defined from BHP (2014)	As per EMM (2020)
Spillway elevation (mRL)	513.5	As per EMM (2020)
C-wall valve discharge rate	Derived rating curve (135 ML/day capacity limit) 3-months from August	As per EMM (2023)
Fortescue River streamflow	20-year average climatic conditions (2001 to 2020)	Looped to achieve 41-year simulation
Groundwater model parameters		
Saturated hydraulic conductivity (K) (m/day)	49 and 7 (both applied for comparison)	As per EMM (2022)
Specific yield, Sy (%)	6.0	As per EMM (2020)
Upstream boundary inflow (m^3/day)	1500	As per EMM (2020)
Evaporation depth, De (m)	2.0	As per EMM (2020)
Evapotranspiration cut-odd depth, d2 (m)	4.8	As per EMM (2020)
Riverbed permeability (mm/d)	100	As per EMM (2020)
Borefield abstraction (ML/day)	Zone 1 – 2.7 Zone 2 – 7.4 Zone 3 – 0.0 Zone 4 – 2.8 Zone 5 – 0.1	As per EMM (2020)
OB23 and OB25 Pit 3 Dewatering and Discharge to infiltration Ponds (ML/day)	15	As per EMM (2020)
TDS mass balance parameters		

Table 2.1 Water balance model parameters for 2024 assessment

Parameter (units)	Value	Comment
River TDS concentration (mg/L)	40	As per EMM (2020)
Rainfall TDS concentration (mg/L)	2.2	As per EMM (2020)
Upstream groundwater inflow concentration (mg/L)	1000	As per EMM (2020)
Surplus water discharge salinity (mg/L)	Jimblebar 750 Eastern Ridge 950 Whaleback (including Western Ridge) 550	As per EMM (2020)

3 Results

Outcomes from the modelling described in Section 2 above are presented in Appendix A. Outputs are provided for Realisation 13, which is consistent with the EMM (2020) reporting.

Key findings of the modelling are:

- The updated water balance includes a period of higher surplus water discharge to Ophthalmia Dam (when compared to the previous modelling to support the Jimblebar proposal), which leads to an associated increase in dam storage during this period (Figure A.2).
- The volume of surplus water discharged to Ophthalmia Dam periodically exceeds the calculated surplus water management capacity of the Dam most notably during the period 2024 - 2027. The simulation presents a 'worst case' scenario against which to assess potential impacts of this proposal. Note that the Dam will continue to be operated according to current operational controls (aligned with the Eastern Pilbara Water Resource Management Plan) which prevent overtopping of the service spillway outside of natural wet weather events.
- The simulated water salinity in Ophthalmia Dam remains within historical values and ranges between approximately 42 and 1503 mg/L TDS, with no trend over time (Figure A.4).
- Simulated groundwater salinity in all five monitoring zones generally increases over the period 2024 - 2040 and then stabilises or decreases slightly over time. The 49 m/d aquifer hydraulic conductivity model scenario predicts a smaller increase in salinity, which aligns with historical observations (Figure A.6 - Figure A.10).
- Predictions of groundwater salinity in both the 7 m/d and 49 m/d scenarios remain below the EPWRMP trigger level of 3000 mg/L TDS in all monitoring zones.

4 Limitations and assumptions

As defined in EMM (2020), there are a range of limitations and assumptions associated with the water balance model, particularly pertinent to the representation of the groundwater system, which should be acknowledged when interpreting the model results and outputs. The water balance modelling approach has largely been developed to:

- provide an efficient and integrated approach to simulate the 'linked' surface and groundwater systems; and
- understand the potential influence of changes to the dam water balance and therefore groundwater seepage from the dam, on the downstream groundwater system.

The modelling approach is not explicitly designed equivalent to a numerical groundwater model and, by definition, is a simplified representation of a complex system.

The model simulations and outputs relating to the groundwater system are best used to interpret potential trends and responses to changes in operations, particularly for comparing relative changes between scenarios, rather than to be interpreted as accurate predictions of future groundwater levels and TDS concentrations.

The water balance for Ophthalmia Dam has been shown, through the model performance review process, to provide a good level of agreement between observed and simulated water volumes and TDS concentrations. The key uncertainties for the dam balance largely relate to the unmeasured components of inflow contributions from the ungauged portion of the dam catchment and seepage losses.

5 Closing

We hope this memorandum for the 2024 Forecast Surplus Discharge assessment adequately address your requirements. If you have any questions of require any additional information, please do not hesitate to contact me.

Yours sincerely

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References

BHP, 2014. Ophthalmia Dam Volume Calculation, Perth, WA: BHP.

EMM, 2020. Eastern Pilbara Hub Water Balance: Integrated water balance model review and Ophthalmia Dam water management capacity scenarios.

EMM, 2021. Western Ridge – Water Balance Modelling Assessment.

EMM, 2022. Eastern Pilbara Hub Water Balance: OB32 Surplus Water GoldSim Modelling – Stochastic and Sensitivity Assessments

EMM, 2023. EPHWB 2023 Forecast Surplus Discharge Assessment

Appendix A
PR10 modelling results

EMM
creating opportunities

A.1 2024 PR10 Forecast Surplus Discharge Ophthalmia Water Balance Figures

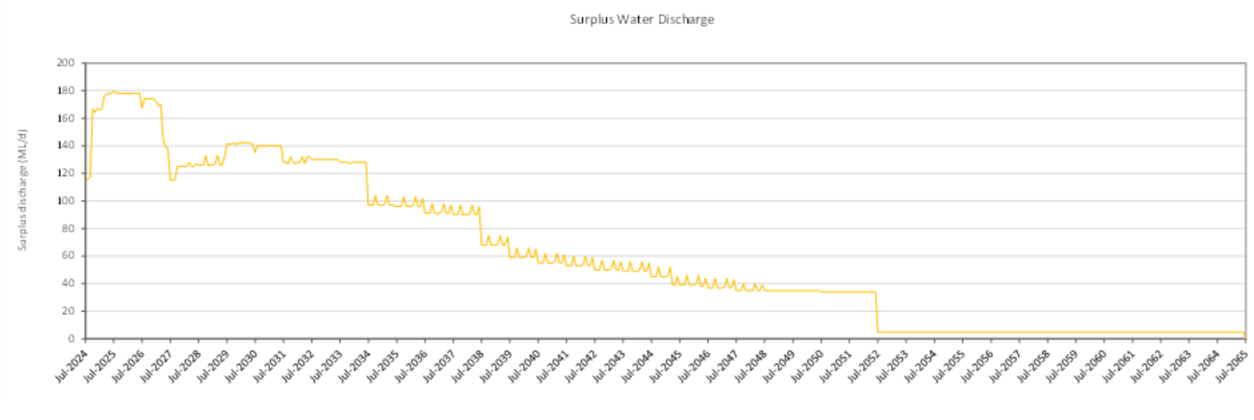


Figure A.1 Surplus Water Discharge (2024 Forecast Surplus Discharge, Realisation 13)

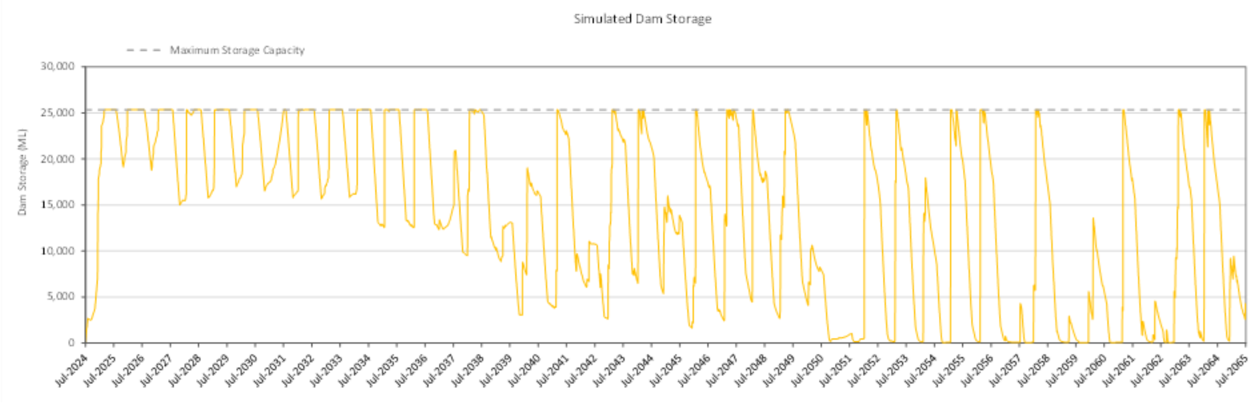


Figure A.2 Simulated Dam Storage (2024 Forecast Surplus Discharge, Realisation 13)

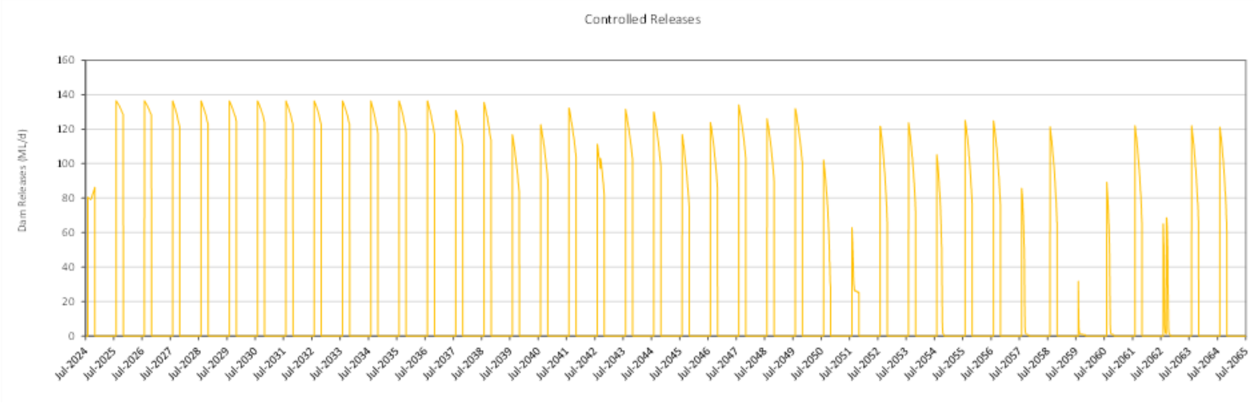


Figure A.3 Controlled Releases (2024 Forecast Surplus Discharge, Realisation 13)

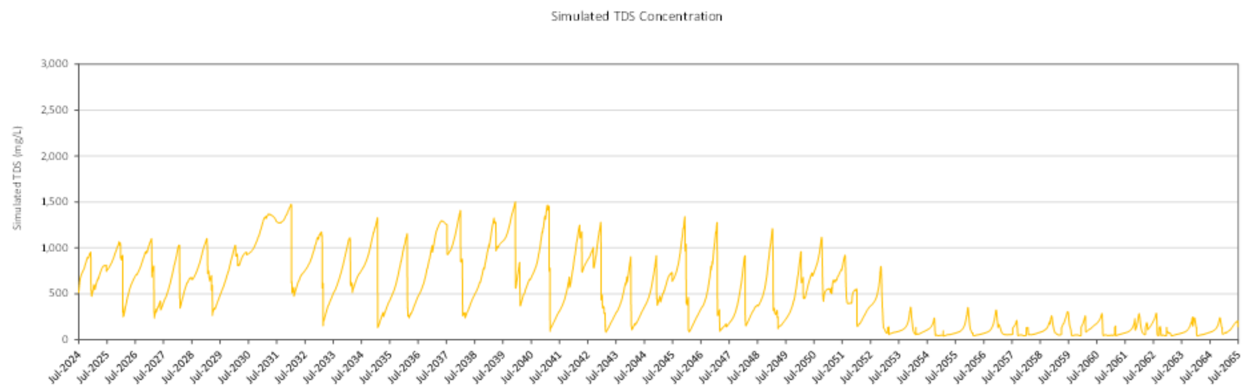


Figure A.4 Simulated TDS Concentration (2024 Forecast Surplus Discharge, Realisation 13)

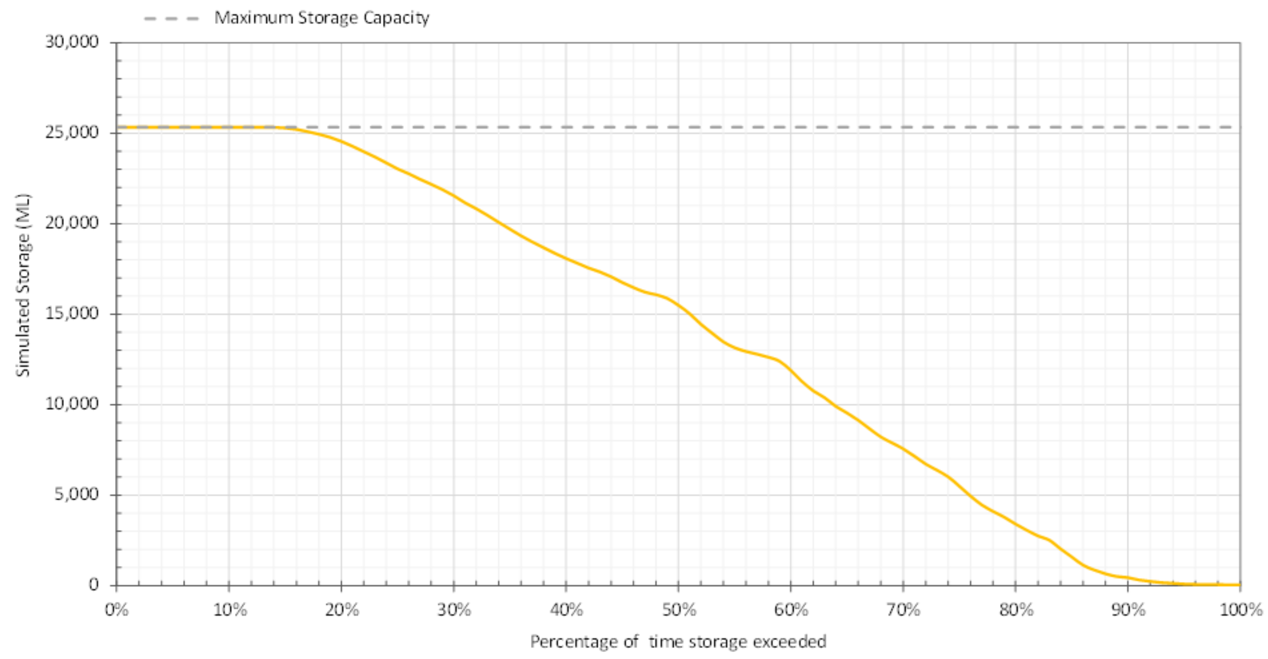
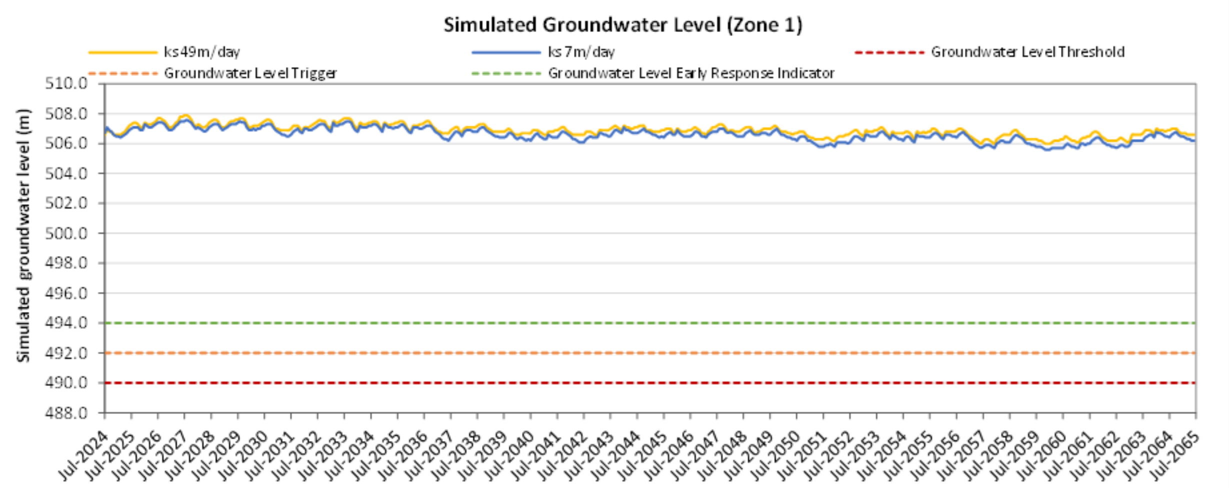


Figure A.5 Storage Duration Curve (2024 Forecast Surplus Discharge, Realisation 13)

A.2 2024 PR10 Forecast Surplus Discharge Simulated Groundwater and Salinity Figures



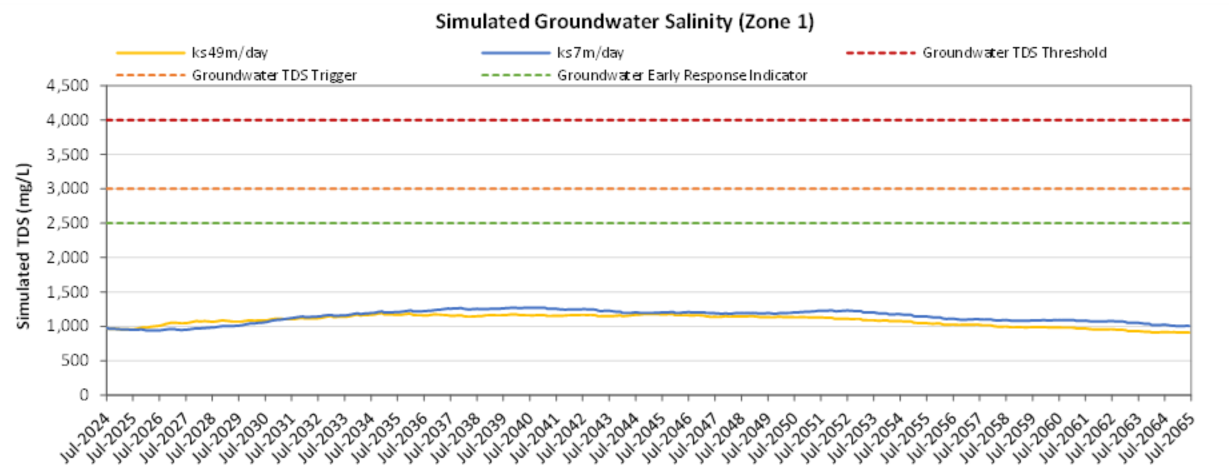
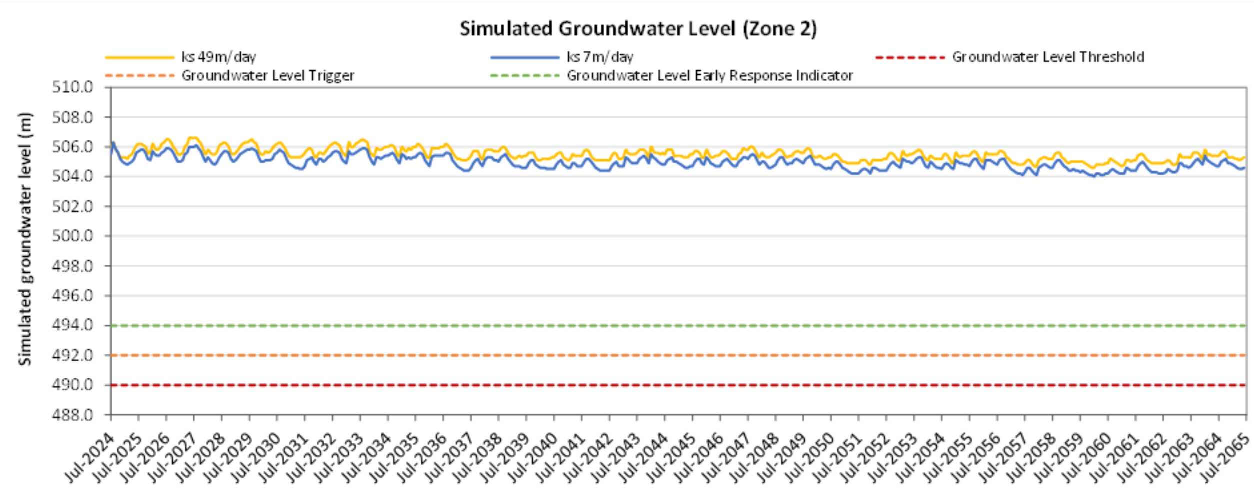


Figure A.6 Simulated model zone 1 groundwater level and salinity (2024 Forecast Surplus Discharge, Realisation 13)



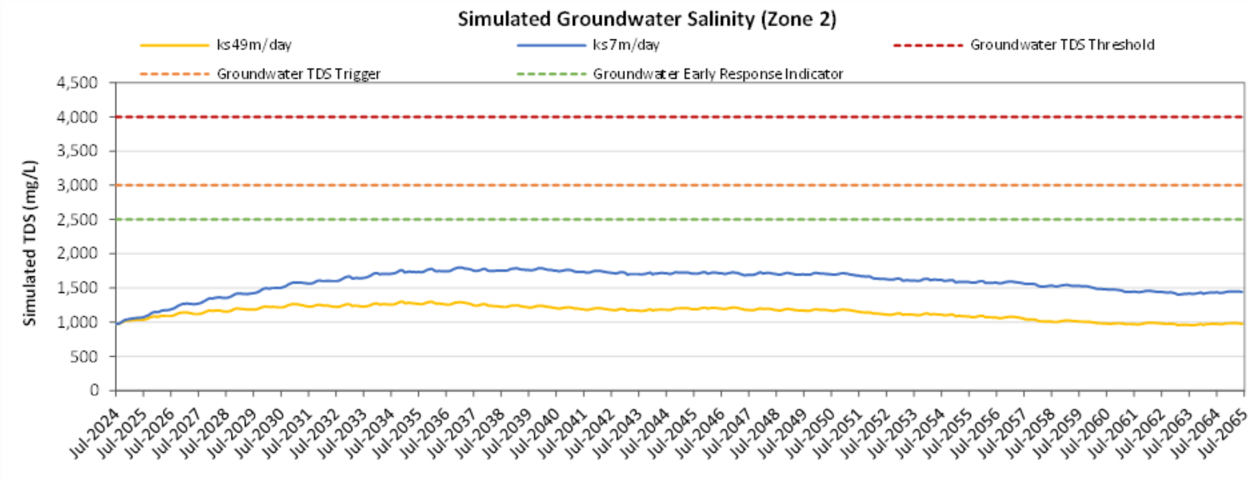


Figure A.7 Simulated model zone 2 groundwater level and salinity (2024 Forecast Surplus Discharge, Realisation 13)

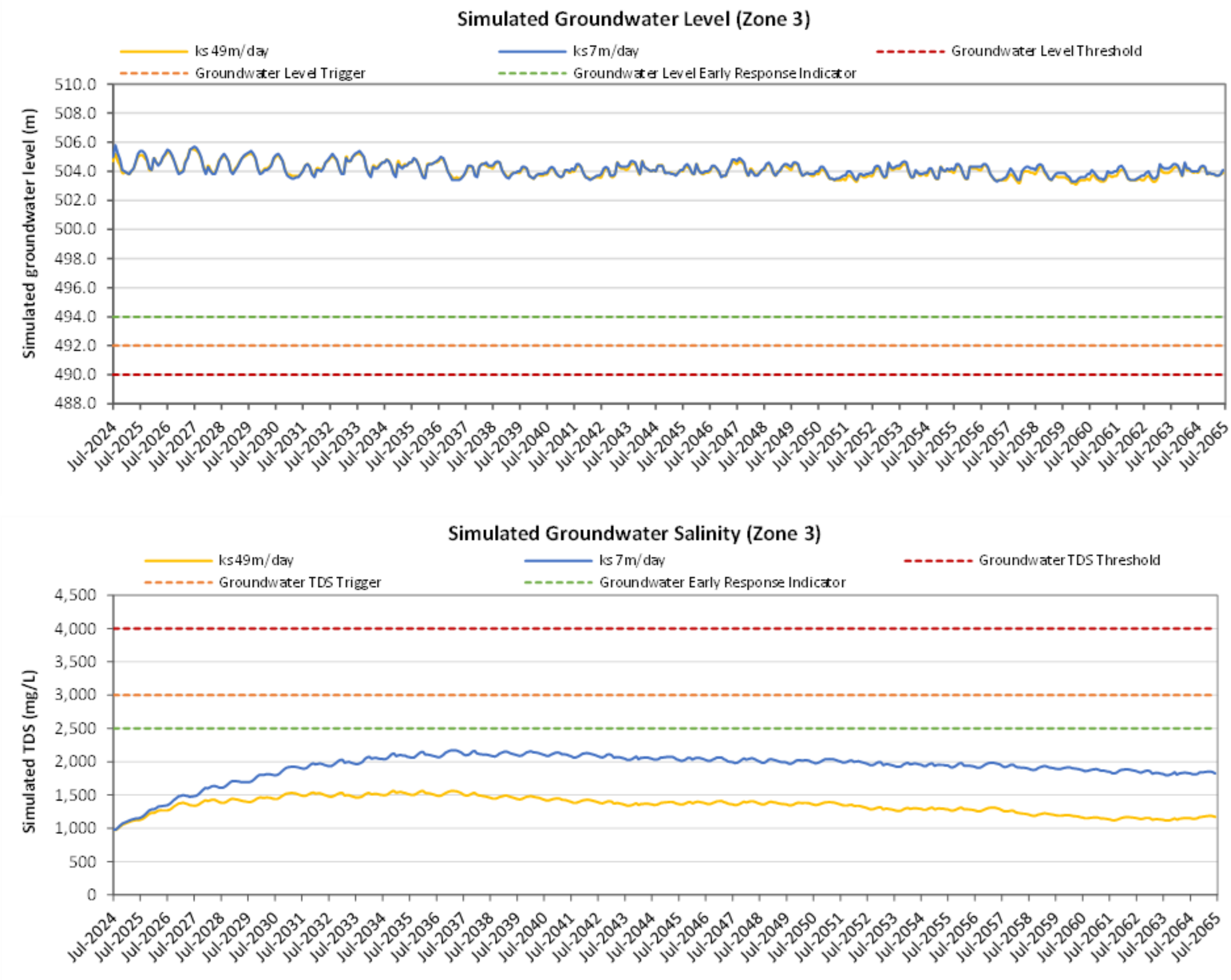
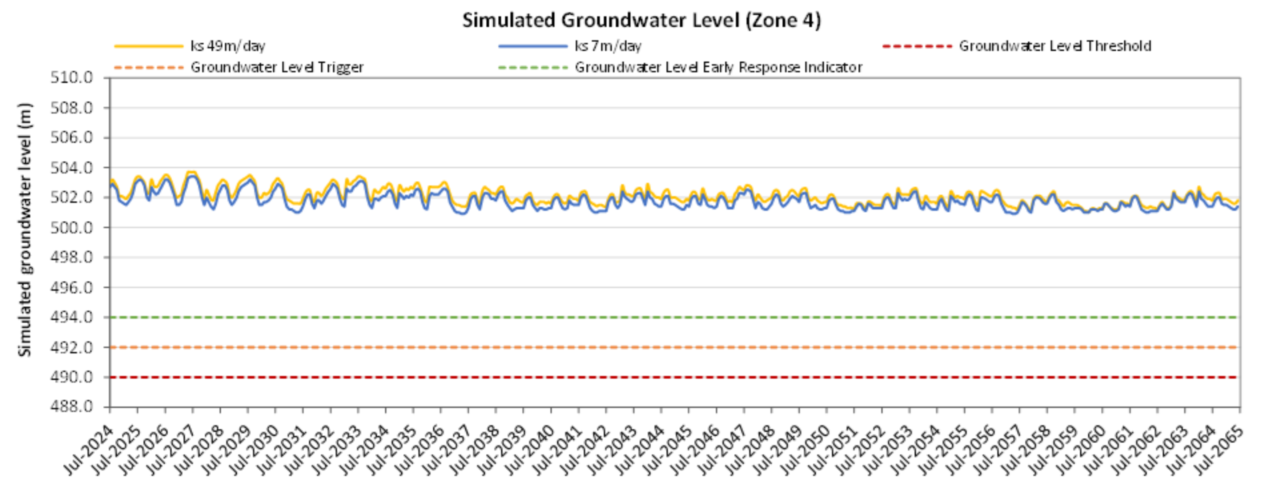


Figure A.8 Simulated model zone 3 groundwater level and salinity (2024 Forecast Surplus Discharge, Realisation 13)



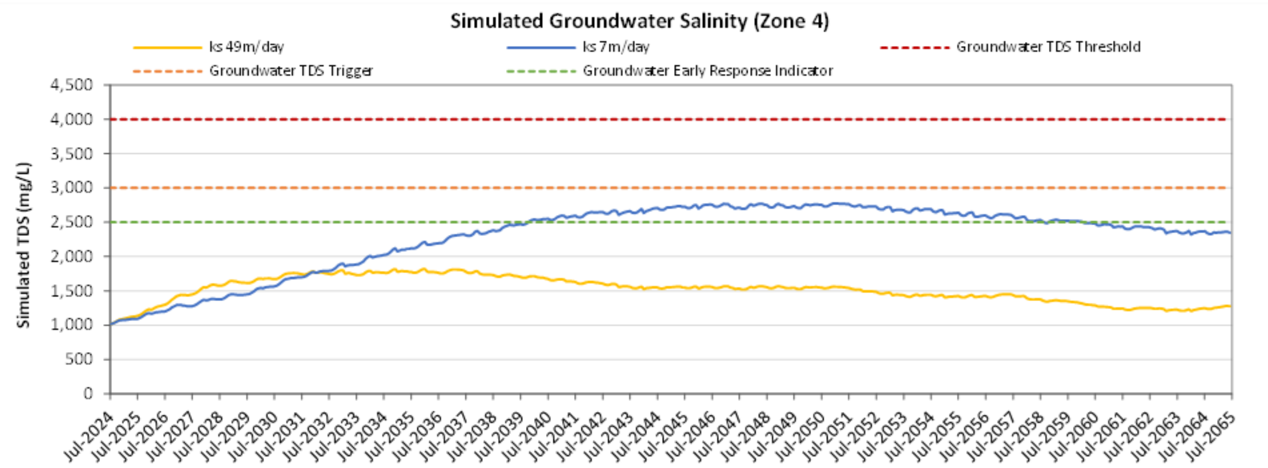
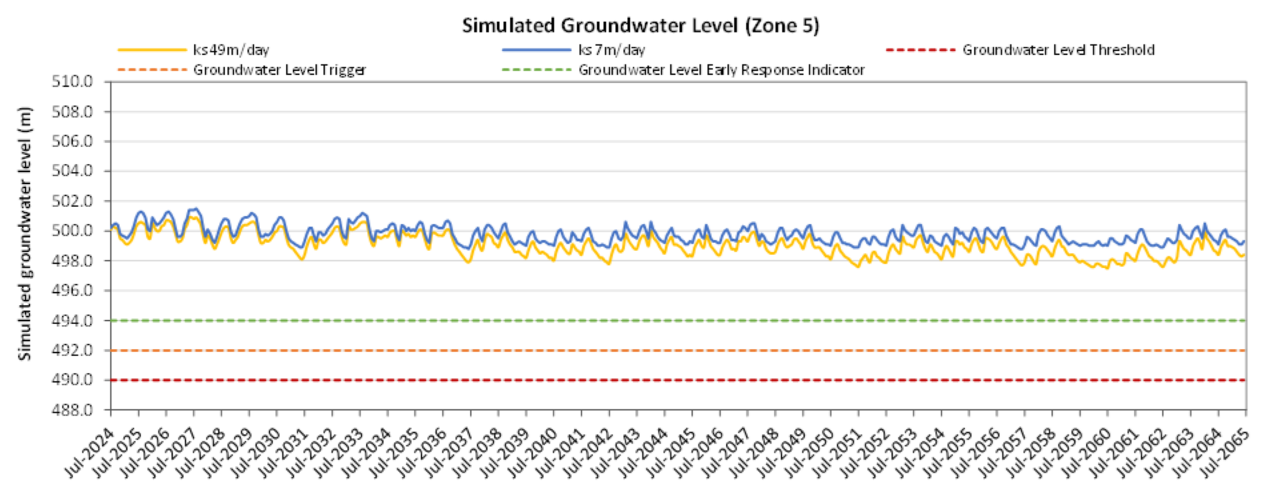


Figure A.9 Simulated model zone 4 groundwater level and salinity (2024 Forecast Surplus Discharge, Realisation 13)



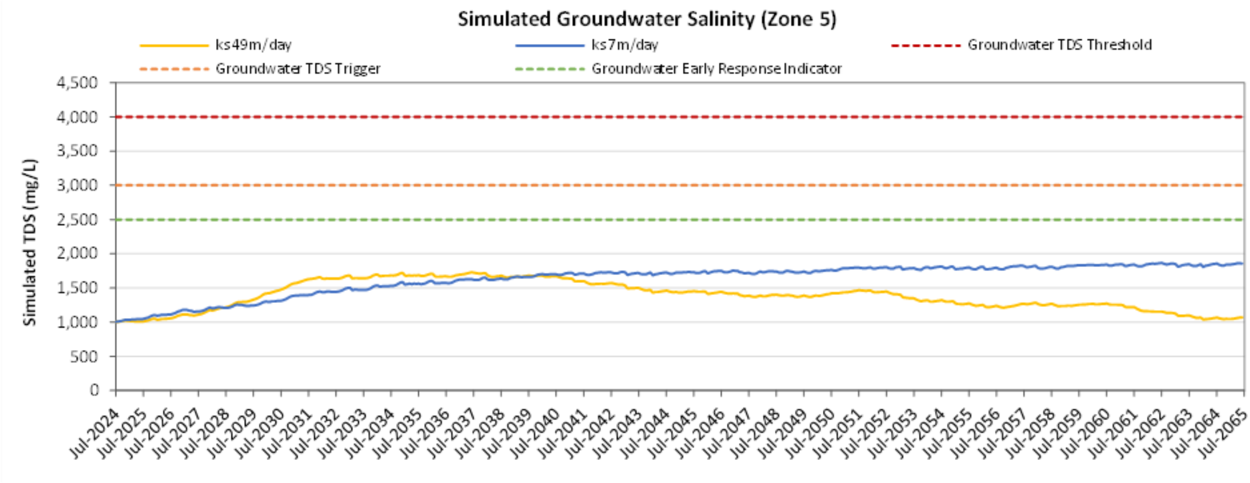


Figure A.10 Simulated model zone 5 groundwater level and salinity (2024 Forecast Surplus Discharge, Realisation 13)