



Mulga Downs Groundwater, Surface Water & Ecohydrological Impact Assessment

Prepared for:

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December 2024

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DOCUMENT STATUS

| Version | Purpose of Document | Author | Reviewed By | Review Date |
|---------|---------------------|-----------|-------------|-------------|
| A | For Client Review | EJB / MAN | DGS | 22/10/24 |
| B | Final | EJB / MAN | DGS | 12/11/24 |
| C | Final | EJB / MAN | DGS | 19/12/24 |
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| Version: | C | | |
| Date: | 19 December 2024 | | |
| AQ2 Ref: | F:\171\3.C&R\Reports\493_Combined Impact\171X_493c.docx | | |

EXECUTIVE SUMMARY

HanRoy Iron Ore Projects Pty Ltd (HanRoy) on behalf of Hancock Prospecting Pty Ltd (HPPL) is proposing to develop the Mulga Downs Iron Ore Mine (the Project) located approximately 210 km south of Port Hedland and 180 km northwest of Newman, in the Pilbara Region of Western Australia. The proposed Mulga Downs Hub and Rail Spur Project is a separate, standalone project as it is intended to be constructed and operated independently to the Mulga Downs Iron Ore Mine and is not considered in this assessment.

The Project encompasses the Murray's Hill and Mulga East Deposits within the Mulga East tenement (currently Retention Licence R47/12, with Mining Lease M47/1621 pending). The Study Area is defined for this report as the area covered by the Mulga East and Malay Well (E47/2117) tenements and areas of the Development Envelope which extend outside of these tenement boundaries. The Study Area extends beyond the Development Envelope for the Project; it represents the area within which baseline data has been collected to allow the development of detailed impact assessments.

The proposed Project comprises seven mining areas (from west to east): Murray's Hill, Anticline Hill, Fridge West, Fridge Central, Fridge Hill, Horseshoe West and Horseshoe Hill. Approximately 20 of the pits are proposed to extend (to varying depths) below the groundwater level and will therefore require dewatering. The lowest estimated pit elevation is 388 mRL (i.e. ~12 to 16 m below the groundwater level).

The mine area is located on the northern slopes of the Fortescue Valley, within the Goodiadarrie Swamp catchment, which includes the Koodjeepindarranna and Gnalka Gnoona freshwater claypans plus other intermittent areas of surface water pooling.

AQ2 has undertaken baseline groundwater, surface water and ecohydrological studies to develop an integrated conceptual model for the Study Area, with specific focus on the culturally and environmentally sensitive wetlands of the Fortescue Valley, inclusive of the Gnalka Gnoona and Koodjeepindarranna Claypans. Full details of the baseline investigations and conceptualisation are provided in a separate Mulga Downs Groundwater, Surface Water & Ecohydrological Studies Baseline Assessment report (AQ2 2024).

Groundwater Impact Assessment & Groundwater Management

Numerical groundwater modelling has been undertaken to determine a feasible mining scenario with a viable groundwater management solution and to assess the potential changes to the groundwater system.

The adopted mining scenario (MDE_LOM_20) has mining commencing in January 2027, with a 15.5-year mine life. Below water table mining commences in 2028 in the west, in the Murray's Hill area, progressing east to Anticline Hill, followed by the mining of Horseshoe West and finally the Fridge West, Fridge Central and Fridge Hill areas.

To achieve dry mining conditions dewatering is predicted to commence in April 2028 at ~8,600 kL/d (~3.2 GL/yr). Peak dewatering rates of between ~30,000 and 31,300 kL/d (~11 to 11.4 GL/yr) are predicted during the concurrent dewatering of Murray's Hill, Anticline Hill and Horseshoe West during 2032 and 2033, with similar peaks (~30,200 kL/d) between 2037 and 2041, during the mining of Fridge Hill and Fridge West. Dewatering rates decline rapidly upon the completion of mining Fridge Hill, with rates of ~4,300 kL/d (~1.6 GL/yr) predicted for the final of year of mining Fridge West.

Water supply requirements during the LOM will preferentially be sourced from the dewatering discharge, with water treated, if required, to meet operational water quality criteria. As dewatering exceeds water demands, excess water will be disposed of by MAR through re-injection within the Study Area. MAR is proposed on the slopes of the valley (i.e., in, and along strike of, the proposed mining areas). Initially, MAR is proposed via re-injection bores, with the potential for repurposing dewatering bores and / or in-pit infiltration, once mining of a pit is complete.

Construction and early LOM water demands (prior to mining below the water table) will preferably be sourced from the proposed mining and / or MAR areas thereby achieving advanced dewatering or increased capacity for MAR.

Without management practices in place, there is the potential for detrimental environmental impacts resulting from changes to groundwater levels and / or quality as a result of the mining activities (in particular dewatering and MAR).

The overarching groundwater management strategy is therefore to:

- Minimise impact on the current beneficial use of the groundwater.
- Minimise the impact on other groundwater users and groundwater dependent ecosystems (i.e., subterranean fauna); this includes minimising the extent of groundwater level changes.
- Maintain groundwater levels such that there is no surface expression of groundwater or water logging of vegetation.

Within the Study Area, groundwater is used by Mulga Downs Station (for stock water) and supports some environmental values. More regionally, groundwater is used for potable supplies at the Wirrilimurra and Youngaleena Communities. In addition, significant cultural-heritage value is derived from water within the Study Area, with Mungurrdu (DPLH Aboriginal Cultural Heritage Lodged Place) being of particular significance.

As the groundwater in the Study Area is only used for stock water, the key groundwater quality criterion for the current beneficial use is based on the drinking water requirements for livestock (cattle). Drinking water guidelines for beef cattle indicate a tolerance limit of 5,000 mg/L TDS (ANZECC, 2000), therefore where shallow groundwater outside of the immediate development area is currently within this limit, the intent is to minimise change above this level.

From ecohydrological studies conducted to date, the vegetation in the Study Area is not considered to be groundwater dependent (AQ2 2024), thus potential impact will not result from dewatering, but rather water logging of roots that may result from MAR.

Although knowledge about the salinity tolerance of Pilbara stygofauna is fairly limited, Bennelongia (2023) has classified the recorded stygofauna species in the Mulga Downs area into those that appear likely to be found only in groundwater of <3,000 mg/L TDS, those that have an apparent upper salinity tolerance of about 5,000 mg/L TDS and those that have an apparent upper salinity tolerance of about 10,000 mg/L TDS. The potential impact of groundwater changes on stygofauna, however, is being assessed separately.

Predicted Impacts During Mining

From the numerical modelling conducted to date, the groundwater drawdown is predicted to extend across the valley, away from the mining areas, however the extent of the drawdown along strike (i.e., in a northwest – southeast direction) is curtailed by MAR. Due to the progressive approach to mining, the maximum extent of the drawdown occurs in different directions at different times. The maximum extent of the predicted 2 m drawdown contour extends ~8 km to the south, ~6 km to the west and ~3.5 km to the east of the mining areas, and is not predicted to reach the modelled boundaries.

As ecohydrological studies to date have found that the vegetation is disconnected from the groundwater system under baseline conditions, a reduction in groundwater levels is not predicted to impact the terrestrial environment. A lowered water table would increase the thickness of unsaturated sediments, which may slightly reduce the responsiveness of the aquifer to recharge events. However, these sediments are not considered to be accessible to plant root systems.

Groundwater level rise (i.e., mounding) will occur as a result of MAR. Based on the ecohydrological conceptual model and measured baseline conditions, the threshold groundwater depth above which interaction with vegetation may occur is estimated to be about 2.0 mbgl (AQ2 2024). If water levels rise above this threshold for prolonged periods, vegetation stress is predicted. Although the predicted depth to groundwater remains below 2.5 mbgl (i.e., below this threshold) in the immediate MAR areas throughout the LOM, areas to the south of both the Murray's Hill / Anticline Hill and Fridge / Horseshoe South MAR areas, at the break of slope, have been identified as areas at risk of exposure to shallow groundwater levels for periods of time.

The maximum extent of the predicted 1 m mounding contour associated with the Fridge / Horseshoe South Borefield extends ~10 km to the south (across the valley) and ~5 km beyond the Mulga East tenement boundary, in a southeasterly direction. The maximum extent of the 1 m mounding contour associated with the Murray's West MAR Borefield is predicted to extend ~7 km to the northwest (along strike) and ~5 to 5.5 km to the south and southwest (across the valley), in the vicinity of the Koojjeepindarranna Claypan.

Groundwater salinity will change as a result of dewatering and MAR activities. The TDS of the combined dewatering discharge for all dewatering bores over LOM is predicted to range between 1,700 and 4,200 mg/L, taking into account the uncertainty associated with aquifer porosity, with this being the range of TDS concentrations that were then assigned to all MAR bores over the LOM.

The modelling indicates that changes in groundwater quality resulting from the proposed dewatering and MAR activities is anticipated to be fairly localised (i.e., <2 km in extent). This is demonstrated by both the simulated groundwater flow paths for the LOM and predicted salinity changes at the simulated observation points. Model predictions indicate that the key driver for groundwater salinity change is the proposed dewatering at Murray's Hill. This is predicted to result in increases to the dewatering discharge salinity as more saline water is drawn in from the valley areas. The subsequent re-injection of this more saline dewatering discharge into the Murray's West and Fridge / Horseshoe South MAR Borefields results in localised areas of increased groundwater salinity as well as subsequent increases to the combined dewatering discharge, as the re-injected water in the east is recirculated towards the Fridge West and Fridge Hill mining areas later in the LOM.

Taking into account the uncertainty associated with aquifer porosity, the greatest changes in salinity outside of the mining areas are predicted in three areas:

- In the Murray's West MAR Borefield area, the TDS is predicted to increase from ~1,200 mg/L to between ~3,600 and 4,700 mg/L (for high and low porosity scenarios), recovering to between ~2,700 and 3,500 mg/L, upon the cessation of MAR in this area and the re-injection of fresher water to the adjacent Murray's Hill / Anticline Hill area.
- Down-slope from the Murray's Hill mining / MAR area, the TDS is predicted to increase from ~3,600 mg/L to between 4,400 and 5,600 mg/L (for high and low porosity scenarios), potentially exceeding the tolerance limit for cattle (i.e., 5000 mg/L). However, when the Murray's Hill / Anticline area is used for MAR, the TDS is predicted to reduce, reaching between ~3,300 and 4,300 mg/L by the end of mining.
- Down-slope from the Fridge / Horseshoe South MAR Borefield, the TDS is predicted to increase from ~2,300 mg/L to between 2,400 and 3,900 mg/L (for high and low porosity scenarios), with TDS at the end of mining predicted to range between 2,300 and 3,700 mg/L.

Predicted groundwater salinity beneath the claypan areas shows only minor fluctuations (<500 mg/L TDS) throughout the LOM.

The excavation and exposure of PAF materials in the pit walls is not anticipated and groundwater contamination from other potential sources such as waste rock dumps or spills is anticipated to be low

risk, being managed by on-going monitoring and adaptive management. Furthermore, the risk of re-injection water becoming acidic or contaminated is low as this water will be sourced predominantly from ex-pit dewatering bores on the southern, down-dip side of the pits, rather than in-pit sump pumping.

Predicted Impacts Post-Mining

HanRoy intend to backfill the pits post-mining to above the pre-mining groundwater level. Modelling indicates the majority of groundwater level recovery has occurred during the LOM as the maximum depths of mining are reached prior to the end of mining. In particular, the western areas of Murray's Hill and Anticline Hill, which were mined (and dewatered) first and subsequently used for MAR have predicted water levels near to pre-mining elevations at the end of the LOM (i.e., at mine closure). As the Horseshoe South area is the last area used for MAR, groundwater levels in the nearby Horseshoe West mining area are recovering from mounding during the closure predictions (i.e., post-mining).

The modelling indicates a rapid recovery of groundwater levels post-mining, with predicted groundwater levels reported to recover to within 0.1 m of pre-mining levels within 10 years of the cessation of mining, at all mining areas, MAR areas and regional simulated observation points (GWC 2024).

The backfilling of the pits at the completion of mining eliminates any post-mining increases in groundwater salinity caused by evaporation from the pit lake surfaces, however, modelling of post-mining groundwater quality has not been conducted to date.

Management Measures

An environmental risk assessment has been undertaken relating to groundwater changes and their associated risk ratings, before and after the application of mitigation measures (Appendix A). A detailed discussion of the proposed management measures is provided in the Water Management Plan (HanRoy, 2024), with key management measures summarised below:

- Surplus water managed via MAR (i.e. via re-injection bores, repurposed dewatering bores and / or in-pit infiltration) to:
 - limit the extent of drawdown from the immediate mining area (accepting recirculation of groundwater).
 - limit the potential for the saline interface to rise as a result of hydrostatic changes in the broader cone of depression.
- Comprehensive baseline and operational monitoring of groundwater levels and groundwater quality to monitor impacts relating to dewatering and MAR; inclusive of on-going monitoring outside of the area of impact to provide further baseline data, thereby allowing differentiation between seasonal and mining-related changes. As the tolerance of vegetation to groundwater level change is site specific and not easily determined, baseline and operational monitoring of both groundwater levels and vegetation health is of particular importance for the areas identified as being at risk of exposure to shallow groundwater levels.
- Operation of multiple MAR areas to allow flexibility of injection and periods of recovery (i.e., reduced injection in one area and increased in another) if required due to groundwater level or groundwater quality triggers being observed.
- Review of dewatering rates if groundwater level or groundwater quality triggers are observed and cannot be managed by modifying the distribution of MAR.
- Backfilling of the pits at closure to allow groundwater levels to return to near pre-development conditions and eliminate further changes to groundwater salinity resulting from evaporation from pit lakes.

In addition to the above management measures, monitoring data will be regularly compared to model predictions and, as necessary, the numerical model can be re-calibrated to recorded responses and used to re-assess integrated groundwater management and mining scenarios.

Surface Water Impact Assessment and Management

The general management objectives for the Project relating to surface water are as follows:

- Maintain the existing hydrological regime as much as is practicable.
- Mitigate impacts on surface water quality from construction and operations by containing and treating impacted water on-site prior to release to the downstream environment.
- Reduce the risk of surface water having a significant impact on mining operations.

Surface water management measures to meet the above objectives have been proposed based on the following design philosophies:

- Clean water should be diverted around the disturbance footprints to the downstream environment to prevent contamination of clean water catchments (and therefore increase the volume of water which is required to be treated).
- Flood mitigation measures are required to prevent flood ingress to open pits and mine infrastructure areas.
- Surface water management infrastructure must incorporate measures to avoid excessive scour, erosion and sediment transport, and should be designed to prevent prolonged ponding following rainfall events.
- Contact runoff from mine disturbance areas (such as waste rock dump and pit runoff) will be contained and diverted to sediment control features for treatment prior to release of water downstream, subject to water quality being suitable for discharge.

A risk assessment was completed to identify the inherent risks of the Project to the hydrological environment without the incorporation of any surface water management measures. 2D flood modelling was conducted to identify surface water management measures (such as diversions and culverts) required to reduce the impact of the Project on the hydrological environment.

The Project development will reduce the catchment area which contributes surface water runoff to the Fortescue Valley. The predicted impact to the hydrological environment of the proposed Project has been assessed by:

- Comparing Baseline and LOM 2D flood model results to quantify changes to the predicted flood depths and velocities.
- Preparing a water balance model of Koojjeepindarranna and Gnalka Gnoona Claypans for pre-development LOM runoff scenarios. The models were used to quantify the impacts on the claypan water levels, inundation durations and water quality (TDS) due to the development of the mine.

The residual risks of the Project to the hydrological environment were assessed taking into account the proposed mitigation measures and the results of the flood modelling and claypan water balance modelling. The residual risks were generally considered to be low with the following key points made with respect to hydrological change, surface water management and potential impacts on mapped vegetation:

- A Water Management Plan (HanRoy 2024) has been prepared and provides additional information on the surface water management measures proposed.

- The 2D flood modelling predicts the reduction in catchment due to the containment of runoff within the mine development areas that will cause a reduction in flood levels within some areas of the Fortescue Valley to the south of the Project. In particular, the areas of ponding within the Goodiadarrie Swamp immediately to the south of Anticline South, Fridge West, Fridge Central and Horseshoe South pits are predicted to have a reduction in flood levels of up to 0.2 m following a 50% AEP rainfall event.
- Where flow is diverted around the mine development areas, some areas of the Fortescue Valley to the south of the Project are predicted to have increased flood levels.
- The modelling indicates that the mining development will have a greater effect on infrequent, large flow events than smaller, more frequent flow events. However, based on the water balance assessment of Fortescue Valley woodland vegetation communities completed by AQ2 (2024), more frequent smaller events have been identified as having the highest importance for maintaining adequate plant available water to minimise vegetation drought stress (AQ2 2024), with the amount of time between effective rainfall events being the most important factor determining vegetation water supply, rather than the magnitude of these events.
- The predicted changes in flood levels following a 63% AEP rainfall event have identified:
 - A total area of approximately 25 ha subject to increased flood levels (>5 cm increase in maximum flood height), comprising a mix of mulga dominated vegetation at the base of the alluvial fans and *E. victrix* woodlands proximal to an area of outcropping basement near the valley fringe.
 - A total area of approximately 310 ha subject to decreased flood levels (>5 cm decrease in maximum flood height). These areas largely comprise the Stony Flats EHU, which is blanketed in fine depositional sediments with patchy vegetation dominated mulga and scattered *E. victrix* in southern portions that transition into the Loamy Flats EHU.
- The vegetation types predicted to be exposed to hydrological change are widespread across the Fortescue Valley and do not contain critical habitat for EPBC listed threatened fauna species.
- The claypan water balance quantified impacts to the claypans during a small, medium and a large inundation event. The impacts are considered negligible and are summarised as follows:
 - Reductions in claypan water level were predicted to range between nil to 0.022 m. Note that the water levels in the Koodjeepindarranna Claypan were only impacted if the water level in the Gnalka Gnoona Claypan exceeded the height of the divide between the two claypans (402.9 mRL).
 - Inundation duration was predicted to decrease in the order of days for large and medium events with negligible change in inundation duration predicted for the small events.
 - Only a marginal change in TDS between the model scenarios.
 - None of the above changes should result in any significant impact to the claypans' ability to provide habitat to support MNES/migratory birds.

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TABLE OF ABBREVIATIONS

| Abbreviation | Definition |
|--------------|--|
| 2D | Two dimensional |
| AEP | Annual Exceedance Probability |
| AMD | Acid Mine Drainage |
| ANZECC | Australian and New Zealand Environment and Conservation Council |
| AR&R | Australian Rainfall and Runoff |
| ARI | Annual Recurrence Interval |
| ARMCANZ | Agriculture and Resource Management Council of Australia and New Zealand |
| BoM | Bureau of Meteorology |
| DCCEEW | Department of Climate Change, Energy, the Environment and Water |
| DEM | Digital Elevation Model |
| DWER | Department of Water and Environmental Regulation |
| EC | Electrical Conductivity |
| ESA | Environmentally Sensitive Area |
| EPA | Environmental Protection Authority |
| FHEZ | Fauna Habitat Exclusion Zone |
| HEC-RAS | Hydrologic Engineering Center's River Analysis System |
| HPPL | Hancock Prospecting Pty Ltd |
| IFD | Intensity-Frequency-Duration |
| IL | Initial Loss |
| km | Kilometre |
| LiDAR | Light Detection and Ranging |
| LOM | Life of Mine |
| l/s | Litre per second |
| m | meter |
| MAR | Managed aquifer recharge |
| Max | Maximum |
| mbgl | Meters below ground level |
| mbTOC | Meters below top of casing |
| MDEC | Mulga Downs Exploration Camp |
| mg/l | Milligram Per Litre |
| mm | millimetre |
| MNES | Matters of National Environmental Significance |
| mRL | Metres Relative Level |
| µS/cm | Micro Siemens per cm |
| NASA | National Aeronautics and Space Administration |
| ND | Nominal Diameter |
| PAF | Potentially Acid Forming |
| PEC | Priority Ecological Community |
| PL | Proportional Loss |
| RFFE | Regional Flood Frequency Estimate |
| RFFP | Regional Flood Frequency Procedure |
| ROM | Run of Mine |
| RORB | Runoff Routing |
| SCL | Stochastic Climate Library |
| SWL | Static Water Level |
| SWML | Surface Water Monitoring Location |
| SRTM | Shuttle Radar Topography Mission |
| TDS | Total Dissolved Solids |
| V | Volt |

1. BACKGROUND

1.1 Introduction

HanRoy Iron Ore Projects Pty Ltd (HanRoy) on behalf of Hancock Prospecting Pty Ltd (HPPL) is proposing to develop the Mulga Downs Iron Ore Mine (the Project) located approximately 210 km south of Port Hedland and 180 km northwest of Newman, in the Pilbara Region of Western Australia. The Project encompasses Murray's Hill and Mulga East Deposits within the Mulga East tenement (currently Retention Licence R47/12, with Mining Lease M47/1621 pending), with no development proposed over the adjacent / nearby exploration tenements of Malay Well (E47/2117) and Mulga West tenement (E47/1315). A location plan is provided as Figure 1.1, showing these tenements. Although other HPPL tenements cover the Project Development Envelope, these have not been shown.

AQ2 has been engaged to undertake baseline groundwater, surface water and ecohydrological studies and impact assessments, to support the environmental assessment of the Project. This report details impact assessments undertaken, with baseline and conceptualisation work documented in a standalone report (AQ2 2024). Subterranean fauna studies (baseline studies and impact assessments) have been undertaken by other consultants and are not part of this report.

The Study Area is defined for this report as the area shown in Figure 1.2, which includes the Mulga East and Malay Well tenements and areas of the Development Envelope which extend outside of these tenement boundaries. The Study Area extends beyond the Development Envelope for the Project; it represents the area within which baseline data has been collected to allow the development of detailed impact assessments. Some of the assessments documented within this report (such as groundwater modelling and flood modelling) extend beyond the limits of the Study Area.

1.2 Objectives

The primary objective of these water and ecohydrological studies are to support the environmental impact assessment of the Project. As such, the objectives comprise:

- Formulating conceptual models for the local and regional hydrology and hydrogeology.
- Identifying environmental assets that may be impacted by hydrological change resulting from the Project (receptors).
- Identifying potential impacts on those receptors as a result of the Project.
- Providing conceptual designs for the proposed water management strategy.
- Assessing residual surface water and groundwater risks remaining after the application of the proposed water management strategy.

1.3 Project Overview

The proposed open cut pit footprints, referenced as MDE_LOM_20_F_20240805 (MDE_LOM_20), are shown in Figure 1.2 together with the indicative Project development layout. The pit footprints comprise seven mining areas (from west to east): Murray's Hill, Anticline Hill, Fridge West, Fridge Central, Fridge Hill, Horseshoe West and Horseshoe Hill. Approximately 20 of the pits are proposed to extend (to varying depths) below the groundwater level and will therefore require dewatering. The lowest estimated pit elevation is 388 mRL (i.e., ~12 to 16 m below the groundwater level).

In addition to the open cut pits, the following additional activities are proposed:

- Waste dump and top soil stockpiles.
- Ore stockpiles, ROM pads and crushing and screening plant.
- Workshops, laydown yards, offices.

- Mine camp.
- Airport.
- Borrow pits.
- Haul roads and access roads, including a haul road between the mine site and the Great Northern Highway.
- Water management infrastructure (as outlined in this report).

As discussed in more detail within this report, dewatering is predicted to result in a surplus of water. Excess water will be disposed of by Managed Aquifer Recharge (MAR).

It should be noted that design updates are ongoing and for example, as shown in Figure 1.2, the updated airport layout differs slightly to the indicative Project layout. The updated airport design has been adopted for the impact assessment.

1.4 Climate

The climate of the Study Area is described as semi-arid, characterised by hot summers, with maximum monthly temperatures often exceeding 40°C, and milder winters. Rainfall is highly variable, but on average about 75% of annual rainfall is received between December and March, in association with thunderstorms and cyclonic events.

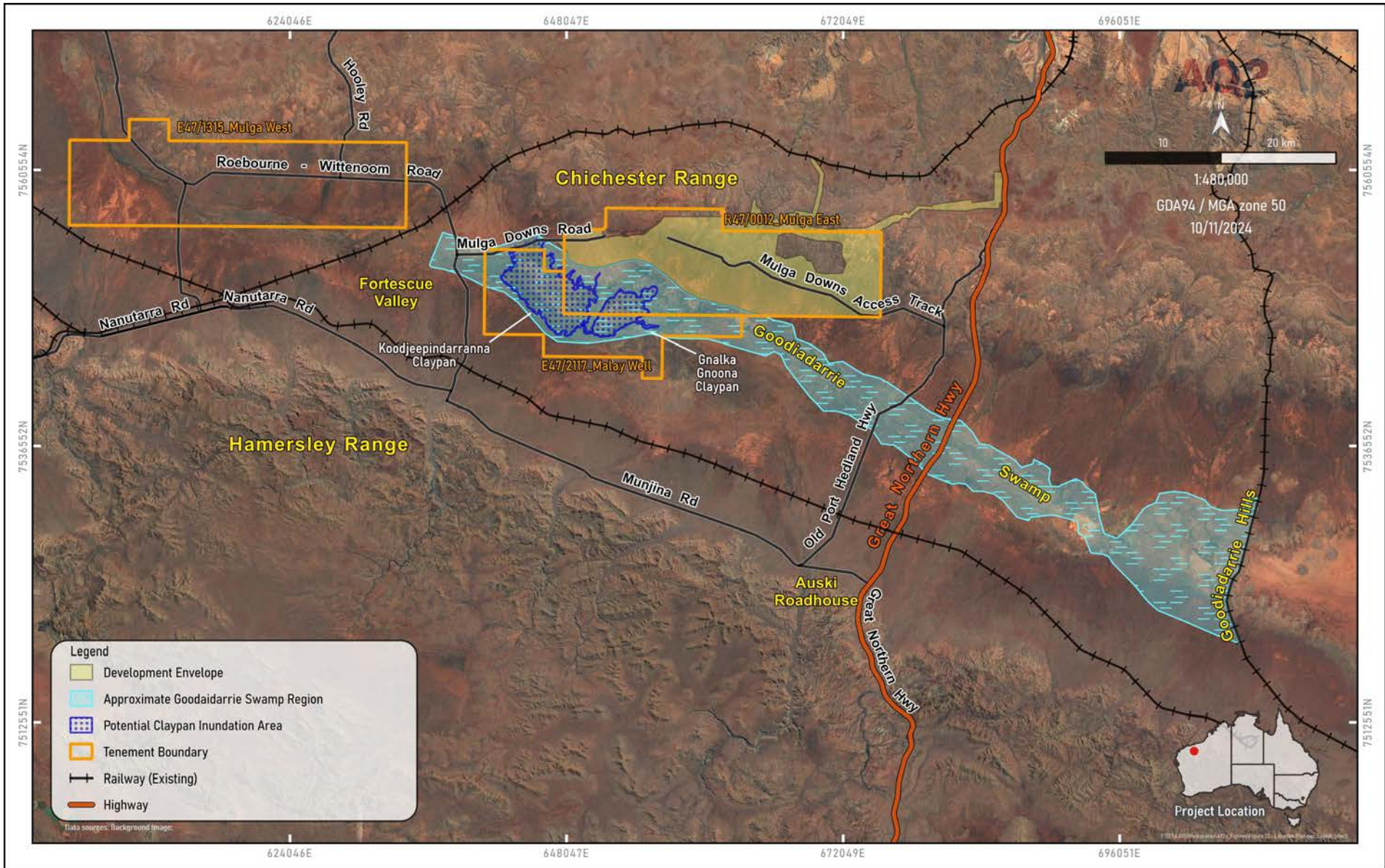


Figure 1.1 Location Plan

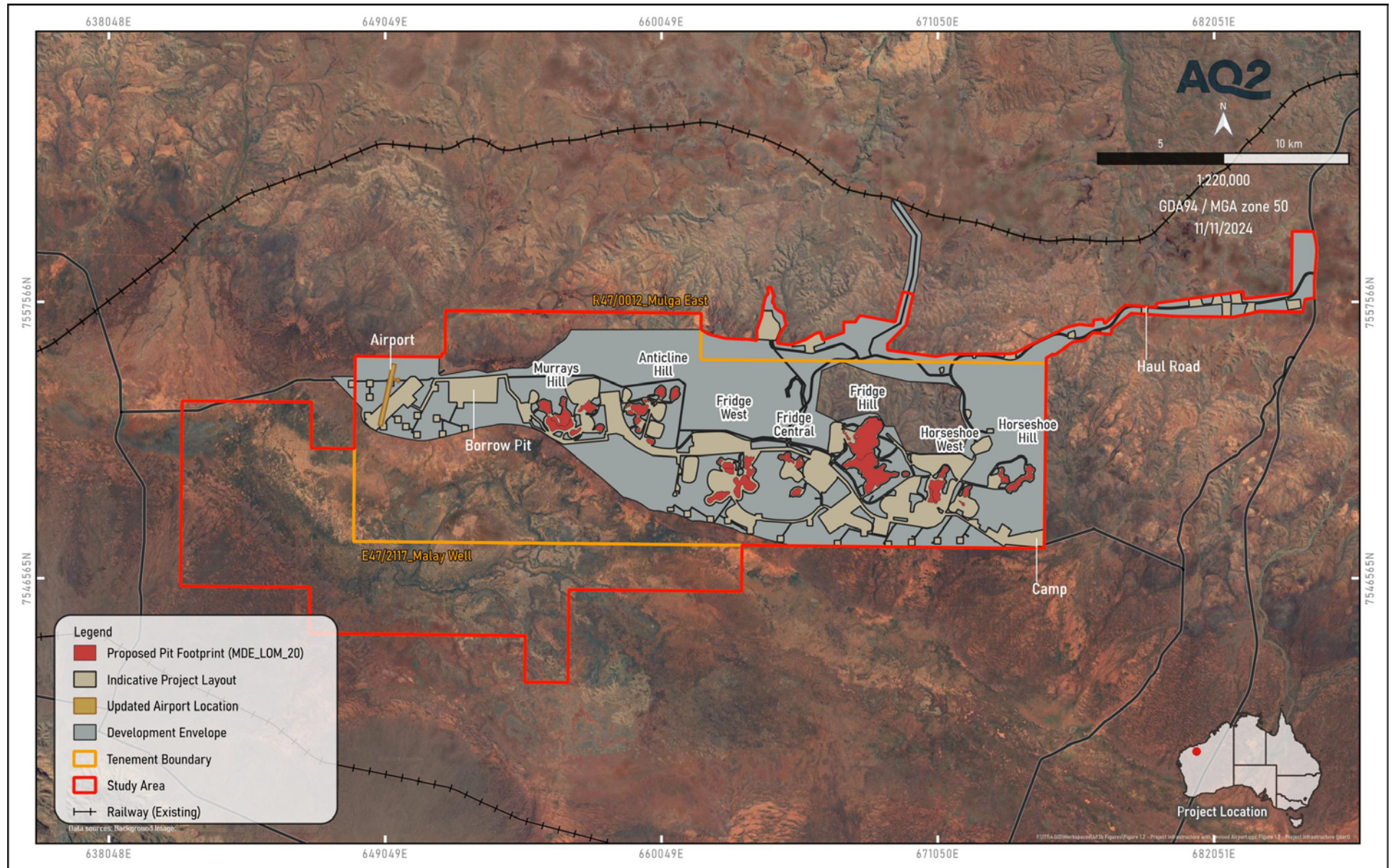


Figure 1.2 Indicative Project Layout

1.5 Physiography

The Study Area is located within the Chichester Range, on the northern flanks of the Fortescue Valley (refer Figure 1.1). The Chichester Range comprises low-lying hills which rise approximately 100 m above the level of the Fortescue Valley floodplain. The hills are cross-cut by narrow, steep-sided gullies, with colluvium and alluvial fans extending from the hills across the valley floor where drainages flow into the Fortescue Valley.

Within the vicinity of the Study Area, the Fortescue Valley comprises a network of interconnected ephemeral swamps, claypans and floodplains (collectively, an area known colloquially as Goodiadarrie Swamp), with the valley floor gently sloping in a westerly direction. The valley is some 20 km wide and is bound to the south by the Hamersley Range.

1.6 Regional Hydrology

The Fortescue Valley is split by the Goodiadarrie Hills (a ~5 m barrier that forms a surface water divide) into the (eastern) Fortescue Marsh and the (western) Goodiadarrie Swamp (refer Figure 1.1). The Fortescue Marsh (approximately 60 km to the east) is the largest ephemeral wetland in the Pilbara region and is recognised as a nationally important wetland. A second surface water divide exists to the west of the Goodiadarrie Swamp (immediately to the west of Koojjeepindarranna Claypan), separating the Goodiadarrie Swamp from the Lower Fortescue River.

1.7 Regional Geology

The bedrock within the Study Area comprises rocks of the Hamersley and Fortescue Groups (refer Table 1.1). The Jeerinah Formation (of the Fortescue Group) and Marra Mamba Iron Formation (Marra Mamba Formation) outcrop in the Chichester Range on the northern side of the Fortescue Valley. The Marra Mamba Formation and Wittenoom Formation subcrop beneath the valley floor within the Study Area, with the overlying Mt Sylvia Formation and Mt McRae Shale occurring to the south. The Brockman Iron Formation forms the Hamersley Range on the southern side of the Fortescue Valley (refer Figure 1.3). Tertiary and Quaternary deposits infill the valley. The Tertiary deposits are collectively referred as “detritals”, comprising pisolite, clay and calcrete; there is also lateritic hardcap development of Tertiary age on basement rocks, which may be ferricrete (goethite) and calcrete / silcrete. The Quaternary deposits comprise alluvium and colluvium.

The mineralisation within the Study Area is primarily associated with the Nammuldi Member of the Marra Mamba Formation (that outcrops along the lower flanks of the Chichester Range), although there is also mineralisation in the overlying Tertiary detrital deposits.

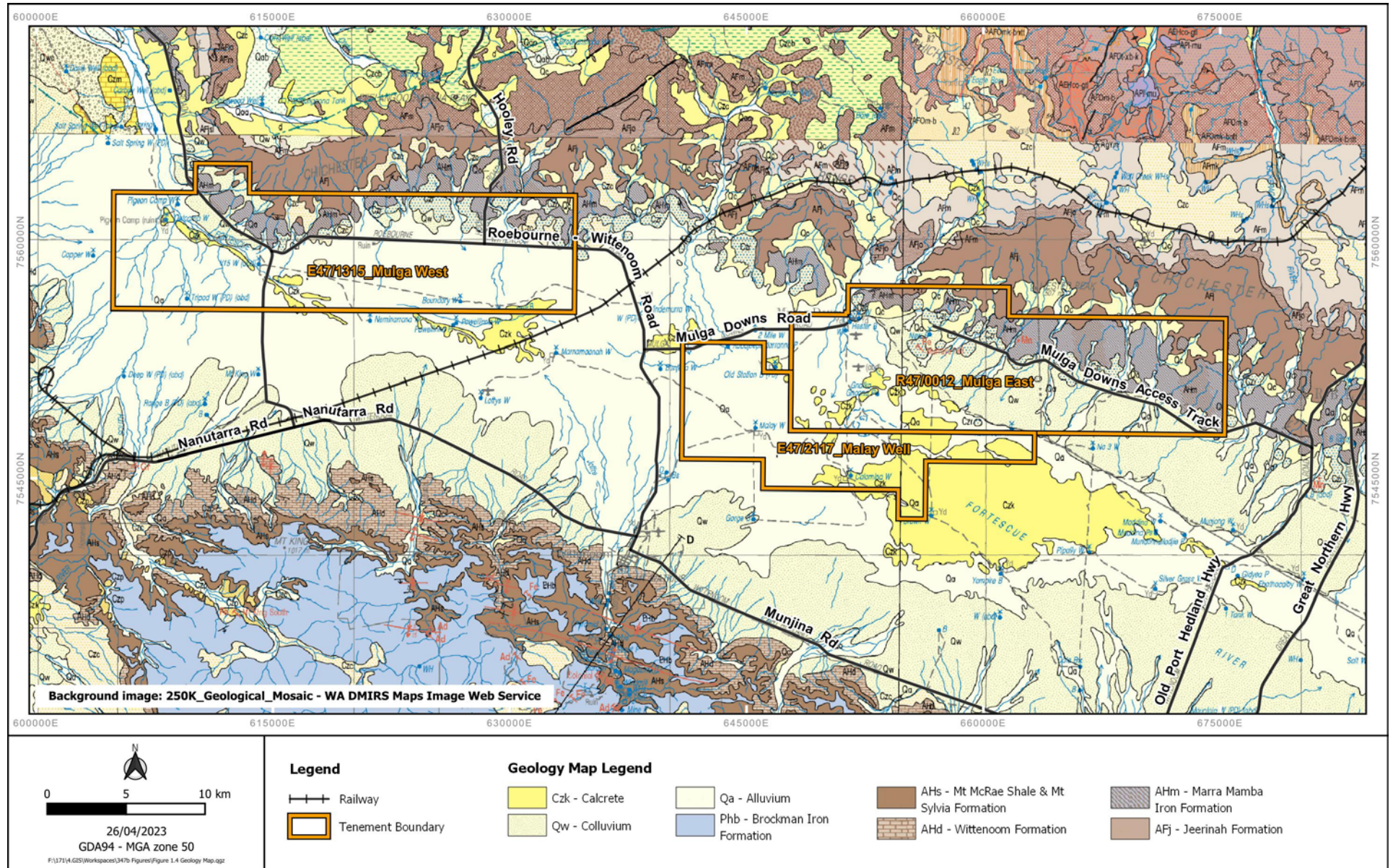


Figure 1.3 Geology Map

Table 1.1 Regional Stratigraphic Sequence within the Study Area

| Group | Formation | Member | Lithological Description |
|-----------------------------|----------------------------|-----------------------|--|
| Recent Alluvium / Colluvium | | | Unconsolidated silt, sand and gravel (clay near pans) |
| Tertiary Detritals (TD) | TD3 | | Red haematitic scree on valley sides. Increasing silt / clay content with distance from slopes / fans Increasing pisolitic content with depth |
| | TD2 | | Silcrete, calcrete (Oakover Formation), Channel Iron Deposit (CID), mottled clay |
| ?? | ?? | Pinjan Chert | Siliceous sediment with alternating laminated chert |
| Hammersley Group | Wittenoom Formation | Bee Gorge Member | Graphitic shale with minor sequences of carbonate, chert, volcanoclastic rock and Banded Iron Formation (BIF) |
| | | Paraburdoo Member | Dolomite with minor amounts of chert and shale |
| | | West Angela Member | Dolomite, dolomitic / manganese-rich shale, BIF and chert |
| | Marra Mamba Iron Formation | Mt Newman Member | BIF with minor shale |
| | | MacLeod Member | Shale, chert and BIF |
| | | Nammuldi Member | BIF, chert and shale |
| Fortescue Group | Jeerinah Formation | Roy Hill Shale Member | Dark grey to black graphitic shale with chert; locally pyritic |
| | | Warrie Member | Grey dolomite with inter-bedded chert (locally ferruginous), shale and mudstone |

*Age of the Pinjan Chert is uncertain

1.8 Native Title and Cultural Significance

The area covered by the water and ecohydrological studies is subject to two Native Title determinations (refer Figure 1.4) The Mulga East and Malay Well tenements fall within the native title area of the Banjima People, whilst the Mulga West tenement straddles the boundary of the Banjima People and Yindjibarndi People Native Title areas.

Mungurrdu (refer Figure 1.4) is a DPLH Aboriginal Cultural Heritage Lodged Place (ID:40484). The Banjima People are the Knowledge Holders for this place, it is culturally significant in multiple ways including as; a ritual and ceremonial area, a meeting place, a hunting place, a water source, and is associated with Creation/Dreaming stories. Banjima representatives first indicated to HanRoy the area had significant heritage values during a heritage survey in July 2023 before it was formally lodged as Mungurrdu with the DPLH in March 2024.

1.9 Land Use & Existing Groundwater Users

The Study Area lies within the administrative boundary of the Shire of Ashburton. The Mulga East and Malay tenements are wholly contained within the Mulga Downs pastoral lease area; whilst the Mulga West tenement is predominantly within the Mount Florence pastoral lease area; except for the western portion (circa 55 km²) that intersects the northwest portion of the Mulga Downs pastoral lease and northeast fringe (circa 8.5 km²) that intersects the Hooley pastoral lease (refer Figure 1.4) There is a long history of pastoral land use in the area, predominantly cattle grazing.

Existing groundwater users in the Study Area include the local and nearby stations (Mulga Downs, Hooley and Mt Florence Stations), for stock watering as well as the Wirrilimurra and Youngaleena Communities (Figure 1.5) and licenced water supplies associated with the construction of the existing FMG (Solomon) railway and RTIO (Goodiadarrie) railway.

1.10 Key Environmental Assets & Significant Fauna Habitat

Recognised conservation assets within and surrounding the Study Area, including identified Priority Ecological Communities (PECs), are summarised as follows, with spatial locations for those proximal to the Study Area shown Figure 1.6:

- Freshwater claypans of the Fortescue Valley PEC (Priority 1) – this PEC includes a series of claypans in the Fortescue Valley, distributed over a distance of about 70 km from near the western end of the Fortescue Marsh to the Roebourne – Wittenoom Rd. The two westernmost claypans, known as the Gnalka Gnoona Claypan and the Koodjeepindarranna Claypan, are located in the Study Area (but outside the Development Envelope). The next claypan in the sequence moving east is the smaller Ebathcalby Claypan, located about 9 km south of the eastern margin of R47/12 (i.e., outside the Study Area). Note that the Koodjeepindarranna Claypan PEC buffer zone (based on Department of Biodiversity, Conservation and Attractions (DBCA) data set (DBCA 2022)) does not extend over the full ponding area which occurs during flooding of this claypan.

DBCA surveys indicate that the wetlands of the Fortescue Valley may support over half of the aquatic fauna species present in the Pilbara (Pinder et al. 2017). Recognised values of and threats to the PEC include (DBCA 2022):

- Values: Important for waterbirds, invertebrates and some poorly collected plants. *Eriachne* spp., *Eragrostis* spp. grasslands. Unique community has few *E. victrix* trees.
- Threats: grazing, weed invasion, infrastructure corridors, altered hydrological flows, altered fire regimes.
- The four plant assemblages of the Wona Land System PEC (Priority 1/3), comprising a system of basalt upland gilgai plains with unusual grassland vegetation assemblages. The PEC occurs north of the Goodiadarrie Swamp sub-catchment divide and is therefore ecohydrologically disconnected from the proposed pit areas, however, the proposed haul road crosses through the PEC. Recognised threats include grazing, clearing for mining related activities and solar farms, altered fire regimes (DBCA 2022).
- Several small, persistent pools in or near the Study Area are considered to have potential local conservation significance including (refer Figure 1.6):
 - Channel pool within the Koodjeepindarranna Claypan complex. This was site P05A in the Pilbara Biological Survey (Pinder et al. 2010).
 - Channel pool at UTM Zone 50 653300E and 7550400N. Identified from aerial photography.
 - Channel pool at UTM Zone 50 661600E and 7547770N. Identified from aerial photography.
 - Gidyeya pool south of the Study Area, proximal to the Ebathcalby Claypan – has significant wetland floor vegetation in contrast with claypans further to the west (Pinder et al. 2017).
 - Immediately upstream of the claypans, water ponding on the northern side of the valley and at the foot of the Chichester Range is apparent. This area partially corresponds with an Environmentally Sensitive Area (ESA) mapped by DWER. The proposed pit footprints are in excess of 1 km from this area.
- Also of note is the prominence of *Acacia stenophylla* in the Fortescue Valley floodplain woodlands within the Study Area. Although this species occurs across much of inland eastern Australia, the Fortescue Valley population is a major outlier from its core distribution.

- The Fortescue Marsh PEC (Priority 1) is located about 30 km to the east of the Great Northern Highway and about 60 km to the east of the Project mining areas. It consists of saline plains and lake beds some 100 km long, 5 to 20 km wide and occupying an area of approximately 1,000 km² (Markey 2017). The conservation values of the Fortescue Marsh are well recognised (EPA 2013). The marsh provides habitat for a variety of plant, invertebrate and vertebrate species of conservation significance. It has particular importance as a breeding and foraging habitat for waterbirds following flood events. In 2015, much of the land encompassing the marsh was excised from four pastoral leases and now constitutes the Fortescue Marsh Nature Reserve (Niyaparli Country), a Class A nature reserve. Forming the terminus of the Upper Fortescue Catchment, the marsh is considered to be hydrologically disconnected from the Study Area.
- A large portion of the Fortescue Valley including the Fortescue Marsh to the east of the Study Area is listed in the Directory of Important Wetlands in Australia¹ (DIWA066, Fortescue Marshes). As outlined in Section 1.8, the Fortescue Valley in the vicinity of the Project (including the freshwater claypans) is listed as a DPLH Aboriginal Cultural Heritage Lodged Place called Mungurrdu (ID:40484), shown on Figure 1.4.
- A number of threatened and migratory species listed under the *Environment Protection and Biodiversity Conservation Act 1999* and conservation fauna under the *Biodiversity Conservation Act 2016* have been identified as potentially utilising the habitats of the Study Area (DCCEEW 2023, JBS&G 2024). Further information is provided in Section 3.

The Study Area does not contain any Threatened Ecological Communities (TECs) listed under the *Biodiversity Conservation Act 2016* or the EPBC Act.

¹ <https://www.dcceew.gov.au/water/wetlands/australian-wetlands-database/directory-important-wetlands>

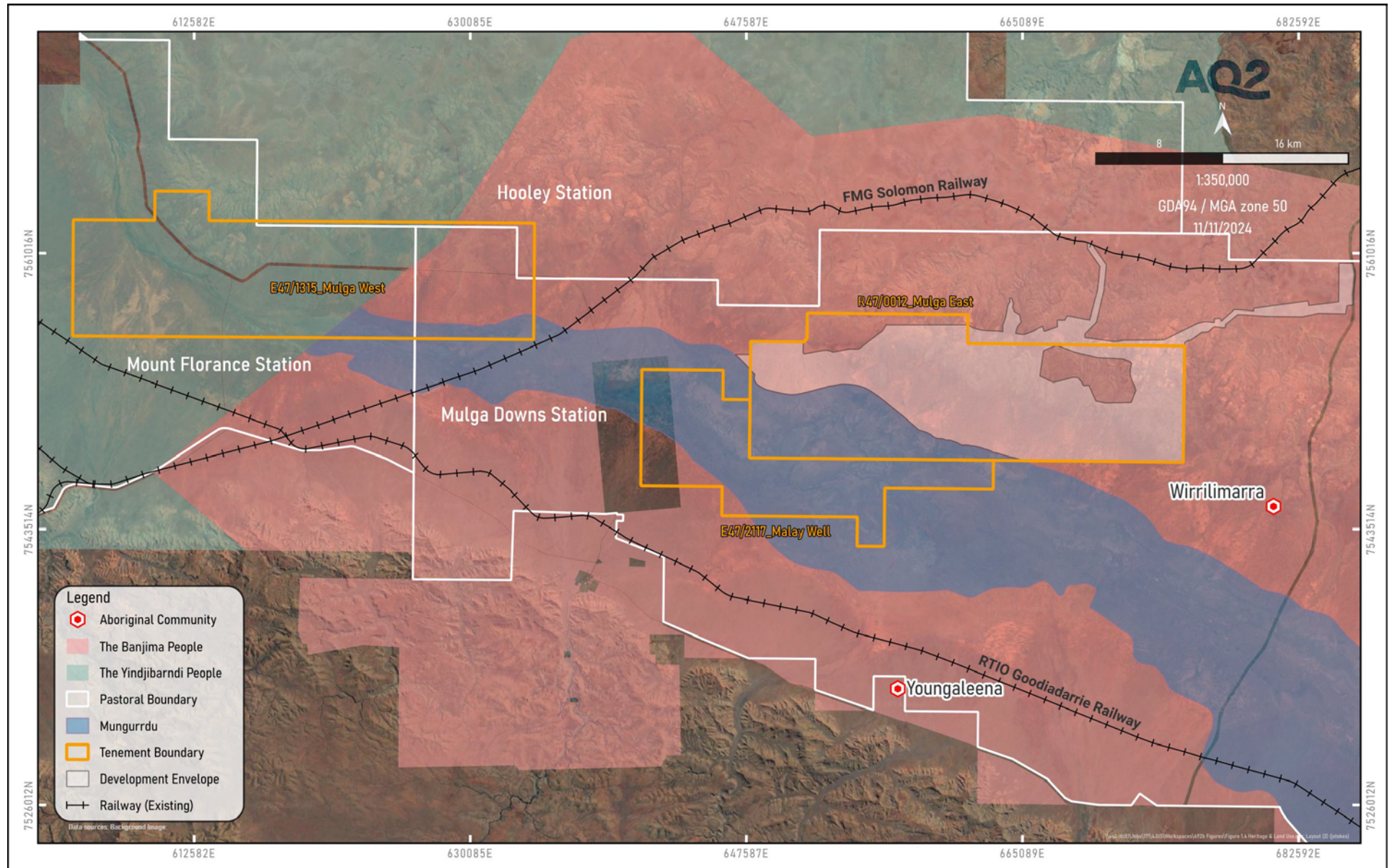


Figure 1.4 Pastoral & Native Title Boundaries

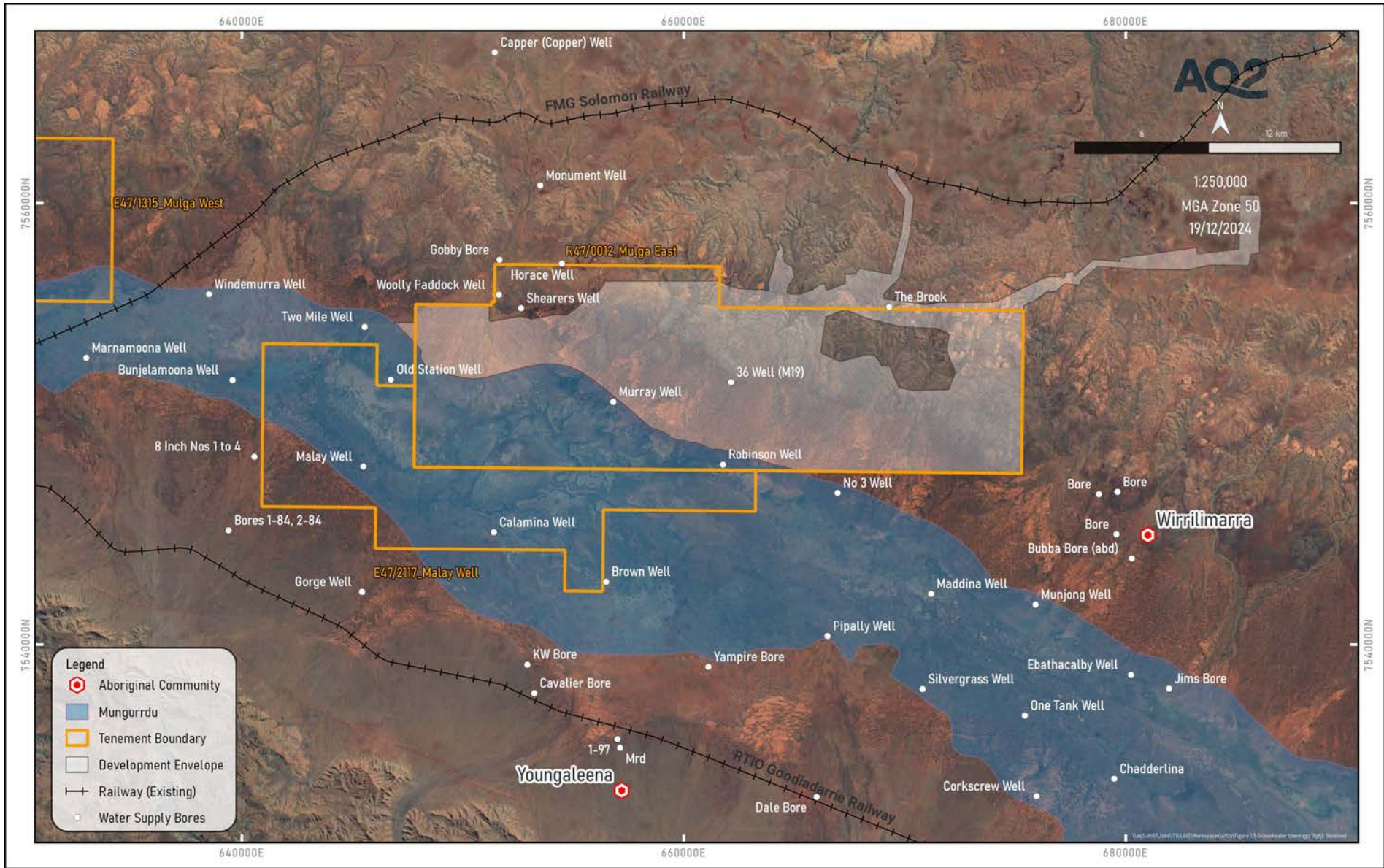


Figure 1.5 Groundwater Users

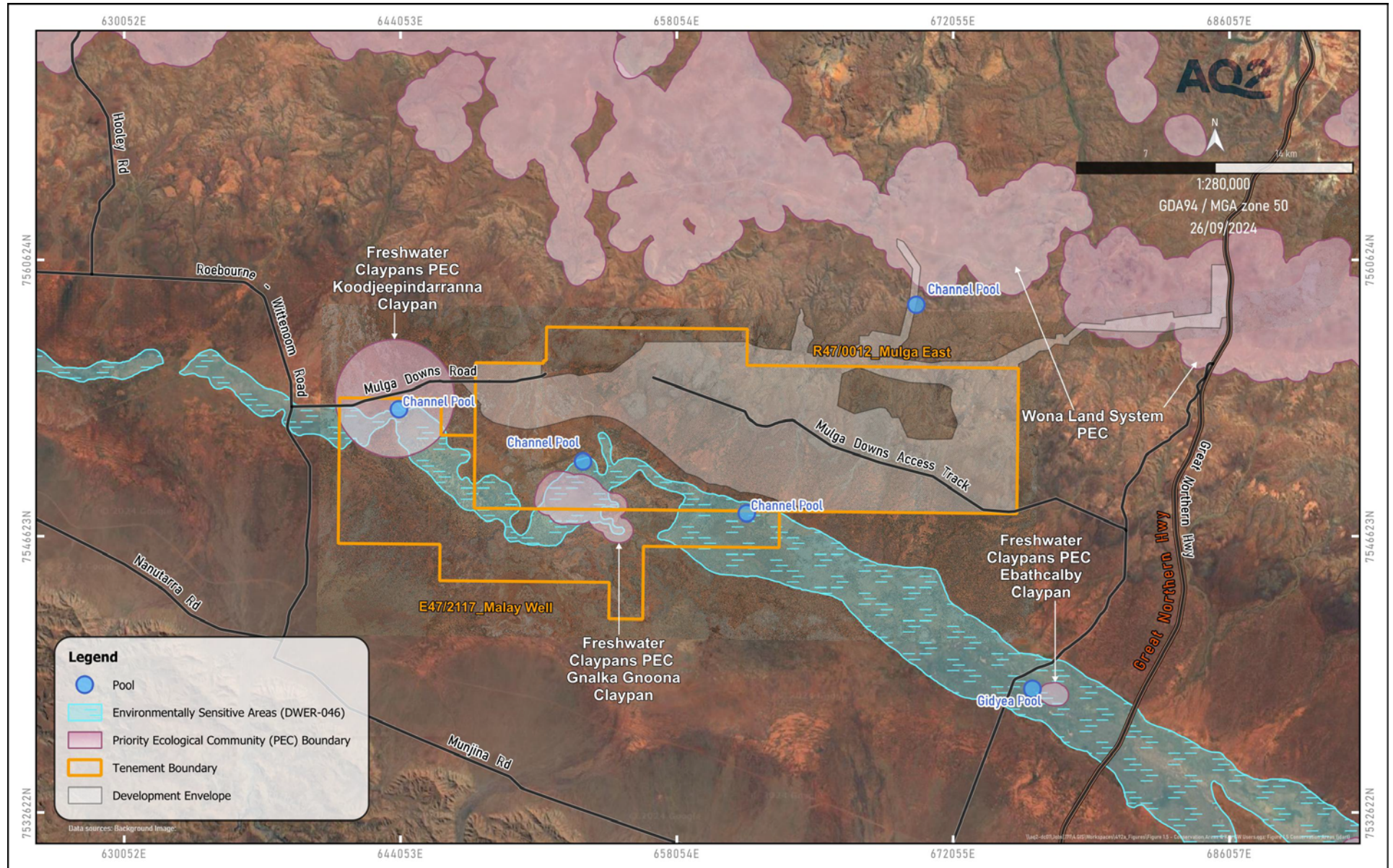


Figure 1.6 Conservation Areas

2. CONCEPTUAL LANDSCAPE MODEL

AQ2 has undertaken baseline groundwater, surface water and ecohydrological studies to develop an integrated conceptual model for the Study Area, with specific focus on the culturally and environmentally sensitive wetlands of the Fortescue Valley, inclusive of the Gnalka Gnoona and Koodjeepindarranna Claypans. Full details of the baseline investigations and conceptualisation are provided in a separate Baseline Assessment report (AQ2 2024). The conceptual model and natural (i.e., pre-mining) baseline are summarised below.

2.1 Conceptual Model

Between 2018 and 2023 a total of 80 monitoring bores and 12 test production bores have been installed across the Mulga East, Malay Well and Mulga West tenements with hydraulic testing conducted on ten of the production bores to date and the majority of the monitoring bores. In addition, eight surface water monitoring stations have been installed (six within creek channels upstream of the Koodjeepindarranna and Gnalka Gnoona Claypans and two within the claypans themselves). Baseline groundwater and surface water monitoring has been undertaken since early 2019. It is noted that the Baseline data collection period commenced at the tail end of a significant drought in the area, which followed a sustained period of high annual rainfall totals in the Pilbara. During the Baseline period, no large, rare rainfall events have occurred.

Further field investigations have comprised ecophysiological measurements of vegetation (three dry season and one wet season programmes) at multiple locations in the Mulga East, Malay Well and Mulga West tenements and ecohydrological site inspections over the Mulga East and Malay Well tenement areas; with the latter comprising observations of hydrological features, geomorphology as well as vegetation composition and structure.

All field data from the drilling, testing and monitoring programmes have been combined with findings from previous hydrogeological investigations and groundwater level monitoring data dating back to 2008 to develop the conceptual hydrogeological model for the area. Whilst 2D flood modelling and claypan water balance modelling has been completed to assist in the development of a conceptual hydrological model for the area. Salient points regarding the current understanding of the hydrogeological / hydrological system are as follows:

- The Study Area is fully contained within the Fortescue Valley catchment, with Goodiadarrie Swamp located immediately to the south of the site. Runoff from smaller rainfall events is likely to be contained within the Goodiadarrie Swamp area, with discharge into the Lower Fortescue River likely to require larger rainfall events.

The Koodjeepindarranna and Gnalka Gnoona Claypans have catchments that drain from both the north (Chichester Range) and the south (Hamersley Range) reporting to them. Very little transfer of water along the valley floor within the Goodiadarrie Swamp area is thought to occur, with no defined preferred drainage paths along the valley floor and a valley floor slope of ~0.01% (10 m elevation fall over 80 km length). Baseline surface water flood modelling has been used to assist in the definition of the claypan catchment areas, which vary depending on the magnitude of the rainfall event. Based on water level monitoring data collected across the site, it appears that rainfall events exceeding a rainfall depth of 35 mm are required to generate runoff in the Chichester Range drainage lines and 90mm of rain to result in inundation in the claypans. Inundation within the claypans appears to occur frequently and it is likely that hydrologic responses from average, relatively frequent rainfall events are important in maintaining ecosystem function at the claypans (i.e., ecosystem function does not just rely on high magnitude low frequency runoff events). The low salinity of the ponded water within the claypans and the recorded depth to groundwater below the claypans indicates that the water is sourced from surface water runoff. Comparing the observed water level recession in the claypans

from recent rainfall events to evaporation data indicates that evaporation plays the primary role in removing collected water from the claypans, with only minor seepage to the groundwater system. Residual salts from this evaporative loss are leached into the groundwater system under the claypans by the small component of seepage. Over time, this is thought to have resulted in saline groundwater beneath the claypans.

- The groundwater system is hosted in predominantly high permeability bedrock and valley fill, with the only low permeability aquitards being the fresh dolomite of the Wittenoom Formation underlying the valley area and the fresh Jeerinah and Marra Mamba Formations that underlie the orebodies and outcrop along the northern boundary of the Study Area. Secondary permeability resulting from mineralisation, fracturing and weathering, is evident throughout most of the Marra Mamba Formation and the overlying West Angela Member; these units are in hydraulic connection and are believed to form a transmissive basement aquifer. Although no faults have been mapped in the area to date, it could be that this basement aquifer has a lower bulk-permeability than currently adopted with a compensatory increased permeability along particular fault lines. Additionally, it is anticipated that faulting in the Malay Well area has resulted in complexities which are not represented in the current geological model.
- The valley fill has been categorised into the following units: Basal Crete, Pisolite / CID, Undifferentiated Tertiary (inclusive of alluvial fans and scree on the valley flanks) and Upper Calcrete. Although the composition and nature of these units are variable, derived permeabilities are generally high for all the units, with only limited intervals of low permeability clay which do not seem to be continuous.
- The transmissive nature of the bedrock and valley fill is reflected in the low hydraulic gradient observed across the orebody area and valley area, with a steeper gradient only evident along the northern boundary of the Study Area (across the low permeability Jeerinah Formation). Groundwater flow generally follows the topography, flowing from the higher elevations into the valley and then in a northwesterly direction along the valley. The depth to groundwater is shallow in the lower lying, valley areas (i.e., approximately 3 to 5 mbgl) and increases with elevation, to depths of up to 45 mbgl in the more elevated areas.
- Groundwater across the Study Area ranges from fresh (180 mg/L TDS) in the upper reaches of the groundwater system, to saline (17,000 mg/L TDS) across the valley area, with salinity profiling data confirming saline groundwater originating from the claypans and extending along the valley as well as beneath the proposed pit areas.
- Recharge to the groundwater system occurs as diffuse recharge from rainfall events, both on the valley flanks where the Marra Mamba outcrops and as infiltration into the Tertiary / Quaternary overburden where runoff is focused on the valley floor.

The findings of the ecohydrological site inspection, combined with remote sensing data and available vegetation mapping and soil assessments was used to evaluate the ecohydrological behaviour of the landscape and define ecohydrological units (EHUs) for the Study Area. Table 2.1 summarises the key elements and functional aspects of each EHU.

A detailed ecohydrological baseline assessment of the Fortescue Valley environs has also been undertaken, involving characterisation of major vegetation types and evaluation of the ecological water requirements of the *E. victrix* woodland communities. The potential groundwater dependence of vegetation in the Fortescue Valley has been evaluated using seven assessment tools outlined in the Australian groundwater-dependent ecosystems toolbox (Richardson et al. 2011). It is concluded that groundwater dependent vegetation does not occur in the Study Area, based on the following supporting evidence:

- Groundwater underlying the Fortescue Valley environs is generally brackish/saline and therefore does not constitute a favourable water source for floodplain vegetation.

- Regolith characteristics in the Fortescue Valley environs suggest that vegetation rooting depth is impeded by massive calcrete or dense, low permeability clay layers. Owing to access and ground disturbance constraints due to heritage values in these areas, direct observation of tree roots was limited to several sump pits associated with hydrogeological drilling.
- Across the Study Area, there are no areas of persistently high greenness as measured by time series NDVI imagery.
- Time series pre-dawn leaf water potentials indicate the tree-root zones are in unsaturated media with widely varying soil matric pressure, that is generally lower (i.e., more negative) than -0.5 MPa. Also taking into consideration the potential influence of brackish groundwater, this precludes the roots being in groundwater or at the capillary fringe.
- Based on water balance modelling supported by on-ground vegetation measurements (i.e., woodland tree size and density), surface water inputs were calculated to be sufficient to support the density of trees occurring in the Fortescue Valley *E. victrix* woodland communities. The more dense woodland stands are associated with better structured soils with relatively higher plant-available water storage capacity.

Table 2.1 Summary of Landscape Ecohydrological Units in the Area of Interest

| | EHU | Summary description | Hydrological behaviour |
|--------------------------|-------------------------|---|--|
| Chichester Range Uplands | Upland Rises | Peaks and upper hillslopes; shallow or skeletal soils overlying basement rocks. | Runoff source areas – shed water to downgradient landscape units. |
| | Upland Valleys | Broader depressions in the Chichester Range where sediments have accumulated, facilitating runoff capture/storage and denser vegetation. | Local sink area, receiving diffuse flow from Upland Rises Surplus from overtopping delivered into Upland Drainages. |
| | Upland Drainages | Single thread channels with cobble beds that traverse and exit the Chichester Range. Unconfined to semiconfined by hills of basement rocks. Channel beds mostly unvegetated with regular gravel bars and scour pockets. Scattered <i>E. victrix</i> trees in deeper soil pockets fringe the channels. | Transfer zones, receive runoff from upland catchments and transmit into Alluvial Fan Drainages. |
| | Basaltic Tablelands | Level to very gently inclined basaltic plains. Soils mostly comprise self-mulching cracking clays supporting tussock grassland communities. | Local sink area, receiving direct rainfall or locally distributed runoff |
| Alluvial Fans | Alluvial Fan Washplains | Banded vegetation (mulga and Snakewood) on a gently sloping stony plain. Runoff is generated in intergrove areas and mostly captured in the adjacent downslope grove. | Local sink area receiving rainfall. Surplus from overtopping delivered into Alluvial Fan Drainages. |
| | Alluvial Fan Drainages | Low sinuosity channels with narrow floodplains, collectively constituting drainage tracts, which dissect the Alluvial Fan Washplains. Supports relatively dense mulga shrubland. | Transfer zones, receive runoff from Upland Drainages and transmit into the Fortescue Valley. |
| Fortescue Valley Flats | Valley Calcrete Plains | Expansive unit of the Fortescue Valley. Variably dissected and overprinted by alluvium, giving rise to a subtle mosaic of benches, rises and depressions. Vegetation type and density related to soil depth, which is constrained by shallow calcrete (generally within 50 cm of the surface). | Benches and rises function as runoff source areas once internal storage is exceeded, shedding water to immediately adjacent units. |
| | Valley Stony Flats | Stony flats in the Fortescue Valley, generally on the valley margins where slope (and hence runoff) is insufficient to support banded vegetation. Prone to accumulation of salts due to poor infiltration; only sparsely vegetated. These areas support transient but not persistent ponding. | Receive inflows from Alluvial Fan Drainages. The flat stony pavement surfaces function as runoff source areas once internal storage is exceeded, shedding water to immediately adjacent units. |
| | Valley Loamy Flats | Broad flats typically inset from the valley margins, where accumulated sediment and organic matter create better soil structure and high infiltration rates. Relatively deep soils (may exceed 100 cm). High surface roughness contributes to some localised surface water redistribution within the unit. These areas support dense patches of woodland and grassland vegetation; with vegetation types related to subtle changes in physical and chemical soil properties. | Predominantly sink areas that receive runoff from adjacent units (Valley Stony Flats and Calcrete Plains). Overtopping is uncommon and associated with large cyclonic rainfall events. |
| | Valley Ponding Flats | The lowest depressions in the Fortescue Valley where water ponds; typified by high clay content topsoil that impedes infiltration. Prone to accumulation of salts due to poor infiltration; only sparsely vegetated. These areas support persistent ponding. | Sink areas that collect rainfall and receive runoff from adjacent units (Valley Stony Flats and Calcrete Plains, and more rarely Loamy Flats). |

3. FAUNA SURVEYS

Baseline fauna habitat and terrestrial fauna surveys, inclusive of a Short-Range Endemic (SRE) invertebrate fauna assessment, have been undertaken for the Project from 2013 to 2024. These surveys have been summarised into milestone reports by Ecologia Environment (2021), Attexo (2023) and, most recently, JBS&G (2024).

The following sections summarise salient findings from this work.

3.1 Habitat Types and Values

Up to 13 broad fauna habitat types have been identified within the Study Area: Chenopod/Cracking Clay Floodplain, Drainage Line/Floodplain, Mulga Woodland, Mixed Eucalypt/Mulga Floodplain, Rocky Hills, Stony Spinifex Plains and Hillslopes, Calcrete Stony Plain, Alluvial Clay Plains, Gibber Cracking Clay Floodplain, Snakewood, Cracking Clay, Rocky Plains & Foothills and Claypan.

Within the Development Envelope there are now nine habitats: Stony Spinifex Plains and Hillslopes, Rocky Hills, Gibber Cracking Clay, Drainage Line/Floodplain, Mulga Woodland, Chenopod/Cracking Clay Floodplain, Cracking Clay, Snakewood and Rocky Plains & Foothills.

Within the Study Area all habitats supported species of conservation significance, providing important foraging and dispersal habitats as well as habitats for breeding. Ranges, caves and breakaways found in the Rocky Hills provide habitat critical to the survival of the Northern Quoll (*Dasyurus hallucatus*). In addition, the caves in this habitat consist of Category 4 nocturnal roosts used by the Pilbara Leaf-Nosed Bat (*Rhinonicteris aurantia*) as refuges; however, no diurnal roosts were identified in the area. Priority foraging habitat for this species also occurs within the Rocky Hills, Drainage Lines and Stony Spinifex Plains and Hillslopes.

The Chenopod/Cracking Clay Floodplain is a habitat considered critical for the survival of the Night Parrot and the Bilby (for foraging) and as supporting habitat for the migratory birds. The Mulga Woodland is habitat considered critical to the survival of the Bilby as well as providing a foraging habitat for the Northern Quoll. Despite extensive targeted searches no Night Parrots or Bilbies were recorded in the Study Area.

The Gnalka Gnoona Claypan is utilised by migratory bird species, several of which were recorded in ponding areas during on-ground surveys (see below). This habitat is also known as a foraging habitat for the Pilbara Leaf-Nosed and Ghost Bats, with the floodplains/paleodrainage area of the Fortescue Valley considered to be important to the Night Parrot, particularly where there are chenopod communities.

The Rocky Hills, Drainage Line/ Floodplain and Stony Spinifex Plains and Hillslopes habitats provide foraging habitat proximal to the Category 4 nocturnal roosts for both the Pilbara Leaf-Nosed and Ghost Bats. These habitats also support the Northern Quolls and the Pilbara Olive Python.

Numerous nesting trees suitable for the Grey Falcon have been recorded within the Mixed Eucalypt/Mulga Floodplain habitat.

3.2 Fauna Species of Conservation Significance

Eleven species of conservation significance were recorded during the surveys (refer Figure 3.1) including: Northern Quoll [Endangered EPBC and BC Act], Pilbara Leaf-Nosed Bat [Vulnerable EPBC Act and BC Act], Ghost Bat (*Macroderma gigas* [Vulnerable EPBC Act and BC Act]), Pilbara Olive Python (*Liasis olivaceus barroni* [Vulnerable EPBC Act and BC Act]), Western Pebble Mound Mouse (*Pseudomys chapmani* [Priority 4 BC Act]), Short Tailed Mouse (*Leggadina lakedownensis*, P4), Pilbara Flat-Headed

(Gane's) Blind Snake (*Anilios ganei* [Priority 1 BC Act]), Common Greenshank (*Tringa nebularia* [Migratory EPBC and BC Act]), Wood Sandpiper (*Tringa glareola* [Migratory EPBC and BC Act]), Red-Necked Stint (*Calidris ruficollis* [Migratory EPBC and BC Act]) and Grey Falcon (*Falco hypoleucos* [Vulnerable EPBC Act and BC Act]).

While the Greater Bilby (*Macrotis lagotis*), Glossy Ibis (*Plegadis falcinellus*) and Peregrine Falcon (*Falco peregrinus*) have been recorded historically from and adjacent to the Study Area.

A targeted survey was undertaken for the Bilby within potential breeding and foraging habitat identified for this species. The areas targeted were the Mulga Woodland and Drainage Line/Floodplain (containing dense *Triodia*) for potential breeding habitat and the Chenopod/Cracking Clay habitat. Where dense, mature *Triodia* was present in the Rocky Plains and Foothills, this area was considered potential habitat for the Bilby. None were recorded, including no dens or secondary evidence identified in the 132.2 km traversed (Spectrum 2024a). Sandy substrate required for burrow excavation occurred patchily in some drainage lines but was largely absent across the surveyed area.

The Study Area intersects an area classified by DBCA as a high priority area for the Night Parrot (*Pezoporus occidentalis* [Endangered EPBC and BC Act]). Potential foraging habitat for this species occurs in the floodplains of the Fortescue Valley. All fauna surveys included targeted searches for the Night Parrot wherever suitable habitat (containing dense, long unburnt *Triodia* hummocks) was identified. A targeted survey was also completed in additional habitats identified as having high value for foraging (i.e., Chenopod/Cracking Clay, Claypan and Rocky Plains & Foothills habitat types). No calls belonging to the Night Parrot were recorded from 1,572 hours of acoustic recording (Spectrum, 2024a). The closest confirmed record to the surveyed area is located at the Fortescue Marsh (approximately 57 km to the east of the Project), where a population appears to reside.

Five introduced animals were recorded including cattle (*Bos taurus*), cats (*Felis catus*), wild dogs/dingoes (*Canis familiaris*), the fox (*Vulpes vulpes*) and Horse (*Equus ferus caballus*) (Attexo 2023). Cats and foxes were recorded occupying the same habitat (Rocky Hills) as Northern Quolls (Ecologia Environment 2021; Spectrum 2024b).

3.3 Further Discussion of EPBC Act Listed Species

Relevant Matters of National Environmental Significance (MNES) for the Project have been determined by the DCCEEW as shown in Table 3.1. These comprise listed threatened fauna species and migratory shorebird species. MNES fauna records from the Study Area are presented in Figure 3.1.

Summarily:

- Northern Quoll has been recorded in upland areas of the Chichester Range in the northeast portion of the Project fauna survey area. A high-density Northern Quoll population has been identified during recent targeted surveys in the Fauna Habitat Exclusion Zone (FHEZ), to the north of the Fridge Hill mining area, (Spectrum, 2024b) which supports Rocky Hills and Drainage Line habitat.
- The Ghost Bat has been recorded at several disjunct locations in the Project fauna survey area. Nocturnal roosts which they have occupied have been identified in the survey area with middens recorded at three caves (Ecologia Environment 2023).
- The Pilbara Leaf-Nosed Bat has been recorded in upland areas of the Chichester Range in the northeast portion of the Project fauna survey area. The Pilbara Leaf-Nosed Bat has a permanent presence in the Drainage Line/Floodplain and Rocky Hills habitats especially near the FHEZ where there is a concentration of Category 4 nocturnal roosts (Ecologia Environment 2023).

- The Pilbara Olive Python (Pilbara Subspecies) has been recorded in the Chichester Range in the northern portion of the Project fauna survey area, at one site. It is known to prefer areas where there is a permanent water source.
- The Greater Bilby has not been recorded in the Project fauna survey area but has been recorded on camera with denning present in the far eastern portion of the Mulga Downs Hub and Rail proposal. It generally prefers sandier habitats (suitable for burrowing) than those that occur in the Study Area.
- The Night Parrot has not been recorded in the Project fauna survey area. This species is elusive and was thought to be extinct for nearly a century prior to being rediscovered in south-west Queensland in 2013 (Pyke and Ehrlich 2014). A population is also known to reside in the Fortescue Marsh area (approximately 57 km to the east of the Project).
- The Grey Falcon has been recorded in the Chichester Range in the northern portion of the Project fauna survey area. The Study Area supports numerous suitable nesting trees for this species (Spectrum 2023c). *Eucalyptus vitrix* is considered a critical habitat for this species as it is their preferred nesting tree.
- The Blind Cave Eel (*Ophisternon candidum*) is a stygobitic vertebrate species utilising groundwater aquifer habitat. Extensive subterranean fauna sampling has occurred within the Study Area and no Blind Cave Eels were yielded from the groundwater (Bennelongia 2024).

With respect to the migratory shorebird species listed in Table 3.1, three of these have been recorded in the Project fauna survey area including the Common Greenshank, Red-Necked Stint and Wood Sandpiper (Figure 3.1). All records are associated with the Gnalka Gnoona Claypan. In the Pilbara region, migratory shorebirds are known to utilise inland waterbodies that form after significant rains.

The DCCEEW (2022) has formulated interim guidelines for Pilbara MNES critical and supporting habitat characterisation. These criteria have been considered with respect to the potential impacts of changed surface water regimes on MNES habitat. Summarily:

- Critical habitat is considered to be habitat critical to the survival of the species, which has been identified in the statutory documentation for each of the listed threatened species protected under the EPBC Act. This generally comprises breeding habitat (e.g., denning, roosting, nesting) and closely surrounding foraging habitat (i.e., within the home range) that supports these breeding activities.
- Supporting habitat is considered to be habitat that facilitates species foraging and dispersal that is not linked to known breeding habitats.

In addition to the interim guidelines, DCCEEW has published species specific information on habitat suitability for the Ghost Bat (Bat Call 2021a), Pilbara Leaf-Nosed-Bat (Bat Call 2021b) and Migratory shorebirds (Commonwealth of Australia 2017). Relevant aspects for this assessment are summarised as follows:

- The ecology of Ghost Bats is defined by the utilisation of diurnal roosting habitat (e.g. caves and abandoned mine adits) and foraging in zones up to 20 km from the diurnal roosts. Critical habitat includes maternity/diurnal roost sites with regular or permanent occupancy. The Ghost Bat foraging strategy includes two modes: perching in vegetation to ambush passing prey (either on the ground or in the air), and gleaning surfaces such as the ground while in flight. The species is known to forage in productive areas, such as around waterholes and riparian zones, but direct evidence of visits to these areas for drinking are rare. Current best practice is to consider semi- and permanent water sources within 5 km of a category 1 roost (permanent occupancy) or category 2 roost (regular occupancy) to be important but not critical habitat for this species.
- The ecology of Pilbara Leaf-Nosed-Bats is also defined by the utilisation of diurnal roosting habitat (e.g. caves and abandoned mine adits) and foraging in zones up to 20-30 km from the diurnal roosts; although foraging distance is reduced in hot and humid conditions. The species forages very widely

and utilises almost all productive and semi-productive habitats. A habitat rating scale was developed by Bat Call (2021b); the vegetation types predicted to be affected by hydrological change largely align with habitat ratings Low – Moderate.

- A large portion of the Fortescue Valley, including the Fortescue Marsh to the east of the Study Area and the complex of freshwater claypans further to the west (including locations immediately south of the proposed mining area) is listed in the Directory of Important Wetlands in Australia. These areas constitute important habitat for Migratory shorebirds. Factors underpinning impacts on migratory shorebirds include:
 - Loss of habitat,
 - Degradation of habitat leading to a substantial reduction in migratory shorebird numbers,
 - Increased disturbance leading to a substantial reduction in migratory shorebird numbers, and
 - Direct mortality of birds leading to a substantial reduction in migratory shorebird numbers.

Table 3.1 Relevant MNES Identified by the DCCEEW (Reference: EPBC 2022/9255)

| Common Name | Scientific name | Listing status |
|---|---------------------------------|----------------|
| Listed threatened fauna species | | |
| Northern Quoll | <i>Dasyurus hallucatus</i> | Endangered |
| Ghost Bat | <i>Macroderma gigas</i> | Vulnerable |
| Pilbara Leaf-Nosed Bat | <i>Rhinionicteris aurantia</i> | Vulnerable |
| Pilbara Olive Python (Pilbara Subspecies) | <i>Liasis olivaceus barroni</i> | Vulnerable |
| Greater Bilby | <i>Macrotis lagotis</i> | Vulnerable |
| Night Parrot | <i>Pezoporus occidentalis</i> | Endangered |
| Grey Falcon | <i>Falco hypoleucos</i> | Vulnerable |
| Blind Cave Eel | <i>Ophisternon candidum</i> | Vulnerable |
| Listed migratory species | | |
| Common Greenshank | <i>Tringa nebularia</i> | Migratory |
| Wood Sandpiper | <i>Tringa glareola</i> | Migratory |
| Red-Necked Stint | <i>Calidris ruficollis</i> | Migratory |
| Glossy Ibis | <i>Plegadis falcinellus</i> | Migratory |
| Fork Tailed swift | <i>Apus pacificus</i> | Migratory |

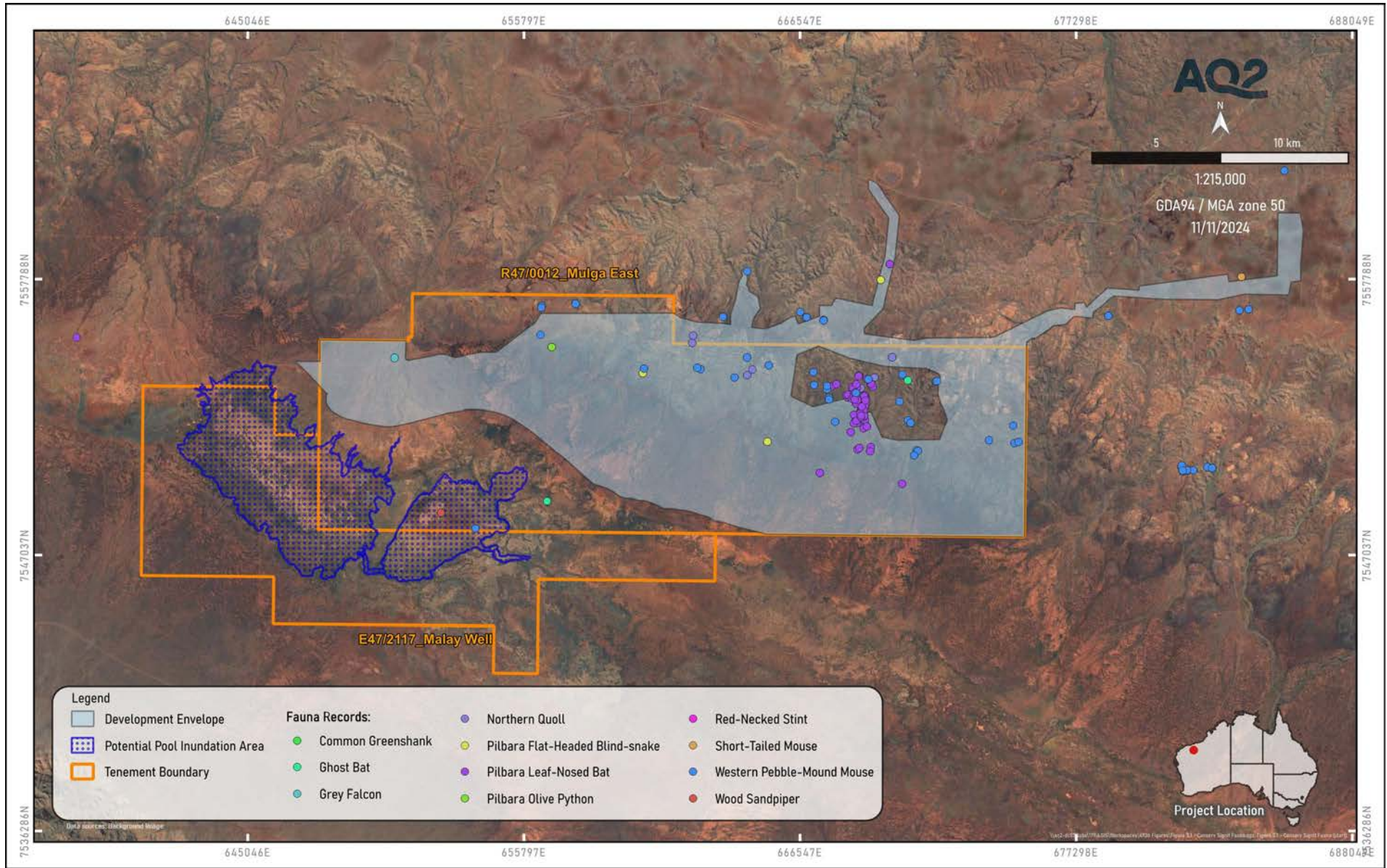


Figure 3.1 Records of Conservation Significant Fauna within the Study Area (source JBS&G 2024)

4. SURFACE WATER IMPACT ASSESSMENT

4.1 Potential Impacts on the Hydrological Environment

The identification of potential impacts from the Project on the hydrological environment was completed by comparing the proposed infrastructure layout to the existing catchments and baseline flood modelling results. The greatest threats to the hydrological environment fall into the following categories:

- Modification of the existing hydrological regime, by increasing or reducing water availability within the downstream environment. This can have impacts both immediately downstream of disturbance area footprints and surface water diversions, and further downstream as an accumulation of impacts from multiple disturbance areas. The receptors which may potentially be impacted by the Project are local vegetation and watercourses, plus the Fortescue Valley, including the claypans, swamp and persistent pools.
- Modification of the physical water quality (i.e., suspended sediments) in the downstream environment, which may be due to erosion of disturbed areas relating to construction, stockpiles, laydowns and waste rock dumps (among others). The environmental impacts from this would be increased sediment loads to the Fortescue Valley (including claypans and pools).
- Modification of the chemical water quality (for example hydrocarbon pollution) resulting in contamination of local waterways and the Fortescue Valley. Based on current assessments, it is understood the Project has a low risk of PAF materials being exposed and impacting water quality.

The surface water risks arising from the Project and their associated risk ratings, before and after the application of mitigation measures, are presented in Appendix A. A detailed discussion of the proposed management measures is provided in the Water Management Plan (HanRoy 2024).

For the purposes of completing the surface water impact assessment, it has been (conservatively) assumed that runoff from within mine disturbance areas will be contained and will not contribute runoff to the Fortescue Valley, downstream of the proposed mining areas. These Surface Water Containment Areas are shown in Figure 4.1. In reality, surface water diversions through these containment areas may be considered (which will reduce the catchment area lost) and water runoff from disturbance areas will be passed through sediment basins for treatment, prior to water release downstream which will reduce the impact of catchment loss. The engineering design of the surface water management measures is currently progressing, with the measures outlined in this report considered worst-case.

4.2 Surface Water Management Philosophy

Storm water runoff across the Study Area (including the mining area and associated ancillary infrastructure) must be managed to limit the environmental impacts of Project operations on the surface water regime and downstream environment. Surface water management infrastructure should reduce the probability and/or consequence of an unwanted event occurring such that it can be appropriately managed to an acceptable level of risk.

The general management objectives for the Project relating to surface water are as follows:

- Maintain the existing hydrological regime as much as is practicable.
- Mitigate impacts on surface water quality from construction and operations by containing and treating impacted water on-site prior to release to the downstream environment.
- Reduce the risk of surface water having a significant impact on mining operations.

Proposed surface water management measures to meet the above objectives have been based on the following design philosophies:

- Clean water should be diverted around the disturbance footprints to the downstream environment to prevent contamination of clean water catchments.
- Flood mitigation measures are required to prevent flood ingress to open pits and mine infrastructure areas.
- Surface water management infrastructure must incorporate measures to avoid excessive scour, erosion and sediment transport, and should be designed to prevent prolonged ponding following rainfall events.
- Surface water will be allowed to infiltrate waste rock dumps and/or runoff from waste rock dumps will be contained and diverted through sediment basins prior to release downstream following treatment.

The following sections discuss the potential impacts that the Project may have on the hydrological environment and proposed mitigation measures to reduce the risk of these potential impacts.

4.3 Modification of the Existing Hydrological Regime

Importantly, all baseline hydrological processes in the Study Area will be maintained. The nature of the hydrological change primarily relates to modification to the magnitude and duration of flooding events.

Construction of the pits, waste rock dumps, borrow pits, airport, haul and access roads, pipelines, and other associated infrastructure for the proposed Project could potentially affect existing surface water drainage features, including creek lines, floodplains and the Fortescue Valley, which contains the claypans and persistent pools. Impacts that the Project may have on the hydrological regime, along with proposed mitigation measures to reduce the risks of these, are discussed below and presented in the risk assessment in Appendix A.

The mine development areas will cause a reduction in surface water flows to the environment on the downstream side of the Project, particularly around the Fridge Hill mining area, due to a reduction in contributing catchment areas. This particularly applies to the development of the pits, waste rock dumps, borrow pits and stockpiles as they are proposed to extend across large areas draining towards the Fortescue Valley and will therefore prevent surface water from draining through those areas. This has the potential to impact vegetation communities which rely on surface water flows (either creek flow or sheet flow) downstream of the mine development areas.

Additionally, where mine development areas block drainage paths, there is a risk of increased inundation on the upstream side of the development area. The increased inundation may lead to vegetation death due to water logging and changes to vegetation composition with more water tolerant vegetation species (including weeds) potentially taking over in these areas.

To reduce the impact of the mine development on the hydrological regime of the downstream and upstream environments, surface water diversions are proposed to divert water around mine development areas and reduce the likelihood of ponding. Figure 4.1 shows the conceptual layout of surface water diversions to keep undisturbed catchments out of mine development areas and facilitate the continued movement of surface water downstream. The requirements for diversions were identified by comparing the results from the baseline flood model (AQ2 2024) with the proposed mine infrastructure footprints. The diversions required are to consist of a combination of constructed earth bunds and excavated drains based on the terrain along the diversion alignments. Where practical, the conceptual layout has been selected to ensure that diverted flows re-enter the landscape as close as possible to their original discharge destination to minimise downstream environmental impacts. The changes to the baseline catchment areas are summarised in Table 4.1 and are shown on Figure 4.1.

A reduction in surface water flows to the environment on the downstream side of linear infrastructure (such as road and rail embankments, pipeline installations) and ponding on the upstream side may occur due to the interruption of surface flow paths. It is proposed to mitigate this water shadowing through the use of adequate surface water crossings (culverts/floodways). It is anticipated, however, that there may be localised impacts on the downstream environment where sheet flow runoff is interrupted and channelled to the nearest culvert.

A network of reticulated pipelines will be required to manage the mine dewatering and re-injection water. Pipelines outside of the active mine operations area will be buried, where suitable, including where the dewatering and MAR pipelines cross drainage lines and flow paths on the flanks of the Chichester Range.

The impacts of the Project on the surface water flow regime have been predicted by comparing Baseline flood mapping (Appendix B) and Life-of-Mine (LOM) flood mapping (Appendix C), to create a set of flood difference maps, the results of which are presented in Appendix D. Additionally, the predicted impacts on the claypans have been quantified using comparisons of Baseline and LOM water balance model results.

Table 4.1 Project Catchment Area Changes

| Catchment | Baseline Area (km ²) | Life-of-Mine Area (km ²) | Change in Area |
|-----------|----------------------------------|--------------------------------------|----------------|
| 1 | 23.1 | 22.0 | -5% |
| 2 | 164.4 | 164.3 | 0% |
| 3 | 39.8 | 35.5 | -11% |
| 4 | 28.4 | 22.5 | -21% |
| 5 | 33.8 | 30.3 | -10% |
| 6 | 13.5 | 2.8 | -79% |
| 7 | 29.0 | 29.9 | 3% |
| 8 | 11.9 | 2.6 | -78% |
| 9 | 43.3 | 13.2 | -69% |
| 10 | 53.9 | 73.7 | 37% |
| 11 | 65.5 | 60.3 | -8% |
| 12 | 1.7 | 1.6 | -4% |
| 13 | 6.3 | 6.0 | -5% |
| 14 | 2.1 | 1.6 | -22% |
| 15 | 4.5 | 4.2 | -8% |
| 16 | 7.3 | 7.1 | -3% |

The catchments to the west and east of the mine disturbance areas (1 to 3 and 11 to 16) experience small changes as a result of the disturbance footprints. The central catchments that experience the greatest reductions are impacted either by the mine development reducing the catchment area contributing to downstream surface water flows, or by the proposed surface water diversions transferring water into an adjacent catchment that delivers flows to an alternative location downstream. Catchment 6 is almost completely developed upon, whereas Catchment 9 is partly developed and mostly diverted into Catchment 10.

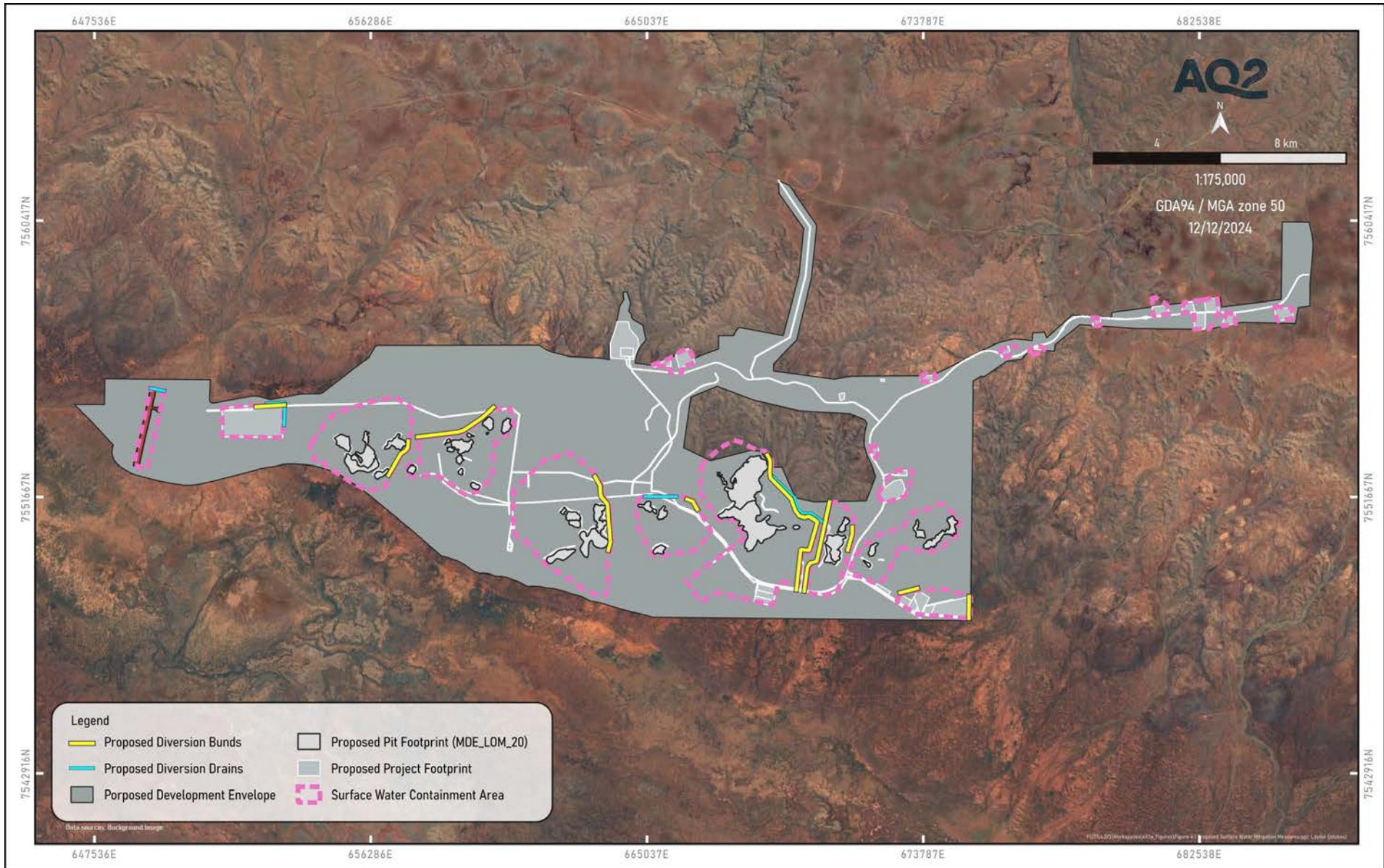


Figure 4.1 Proposed Surface Water Mitigation Measures

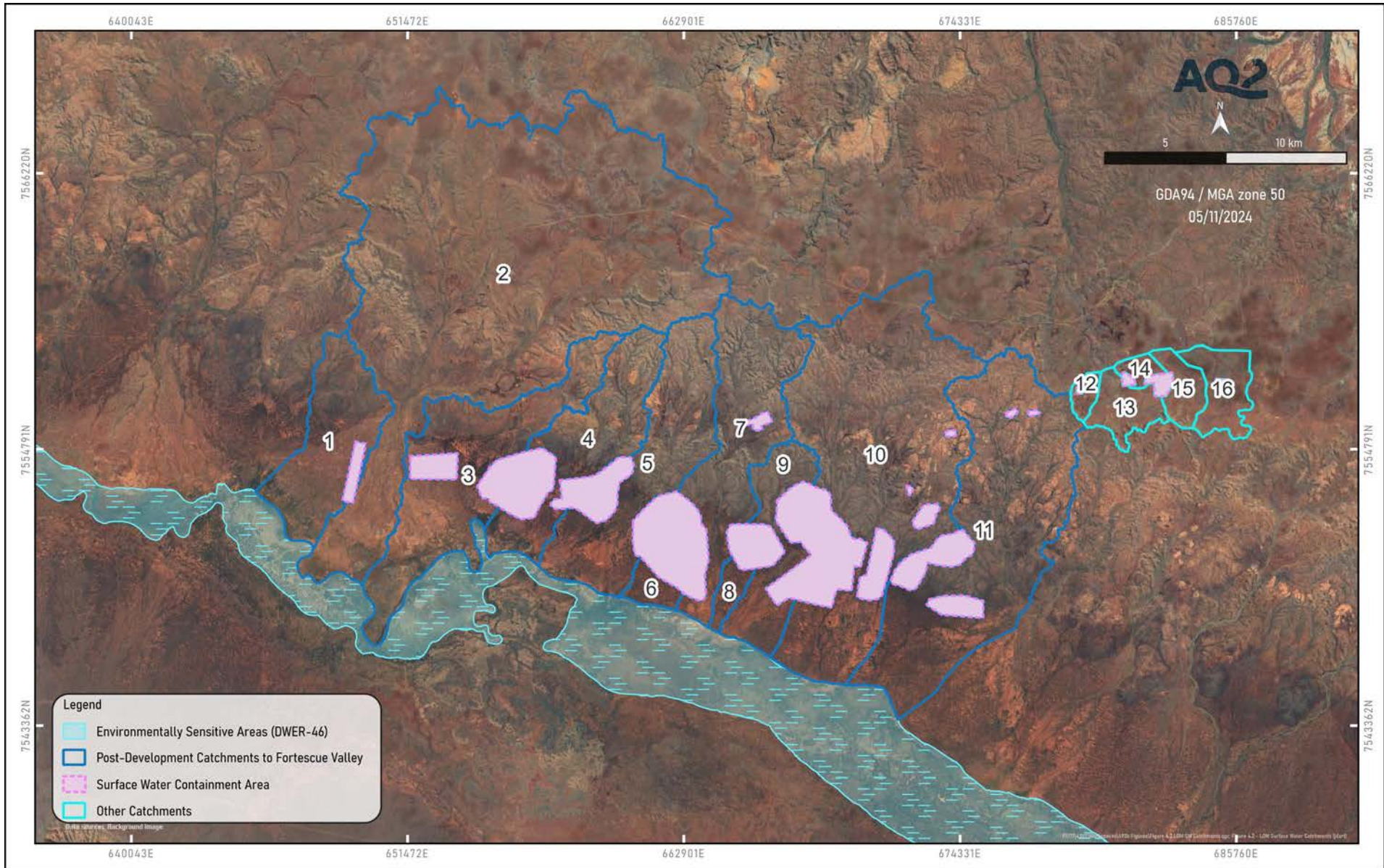


Figure 4.2 LOM Surface Water Catchments

4.3.1 Flood Modelling - Life-of-Mine Scenario

A LOM scenario 2D flood model has been prepared incorporating the LOM mine development terrain (including haul road embankments) and adopting the conceptual flow diversions proposed in Figure 4.1, plus incorporating proposed culverts beneath haul roads (which have been preliminarily sized) in order to assess the impacts of the Project on the hydrological environment. The model excludes any runoff generated from within the pit and waste rock dump development areas (Surface Water Containment Areas).

It should be noted that a mine development staging plan was not considered in the identification of required surface water management measures and the subsequent LOM flood modelling. Additional interim flood management measures may be required to divert flow around the pits and waste rock dumps as the mine develops. The nominal flow diversions simulated in the model have also been aligned to divert flow around the Surface Water Containment Areas, however there may be options to divert sub-catchments through the mine development area (i.e., between pits, waste dumps and ore handling areas) which would return surface flows back closer to the original drainage line than what is shown in the presented LOM flood modelling, and therefore have a reduced impact on the distribution of flooding in the valley compared to what has been adopted for this impact assessment.

When creating the 2D LOM flood model, the grid sizing and model extent adopted for the Baseline Flood Model was used, with the footprints for the Surface Water Containment Areas (covering the pits, waste rock dumps, ore handling plant and topsoil stockpiles excluded from generating runoff to the surrounding environment within the model as surface water from these areas will be captured within sediment containment structures for treatment prior to release to the downstream environment. The outlines for the Surface Water Containment Areas were used to represent these footprints.

A 2D flow area with a 50 m x 50 m grid was delineated to cover the extents of the available terrain data. Breaklines with a computational mesh spacing of 10 m by 10 m were applied to natural flow paths and proposed features such as haul roads, bunds and embankment slopes. The breaklines orient the computational mesh to align cell edges with the features reflected in the terrain surface. HEC-RAS recognises sub-grid terrain resolution, and the computation of flow transfer between individual grid cells accounts for the geometry of the underlying surface at the terrain resolution of 1 m by 1 m.

The proposed haul road alignments have been accounted for within the model, with elevations and culvert sizing provided from preliminary civil designs of this infrastructure. Culvert design will be completed in detail in future stages of work. Not all proposed culverts were included in the 2D flood model, but there appears to only be one location in the model where the missing culvert has caused the model to significantly overestimate the impact on flow depths (between Fridge Hill and Fridge Central).

The maximum flood depth and flow velocity predictions, including difference maps to the Baseline Flood Model predictions, are presented in Appendix D. The Baseline Flood Maps are also provided in Appendix A for reference. The LOM model predictions demonstrate that the diversions convey the majority of flows around infrastructure footprints and minimise the upstream ponding that may be present otherwise. Where water is predicted to build up behind development areas, the ponding is typically only temporary, with the model predicting the pond to recede as water drains to the south. On the valley floor where a reduction in flow is predicted on difference maps, it is important to note that this is typically due to a reduction in catchment area as runoff is conservatively assumed to be contained within the Surface Water Containment Areas. In some cases, the diversion of catchments upstream of the Surface Water Containment Areas is diverted into alternate catchments which also results in a reduction of flow.

4.3.2 Claypan Water Balance Modelling – Life of Mine Scenario

As discussed in the Baseline Assessment report (AQ2 2024), a water balance for the claypans was created and calibrated to inundation events as observed in satellite imagery and the claypan surface water monitoring stations. The Baseline Assessment report included Baseline claypan water balance model predictions, which were driven by historic rainfall observations in proximity to Mulga Downs.

To quantify the impact due to the potential loss in catchment due to the proposed mine development, Pre-Development and LOM water balances were developed and compared. The parameters used in the Pre-Development water balance are the same as the Baseline water balance model (refer Baseline Assessment report), except the Pre-Development claypan water balance uses a different rainfall dataset (discussed further below) which simulates a potential future (synthetic) rainfall sequence.

The Pre-Development and LOM model generally use the same parameters (including rainfall data), but the LOM model assumes that runoff from the Surface Water Containment Areas (shown in Figure 4.1) does not report to the claypans. A comparison between the Pre-Development and LOM models allows the impact of catchment loss associated with the Project on the hydrological behaviour of the claypans to be predicted.

Note that the hydrological function of the claypans is independent of the proposed mine site's water circuit (and therefore independent of the mine site's water balance) for the following reasons:

- Water supply for the mine site will be sourced from dewatering and the drawdown due to groundwater abstraction is not predicted to impact the runoff from the claypan catchments or the water level in the claypans (as the claypans sit above the water table as discussed in Section 2).
- Surplus dewatering will be injected into the aquifer and will not report to the claypan.
- Runoff from the mine disturbance footprints will be diverted through sediment basins and released to the downstream environment when water quality is sufficient for release. However, for the purposes of this assessment, it is assumed that no runoff from the Surface Water Containment Areas is released (to result in a conservatively high reduction in water volumes at the claypans).

The Pre-Development and LOM water balances developed to assess the potential impact of the mine development were run with synthetic rainfall datasets which are statistically comparable to the baseline daily rainfall dataset between 1922 to 2023. This period was used as daily rainfall records pre 1922 were largely missing.

A synthetic daily rainfall dataset was developed for use in the water balance by loading the baseline rainfall dataset (as discussed in the Baseline Assessment report (AQ2 2024), comprising mostly of Mulga Downs and MDEC rainfall data) into the eWater Stochastic Climate Library (SCL) to produce 100 sets of 100-year synthetic rainfall data series. The SCL program (CRC for Catchment Hydrology, 2006) is a library of stochastic models for generating climate data, which generates random numbers that are modified to have the same characteristics such as mean, skew, variance, persistency etc, as the historical data they are based on. The single-site daily rainfall model was selected in the SCL to generate the synthetic daily rainfall dataset for the claypans LOM water balance.

The 100 separate synthetic rainfall data series of 100-years in length were loaded into the GoldSim LOM water balance model and a model realisation was run for each series. The synthetic rainfall data was used to drive the variability in the model and is the only model input parameter which changes in each model realisation.

The LOM water balance is based on the assumption the Surface Water Containment Areas shown in Figure 4.1 do not contribute runoff to the claypans. The containment areas are based off the LOM mine plan and generally cover the mine development areas that may impact the surface water quality from

construction and operations. A comparison of the assumed changes to the claypan catchments is summarised in Table 4.2.

Table 4.2 Claypan Catchment Area Reduction

| Claypan | Catchment Type | Pre-Development (km ²) | LOM (km ²) |
|--------------------|--------------------|------------------------------------|------------------------|
| Koodjeepindarranna | Range | 241 | 241 |
| | Valley / Hamersley | 576 | 575 |
| Gnalka Gnoona | Range | 79 | 71 |
| | Valley | 136 | 124 |

Note. The claypan footprint areas are included within the Valley catchment type

The proposed mine development represents a loss of surface water catchment of 21 km² which is a 10% reduction to the Gnalka Gnoona catchment and a 2% reduction to the combined claypan catchment areas. The catchment reduction estimated for Koodjeepindarranna is insignificant compared to the Baseline catchment (<0.5%). Although the water balance assumes runoff is contained within the Surface Water Containment areas and does not contribute to the water ponded in the claypans, in practice there is likely to be the opportunity to release captured runoff from within these areas once runoff has been treated for sediment.

During large runoff events, if additional catchment areas report to the claypan areas (either from the Hamersley Range or from upstream areas of the Fortescue River) then the percentage catchment reduction due to the proposed mine development would reduce (lower impact).

The key characteristics of the claypans which may be impacted by the proposed development are changes to the inundation depths, ponding duration (hydroperiod) and water quality (TDS) of ponded water. The predicted impact on inundation depths and the hydroperiod is discussed in the following sections, while the impact on water quality is discussed in Section 4.4.2.

4.3.2.1 Claypan Water Level

The impact of the loss of catchment area on claypan water levels is typically less than 0.02 m within the Gnalka Gnoona claypan. Plots of the impact on the claypan water levels from three selected runoff events within the modelling (large, medium and small event) are shown in Figure 4.3 and Figure 4.4. The results indicate that the loss of catchment has nil to minor impact on the ponded water levels. Note that the water levels in the Koodjeepindarranna claypan are only impacted if the water level in the Gnalka Gnoona claypan exceed the height of the divide between the two claypans (402.9 mRL).

The changes to the water levels in the claypans should not impact on their hydrological function.

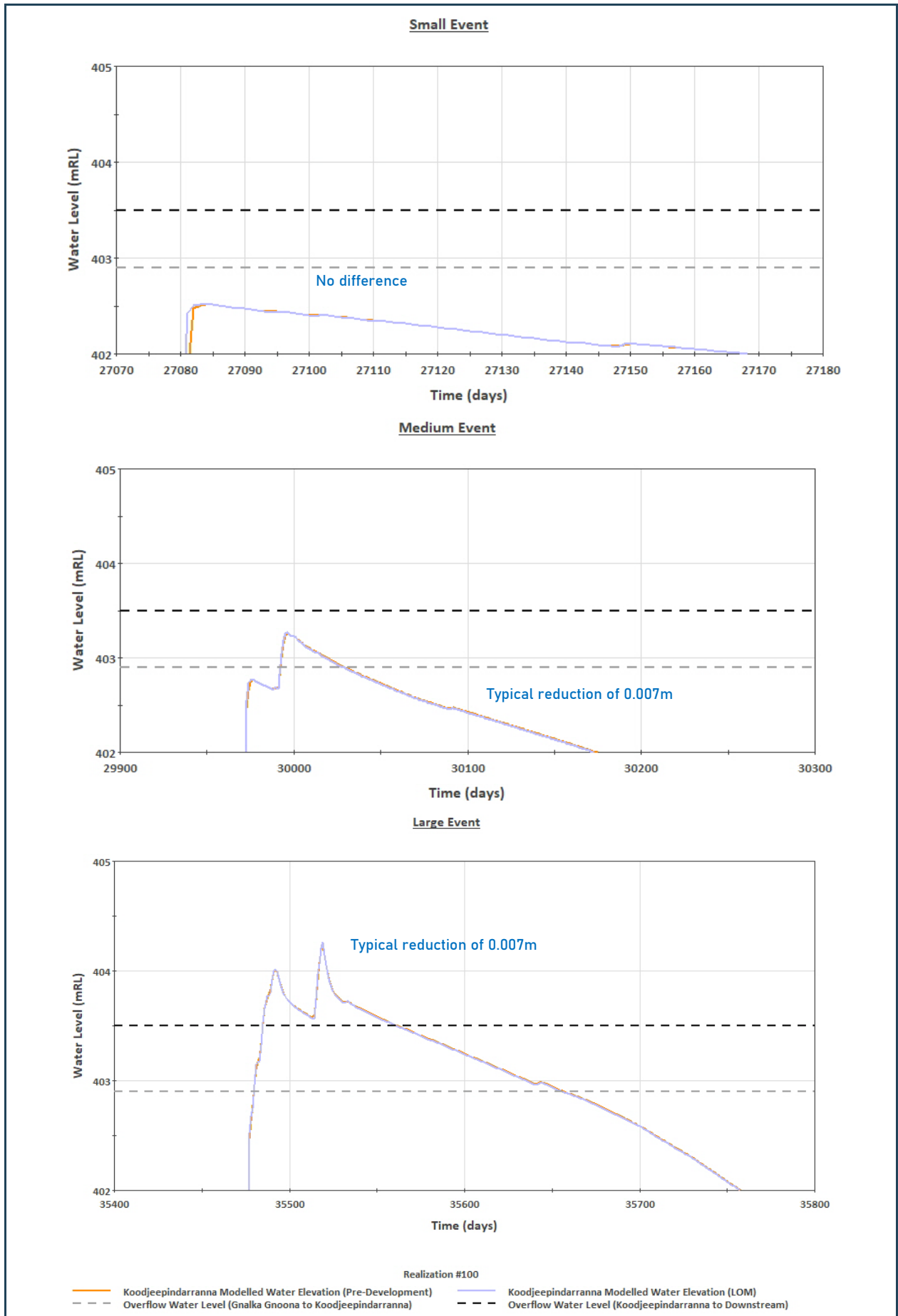


Figure 4.3 Koodjeepindarranna Claypan – Pre-Development vs LOM Water Level Prediction Snapshots

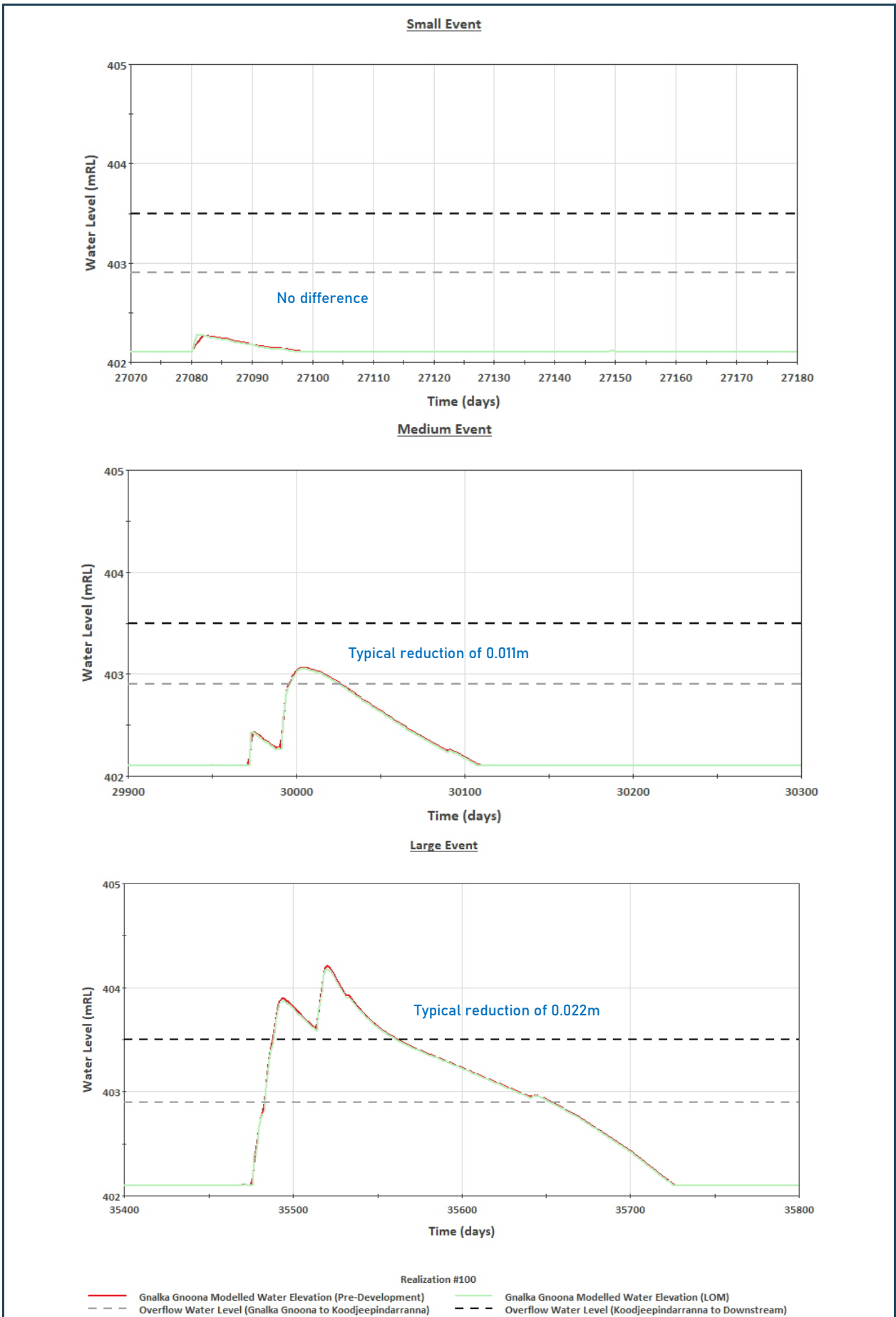


Figure 4.4 Gnalka Gnoona Claypan - Pre-Development vs LOM Water Level Prediction Snapshots

4.3.2.2 Hydroperiod

The hydroperiod (ponding duration) for the claypans is understood to be an important characteristic for supporting aquatic fauna, including supporting migratory birds, invertebrate life cycles and replenishing the vadose zone with plant-available water. The average daily evaporation rate at the Project is in the order of 6 mm/d. Based on the average evaporation loss rate and the water level differences predicted (shown in Section 4.3.2.1) the reduction in the duration of water ponding within the claypans due to the loss catchment associated with the proposed mine development is negligible for small inundation events (total event duration approximately 2 weeks), and is in the order of days for medium to large inundation events (total event duration between 3 months to a year).

It is unlikely these reductions to the ponding duration will have a significant impact on the hydrological ecosystem function provided by the claypans.

4.3.3 Residual Impacts

4.3.3.1 General

The maximum predicted flood depth difference mapping included in Appendix D, show the spatial extent of flood level changes progressively tend to increase with reducing AEP flood frequency or increasing flood magnitude. Increases in the predicted velocities also tend to occur along the diversions and in the Fortescue Valley immediately downstream of the diversion with reducing AEP flood frequency or increasing flood magnitude. This indicates that mining development will have a greater effect on infrequent, large flow events rather than smaller, more frequent flow events.

The water balance assessment of Fortescue Valley woodland vegetation communities completed by AQ2 (2024) indicated the smaller frequent events are of the highest importance for alleviation of acute vegetation drought stress (refer Section 6 for more detail). The surface water risk assessment (refer Appendix A) outlines both the inherent risk of the Project (i.e., without management measures) and the residual risks to the environment (i.e., when considering the proposed management measures). The residual risks relating to the impact of the modification of the existing hydrological regime have been assigned a "Low" risk rating. The reasons for the Low risk rating are discussed below.

4.3.3.2 Claypan Predictions

The potential footprints of the Surface Water Containment Areas (covering the pits, waste rock dumps, ore handling plants, borrow pits, and stockpiles) extend across approximately 20 km² within the claypan catchments. To prevent the impact of potentially sediment laden runoff from these areas impacting the downstream environment, for the purpose of completing the claypan water balance model for the impact assessment, it has been assumed that any rainfall across these footprints will be contained and be prevented from contributing flows to the downstream environment. These footprints represent approximately 10% of the assumed total catchment area estimated for the Gnalka Gnoona claypan and 2% of the combined Gnalka Gnoona and Koodjeepindarranna claypan area (1,033 km² total, as reported in the Baseline Assessment report (AQ2 2024)). Water balance model predictions of the claypan water levels indicate that the potential reduction in claypan catchment areas result in only a negligible reduction on the hydroperiod (in the order of days) and water levels of the claypans (between nil to 0.022 m).

4.3.3.3 Surface Water Modelling

Although the surface water diversions aim to return the water back to the downstream surface water drainage line, the diversions do change the distribution and velocities of surface water flows in the Fortescue Valley, particularly in the area immediately to the south of the Fridge pits, Murray's Hill and Horseshoe West pits. Difference mapping of Baseline and LOM maximum water depth and velocity model predictions are shown in Appendix D for the design rainfall events.

The 1% AEP flood velocity difference map indicates an increase by 0.6 m/s and 0.8 m/s along the diversions and in the Fortescue Valley immediately downstream of the diversion. The increases to the predicted maximum flow velocities increases the risk of erosion on the alluvial fans. Along the diversions, where velocities are predicted to be greater than 1.5-2 m/s, rock armouring may be required to reduce risks of scour and erosion.

In terms of potential impact to vegetation communities, the changes to the more frequent event flood depths (such as the 63% and 50% AEP events) are more important than the changes to the 1% AEP event given the distribution of vegetation is correlated to the inundation patterns in smaller, more regular runoff events.

The 63% AEP flood difference maps (refer Figure 4.5 and Figure 4.6) indicate that a reduction in maximum flood depths of up to 0.2 m is predicted to occur in the valley ponding areas which are located south of the Fridge pits, which is related to the diversion of a large catchment to the west of Fridge Hill Pit. Refer Figure 4.5 showing the most extensive area of water level reduction located south of Fridge West. Some larger reductions in flood depths are predicted in localised areas within the model which represent drainage lines that have had flow diverted around them due to the proposed mine development.

Conversely, the diversion of runoff around the disturbance footprints is predicted to cause an increase in water depths along the diversions and in the Fortescue Valley immediately downstream of the diversion. Water depth increases of up to 0.3 m are predicted in some areas of valley floor ponding. Refer Figure 4.5 showing the most extensive area of increased ponding within the Fortescue Valley caused by the diversion between Fridge Hill and Horseshoe West.

Water shadowing downstream of linear infrastructure (i.e., roads) is minimal due to the preliminary locations selected for the proposed culverts as captured in the model, which allow flows to continue downstream of the infrastructure. The modelling has indicated further areas where additional culverts may be considered to reduce the impact on surface water flows, albeit these are generally on smaller drainage lines, which in future will be considered through more detailed civil design works. Zoomed in model results showing typical creek road crossings are provided in Figure 4.7 and Figure 4.8.

The modelling predicts only localised impacts on surface water inundation depths upstream and downstream of roads, with the largest impact at locations where culverts haven't been considered to date.

Broader mapping of the predicted water level differences between the Baseline and Post-Development flood models are shown in Appendix D. Note the relatively small area of impact that the linear infrastructure has on the surface flows compared to the mine development area.

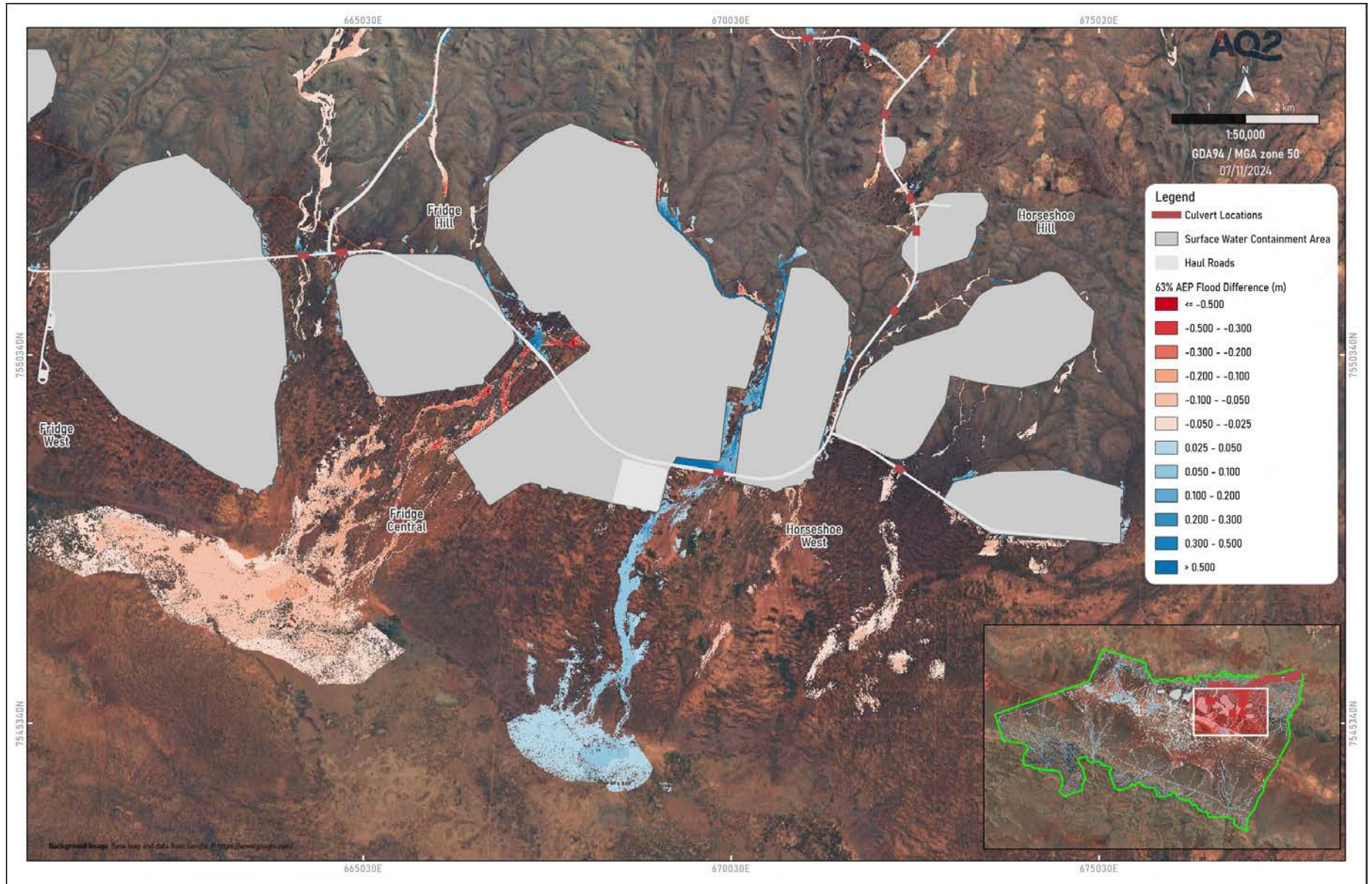


Figure 4.5 2D Model Predicted Maximum Flood Depth under the LOM Development Scenario (63% AEP) – Location 1

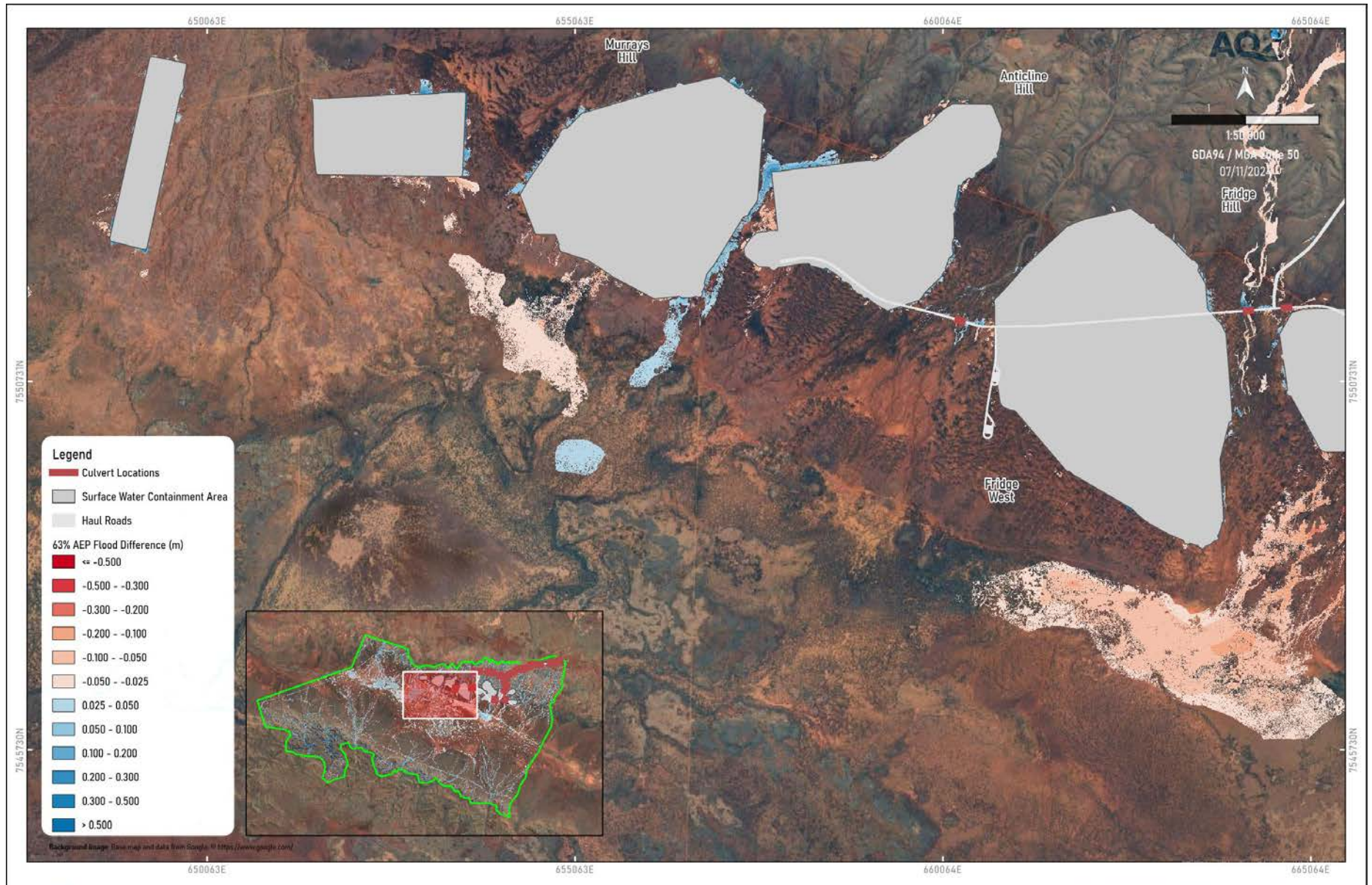


Figure 4.6 2D Model Predicted Maximum Flood Depth under the LOM Development Scenario (63% AEP) – Location 2

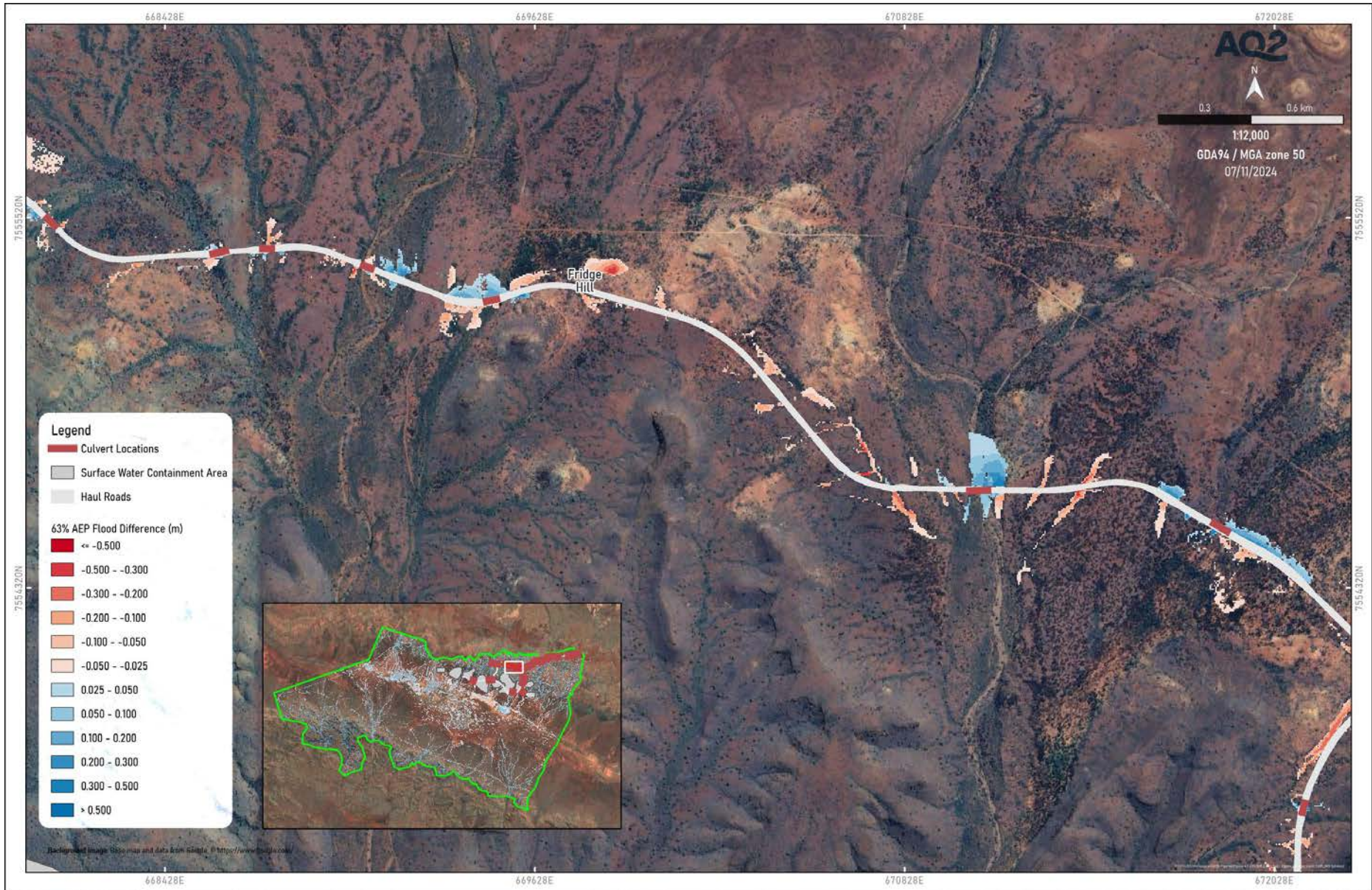


Figure 4.7 Linear Infrastructure Example 1 – Water Level Impacts (63% AEP Model: Zoomed)

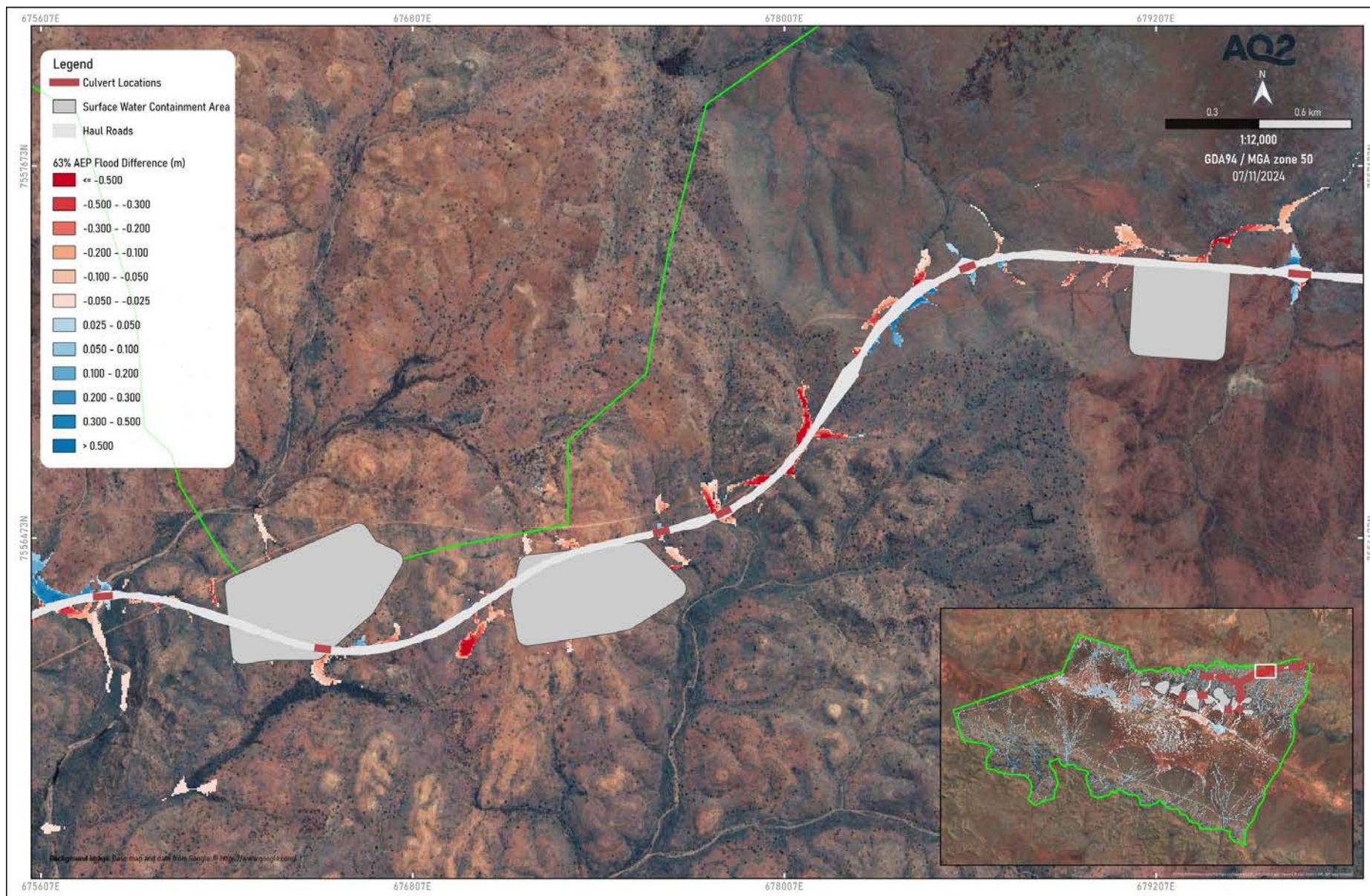


Figure 4.8 Linear Infrastructure Example 2 – Water Level Impacts (63% AEP Model: Zoomed)

4.4 Modification of the Physical Water Quality

4.4.1 Proposed Management Measures

Mining operations at the Project will cause ground disturbance related to mining and construction of ancillary infrastructure, such as the ROM pads, stockpiles and waste rock dumps. These activities tend to increase sediment loads transported in runoff and could result in sedimentation of vegetated and other sensitive ecological areas downstream within the Fortescue Valley.

The philosophy behind surface water management for the Project is to divert clean water around potentially sediment-generating areas (to prevent increasing the volume of water that may be sediment laden, or “dirty”) and capture and treat dirty runoff prior to release downstream.

Management measures that are proposed to be implemented are discussed in more detail in the Water Management Plan (HanRoy 2024) and are summarised below:

- Implementation of catch drains to collect and convey dirty water to a sediment basin.
- Construction of diversion channels and levees to divert clean stormwater around mine disturbance areas therefore segregating the clean water from dirty water catchments.
- Construction of sedimentation basins to collect and treat dirty water prior to release to the downstream environment.

It is assumed that the dirty runoff collected from the pits and waste rock dumps does not contain any chemical contamination that prevents the collected water from being discharged to the downstream environment. Work is being completed to assess the acid mine drainage (AMD) risk of the pits and waste rock dumps, but the current management plan assumes that the site has a low AMD risk.

Diversion drains and levees will be constructed to keep the main drainage lines away from the waste rock dumps such that there is a low likelihood of floodwaters impacting the stability of the waste rock dump landforms.

4.4.2 Residual Impacts

The residual risks to the physical quality of surface water have been rated Low (refer Appendix A). The Water Management Plan (HanRoy, 2024) outlines the management measures to manage sediment transport, with the key measures summarised in the preceding section of this report.

4.5 Modification of the Chemical Water Quality

4.5.1 Potential Impacts

Mine developments have the potential for adverse impacts to surface water quality due to:

- Spillage of hydrocarbons and chemicals stored, handled or transported on site.
- Runoff from the mine pit, stockpiles, ROM pad and waste rock dump areas containing metals or other elements.
- Runoff in contact with PAF material has the potential for low pH and increased metal concentrations.
- Production of poor-quality water that is surplus to site water demands which is discharged to the surface water environment.
- Changes to the salt balance at the claypans.
- Spillage of non-fresh water from dewatering and re-injection systems during the transfer of dewatering across the Study Area.

4.5.2 Proposed Management Practices

Standard local runoff management practices will be deployed within plant and mining areas as outlined in the HPPL Environmental Management System. The intention of these practices is to reduce the risk of contaminated water being released to the downstream environment where it has the potential to impact on local waterways and the downstream Fortescue Valley and claypans. Practices include:

- Dust suppression operations to be managed to prevent over-watering of roads.
- Road spoon drains to prevent dust suppression runoff to surrounding areas.
- Vegetation health monitoring adjacent to roads.
- Containment of runoff and waste-water at washdowns, carparks, workshops etc., for treatment and reuse in the mine process.
- Deployment of spill kits to clean up local oil spills immediately when they occur.
- Ongoing monitoring of groundwater and surface water for potential contaminants.
- Discharge of surplus groundwater dewatering to a Managed Aquifer Recharge system.

Mine development areas, , where there is potential for hydrocarbons and chemicals to contaminate runoff (such as the airport, bulk fuel storage and workshop areas), will implement targeted containment management practices. Runoff in these areas will be collected, treated, and reused on-site to minimise the risk of releasing contaminated water to the downstream environment.

Assessments of the AMD risk for the Project have not been considered when completing this impact assessment of the Project to the water quality in the downstream environment. A low AMD risk has been assumed, but final AMD assessments are still in progress.

4.5.3 Residual Impacts

On the basis that the proposed management practices mitigate the direct impact of the project on the downstream water quality a Post-Development salt balance on the claypans has been completed.

A salt balance was completed in conjunction with the water balance model completed for Gnalka Gnoona and Koojjeepindarranna claypans to assess the potential impact of the Project on the water quality of the claypans. The development of the water and salt balances are discussed in the Baseline Report. Comparisons of the Pre-Development and LOM salt balance predictions were completed on the same “small”, “medium” and “large” claypan inundation event as the water level comparisons completed in Section 4.3.2.

The results shown in Figure 4.9 and Figure 4.10 indicate the salinity will vary marginally between the Pre-Development and LOM model scenarios. When reviewing the results note:

- As discussed in the Baseline Report, within the water and salt balance the calculated salt concentration becomes large when the stored water volume is low.
- The model logic adopts a salt concentration of 0 mg/L when the stored water volume in the claypan becomes nominally less than 0.1% of the maximum storage volume in the claypan so that high TDS concentrations in the remnant small volume of water that remains as the claypan dries aren't shown on the figures.
- Therefore, comparing the final Pre-Development and LOM salinity values that are shown in the results prior to the salinity resetting to 0 mg/L is largely irrelevant as these are impacted by when the stored water in the claypan reaches the 0.1% storage volume threshold.
- Aside from these periods at the end of the ponding events, the results show that the Pre-Development and LOM salinity values would be relatively similar.

- This is expected, as the reduction in catchment area reporting to the claypan reduces both the mass of salt and the volume of water which would report to the claypans.

4.6 Impact Risk Outcome

The surface water mitigation measures discussed above and outlined in more detail in the Water Management Plan (HanRoy 2024) are anticipated to reduce all of the surface water risks identified for the Project to a Low risk rating, as shown in Appendix A.

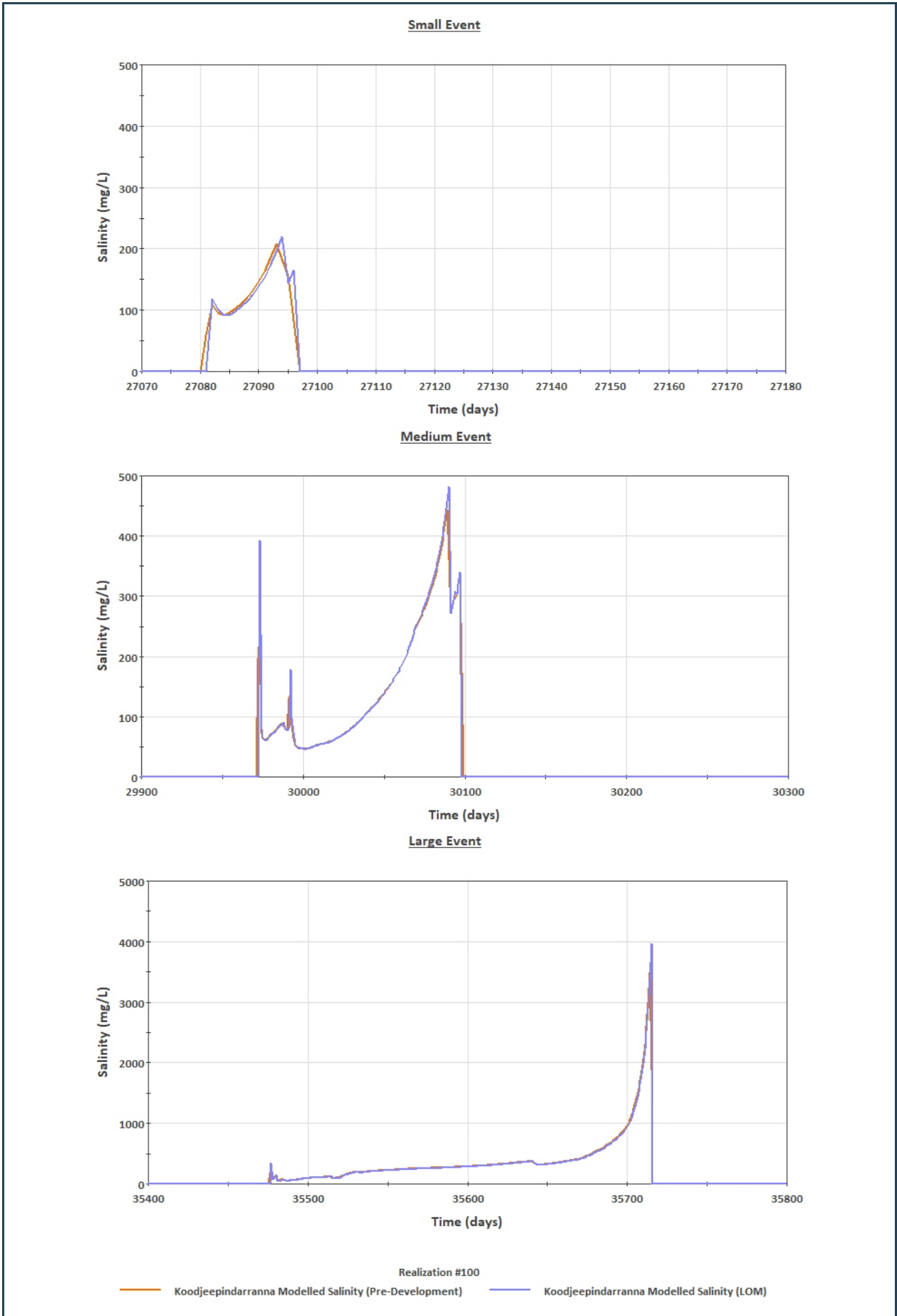


Figure 4.9 Koodjeepindarranna Claypan – Pre vs Post Development Salinity Prediction Snapshots

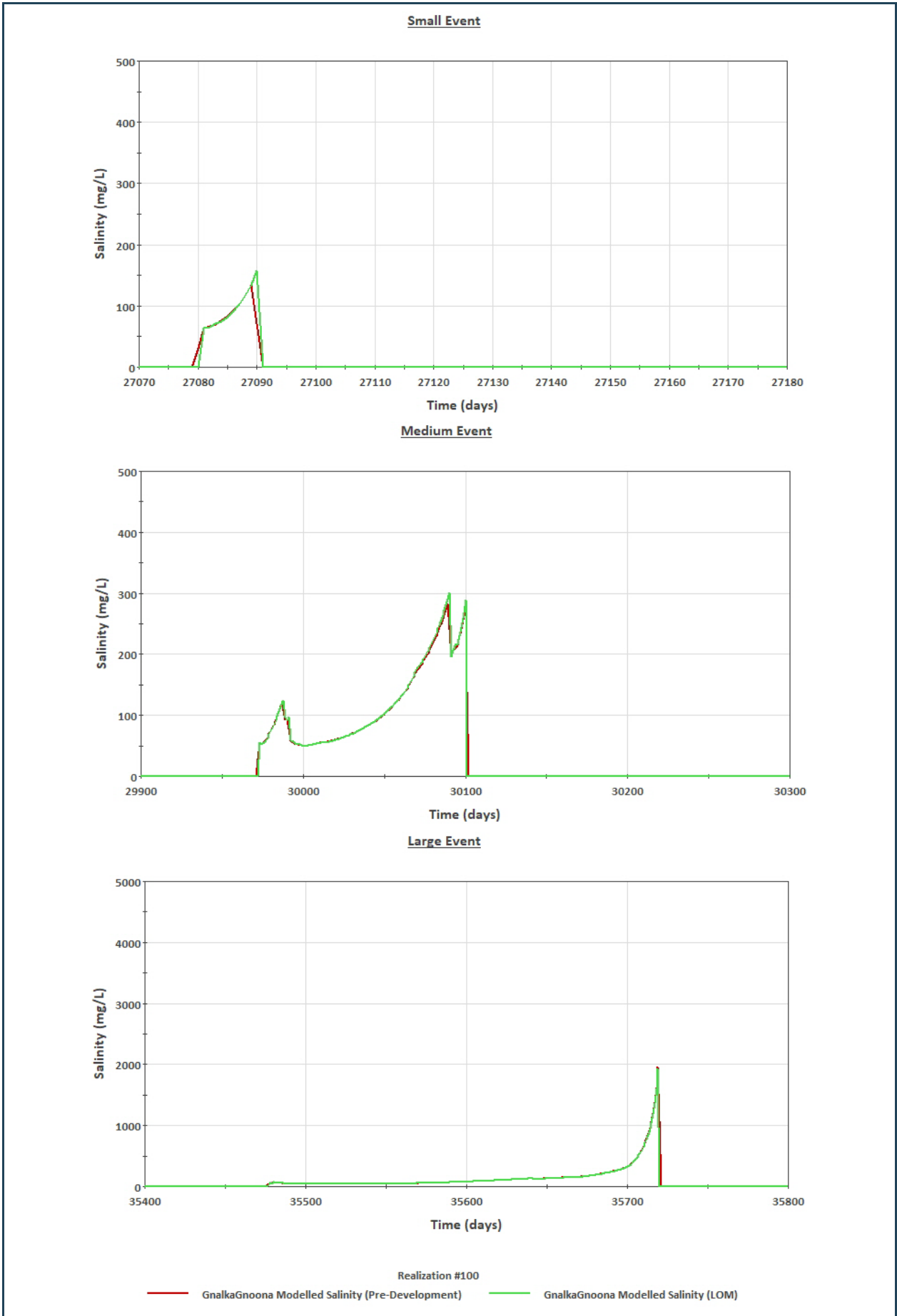


Figure 4.10 Gnalka Gnoona Claypan – Pre vs Post Development Salinity Prediction Snapshots

5. GROUNDWATER IMPACT ASSESSMENT

5.1 Proposed Pits

Figure 5.1 presents the location of the proposed pits for the Mulga Downs Iron Ore Mine. It comprises seven mining areas (from west to east): Murray's Hill, Anticline Hill, Fridge West, Fridge Central, Fridge Hill, Horseshoe West and Horseshoe Hill. All but 13 of the pits extend (to varying depths) below the groundwater level (refer Figure 5.1) and will therefore require dewatering. The lowest estimated pit elevation is 388 mRL (i.e., ~12 to 16 m below the groundwater level).

5.2 Approach to Groundwater Management During Mining

Figure 5.2 presents the impact of mining on the groundwater system based on the conceptual hydrogeological understanding of the area outlined in Section 2. The following section outlines the proposed approach to dewatering, water supply and the management of excess water that was considered as part of the groundwater management and impact assessment.

5.2.1 Dewatering

The preferred approach to dewatering is via ex-pit dewatering bores with in-pit bores only used where additional abstraction is required to achieve required drawdown levels. In-pit sumps may be used towards the end of mining a pit to access the deepest part of the pit.

For pits located closer to the claypan areas (i.e., in the Murray's Hill and Fridge West areas), there is the potential for dewatering discharge to become more saline over time as groundwater is drawn from the higher salinity, valley areas (refer Figure 5.2). As the proposed pits are only being mined to ~388 mRL and do not have saline water directly beneath them, up-coning of deeper, more saline water is not anticipated with the proposed dewatering abstraction.

5.2.2 Water Supply

HanRoy estimates an approximate average water demand of 0.73 GL/yr (~2,000 kL/d) over the construction period (i.e., a period of 1 to 2 years prior to mining) and throughout the life of mine.

It is intended that construction water will be sourced from the mining area and, as such will either provide advance dewatering and / or increased aquifer capacity for the disposal of excess water (refer Section 5.2.3), dependent on the source area. Throughout the mining period water demands will be preferentially met by dewatering volumes and, if required, water treatment will ensure that the water quality criteria are met.

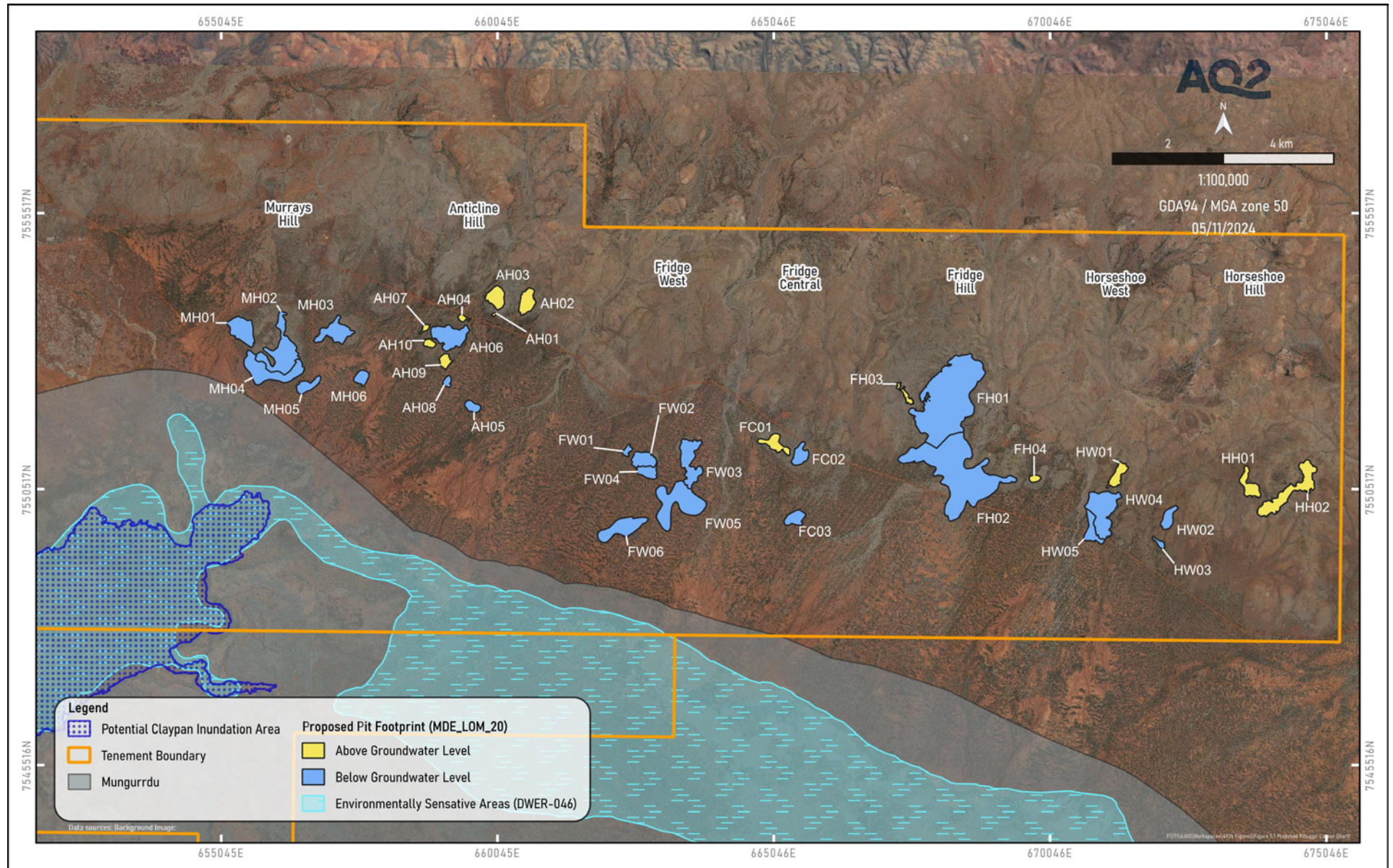


Figure 5.1 Proposed Pit Locations

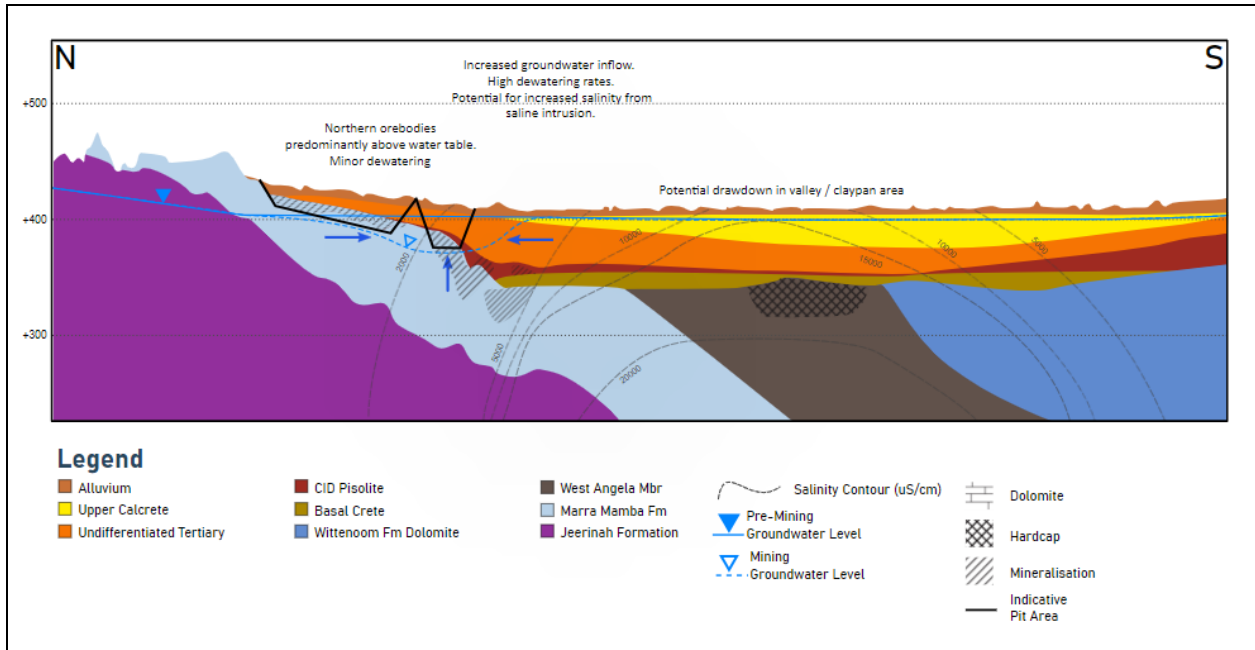


Figure 5.2 Conceptual Cross-Section Showing Potential Impact of Mining

5.2.3 Excess Water Disposal

Where dewatering exceeds water demands, excess water will be disposed of by MAR through re-injection.

MAR is proposed on the slopes of the valley (i.e., in, and along strike of, the proposed mining areas). Initially, MAR is proposed via re-injection bores, with the potential for using repurposed dewatering bores and / or in-pit infiltration, once mining of a pit is complete.

From the field investigations conducted to date (AQ2 2024), the following are key points relating to the MAR potential for this area:

- The Altered Marra Mamba unit is an extensive and continuous aquifer, as is the Tertiary overburden.
- Although weathered shale and / or clay dominant intervals within the Tertiary overburden exist, no continuous, extensive confining layer to allow pressurised MAR has been identified by investigations completed to date.
- The generally unconfined nature of the identified Tertiary and bedrock aquifers means that MAR will be limited by the available freeboard (i.e., the unsaturated aquifer above the current groundwater level and below the ground surface / root zones). However, with regional groundwater levels being drawn down by the dewatering of the pit areas, the freeboard is likely to increase.
- The increased depth to groundwater in the eastern areas provides greater freeboard, however, these areas have inherently fresher groundwater, being further from the claypan areas, therefore potential changes to water quality will need to be assessed and managed.
- The MAR will reduce the extent of drawdown, however, the proximity of the proposed MAR areas to the pits is anticipated to result in re-circulation of the re-injected water back to the pits.
- With respect to the beneficial use of the groundwater in the Study Area: Although the groundwater salinity is naturally elevated near the claypans, the salinity reduces with increased distance from the claypans due to the lateral flow of fresher groundwater from the valley slopes; with preferential flow evident through the lower units of the Tertiary sequence (i.e., the CID / Pisolite and Basal Crete) and upper bedrock units. Station bores for livestock drinking water are installed in the Tertiary aquifer units.

5.2.4 Integrated Groundwater Management and Mining

The mine plan has been developed to account for the constraints imposed by dewatering and MAR. The adopted mining scenario (MDE_LOM_20) has mining commencing in January 2027, with a 15.5-year life of mine. Below water table mining commences in 2028 in the west, in the Murray's Hill area, progressing east to Anticline Hill, followed by the mining of Horseshoe West and finally the Fridge West, Fridge Central and Fridge Hill areas. This is summarised and depicted in Figure 5.3.

This generally progressive west to east mining approach (with the exception Horseshoe West mining) allows excess water to be injected and/or infiltrated along strike (i.e., into other mining areas in advance of or after mining in that area) as well as across strike (i.e., to the south of the eastern mining areas).

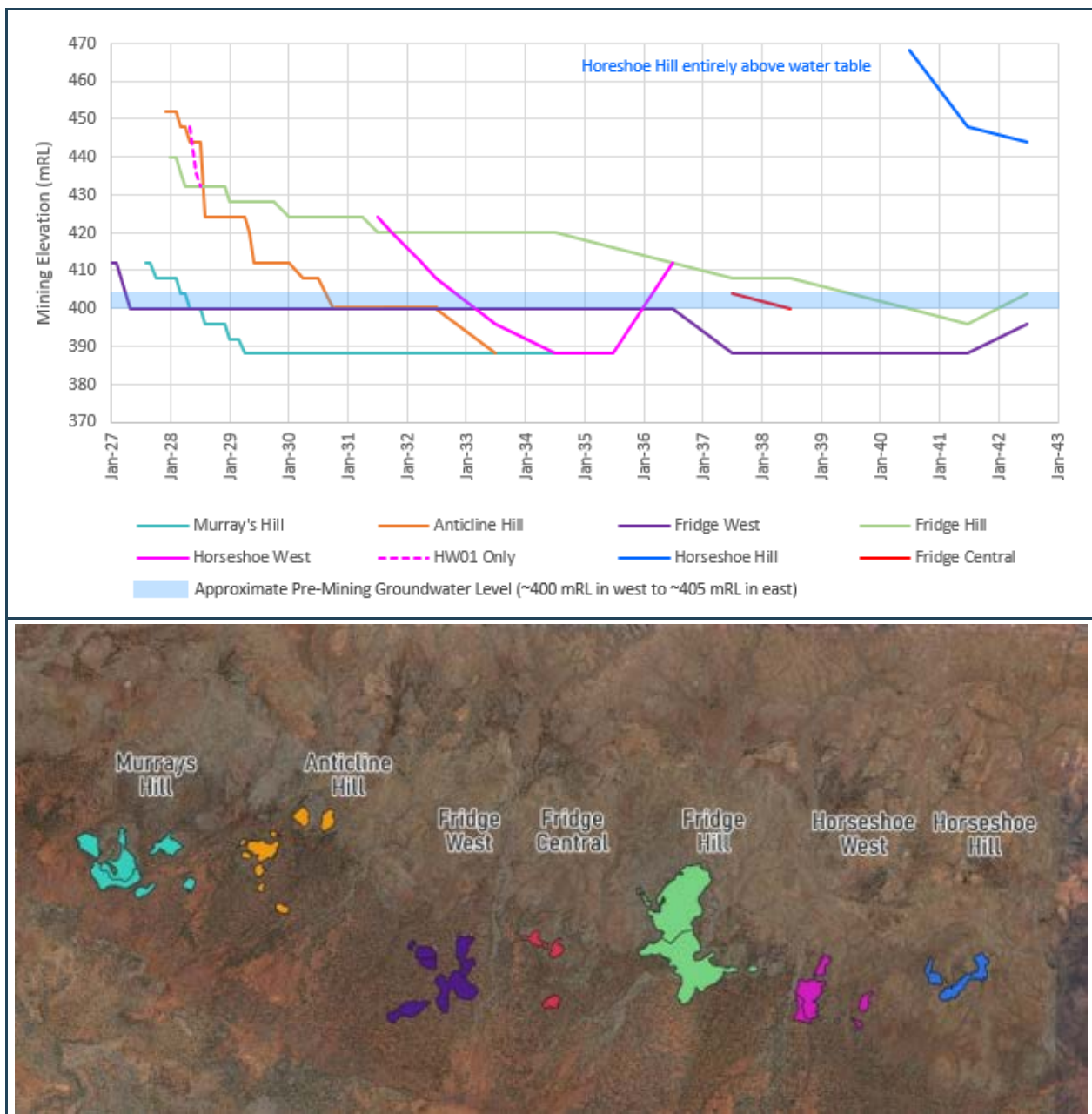


Figure 5.3 Mining Elevation below Water Level versus Time (MDE_LOM_20)

5.3 Potential Impacts Relating to Groundwater & Associated Management Strategy

To provide an integrated assessment of changes to the groundwater system resulting from the development of the Project, numerical groundwater modelling has been undertaken. The overarching groundwater management strategy is to:

- Minimise impact to the current beneficial use of the groundwater.
- Minimise the impact on other groundwater users and groundwater dependent ecosystems (i.e., subterranean fauna); this includes minimising the extent of groundwater level changes.
- Maintain groundwater levels such that there is no surface expression of groundwater or water logging of vegetation.

Within the Study Area, groundwater is used by Mulga Downs Station (for stock water) and supports some environmental values. More regionally, groundwater is used for potable supplies at the Wirrilimurra and Youngaleena Communities (Figure 1.4). In addition, significant cultural-heritage value is derived from water within the Study Area, with Mungurrdu being of particular significance.

As the groundwater in the Study Area is only used for stock water, the key groundwater quality criterion for the current beneficial use is based on the drinking water requirements for livestock (cattle). Drinking water guidelines for beef cattle indicate a tolerance limit of 5,000 mg/L TDS (ANZECC, 2000), therefore where shallow groundwater outside of the immediate development area is currently within this limit, the intent is to minimise the extent and magnitude of change above this threshold.

Vegetation in the Study Area is not considered to be groundwater dependent (AQ2 2024) and drawdown does not pose a risk. Potential impact may result from water logging of roots from MAR and groundwater level rise (i.e., mounding) will be constrained to avoid this. As the intent is to avoid any water logging of the root zones, the salinity of the mounded groundwater and the tolerance of vegetation to salinity changes has not been considered further.

Knowledge about the salinity tolerance of Pilbara stygofauna is limited. The Pilbara Biodiversity Survey (Halse et al. 2014) suggested the fauna are comprised mostly of species that have an upper salinity tolerance of <5,000 mg/L TDS. Whilst a more recent assessment (Bennelongia 2023) reports a scheme that classifies salinity according to the pattern of occurrence of aquatic invertebrate species. This recognises a group of freshwater species that are restricted to salinity <3,000 mg/L TDS, a second group of hyposaline species that occur in freshwater but tolerate a variable range of salinity up to about 20,000 mg/L (many are much less tolerant), and a group of saline species that occur in both hyposaline water and saline water of >20,000 mg/L (Williams 1964; Hammer 1986); however, saline species are absent, or nearly so, from the Pilbara. In the Mulga Downs area, Bennelongia (2023) has classified the recorded stygofauna species into those that:

- Appear likely to be found only in groundwater of <3,000 mg/L TDS.
- Have an apparent upper salinity tolerance of about 5,000 mg/L TDS.
- Have an apparent upper salinity tolerance of about 10,000 mg/L TDS.

The potential impact of groundwater changes on stygofauna is being assessed as a separate study and is not considered further in this report.

5.4 Numerical Groundwater Modelling

A numerical groundwater model for the proposed Mulga Downs mine area and the surrounding groundwater catchment was developed in 2021 as part of a preliminary groundwater assessment. The model was updated and re-calibrated with the findings from the 2021 field investigations and the updated conceptual understanding of the area. The groundwater model was used to:

- Determine a feasible mining scenario with a viable dewatering and MAR solution.
- Predict dewatering rates required to achieve dry mining conditions (i.e., groundwater levels at or just below the projected base of mining throughout the life of the mine which is the standard approach for this level of study).
- Predict regional groundwater drawdown / mounding and changes to the regional groundwater balance resulting from dewatering and MAR.
- Predict potential changes to groundwater salinity resulting from dewatering and MAR.
- Predict the recovery of the groundwater system at the end of mining and dewatering, including the time taken for recovery of groundwater levels to a final equilibrium.

Details of the model set up are presented in Appendix E; key points of note are as follows:

- The extent of the model domain is shown in Figure 5.4.
- The model grid is rotated 26 degrees to align it with the inferred direction of groundwater flow through the valley aquifer (approximately southeast to northwest). Cell dimensions range between 100 m x 100 m (in the immediate mine area) to 1,000 m by 1,000 m near the model boundaries.
- The model comprises 11 flat lying layers to simulate the geometry of the Leapfrog static model developed from the HPPL geological model and additional hydrogeological drilling data. The groundwater model layers are generally 10 m thick, with thicker layers in the lower layers and in areas of higher topographic elevation.
- The aquifer parameters assigned to the model represent:
 - The Tertiary aquifers that occur across the valley and along the lower slopes of the Chichester Range.
 - The basement aquifers and aquitards associated with the Brockman, Wittenoom, Marra Mamba and Jeerinah Formations. Higher permeability sub mineralised and mineralised / orebody areas in the Marra Mamba Formation are also represented. Aquifer parameters have also been applied to represent where faulting is anticipated to have resulted in the juxta-positioning of the Paraburdoo and West Angela Members in the Malay Well area.
 - Recharge to the aquifer system from flow along surface water drainages and from incident rainfall.
 - Groundwater inflows from upstream and groundwater outflow to downstream.
 - Evaporation from shallow water tables and evapotranspiration from vegetation across the valley floor.
- The model has been calibrated to the baseline monitoring data for the period 2009 to 2021, long-term monitoring data for the period 2004 to 2021 (where available) and constant rate pumping tests of 3 to 5 days duration. A summary of the calibrated aquifer parameters is presented in Table 5.1.

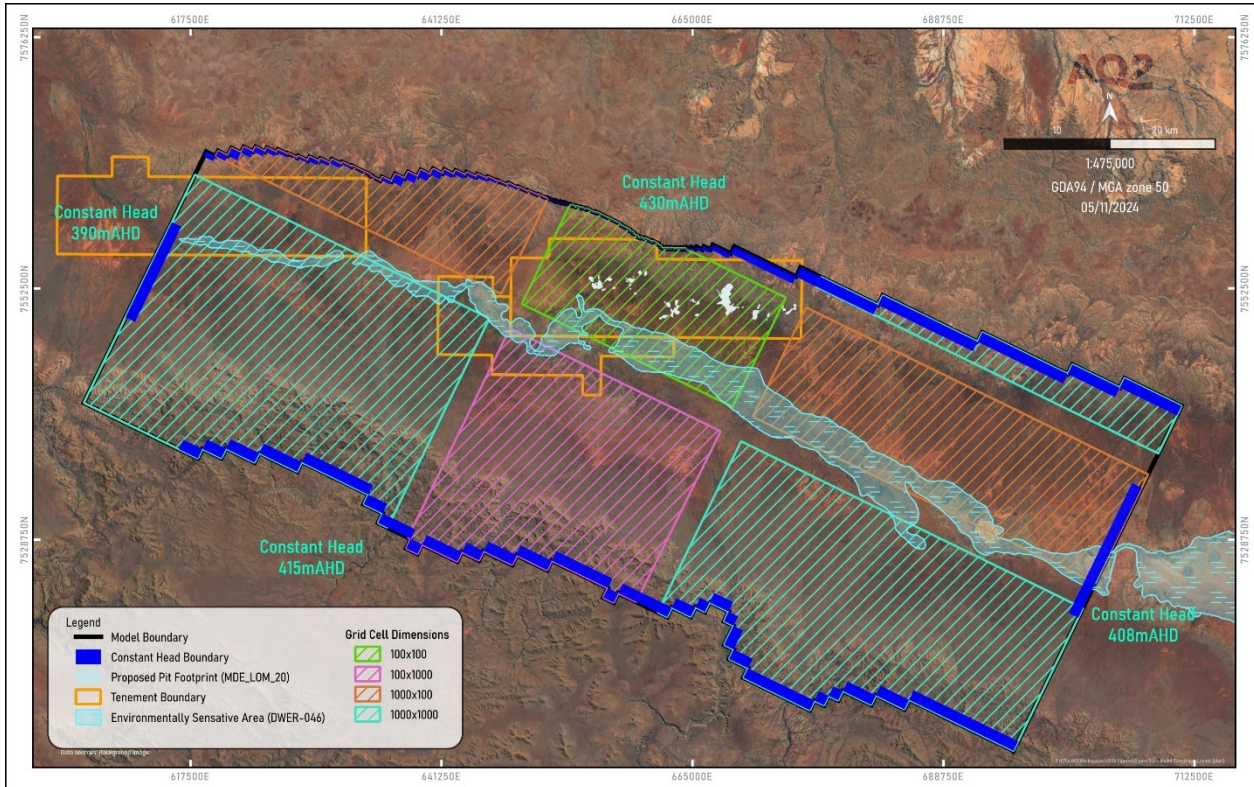


Figure 5.4 Extent of the Numerical Model

Table 5.1 Calibrated Aquifer Parameters

| | Unit | Horizontal Hydraulic Conductivity, Kh (m/d) | Vertical Hydraulic Conductivity, Kv (m/d) | Specific Yield, Sy (%) | Specific Storage, S (1/m) | Porosity, θ (%)* |
|------------------------------|---|---|---|------------------------|---------------------------|-------------------------|
| Tertiary Cover | Upper Calcrete | 10 | 1 | 1 | 1 x 10 ⁻⁶ | 10 |
| | Undifferentiated Tertiary | 8 | 0.8 | 2 | 1 x 10 ⁻⁶ | 25 |
| | Pisolite / CID | 14 | 1.4 | 5 | 1 x 10 ⁻⁶ | 15 |
| | Basal Crete | 9 | 0.9 | 1 | 1 x 10 ⁻⁶ | 10 |
| Bedrock | Brockman Fm | 0.01 | 0.001 | 0.1 | 1 x 10 ⁻⁶ | 1 |
| | Fresh Dolomite of Wittenoom Fm | 0.01 | 0.001 | 0.1 | 1 x 10 ⁻⁶ | 5 |
| | Weathered West Angela Mbr | 1 | 0.1 | 1 | 1 x 10 ⁻⁶ | 20 |
| | West Angela Hardcap | 20 | 2 | 5 | 1 x 10 ⁻⁶ | 20 |
| | West Angela Hardcap (in the vicinity of bore MDPB0020)** | 130 | 13 | 5 | 1 x 10 ⁻⁶ | 20 |
| | Marra Mamba / West Angela Ore (includes sub-mineralised halo) | 25 | 2.5 | 3 | 1 x 10 ⁻⁶ | 15 |
| | Unmineralised / Fractured Marra Mamba (Mulga East) | 10 | 1 | 1 | 1 x 10 ⁻⁶ | 8 |
| | Unmineralised Marra Mamba (Regional) | 0.05 | 0.005 | 0.5 | 1 x 10 ⁻⁶ | 5 |
| Fresh Marra Mamba / Jeerinah | 0.01 | 0.001 | 0.1 | 1 x 10 ⁻⁶ | 1 | |

*Used for groundwater salinity simulations. Value not determined from model calibration; refer Appendix E for further details.

**Extent determined from assessment of the lithological logging for surrounding mineral drillholes.

5.5 Model Predictions

As described above, model predictions were run to determine a feasible mining scenario with a viable dewatering and MAR solution. Model predictions were conducted by Groundwater Consulting Pty Ltd (GWC) under contract to Darkwater Consulting Pty Ltd (Darkwater) and are detailed in Appendix F. A summary is provided below.

The adopted mine schedule (MDE_LOM_20) spans over a 15.5-year period (January 2027 to July 2042) and is summarised in Figure 5.3.

5.5.1 Dewatering Estimates

Figure 5.5 presents the predicted dewatering rates for the adopted mining schedule. Predicted dewatering commences in April 2028 at ~8,600 kL/d (~3.2 GL/yr). Peak dewatering rates of between ~30,000 and 31,300 kL/d (~11 to 11.4 GL/yr) are predicted during the concurrent dewatering of Murray's Hill, Anticline Hill and Horseshoe West during 2032 and 2033, with similar peaks (~30,200 kL/d) between 2037 and 2041, during the mining of Fridge Hill and Fridge West. Dewatering rates decline rapidly upon the completion of mining Fridge Hill, with rates of ~4,300 kL/d (~1.6 GL/yr) predicted for the final of year of mining Fridge West. The proposed Fridge Central pits (FC02 and FC03) only extend ~2 meters below the groundwater level and, as such, these pits are dewatered passively by interference effects from the dewatering of neighbouring pits.

Dewatering was simulated using 23 dewatering bores. The locations of the modelled bores are presented in Figure 5.6. The ex-pit dewatering bores are generally located immediately adjacent to the deepest parts of the pits and where the aquifer is deepest. Dewatering bores are therefore generally located on the down-dip side of the pits to ensure the maximum duration of pumping (with up-dip locations becoming dewatered first). Maximum dewatering rates at the individual bore sites range between 2,600 and 4,300 kL/d (30 and 50 L/s), with yields at some bores declining as the aquifer units are dewatered, particularly the northernmost bores.

The impacts associated with dewatering are discussed in Section 5.5.6.

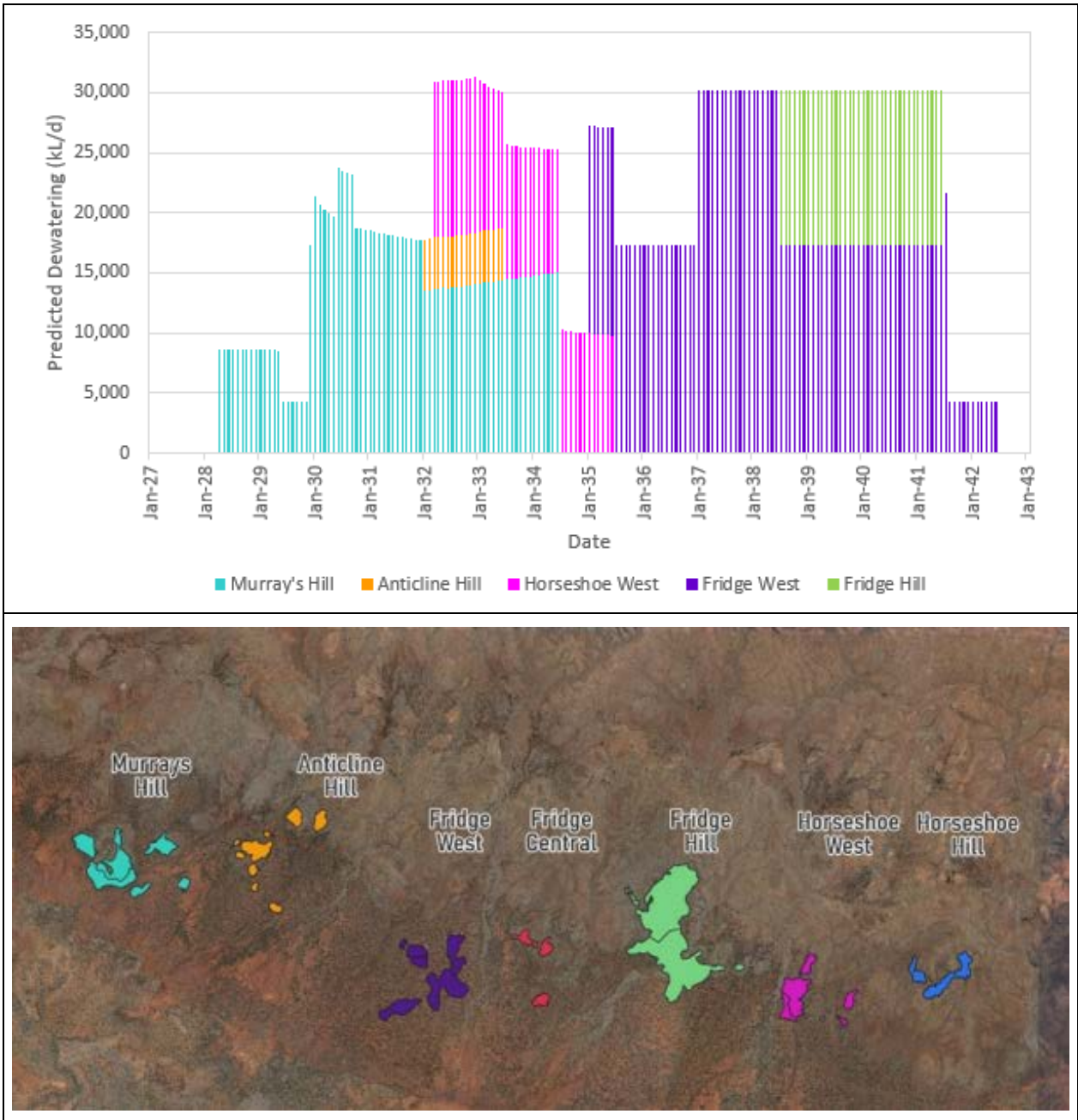


Figure 5.5 Predicted Dewatering for the Adopted Mine Schedule (reproduced from GWC 2024)

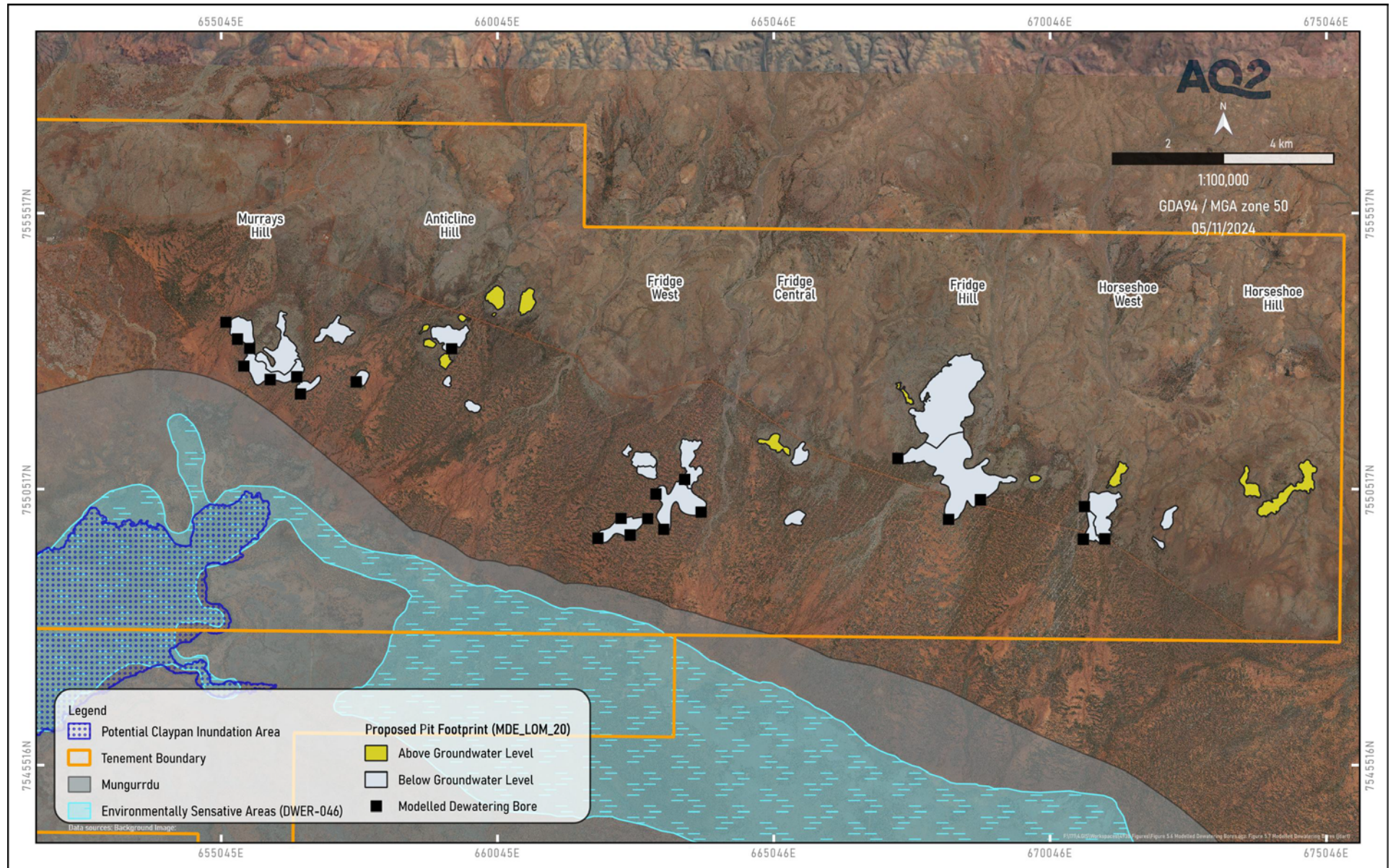


Figure 5.6 Modelled Dewatering Bore Locations (reproduced from GWC 2024)

5.5.2 Mine Site Operational Water Balance

As reported in Section 5.5.3, the water demand for the Project will be primarily sourced from pit dewatering. The intent is also for all excess water to be disposed of by MAR within the Study Area, with an assessment of potential changes to the groundwater quality conducted as part of the groundwater impact assessment (as detailed in subsequent sections of this chapter). Therefore, for the purpose of groundwater modelling predictions, the water balance is simply:

$$\text{Total Dewatering} - \text{Water Demand} = \text{Excess Water for Disposal (i.e., MAR requirements).}$$

Figure 5.7 presents the water balance adopted for the numerical groundwater modelling.

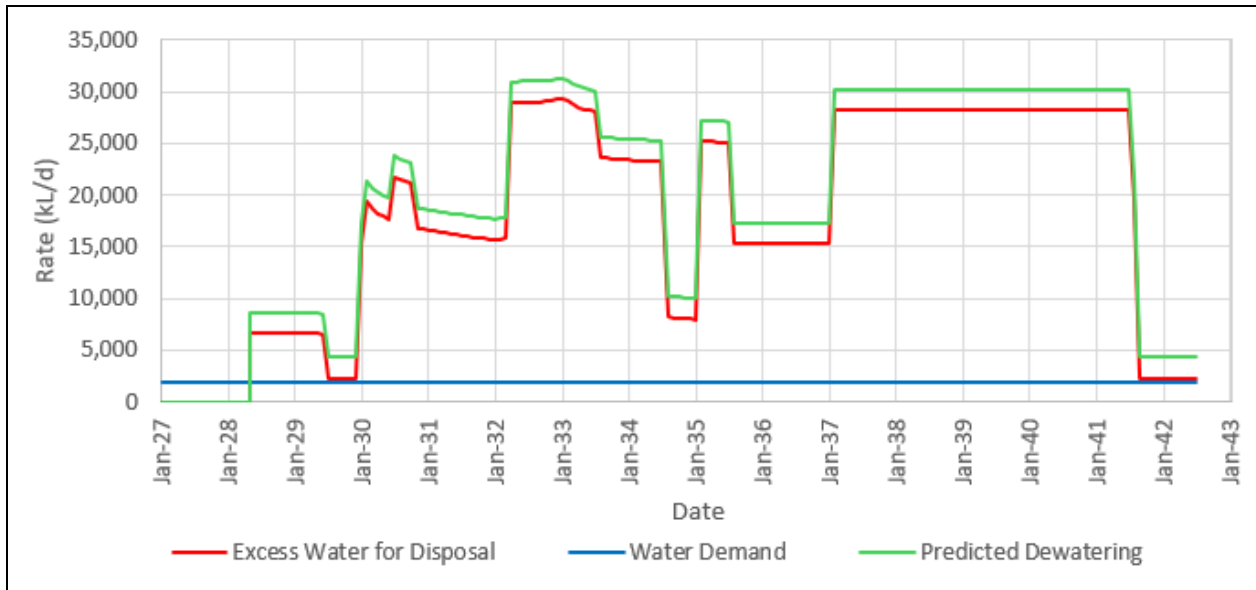


Figure 5.7 Predicted Water Balance

5.5.3 Water Supply

As detailed above, dewatering discharge will be used to meet the water supply requirements. Although a water supply will be required for construction and the early years of mining, groundwater abstraction has only been modelled to meet dewatering requirements (i.e., commencing in April 2028). As the water demand areas are within the mining / MAR areas, earlier groundwater abstraction will provide advanced dewatering and / or increased MAR capacity. As such, and as the water demands are relatively small compared to predicted dewatering, the early groundwater abstraction for supply purposes are not anticipated to have a significant effect on the modelled drawdown / drawup with respect to impact assessment.

5.5.4 Excess Water Disposal

As outlined above, the adopted mining scenario allows for MAR along strike and within the mining areas. MAR was simulated at 28 re-injection bores, at three proposed MAR areas (refer Figure 5.8):

- A MAR borefield in Murray's West.
- A MAR borefield in Fridge / Horseshoe South.
- Re-injection in the Murray's Hill and Anticline Hill areas (once mining of these areas is complete), either via previous dewatering bores or pit infiltration.

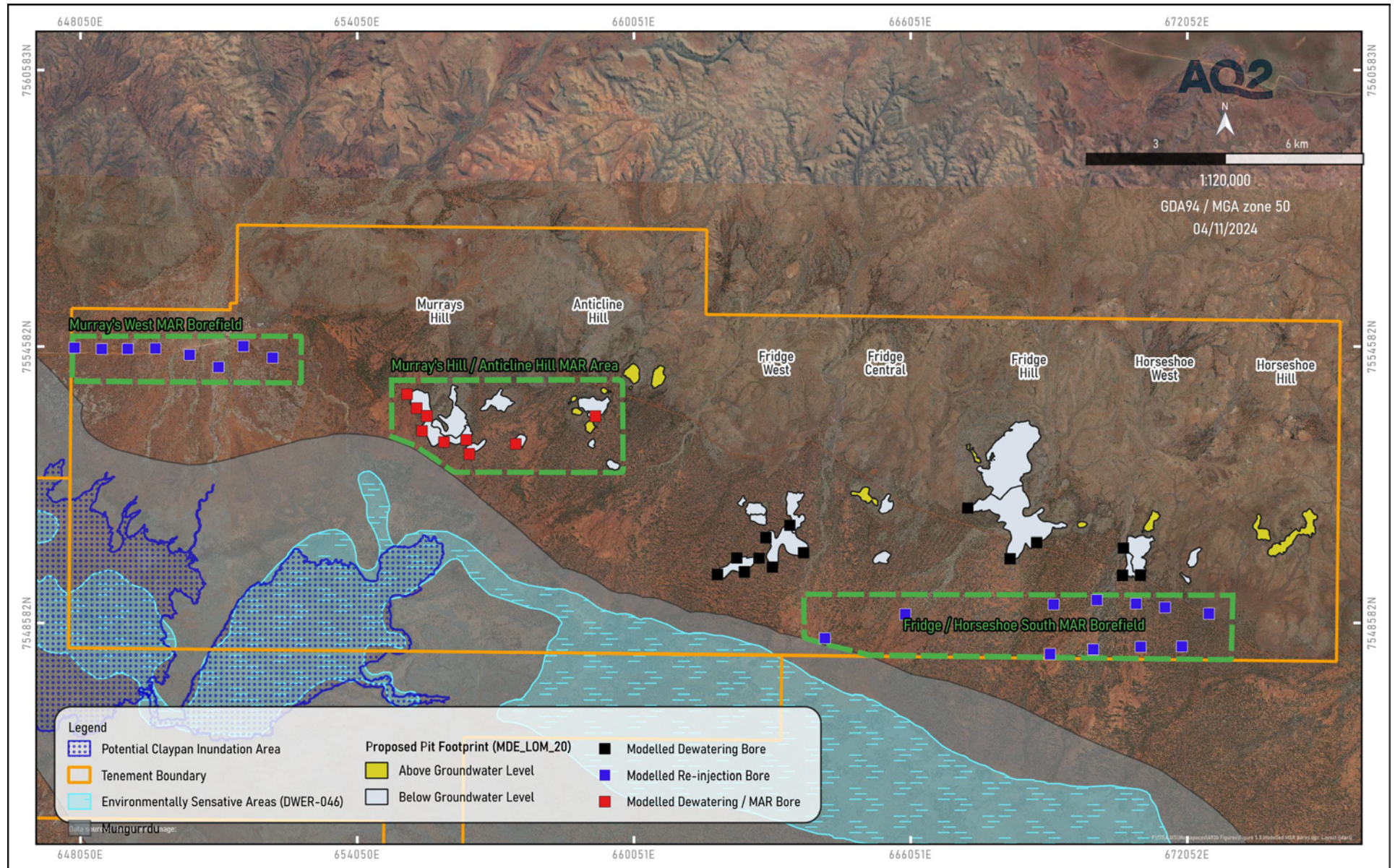


Figure 5.8 Modelled MAR Bore Locations (reproduced from GWC 2024)

In general, modelled MAR was maximised in the areas furthest from the active mining area, with additional areas then “brought on-line”; prioritising operational MAR bores by proximity to the active mining thereby limiting re-circulation as much as possible. The MAR areas were modelled for the adopted mining scenario as follows (refer Figure 5.9):

- When mining in the Murray’s Hill and Anticline Hill areas (in the west), MAR was simulated initially in the Fridge / Horseshoe South Borefield (in the east) and then the Murray’s West Borefield (when mining at Horseshoe West commences).
- When mining in the Horseshoe West area (in the east), MAR was simulated in the west, in the Murray’s West Borefield and the Murray’s Hill / Anticline Hill pit areas.
- When mining in the Fridge West area, MAR was simulated in the Fridge / Horseshoe South Borefield (to the east) as well as Murray’s Hill / Anticline Hill pit areas (to the west).
- When mining in the Fridge Hill area (in the east), MAR was simulated in the Murray’s Hill / Anticline Hill pit areas (in the west) and reduced in the nearby Fridge / Horseshoe South Borefield.

As shown in Figure 5.9, effectively variable bores of the Fridge / Horseshoe South MAR Borefield are used throughout the LOM, with the exception of approximately two years (mid-2033 to mid-2035), during the mining of Horseshoe West.

Details of the approach used to simulate MAR and predict re-injection rates for each MAR area over the life of mine are presented in Appendix F. Key points include:

- The simulated groundwater mounding at each modelled MAR bore was restricted to 2.5 mbgl (referred to hereafter as the maximum mounding criterion), with drain cells used in the model to identify groundwater level exceedances, such that re-injection water could be redistributed and extended periods of water logging of vegetation roots would not occur.
- Prediction scenarios allowed for recharge which was based on a historical rainfall data set, resulting in simulated seasonal groundwater level rises in addition to those resulting from MAR.

The maximum groundwater mounding criterion of 2.5 mbgl is below the vegetation root zone, which is constrained by largely impenetrable subsoil/regolith materials (e.g. calcrete). Based on the ecohydrological conceptual model and measured baseline conditions (AQ2, 2024), the threshold groundwater depth above which interaction with vegetation may occur is estimated to be about 2.0 mbgl (refer Section 6).

As detailed in Appendix F, the modelling indicates that all excess water can be disposed of by MAR. Figure 5.9 presents the simulated MAR rates by area, in comparison to the dewatering by area. It can be seen that variable bores of the Fridge / Horseshoe South MAR Borefield are used throughout the LOM, with the exception of approximately two years (mid-2033 to mid-2035), during the mining of Horseshoe West. With the influence of dewatering creating additional freeboard across the area, maximum predicted re-injection rates reach ~28,000 kL/d (~10 GL/yr) for the Fridge / Horseshoe South Borefield, 23,000 kL/d (~8.5 GL/yr) for the Murray’s West Borefield pit areas and ~25,000 kL/d (~9 GL/yr) for the Murray’s Hill / Anticline Hill pit areas.

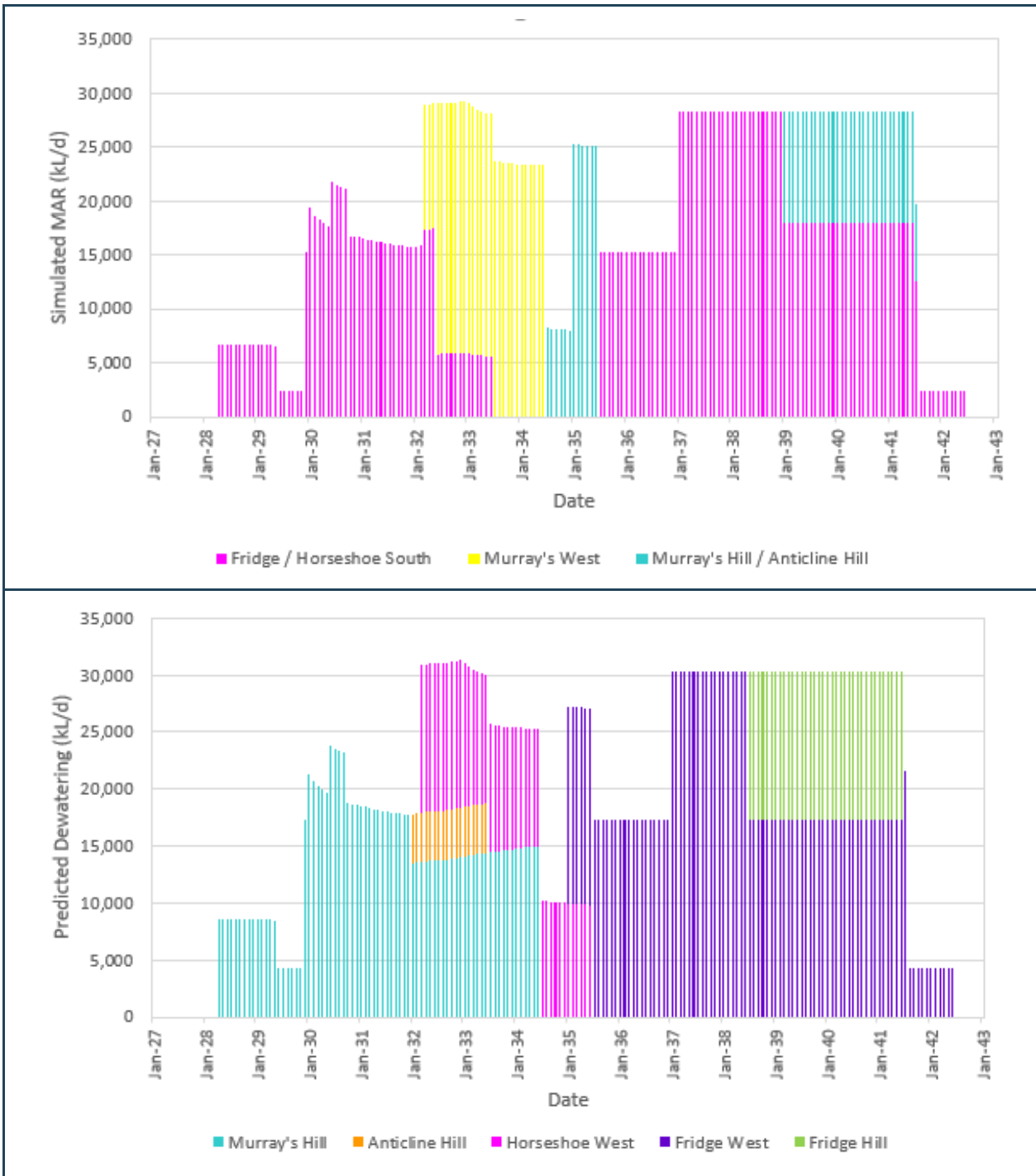


Figure 5.9 Simulated Re-injection Rates and Predicted Dewatering Rates by Area

Modelled MAR bore locations are presented Figure 5.8. Modelled MAR bore re-injection rates ranged between ~460 and 2,960 kL/d (5 and 34 L/s), with some yields declining:

- During wet seasons during periods of increased recharge.
- With reduced freeboard as groundwater levels rebound after the cessation of dewatering in nearby mining areas.

The impacts associated with MAR are discussed in Section 5.5.6.

5.5.5 Water Quality

Groundwater Salinity

The numerical model was used to simulate changes in groundwater salinity resulting from dewatering and MAR (refer Appendix F). Salinity profiles from 61 monitoring bores were used to generate depth-based initial salinity conditions (in TDS) for each model layer across the modelled area.

Predicted TDS for the abstracted groundwater (i.e., discharge) at each of the dewatering bores was determined. The predicted TDS of the dewatering discharge from each mining area was then calculated as the weighted average of the combined dewatering bore discharge for each area. The predicted TDS of the dewatering discharge for the five mining areas with dewatering bores is presented in Figure 5.10 and Figure 5.11.

The predicted TDS of the combined dewatering discharge for all dewatering bores over the life of mine (LOM) is presented in Figure 5.12. This represents the TDS concentrations that were then assigned to all MAR bores over the LOM. It is assumed that there will be no increase in the salinity of the re-injected water resulting from evapoconcentration as, for the rates being considered, only limited storage (i.e., less than a week) would be feasible based on the required dewatering rates. Figure 5.12 shows results from the base case scenario (with model parameters as shown in Table 5.1), together with results from the porosity sensitivity analysis outlined in Section 5.7.1. The TDS of the combined dewatering discharge is predicted to vary between 1,800 and 3,000 mg/L for the base case, with the potential to range between 2,200 and 4,200 mg/L (for Sensitivity Case 1) or between 1,700 and 2,900 mg/L (for Sensitivity Case 2) if porosity values are lower or higher than the base case values, respectively.

The water quality impacts associated with dewatering and MAR are discussed in Section 5.5.6 with further discussion regarding the porosity sensitivity analysis provided in Section 5.7.1.

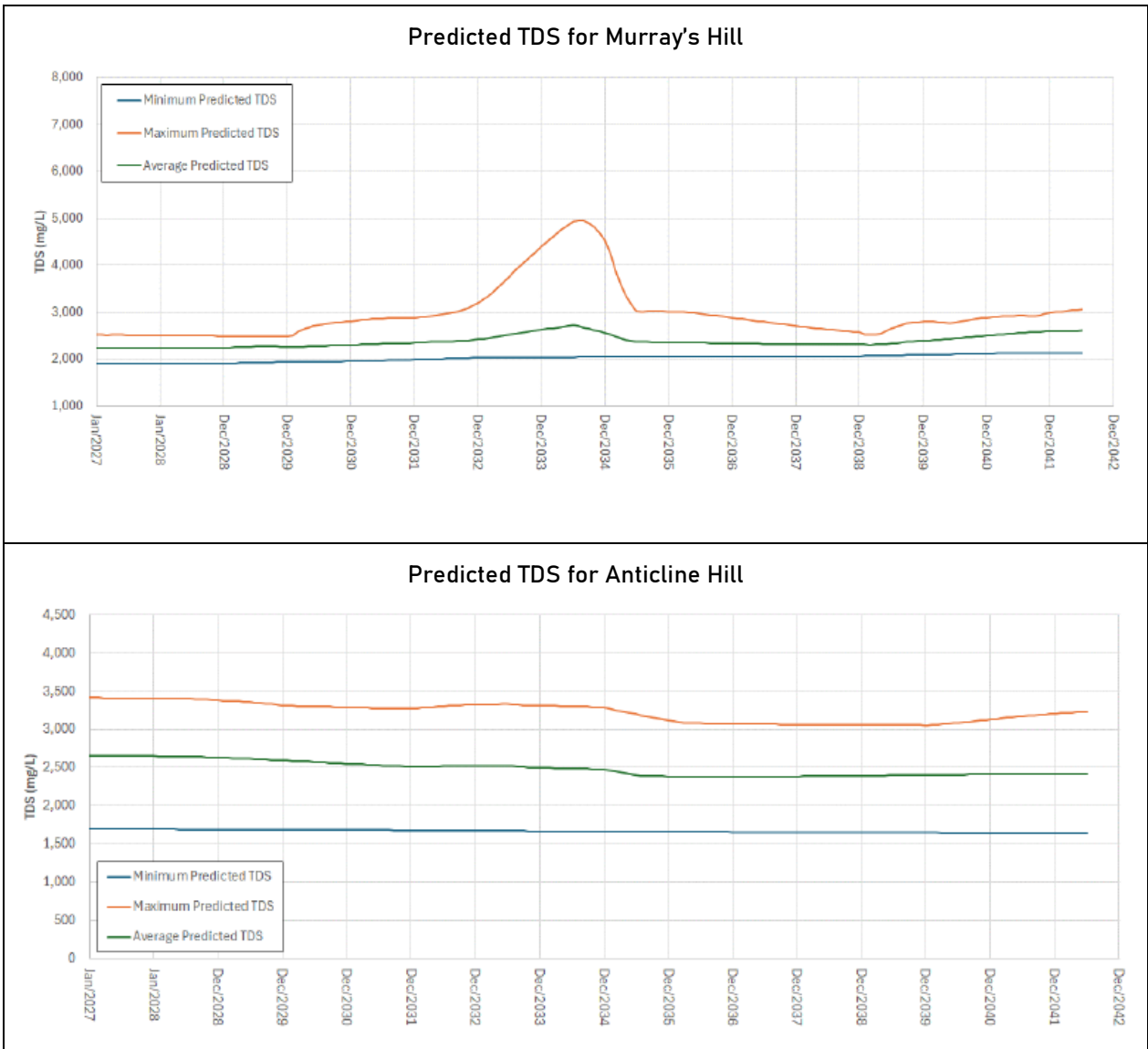


Figure 5.10 Predicted TDS of Dewatering Discharge for Western Mining Areas (GWC 2024)

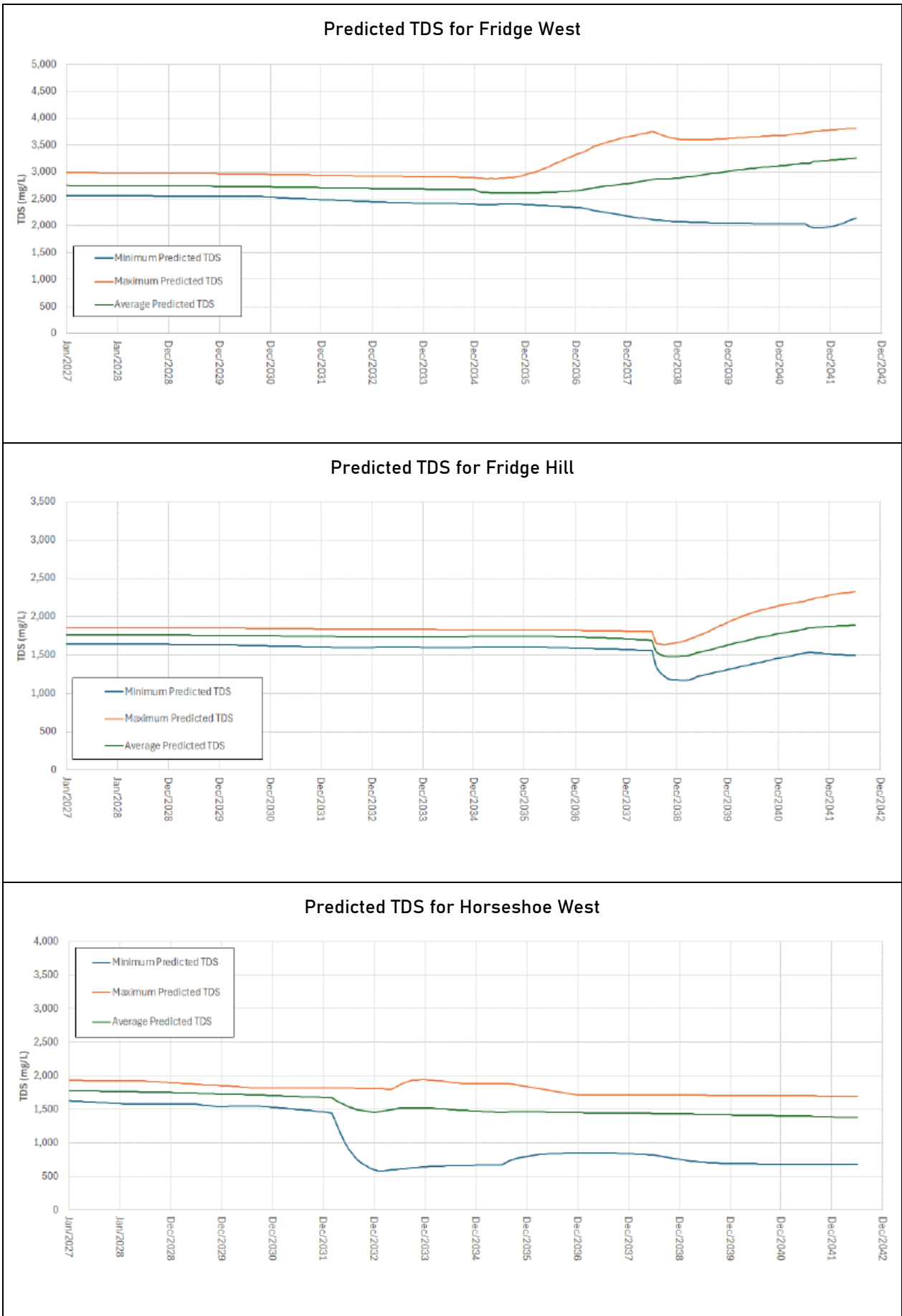


Figure 5.11 Predicted TDS of Dewatering Discharge for Eastern Mining Areas (GWC 2024)

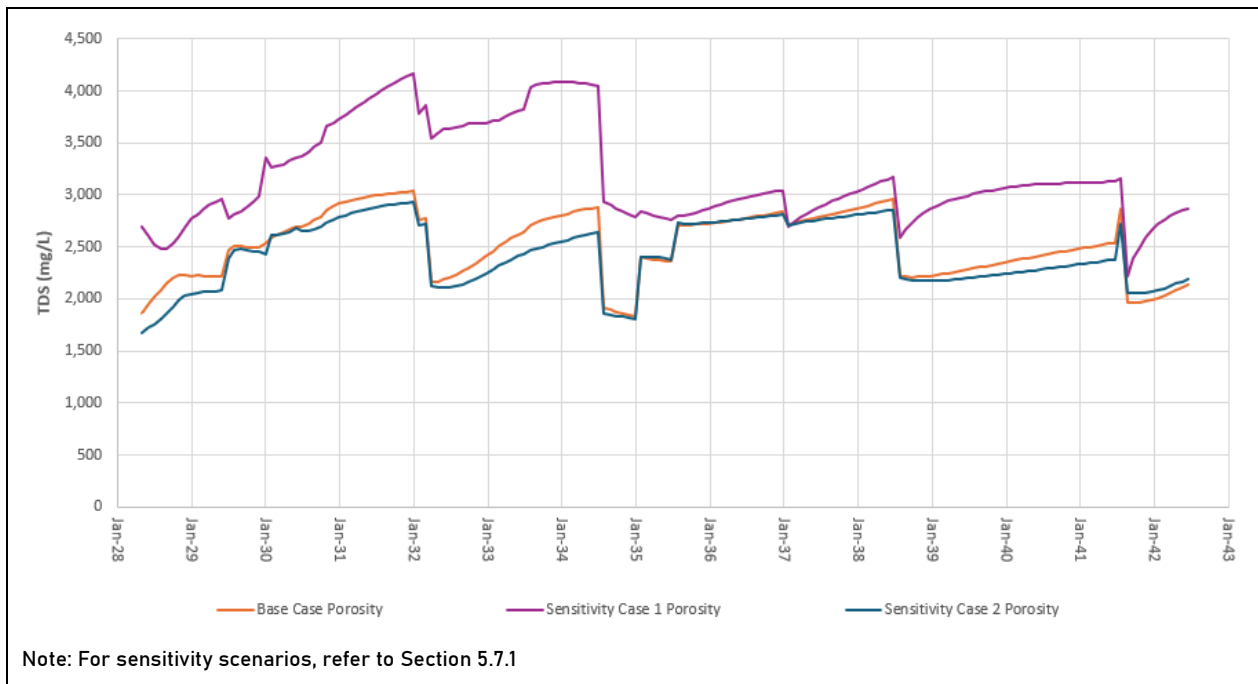


Figure 5.12 TDS Concentration Assigned to MAR Bores (GWC 2024)

5.5.6 Impact Assessment During Operations

Groundwater Levels

Predicted changes in groundwater levels resulting from the modelled dewatering and MAR have been plotted as drawdown / mounding contours for 11 time periods and are presented in Appendix F. Plots for the end of selected periods of dewatering / MAR and for the end of mining (June 2042) are presented in Figure 5.13 to Figure 5.15. The maximum extents of the predicted 1 m mounding and 2 m drawdown contours, throughout the LOM, are shown in Figure 5.16.

Predicted drawdown / mounding and groundwater levels (as depth below ground level) have also been plotted as hydrographs for various simulated observation points outside of the proposed mining areas (T1 to T18; locations shown in the drawdown contour plots). The full suite of hydrographs is presented in Appendix F, with several plots for the valley / claypan areas (with less available freeboard) presented in Figure 5.17.

The following observations are made regarding the predicted groundwater level changes:

- Maximum drawdowns are predicted in the active mining areas, with maximum drawdown depths of up to 25 m (i.e., allowing dry mining conditions for the proposed depths of mining).
- Drawdown is predicted to extend across the valley, away from the mining areas, however the extent of the drawdown along the strike of the valley is curtailed by MAR in both the east and the west of the Mulga East tenement for various periods through the LOM.
- The maximum extent of the predicted 2 m drawdown contour across the valley occurs between July 2038 and the end of mining July 2042, extending ~8 km south-southwest of Fridge West. The drawdown is not predicted to reach the Hamersley Range (nor the model boundary).
- The maximum extent of the predicted 2 m drawdown contour in the vicinity of the claypans occurs in October 2032, extending ~7.5 km south-southwest of the Murray's Hill mining area, across the Gnalka Gnoona Claypan area.

- The maximum western extent of the predicted 2 m drawdown contour occurs in January 2032, during the mining of Murry's Hill and prior to the commencement of MAR in the Murray's West Borefield; it extends ~6 km along strike to the west of the Murry's Hill mining area.
- The maximum eastern extent of the predicted 2 m drawdown contour occurs in July 2035, extending ~3.5 km to the east of the main Horseshoe West pit (HW05).
- Maximum peaks in groundwater level (mounding) of ~11 to 12 m are predicted in the Fridge / Horseshoe South MAR Borefield area in January 2032 and through the latter half of 2038, with predicted hydrographs for the down-gradient observation points (T14 and T16) showing more subdued mounding responses over these periods (refer Figure 5.17).
- The maximum extent of the 1 m mounding contour associated with the Fridge / Horseshoe South MAR Borefield is predicted to occur between January 2032 and July 2033, extending ~10 km to the south (across the valley) and ~5 km beyond the Mulga East tenement boundary in a southeasterly direction.
- Maximum peaks in groundwater level (mounding) associated with the Murray's West MAR Borefield and Murray's Hill / Anticline Hill MAR area are predicted to be ~4 to 6 m occurring in 2033 to 2034 and July 2035 respectively (refer Figure 5.17 observation points T1 and T4).
- The maximum extent of the 1 m mounding contour associated with the Murray's West MAR Borefield is predicted to in July 2034, extending ~7 km to the northwest (along strike) and ~5 to 5.5 km to the south and southwest (across the valley), in the vicinity of the Koojjeepindarranna Claypan.
- Predicted groundwater level hydrographs in the vicinity of the claypans (refer Figure 5.17 observation points T3 and T6), show only subdued responses to dewatering and MAR, with predicted groundwater levels remaining below the maximum mounding criterion of 2.5 mbgl.

Further discussion regarding the indirect impacts of groundwater drawdown and mounding is provided in Section 6.2.

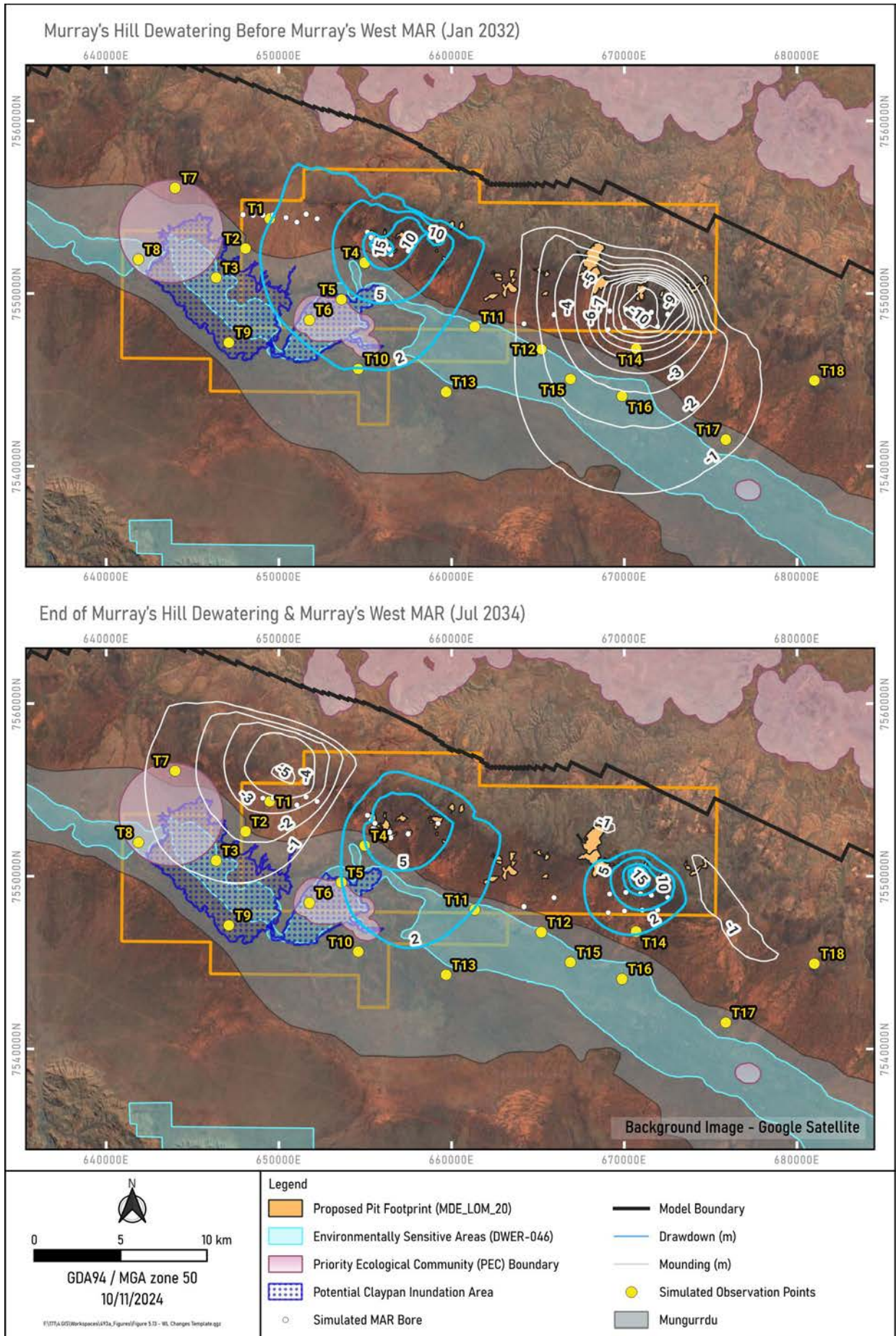
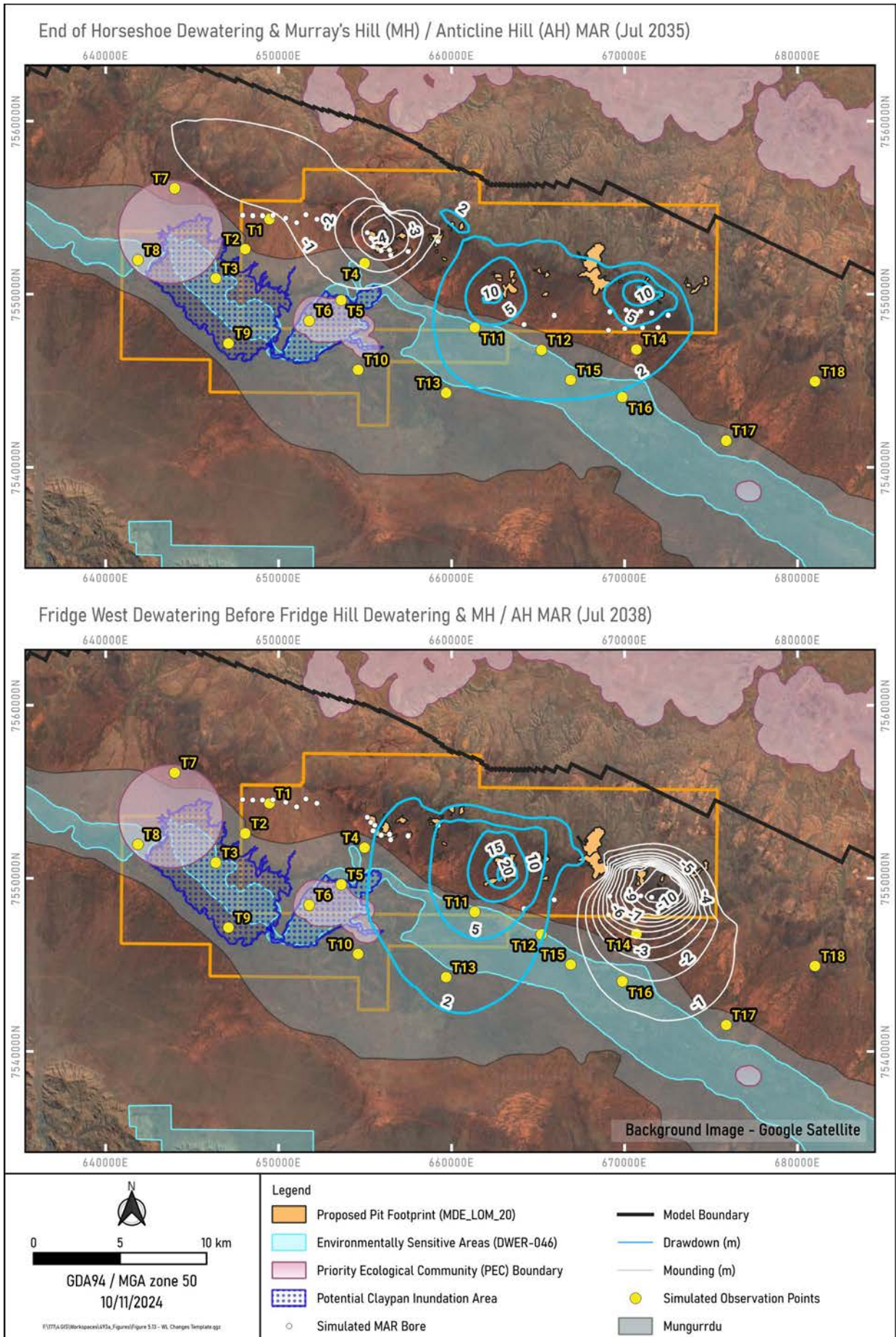


Figure 5.13 Predicted Groundwater Drawdown/ Mounding for January 2032 & July 2034 (from GWC 2024)



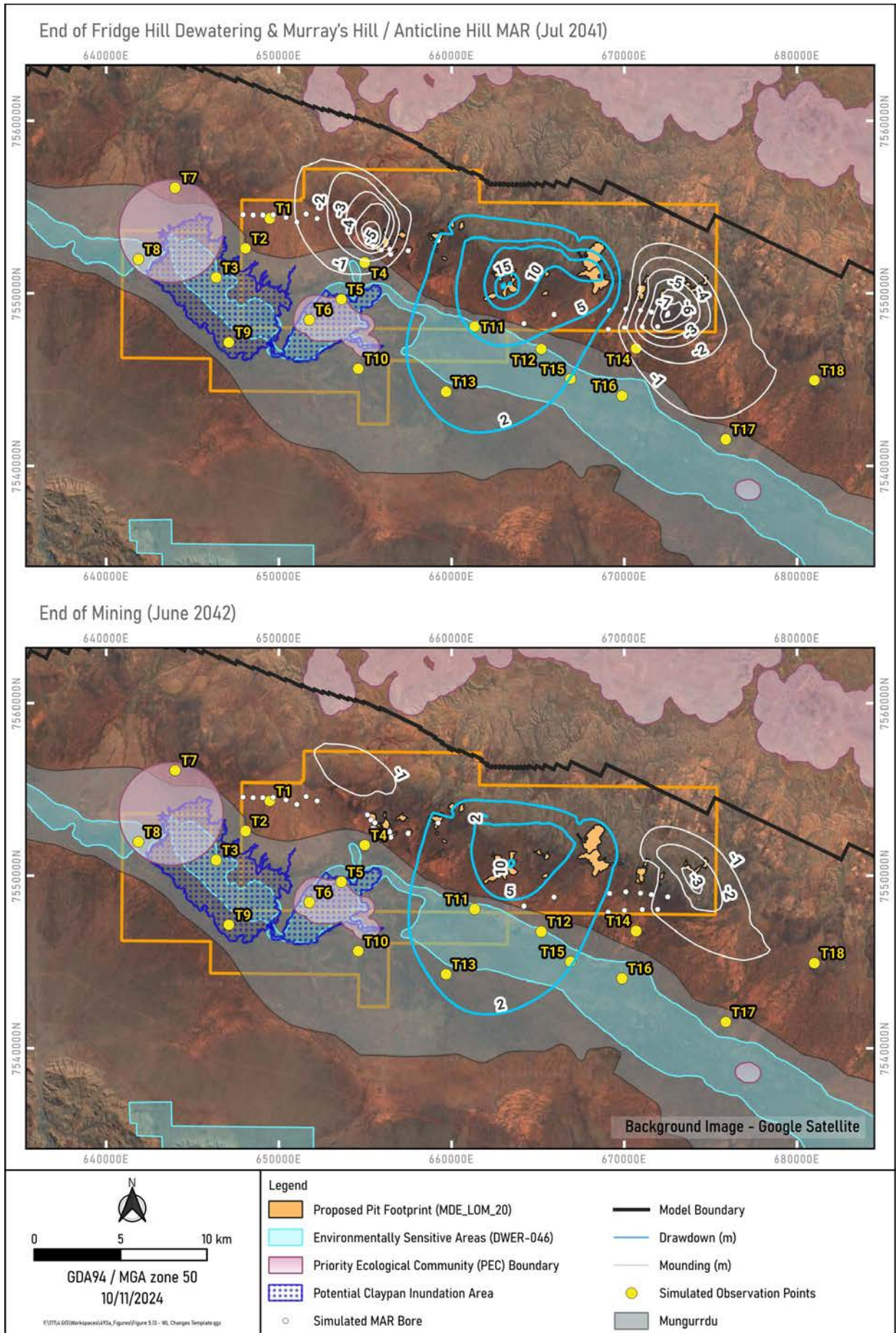


Figure 5.15 Predicted Groundwater Drawdown / Mounding for July 2041 & July 2042 (from GWC 2024)

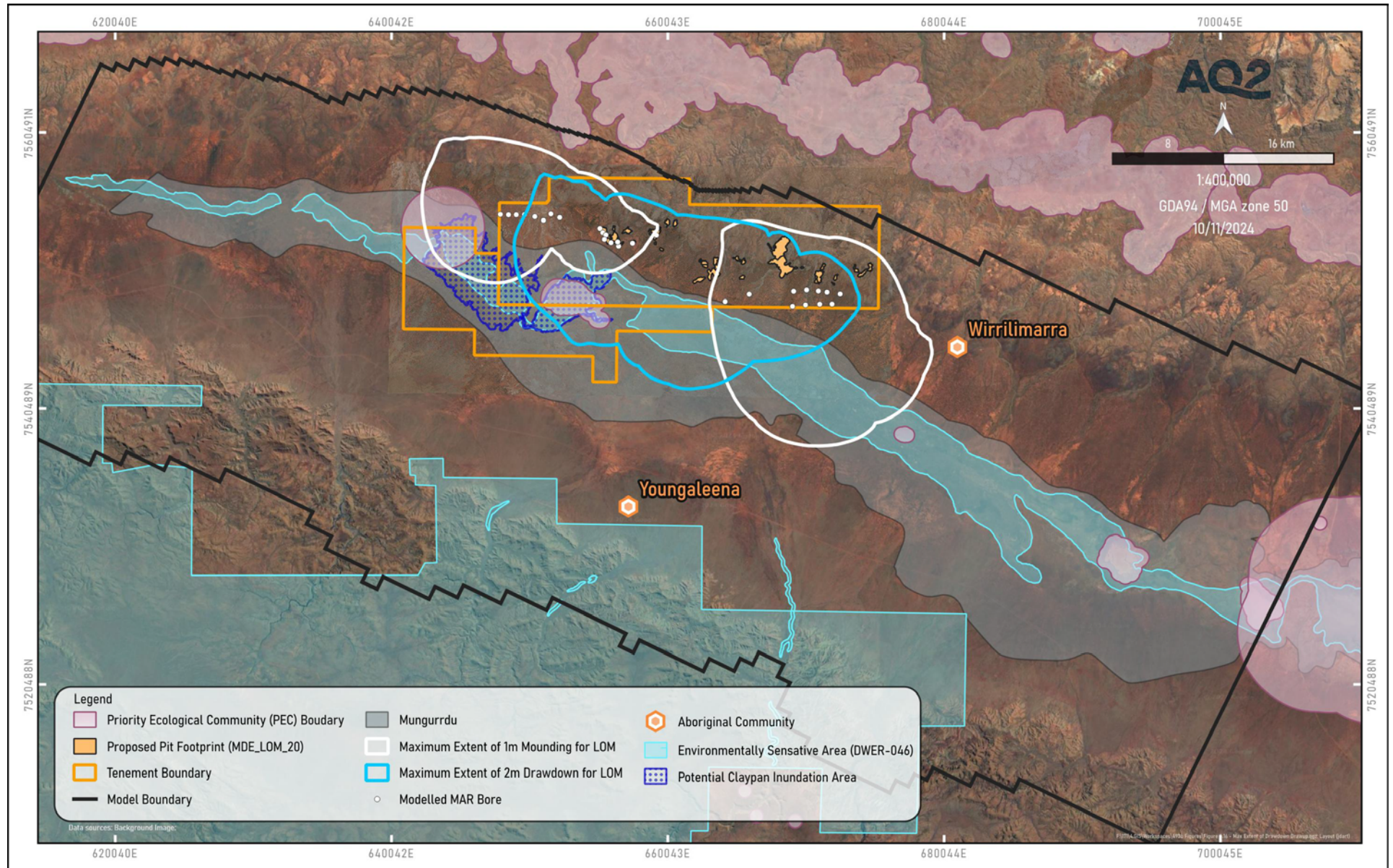


Figure 5.16 Maximum Extent of Predicted Drawdown and Mounding throughout LOM



Figure 5.17 Predicted Groundwater Level Hydrographs for Selected Simulated Observation Points (from GWC 2024)

Groundwater Quality

Groundwater salinity will change as a result of dewatering and MAR activities. The TDS of the combined dewatering discharge for all dewatering bores over LOM is predicted to range between 1,700 and 4,200 mg/L, taking into account the uncertainty associated with aquifer porosity, with this being the range of TDS concentrations that were then assigned to all MAR bores over the LOM (refer Figure 5.12).

Key observations from the predicted changes in dewatering discharge (Figure 5.10 to Figure 5.12) are as follows:

- The predicted TDS of the combined dewatering discharge water increases during the dewatering of Murray's Hill as more saline water is drawn in from the claypan areas; however, this trend is interrupted in 2032, with the introduction of fresher dewatering discharge from Horseshoe West.
- The predicted TDS of dewatering discharge for Fridge West is likely to increase as a result of more saline water being drawn from the valley area and / or the Fridge / Horseshoe South MAR Borefield area (where the more saline Murray's Hill dewatering discharge is re-injected).
- Although the predicted TDS of dewatering discharge for Fridge Hill is initially fairly fresh (i.e., in mid-2038), resulting in the salinity of the combined dewatering discharge also reducing, it is predicted to increase as more saline water is drawn from the Fridge / Horseshoe South MAR Borefield area.

Predicted groundwater salinity changes have also been derived for the simulated observation points (T1 to T18), outside of the mining areas, for the LOM (GWC 2024). The results of the base case predictions are plotted as hydrographs in Figure 5.18 and the following observations are made:

- Only minor fluctuations in salinity (<500 mg/L TDS) are predicted at all but three of the simulated observation points, with the three points (T1, T2 and T4) being closest to the proposed Murray's West and Murray's Hill / Anticline Hill MAR areas. This demonstrates the localised nature of the predicted salinity changes, resulting from the proposed dewatering and MAR activities.
- The greatest change in salinity is predicted at T1, in the Murray's West MAR Borefield area, yet it is predicted to remain below the tolerance limit for cattle (i.e. 5,000 mg/L). TDS at this location is predicted to increase from ~1,200 mg/L to 3,900 mg/L as a result of re-injecting more saline dewatering discharge from the Murray's Hill area. Upon the cessation of MAR in the Murray's West Borefield (in mid-2034), and the re-injection of fresher water to the adjacent Murray's Hill / Anticline Hill area, the predicted TDS at T1 reduces to ~3,000 mg/L.
- The predicted salinity at T4, down-slope from Murray's Hill, increases from ~3,600 mg/L to 4,600 mg/L during the mining (dewatering) of the Murray's Hill area, in response to more saline water being drawn from the claypan area. As with T1, the predicted TDS at T4 reduces slightly with the re-injection of fresher water to the adjacent Murray's Hill / Anticline Hill area.
- The predicted salinity at T2, between the Murray's West MAR Borefield and the Koodjeepindarranna Claypan, decreases from ~4,500 mg/L to 3,700 mg/L (in mid-2032), in response to the commencement of MAR in Murray's West. It is anticipated that this results from mounding in the MAR area causing the fresher, in situ water (rather than the re-injected water) from the Murray's West area to flow down-gradient towards the valley.

Particle tracking has also been undertaken to further assess the potential groundwater quality changes resulting from the proposed dewatering and MAR (GWC 2024). Figure 5.19 shows the predicted groundwater flow paths for the various dewatering and MAR areas throughout the LOM. The extent of the flow paths associated with dewatering, demonstrate the predicted capture zones for dewatering. The limited extent of these capture zones over the higher salinity valley areas, supports the limited changes to the salinity of the dewatering discharge (refer Figure 5.12). The groundwater flow paths for the MAR areas show the predicted injection zones for those areas (i.e., the extent that injected solutes will migrate) as well as the predicted recirculation of injected water to the Fridge Hill and Horseshoe West Pits.

Both the capture and injection zones demonstrate the localised nature (i.e., less than 2 km) of the predicted groundwater quality changes resulting from the proposed groundwater management activities.

In addition to groundwater salinity changes related to dewatering and MAR, changes to the groundwater quality may result from potentially acid forming materials exposed in the pit walls and / or groundwater contamination from potential sources such as waste rock dumps or spills.

Disseminated sulphides occur within the Jeerinah Formation, and potentially within the dolomitic shale at the base of the Nammuldi Member (DNAM). If potentially acid forming (PAF) material is exposed in mine workings and is coincident with water inflow, then there is the potential for produced water to become acidic. However, it is understood that excavation or exposure of PAF material in the pit walls is not anticipated at the Mulga Downs Iron Ore Mine.

It should be noted, that the risk of re-injection water becoming acidic or contaminated is low as this water will be sourced predominantly from ex-pit dewatering bores on the southern, down-dip side of the pits, rather than in-pit sump pumping.

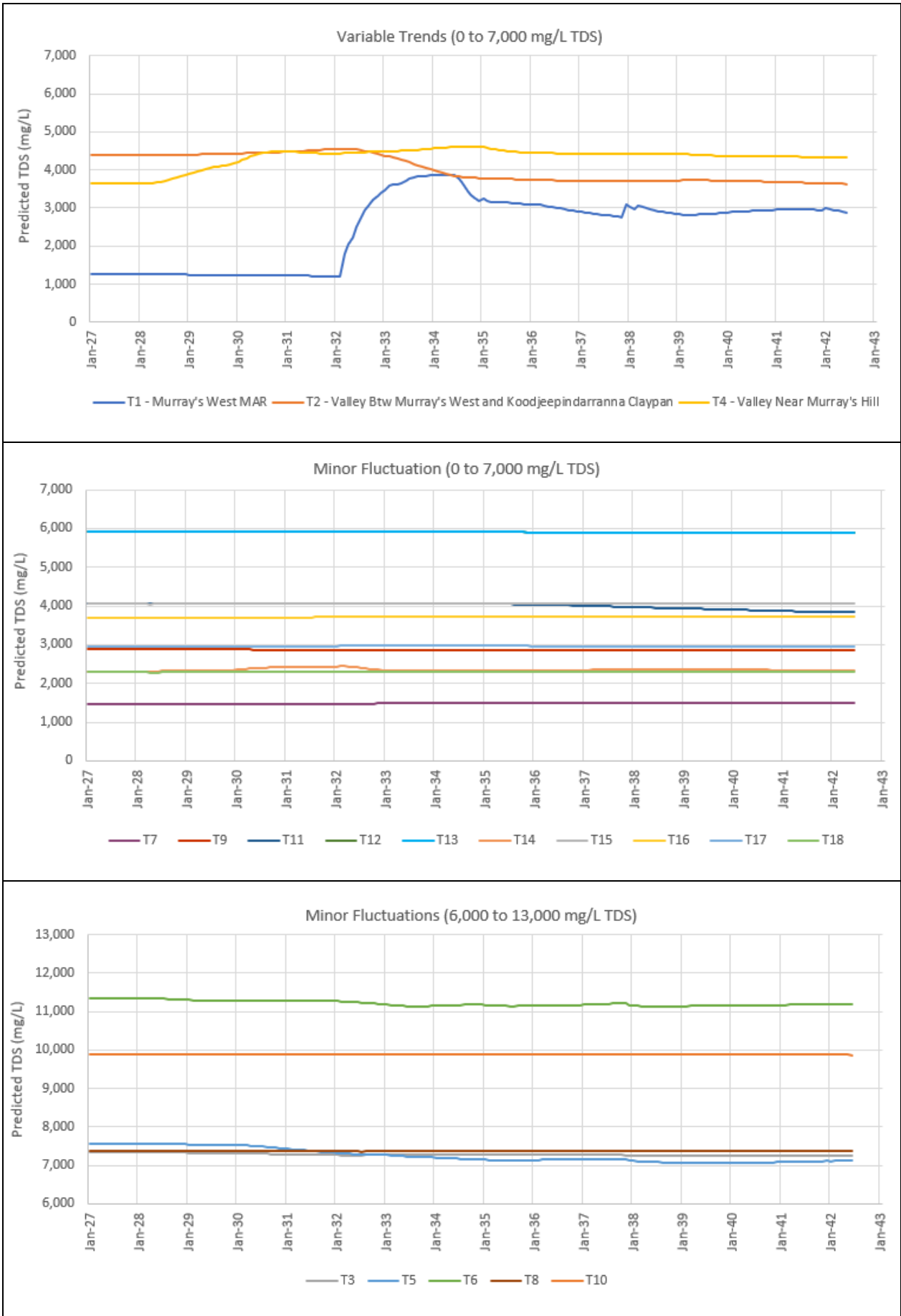


Figure 5.18 Base Case Predicted TDS for Modelled Observation Points (produced from GWC 2024)

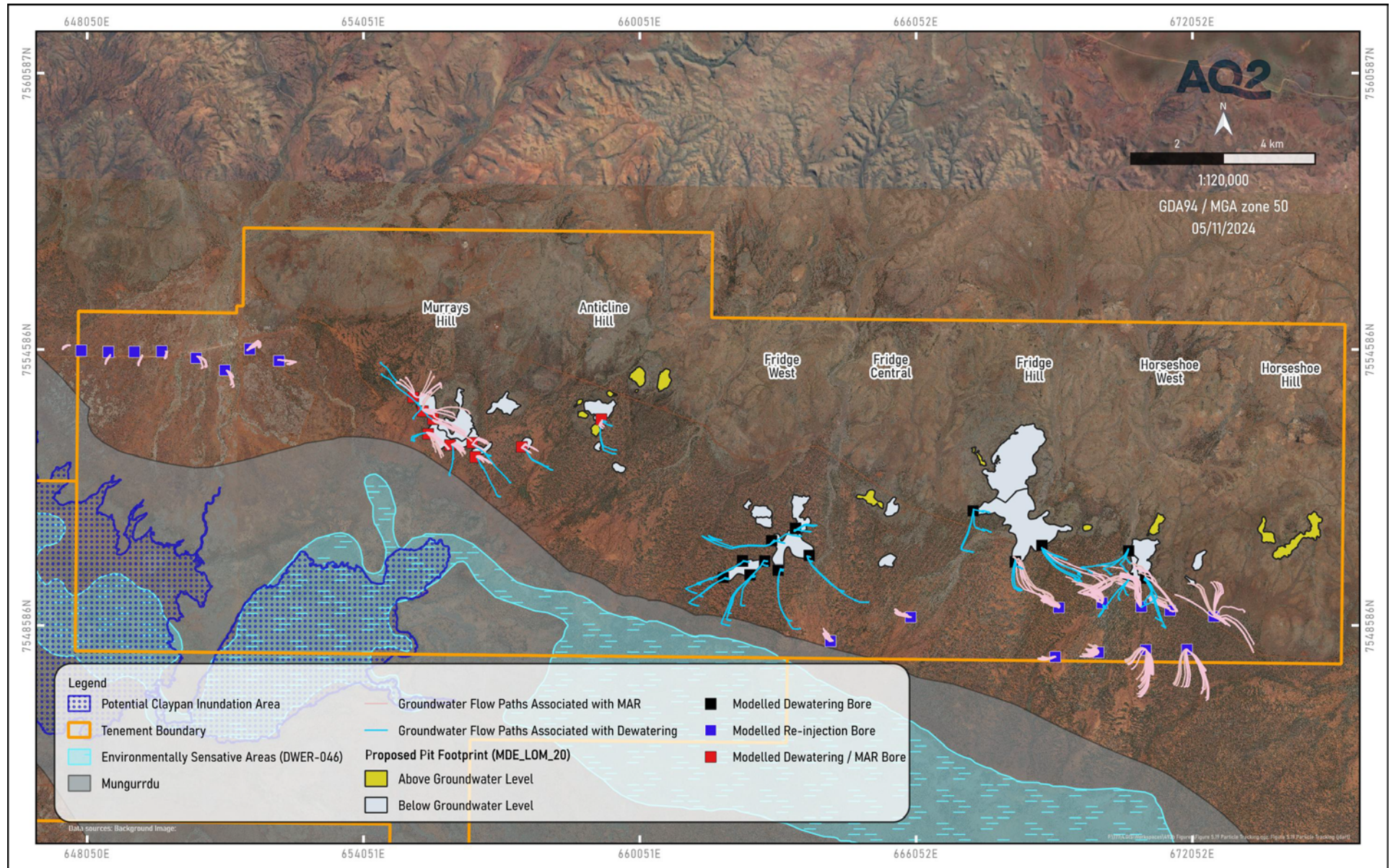


Figure 5.19 Base Case Predicted Groundwater Flow Paths (produced from GWC 2024)

5.5.7 Post-Mining Impact Assessment

HanRoy intend to backfill the pits post-mining to above the pre-mining groundwater level. Modelling of the groundwater system at closure has been completed by GWC with details presented in Appendix F. Closure predictions for the backfilled pits were completed from the end of mining (June 2042) until predicted groundwater levels in the Mulga Downs area recovered to a final or equilibrium level.

Two backfill scenarios were simulated:

- The aquifer parameters for the infill material were the same as those assigned to the Undifferentiated Tertiary unit, based on the assumption that this unit would mostly likely make up the waste material. This was considered the base case closure scenario.
- The aquifer parameters of the infill waste were the same as the Marra Mamba Ore (i.e., the mined-out material), with higher permeability and storage values than the Undifferentiated Tertiary unit.

Groundwater Levels

Representative hydrographs showing the predicted recovery of groundwater levels for each mining area are presented in Figure 5.20 and Figure 5.21. "Backfill_Waste" refers to the predictions adopting Undifferentiated Tertiary parameters for the backfill and "Backfill_In situ" refers to the predictions where Marra Mamba Ore parameters were adopted. There is negligible difference between the results of the two backfill scenarios.

It should be noted that the majority of groundwater level recovery has occurred prior to the commencement of the closure predictions (i.e., during the LOM), as the maximum depths of mining are reached approximately one year prior to the end of mining (refer Figure 5.3) and, as such, dewatering and MAR significantly reduces in the final year of mining (refer Figure 5.9). In particular, the western areas of Murray's Hill and Anticline Hill, which were mined (and dewatered) first and subsequently used for MAR have predicted water levels near to pre-mining water levels at the commencement of the closure prediction (refer Figure 5.20). As the Horseshoe South area is the last area used for MAR, groundwater levels in the nearby Horseshoe West mining area are recovering from mounding during the closure predictions (refer Figure 5.21).

The closure predictions show a rapid recovery of groundwater levels. GWC 2024 (Appendix F) reports that groundwater levels are predicted to recover to within 0.1 m of pre-mining levels, within 10 years of the cessation of mining, at all mining areas, MAR areas and regional simulated observation points (T1 to T18).

Groundwater Quality

The backfilling of the pits at the completion of mining eliminates any post-mining increases in groundwater salinity caused by evaporation from the pit lake surfaces.

No modelling of post-mining groundwater quality has been conducted to date, however, it is anticipated that the return of the groundwater salinity distribution to pre-mining conditions will take considerably longer (i.e., geological times scales) to achieve than the recovery of groundwater levels.

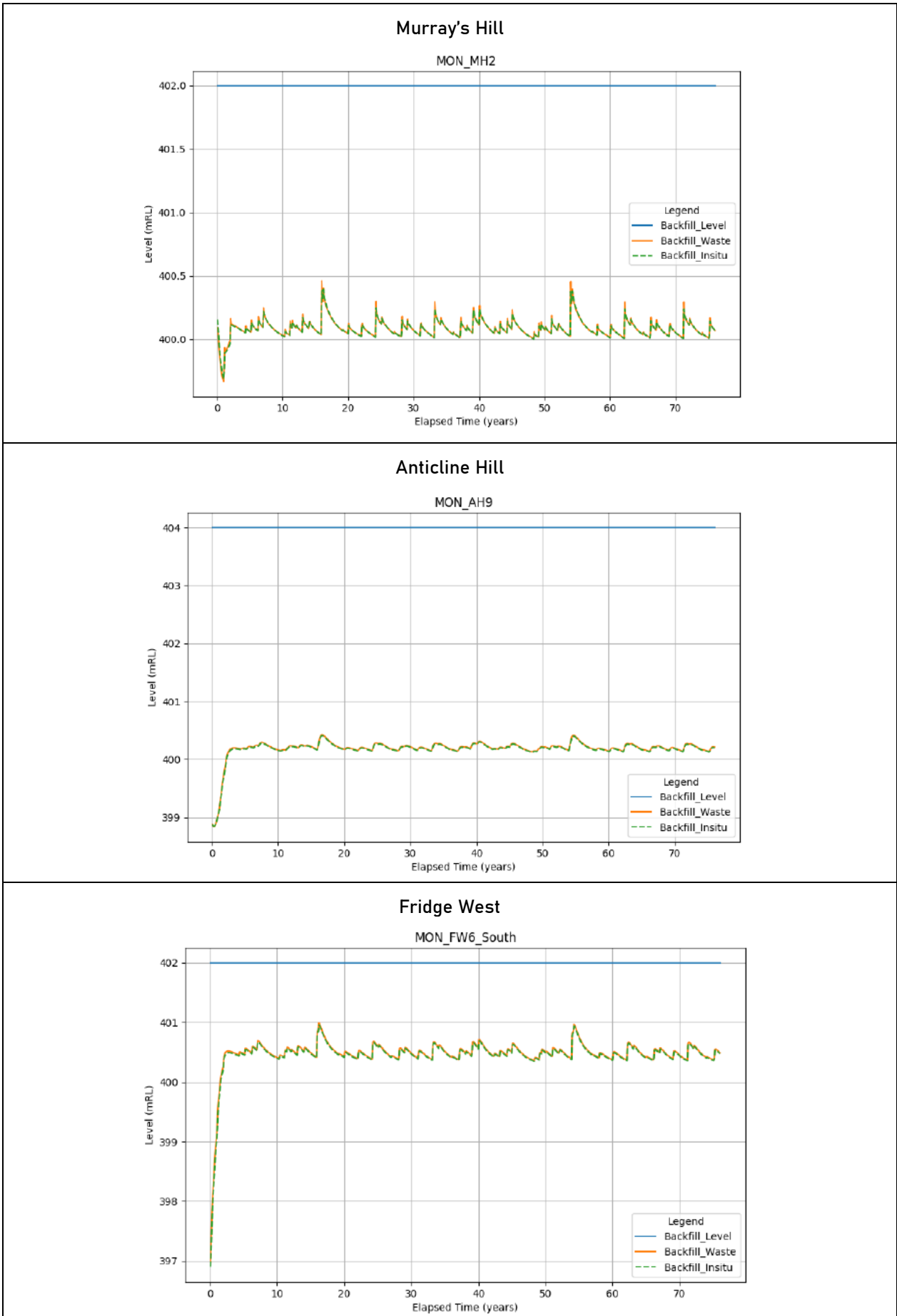


Figure 5.20 Predicted Groundwater Levels Post-Mining – Western Mining Areas (from GWC 2024)

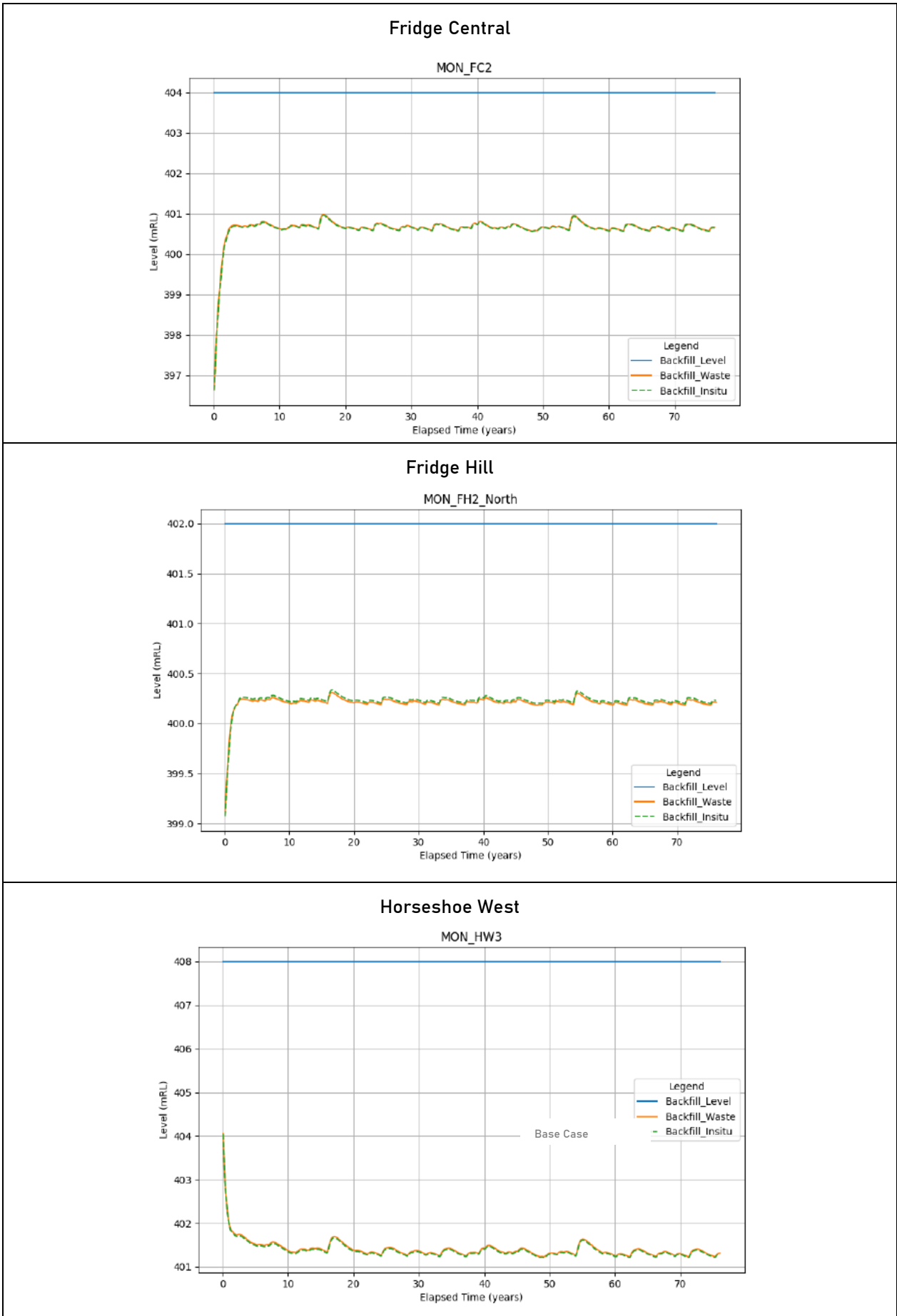


Figure 5.21 Predicted Groundwater Levels Post-Mining – Eastern Mining Areas (from GWC 2024)

5.6 Environmental Risk Assessment & Management Measures Relating to Groundwater

The environmental risks relating to groundwater and their associated risk ratings, before and after the application of mitigation measures, are presented in Appendix A. A detailed discussion of the proposed management measures is provided in the Water Management Plan (HanRoy 2024), with key management measures summarised below:

- Surplus water managed via MAR (i.e. via re-injection bores, repurposed dewatering bores and / or in-pit infiltration) to:
 - limit the extent of drawdown from the immediate mining area (accepting recirculation of groundwater).
 - limit the potential for the saline interface to rise as a result of hydrostatic changes in the broader cone of depression.
- Comprehensive baseline and operational monitoring of groundwater levels and groundwater quality to monitor impacts relating to dewatering and MAR; inclusive of on-going monitoring outside of the area of impact to provide further baseline data, thereby allowing differentiation between seasonal and mining-related changes.
- Operation of multiple MAR areas to allow flexibility of injection and periods of recovery (i.e., reduced injection in one area and increased in another) if required due to groundwater level or groundwater quality triggers being observed.
- Review of dewatering if groundwater level or groundwater quality triggers are observed and cannot be managed by modifying the distribution of MAR.
- Backfilling of the pits at closure to allow groundwater levels to return to near pre-development conditions and eliminate further changes to groundwater salinity resulting from evaporation from pit lakes.

In addition to the above management measures, monitoring data will be regularly compared to model predictions and, as necessary, the numerical model can be re-calibrated to recorded responses and used to re-assess integrated groundwater management and mining scenarios.

The potable water supply bores for the Wirrilimurra and Youngaleena Communities are located outside of the predicted maximum extent of the 1 m mounding and 2 m drawdown contours (refer Figure 5.16) and the predicted injection zones (refer Figure 5.19). It is therefore not anticipated that either the quantity or quality of the Community water supplies will be affected by the proposed dewatering and MAR activities. However, should the water supplies be unduly impacted, an alternative supply will need to be provided.

5.7 Technical Risk Assessment

Residual technical uncertainty may alter the proposed management of groundwater and therefore affect the potential groundwater related impacts. Key uncertainties are:

- Uncertainties related the conceptual hydrogeological model.
- Uncertainties related to climate variability.

The following sections outline assessments that have been undertaken related to these technical risks.

5.7.1 Model Uncertainty

While significant fieldwork has been conducted to derive the current conceptual hydrogeological model and the assigned aquifer parameters, the numerical model has been used to assess the uncertainty in predicted groundwater drawdown and / or mounding at the identified environmental observation points (T1 to T18). This uncertainty analysis was undertaken by GWC (2024), in accordance with the Groundwater Modelling Guidelines (Barnet et al 2012) and the IESC Guidelines (IESC 2024), and is detailed in Appendix F.

Based on the model set-up and the Medium risk-ranking of groundwater-related impacts (refer Appendix A), a linear error propagation approach was adopted for the uncertainty analyses. By adopting this methodology, the following could be derived, for the range of parameters presented in Table 5.2:

- The probability of the predicted groundwater level at each of the simulated observation points (T1 to T18) exceeding the maximum mounding criterion (i.e., 2.5 mbgl), in response to the simulated base case dewatering and MAR.
- The contributions to predicted uncertainty variance (or relative sensitivity to parameter variation) at each of the simulated observation points.

Table 5.2 Simulated Range of Aquifer Parameters

| Unit | | Horizontal Hydraulic Conductivity, Kh (m/d) | | Specific Yield, Sy (%) | | Specific Storage, S (unitless) | |
|----------------|---|---|------|------------------------|-----|--------------------------------|----------------------|
| | | Min | Max | Min | Max | Min | Max |
| Tertiary Cover | Upper Calcrete | 1 | 20 | 1 | 10 | 1 x 10 ⁻⁷ | 1 x 10 ⁻⁵ |
| | Undifferentiated Tertiary | 1 | 15 | 1 | 5 | | |
| | Pisolite / CID | 5 | 25 | 1 | 10 | | |
| | Basal Crete | 0.5 | 15 | 1 | 5 | | |
| Bedrock | Brockman Fm | 0.0001 | 0.01 | 0.1 | 0.5 | | |
| | Fresh Dolomite of Wittenoom Fm | 0.001 | 0.1 | 0.1 | 1 | | |
| | Weathered West Angela Mbr | 0.01 | 5 | 0.1 | 1 | | |
| | West Angela Hardcap | 5 | 40 | 1 | 10 | | |
| | West Angela Hardcap (in the vicinity of bore MDPB0020)** | 20 | 150 | 1 | 10 | | |
| | Marra Mamba / West Angela Ore (includes sub-mineralised halo) | 10 | 50 | 1 | 10 | | |
| | Unmineralised / Fractured Marra Mamba (Mulga East) | 1 | 20 | 0.1 | 2 | | |
| | Unmineralised Marra Mamba (Regional) | 0.0001 | 0.1 | 0.1 | 1 | | |
| | Fresh Marra Mamba / Jeerinah | 0.01 | 0.1 | 0.1 | 1 | | |

*A kh:kv ratio of 10:1 was maintained consistent with the base case model.

Key findings from the uncertainty analyses are as follows:

- Groundwater levels are predicted to remain below the proposed maximum mounding criterion of 2.5 mbgl at all simulated observation points except T1 and T4 throughout the LOM.
- Simulated observation points T1 (in the Murray's West MAR Borefield area) and T4 (down-gradient from the Murray's Hill mining (dewatering / MAR) area) were identified as sites where groundwater levels resulting from MAR could potentially exceed the maximum mounding criterion, set at 2.5 mbgl.
- Based on the defined narrative descriptors of the ISEC Guidelines (2024):
 - It is "as likely as not" that the predicted mounding at T1 would exceed the 2.5 mbgl maximum mounding criterion.
 - It is "unlikely" that the predicted mounding at T4 would exceed the 2.5 mbgl maximum mounding criterion.

- Predicted groundwater levels at T1 are most sensitive to:
 - Hydraulic conductivity of Unmineralised / Fractured Marra Mamba, CID/Pisolite and Undifferentiated Tertiary units, as these aquifer parameters will affect the hydraulic connection between the Murray's West MAR Borefield area and the Murry's Hill mining (dewatering / MAR) area, resulting in more or less mounding or drawdown.
 - Storage parameters of the Upper Calcrete as these will affect the MAR capacity and associated responses to MAR in this area.
 - Hydraulic conductivity of the Fresh Marra Mamba / Jeerinah hydrostratigraphic unit as this unit hosts the constant head inflow boundary on the northern edge of the model and therefore affects the groundwater inflow in the T1 area.
- Predicted groundwater levels at T4 are most sensitive to:
 - Hydraulic conductivity of Unmineralised / Fractured Marra Mamba and Marra Mamba Ore as these aquifer parameters will affect the hydraulic connection between the T4 observation point and the nearby Murry's Hill mining (dewatering / MAR) area.
 - Storage parameters of the Unmineralised / Fractured Marra Mamba (specific storage) and Marra Mamba Ore (both specific storage and specific yield) as these will also affect the responses to the dewatering and MAR in this area.

Hydraulic conductivity of the Fresh Marra Mamba / Jeerinah hydrostratigraphic unit as this unit hosts the constant head inflow boundary on the northern edge of the model and therefore affects the groundwater inflow in the T4 area.

As the uncertainty analysis defines the likelihood of exceeding the maximum mounding criterion (i.e., 2.5 mbgl), the accuracy related to determining this criterion, in terms of an elevation in the model, should also be identified. The use of SRTM data as opposed to LiDAR data for the modelled ground surface is a limitation in this respect, as is the calibration of modelled groundwater levels to inferred elevations where access prevents measured groundwater levels. This is further discussed in Section 6.2.

The modelling provides valuable guidance for identifying areas of risk and input to water management plans for the Project. The modelling coupled with a comprehensive water management plan (detailing monitoring and response strategies such as redistribution of MAR) will ensure that exceedances of the maximum mounding criterion at any sensitive location will be avoided

In addition to the uncertainty assessment outlined above, a sensitivity analysis has been conducted on the modelled porosity values (GWC 2024), as the porosity values are not calibrated or constrained by the model calibration completed to date. The porosity values are used for particle tracking and solute transport modelling, with lower porosity values allowing increased flow velocities. As detailed in Appendix F, base case porosity values were both lowered (equivalent to the unconfined storage values) and increased.

Salient points from the sensitivity analysis using lower porosity values (resulting in the more detrimental impacts) are as follows; it should be noted, however, that aquifer porosity will generally be higher than unconfined storage (noting however that effective porosity can be significantly lower than total porosity). Notwithstanding, the resultant flow velocities for this simulation should be considered as a worst-case or, more likely, overestimates:

- The more saline groundwater from the claypan areas reaches Murray's Hill (the mining area closest to the claypans) sooner, with the predicted maximum TDS of dewatering discharge in this area increasing to ~7,100 mg/L as compared to ~5,000 mg/L for the base case.

- Similarly, the more saline groundwater from the valley area reaches Fridge West (the next closest mining area to the valley) sooner, with the predicted maximum TDS of dewatering discharge in this area increasing to ~4,800 mg/L as compared to ~3,800 mg/L for the base case.
- The predicted TDS of the combined dewatering discharge for all dewatering bores over the LOM varies between 2,300 and 4,200 mg/L for the low porosity simulation as compared to 1,800 to 3,000 mg/L for the base case (with this being the TDS concentrations that were then assigned to all MAR bores over the LOM). The greatest difference between the low porosity and base case simulations occurs in the first 6 years of mining, due to the increased salinity predicted in the Murray's Hill area.
- The increased TDS of the MAR water for the low porosity scenario results in earlier and higher predicted increases in salinity in the Horseshoe West mining area (with a maximum predicted TDS of 3,500 mg/L as compared to ~2,000 mg/L for the base case) due to the proximity of this area to the Fridge / Horseshoe South MAR Borefield.
- Similarly, the earlier and higher predicted increases in TDS in the Fridge Hill area during the final six years of the LOM (with a maximum predicted TDS of 3,000 mg/L as compared to ~2,300 mg/L for the base case) are due to the increased TDS of the MAR simulated in the Fridge / Horseshoe South MAR Borefield. This also results in the predicted increase in TDS (as compared to the base case) for the combined dewatering discharge over this period.
- In the Murray's West MAR Borefield area (i.e., at the T1 simulated observation point), the TDS for the low porosity scenario is predicted to increase from ~1,200 mg/L to ~4,700 mg/L, as compared to a maximum of 3,900 mg/L for the base case. This results from the re-injection of more saline dewatering discharge from the Murray's Hill area. Upon the cessation of MAR in the Murray's West Borefield (in mid-2034), and the re-injection of fresher water to the adjacent Murray's Hill / Anticline Hill area, the predicted TDS for the low porosity scenario at T1 reduces to ~3,500 mg/L (as compared ~3,000 mg/L for the base case).
- At the other simulated observation points, the greatest predicted fluctuations in TDS for the lower porosity scenario, as well as the greatest divergences from the predicted base case TDS, are at T4 (down-slope from the Murray's Hill mining area) and T14 (down-slope from the Fridge / Horseshoe South MAR Borefield). At T4, the maximum predicted TDS for the low porosity scenario reaches ~5,600 mg/L (as compared to ~4,600 mg/L for the base case). This exceeds the 5,000 mg/L TDS guideline limit for beef cattle. However, the predicted TDS for the low porosity scenario also shows much greater reductions in salinity (as compared to the base case), when the nearby Murray's Hill / Anticline area is used for MAR; reducing to ~3,300 mg/L at the end of mining. At T14, the maximum predicted TDS for the low porosity scenario reaches ~3,900 mg/L (as compared to ~2,400 mg/L for the base case).

As per the above-mentioned management measures, on-going review of monitoring data will highlight the need for the potential re-calibration of the model to recorded responses and re-assessment of integrated groundwater management and mining scenarios.

5.7.2 Climate Variability

Climate projections for the Pilbara region do not compare well with observed regional climate trends, with the observed historical climate variability being stronger than the climate change signal (DWER 2015). Therefore DWER (2015) suggests the use of long-term historical climate rather than the Pilbara scenarios for water resource planning, as the scenarios are not representative of what may happen in the future. Although considerable uncertainty surrounds the scenarios for these regions, the temperature and potential evapotranspiration projections may still be appropriate for use for some applications.

To assess the potential impact of climate variability, namely rainfall variability, GWC has undertaken a sensitivity analysis on the modelled closure simulations (refer Appendix F). As reported by GWC, the simulations were based on the rainfall projections by CSIRO (CSIRO 2015) which documents the projected

range between wet and dry periods for the Mulga Downs area (i.e., the Rangelands - North projection area). The rainfall sequence used in the base case closure model (i.e., a repeated data set of monthly rainfall for the period 1960 to 1982) was increased by 27% to simulate a wet climate and reduced by 27% to simulate a dry climate. No changes to the simulated ET rates were included in model predictions.

The results, presented in Appendix F, show:

- For the simulated dry climate scenario (where the rainfall recharge of the base case closure model was reduced by 27%), the predicted aquifer recovery was up to 37% slower than that of the base case closure model. That is, the recovery of the groundwater level to within 0.1 m of the pre-mining level occurred between <0.5 to 2 years slower than the base case.
- For the simulated wet climate scenario (where the rainfall recharge of the base case closure model was increased by 27%), the predicted aquifer recovery was up to 40% faster than that of the base case closure model. That is, the recovery of the groundwater level to 0.1 m below the pre-mining level occurred 1.3 to <0.5 years faster than the base case.

6. ECOHYDROLOGICAL IMPACT ASSESSMENT

6.1 Overview

Implementation of the Project will result in changes to the hydrological regime of the Fortescue Valley within and proximal to the Study Area. Relevant mechanisms of change include:

- Groundwater drawdown caused by orebody dewatering.
- Groundwater mounding caused by the discharge of surplus water via MAR.
- Surface catchment modifications resulting in changed surface water regimes, in particular reduced inflows to portions of the valley environment.

The conceptual ecohydrological model provides a basis for evaluating how these changes could affect the Fortescue Valley vegetation and claypans.

6.2 Groundwater Drawdown and Mounding

As detailed in Section 5, ongoing groundwater management associated with orebody dewatering and disposal of surplus water will be required over the life of the Project. Numerical groundwater modelling has been undertaken (GWC 2024, Appendix F) to predict the dewatering and MAR rates required to meet the proposed mining scenario, as well as the associated changes in groundwater levels across the Study Area, throughout the LOM.

A schematic description of the effect of altered groundwater levels on the Fortescue Valley *E. victrix* woodlands and adjacent claypans is shown in Figure 6.1. Salient aspects are as follows:

- Given that the vegetation is inferred to be disconnected from the groundwater system under baseline conditions, a reduction in groundwater levels is not predicted to impact the terrestrial environment. A lowered water table would increase the thickness of unsaturated sediments, which may slightly reduce the responsiveness of the aquifer to recharge events. However, these sediments are not considered to be accessible to plant root systems.
- Groundwater mounding will also not impact the terrestrial environment if there is no interaction between the water table and the overlying soil profile occupied by tree roots, either by direct intersection or via capillary rise. Based on the ecohydrological conceptual model and measured baseline conditions, the threshold groundwater depth above which interaction with vegetation may occur is estimated to be about 2.0 mbgl (AQ2 2024). If water levels rise above this threshold, the following system responses are predicted:
 - Tree roots that become inundated for more than a few weeks to months will senesce, due to oxygen deficiency, effectively pruning the deeper roots. Consequently, vadose storage of Plant Available Water (PAW) will be reduced, although soil water depletion in this zone during drought phases would be partially offset by inputs from capillary rise. If sustained over long periods, this could result in vegetation leaf area index adjustments (either increased or decreased) based on the net effect of interactions between climate (droughts or floods) and soil water replenishment processes. Note that in the extreme case of prolonged saturation of the entire root system, tree deaths could occur.
 - Owing to impeded drainage in the valley environs, waterlogging associated with flood events may be more spatially extensive and of longer duration, causing increased exposure of vegetation to this stress agent relative to baseline conditions.
 - Salt may accumulate in the upper soil profile resulting from the combined effects of increased evaporative concentration and/or reduced salt leaching into the deeper profile. If sustained over long periods, this could have adverse impacts on vegetation health by reducing soil water extractability. Claypan water quality could also be affected by increased salt loads.

- With the recession of water table associated with decreased MAR, surviving tree root systems (i.e., above zone of prolonged saturation) would be expected to gradually recolonise the desaturated zone down to root impeding layers and salt flushing processes would be reinstated. However, the rate of system recovery is difficult to predict and it may be limited to younger trees and/or recruits (where the root systems of older trees have become determinate).

Accordingly, potential negative impacts on *E. victrix* woodland vegetation communities are associated with groundwater mounding into the vegetation root zone. The magnitude of impacts is likely to be directly proportional to the duration of elevated water levels and the degree to which root systems are exposed to inundation.

The maximum extents of groundwater mounding as a result of the proposed MAR have been predicted using the numerical groundwater model over the life of the Project (refer Section 5.5.6) and an analysis has been undertaken to assess uncertainties relating to the aquifer parameters (refer Section 5.7.1). To assess uncertainties relating using SRTM ground elevation data in the groundwater model, the model mounding outputs, together with the regional depth to groundwater data, have been used to identify areas where there is a risk of maximum groundwater levels lifting to within 2.0 m of the ground surface (i.e., 2 mbgl). These areas are shown in Figure 6.2; they occur down gradient from the Fridge / Horseshoe South MAR Borefield and the Murray's Hill / Anticline Hill MAR area coinciding with the break of slope. Also shown in Figure 6.2 is the location of the ecohydrological unit associated with the occurrence of *E. victrix* woodland communities (i.e., the "Loamy Flats EHU, refer Section 2). The predicted drawdown / mounding hydrographs from the numerical groundwater modelling for key locations in the Fortescue Valley are shown in Figure 6.3.

Salient aspects regarding the modelled groundwater mounding are summarised as follows:

- When interpreting Figure 6.2, it is important to recognise that there are no measured groundwater levels off-tenement (i.e., to the south of the Fridge / Horseshoe South MAR Borefield) owing to access restrictions. Therefore the depths to groundwater in these areas are inferred. Accordingly, the predictions of groundwater rising above the 2 mbgl threshold are indicative only; they should not be regarded as certain or spatially definitive. Rather these areas are at risk of exposure to shallow water tables for periods of time making them a focus for ongoing monitoring and adaptive management. Higher risk is associated with greater durations of elevated water levels.
- As indicated in Figure 6.2 and Figure 6.3, very little groundwater mounding is predicted in proximity to the claypan areas. Therefore, the risk of groundwater rising above the 2 mbgl threshold is negligible.
- Predicted peaks in water levels in the area to the south of Murray's Hill are temporary and recede in a matter of months (refer Figure 6.3). In this area the risk of groundwater rising above the 2 mbgl threshold is considered to be low.

Longer term peaks in water levels to the south of the Fridge / Horseshoe South MAR Borefield are predicted (refer Figure 6.3). In this area the risk of groundwater rising above the 2 mbgl threshold is considered to be high. However, the topographic surface in the groundwater model for this area is based on SRTM data for which the predicted water levels did not trigger a requirement to reduce MAR and lower water levels. Therefore, further optimisation and redistribution of MAR to reduce groundwater mounding in this area is possible under an adaptive management framework.

In overall terms, potential impacts to the Fortescue Valley *E. victrix* woodland communities from groundwater mounding are likely to be spatially restricted and transient over the life of the Project. However, given the level of uncertainty associated with predictive modelling of groundwater levels, and noting that the tolerance of vegetation to groundwater level change is site specific and not easily determined, a program of ongoing monitoring of groundwater levels and vegetation health over the life of the Project is warranted.

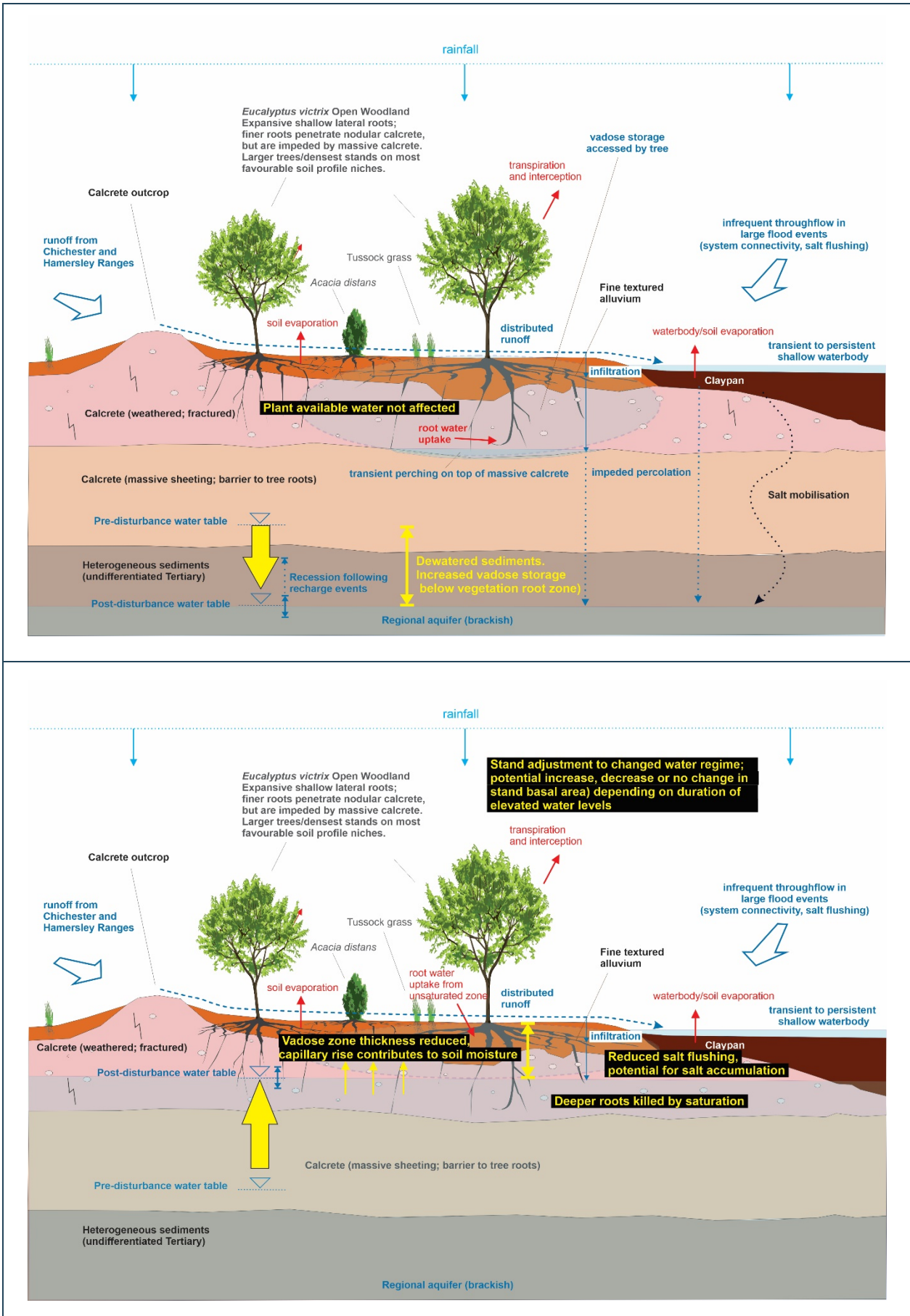


Figure 6.1 Predicted system responses to lowered (top) or lifted (bottom) water tables in the Fortescue Valley environs

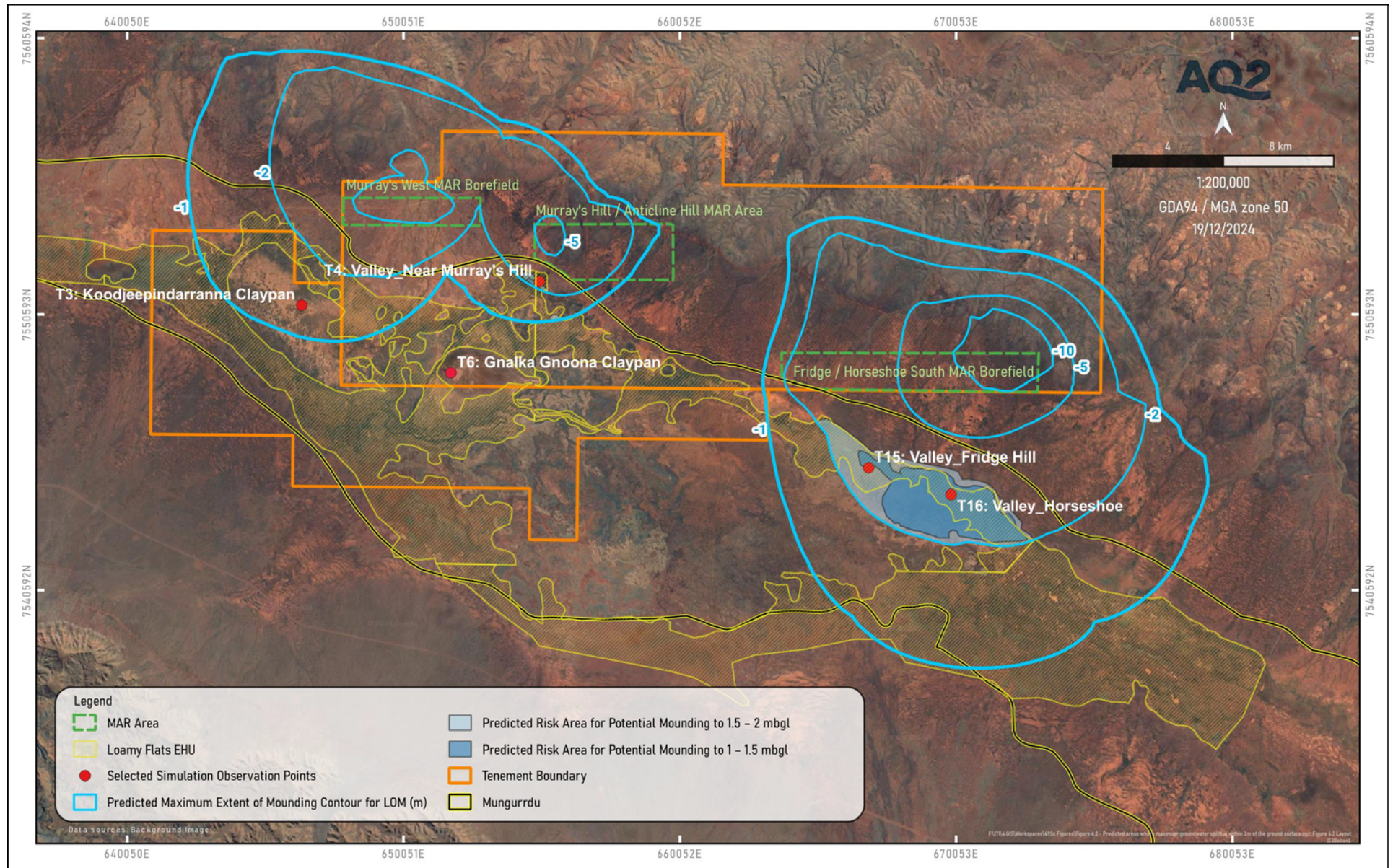




Figure 6.3 Predicted Drawdown / Mounding Hydrographs for the Valley Area (reproduced from GWC, 2024)

6.3 Surface Water Change

6.3.1 Characterisation of Surface Water Change

Two broad types of changes to the surface water regime are anticipated under the LOM Development scenario:

- Increase in flood levels caused by increased inflows from upgradient areas. By inference, this would be associated with greater infiltration and soil water replenishment relative to the baseline condition. Potentially, the duration of soil saturation immediately following rainfall and flow events could be increased. Prolonged waterlogging can be detrimental to plants by drowning and killing root systems; and
- Reduction in flood levels caused by reduced inflows from upgradient areas. By inference, this would be associated with less infiltration and soil water replenishment relative to the baseline condition. The significance of reduced soil water replenishment is principally related to the rate of PAW depletion between replenishment events, which is a function of soil water storage capacity, vegetation density/leaf area index and the duration of drought phases. Vegetation can naturally adjust to reduced soil water availability by down regulating plant water use (e.g., stomatal closure) or reducing leaf area index (via leaf shedding or in more extreme cases vegetation density reduction by partial senescence).

Importantly, the hydrological impact assessment identifies that all baseline hydrological processes in the Study Area will be maintained. The predicted hydrological change primarily relates to the magnitude and duration of flooding events.

As detailed in Section 4.3, progressive reductions in AEP flood frequency and/or increases in flood magnitude are associated with:

- Increases in maximum predicted flood depth differences relative to baseline conditions.
- Increases in predicted velocities along the diversions and in the Fortescue Valley immediately downstream of the diversions.

This indicates that mining development will have a greater effect on infrequent, large flow events than smaller, more frequent flow events.

However, based on the water balance assessment of Fortescue Valley woodland vegetation communities completed by AQ2 (2024), more frequent smaller events are of the highest importance for maintaining adequate PAW to minimise vegetation drought stress. This is a consequence of the constrained depth of the vegetation root zone and hence PAW storage limits of the soil profile. Smaller replenishment events top up the soil water reservoir but in larger events the storage capacity is exceeded; with the surplus water either exported to other areas or evaporated in situ. It follows that the amount of time between effective rainfall events (i.e., sufficient to contribute to PAW) is the most important factor determining vegetation water supply, rather than the magnitude of these events. This also means that the vegetation communities are periodically exposed to drought and waterlogging stress under baseline conditions and have adaptations to cope with this.

Notably, the claypan water balance modelling (refer Section 4.3) suggests minimal impact on the surface water regime of the claypans resulting from implementation of the Project. This is attributable to the natural impediments to water transfer into the claypans from the broader landscape during small and medium sized rainfall events, consistent with the landscape ecohydrological conceptual model (AQ2 2024, summarised in Section 2).

6.3.2 Spatial Footprint of Hydrological Change

The net difference in flood levels between the Baseline (pre-development) scenario and the LOM Development scenario for the 63% AEP rainfall event (i.e., ~1 year average recurrence interval) is shown in Figure 6.4. In the vast majority of areas south of the proposed surface water management structures, the predicted change is within ± 3 to 10 cm of the baseline condition.

Under the LOM Development scenario, the principal areas subject to increased flood levels (relative to the baseline condition) include (refer to Figure 6.4):

- An area of approximately 40 ha associated with the drainage diversion between Murray's Hill and Anticline Hill where increased flood levels of approximately 3 cm (but all <5 cm) are predicted (point Inc_1 on Figure 6.4). This area includes the terminal end of an alluvial fan drainage tract, comprising vegetation dominated by mulga.
- An area of approximately 25 ha southeast of the drainage diversion between Fridge Hill and Horseshoe West where increased flood levels >5 cm are predicted (point Inc_2 on Figure 6.4). This area is outside the extent of Project vegetation mapping. From aerial photography, the area appears to support patchy vegetation (mulga and scattered *E. victrix*) and is blanketed in fine depositional sediments that are characteristic of the alluvial fan drainage termini on the valley margins.

The principal areas subject to decreased flood levels (>5 cm decrease relative to the baseline condition) include:

- An area of approximately 8 ha southwest of Murray's Hill (point Dcr_1 on Figure 6.4). This area occurs within the Loamy Flats EHU comprising mulga and scattered *E. victrix* on the valley margins.
- An area of approximately 300 ha southwest of Fridge Central (point Dcr_2 on Figure 6.4; zoomed in image provided in Figure 6.5). The majority of this area is outside the extent of Project vegetation mapping, however from the on-ground inspection (refer to Figure 6.5) it largely comprises Stony Flats EHU that are blanketed in fine depositional sediments with patchy vegetation dominated by mulga and scattered *E. victrix* in southern portions that transition into the Loamy Flats EHU. Although a channel pool is located within the area of predicted flood depth reduction, the LOM Development flood modelling for a 63% AEP rainfall event (Figure Appendix C1, Appendix C) predicts that surface water flow to the pool is not interrupted (i.e., the pool will continue to be supported by surface water).

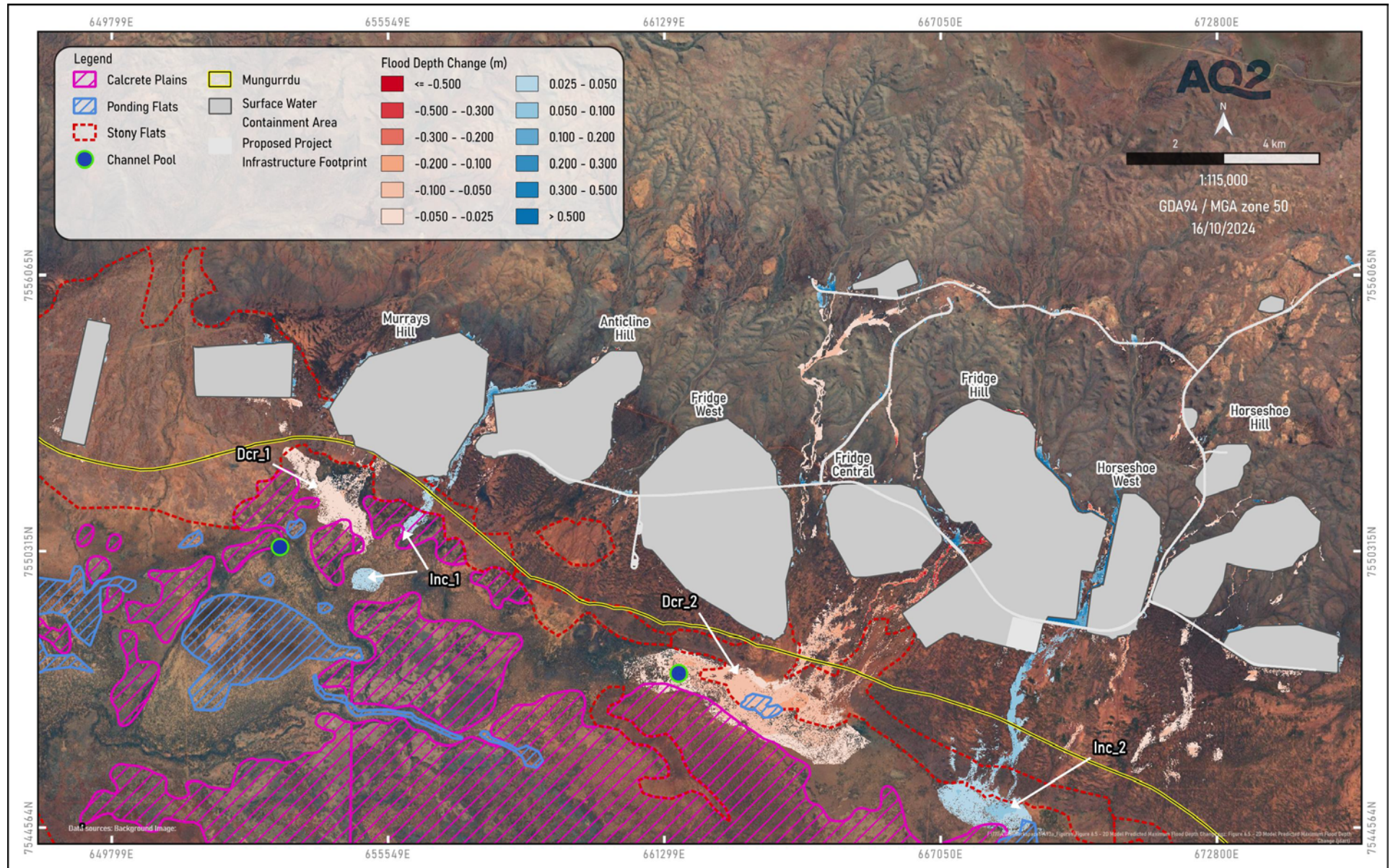


Figure 6.4 2D Model Predicted Maximum Flood Depth Change (LOM Minus Baseline)

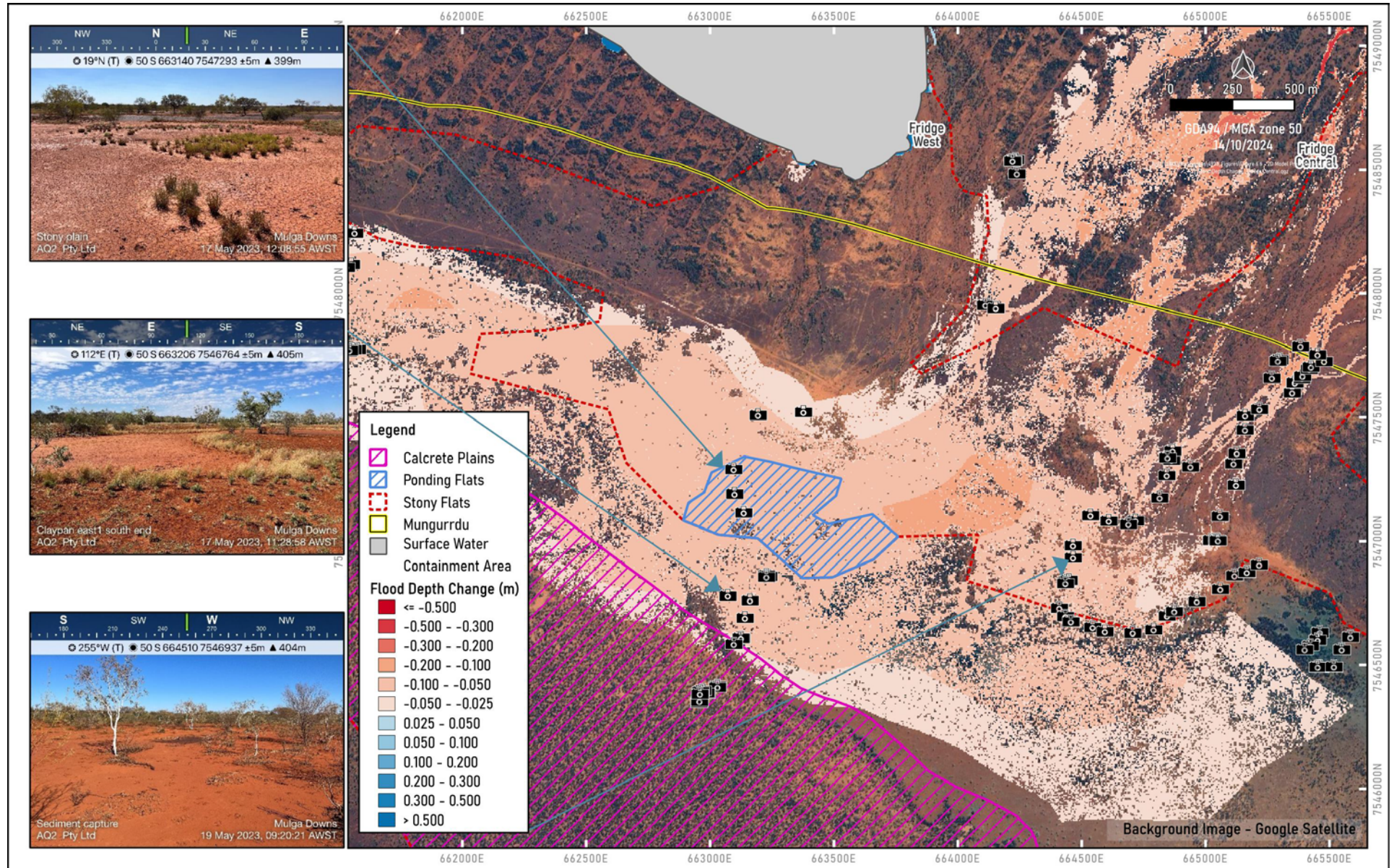


Figure 6.5 2D Model Predicted Maximum Flood Depth in Selected Ponding Zone

6.4 Significance of Groundwater and Surface Water Change

The potential impacts of hydrological change on mapped vegetation types and associated habitat attributes for MNES fauna species was qualitatively assessed, based on spatial interactions between these factors. This assessment took into account the DCCEEW Significant Impact Guidelines (Commonwealth of Australia 2013), which provide overarching guidance on determining whether an action is likely to have a significant impact on a matter protected under the EPBC Act. Figure 6.6 presents the records of conservation significant fauna with respect to the key areas where predicted groundwater and surface water change may impact vegetation. The findings of the assessment are summarised as follows:

- From ecohydrological studies conducted to date, the vegetation has been found to be disconnected from the groundwater system under baseline conditions, therefore a reduction in groundwater levels is not predicted to impact the terrestrial environment and associated habitats.
- Two areas have been identified as being at risk of exposure to shallow groundwater levels for periods of time, as a result of MAR in the Murray's Hill / Anticline Hill and Fridge / Horseshoe South areas. If groundwater mounds to above 2.0 mbgl, vegetation stress is predicted, however, no conservation significant fauna is recorded within these risk areas (refer Figure 6.6). Ongoing monitoring and adaptive management (i.e., redistribution of MAR) will avoid the impact of groundwater mounding on vegetation.
- A total area of approximately 25 ha is predicted to be subject to increased flood levels (>5 cm increase maximum flood height), comprising a mix of mulga dominated vegetation at the base of the alluvial fans and *E. victrix* woodlands proximal to an area of outcropping basement near the valley fringe. The magnitude of predicted change is modest. In the majority of cases, the dominant species in these vegetation types are well adapted to periodic flooding and drying and are unlikely to be significantly affected by the predicted hydrological change of increased surface water inputs. Vegetation types dominated by mulga (*Acacia aneura* complex) are susceptible to increased waterlogging, which could cause a decline in tree health. Such areas are relatively small in the overall affected area. Although this area has also been identified as being at risk of exposure to shallow groundwater levels (from MAR), as mentioned above, prolonged periods of groundwater mounding can be avoided with a programme of ongoing monitoring and adaptive management.
- A total area of approximately 310 ha is predicted to be subject to decreased flood levels (of >5 cm decrease maximum flood height). These areas largely comprise the Stony Flats EHU, which is blanketed in fine depositional sediments with patchy vegetation dominated mulga and scattered *E. victrix* in southern portions that transition into the Loamy Flats EHU. The magnitude of predicted change is modest. The dominant species in these vegetation types are well adapted to periodic flooding and drying and are unlikely to be significantly affected by the predicted hydrological change of decreased flood levels. Denser patches with high percentage cover of *E. victrix* (vegetation types AdEvWL and EvWL), have the greatest potential to experience soil water depletion and drought stress during prolonged interfloods.
- The vegetation types predicted to be exposed to hydrological change are widespread across the Fortescue Valley and do not contain critical habitat (as defined in Section 3.3) for EPBC listed threatened fauna species. Some instances of dense lignum thickets (relevant for the Night Parrot) occur further into the Fortescue Valley in association with *E. victrix* woodland communities, but these are distant from the areas potentially exposed to hydrological change.

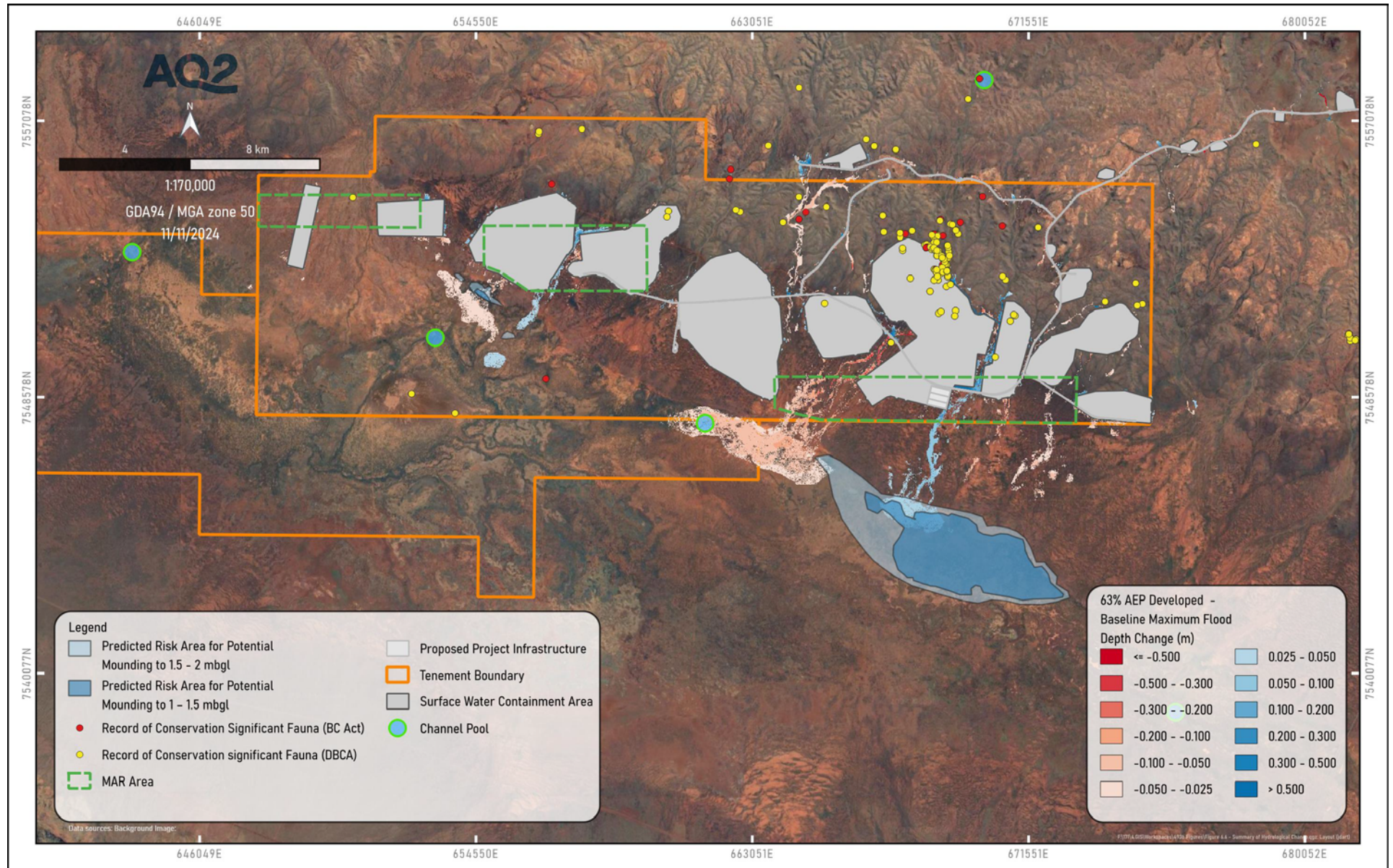


Figure 6.6 Summary of Groundwater and Surface Water Impact Areas with Respect to Conservation Significant Fauna

7. SUMMARY OF PREDICTED IMPACTS AND WATER MANAGEMENT

7.1 Groundwater

Numerical groundwater modelling has been undertaken to determine a feasible mining scenario with a viable groundwater management solution and to assess the potential changes to the groundwater system.

The adopted mining scenario (MDE_LOM_20) has mining commencing in January 2027, with a 15.5-year mine life. Below water table mining commences in 2028 in the west, in the Murray's Hill area, progressing east to Anticline Hill, followed by the mining of Horseshoe West and finally the Fridge West, Fridge Central and Fridge Hill areas.

To achieve dry mining conditions dewatering is predicted to commence in April 2028 at ~8,600 kL/d (~3.2 GL/yr). Peak dewatering rates of between ~30,000 and 31,300 kL/d (~11 to 11.4 GL/yr) are predicted during the concurrent dewatering of Murray's Hill, Anticline Hill and Horseshoe West during 2032 and 2033, with similar peaks (~30,200 kL/d) between 2037 and 2041, during the mining of Fridge Hill and Fridge West. Dewatering rates decline rapidly upon the completion of mining Fridge Hill, with rates of ~4,300 kL/d (~1.6 GL/yr) predicted for the final of year of mining Fridge West.

Water supply requirements during the LOM will be preferentially sourced from the dewatering discharge, with water treated, if required, to meet the operational water quality criteria. As dewatering exceeds water demands, excess water will be disposed of by MAR through re-injection within the Study Area. MAR is proposed on the slopes of the valley (i.e., in, and along strike of, the proposed mining areas). Initially, MAR is proposed via re-injection bores, with the potential for repurposing dewatering bores and / or in-pit infiltration, once mining of a pit is complete.

Construction and early LOM water demands (prior mining below the water table) will preferably be sourced from the proposed mining and / or MAR areas thereby achieving advanced dewatering or increased capacity for MAR.

Without management practices in place, there is the potential for detrimental environmental impacts resulting from changes to groundwater levels and / or quality as a result of the mining activities (in particular dewatering and MAR).

The overarching groundwater management strategy is therefore to:

- Minimise change to the current beneficial use of the groundwater.
- Minimise the impact on other groundwater users and groundwater dependent ecosystems (i.e., subterranean fauna); this includes minimising the extent of groundwater level changes.
- Maintain groundwater levels such that there is no surface expression of groundwater or water logging of vegetation.

Within the Study Area, groundwater is used by Mulga Downs Station (for stock water) and supports some environmental values. More regionally, groundwater is used for potable supplies at the Wirrilimurra and Youngaleena Communities (Figure 1.4). In addition, significant cultural-heritage value is derived from water within the Study Area, with Mungurrdu being of particular significance.

As the groundwater in the Study Area is only used for stock water, the key groundwater quality criterion for the current beneficial use is based on the drinking water requirements for livestock (cattle). Drinking water guidelines for beef cattle indicate a tolerance limit of 5,000 mg/L TDS (ANZECC, 2000), therefore where shallow groundwater outside of the immediate development area is currently within this limit, the intent is to minimise change above this level.

From ecohydrological studies conducted to date, the vegetation in the Study Area is not considered to be groundwater dependent (AQ2 2024), thus potential impact will not result from dewatering, but rather water logging of roots that may result from MAR.

Although knowledge about the salinity tolerance of Pilbara stygofauna is fairly limited, Bennelongia (2023) has classified the recorded stygofauna species in the Mulga Downs area into those that appear likely to be found only in groundwater of <3,000 mg/L TDS, those that have an apparent upper salinity tolerance of about 5,000 mg/L TDS and those that have an apparent upper salinity tolerance of about 10,000 mg/L TDS. The potential impact of groundwater changes on stygofauna, however, is being assessed as a separate study.

7.1.1 Predicted Impacts During Mining

From the numerical modelling conducted to date, the groundwater drawdown is predicted to extend across the valley, away from the mining areas, however the extent of the drawdown along strike (i.e., in a northwest – southeast direction) is curtailed by MAR. Due to the progressive approach to mining, the maximum extent of the drawdown occurs in different directions at different times. The maximum extent of the predicted 2 m drawdown contour extends ~8 km to the south, ~6 km to the west and ~3.5 km to the east of the mining areas, and is not predicted to reach the modelled boundaries (refer Figure 5.16).

As ecohydrological studies to date have found that the vegetation is disconnected from the groundwater system under baseline conditions, a reduction in groundwater levels is not predicted to impact the terrestrial environment. A lowered water table would increase the thickness of unsaturated sediments, which may slightly reduce the responsiveness of the aquifer to recharge events. However, these sediments are not considered to be accessible to plant root systems.

Groundwater mounding will occur as a result of MAR. Based on the ecohydrological conceptual model and measured baseline conditions, the threshold groundwater depth above which interaction with vegetation may occur is estimated to be about 2.0 mbgl. If water levels rise above this threshold for prolonged periods, vegetation stress is predicted. Although the predicted depth to groundwater remains below 2.5 mbgl (i.e., below this threshold) in the immediate MAR areas throughout the LOM, areas to the south of both the Murray's Hill / Anticline Hill and Fridge / Horseshoe South MAR areas, at the break of slope, have been identified as areas at risk of exposure to shallow groundwater levels for periods of time.

The maximum extent of the predicted 1 m mounding contour associated with the Fridge / Horseshoe South Borefield extends ~10 km to the south (across the valley) and ~5 km beyond the Mulga East tenement boundary, in a southeasterly direction. The maximum extent of the 1 m mounding contour associated with the Murray's West MAR Borefield is predicted to extend ~7 km to the northwest (along strike) and ~5 to 5.5 km to the south and southwest (across the valley), in the vicinity of the Koojjeepindarranna Claypan.

Groundwater salinity will change as a result of dewatering and MAR activities. The TDS of the combined dewatering discharge for all dewatering bores over LOM is predicted to range between 1,700 and 4,200 mg/L, taking into account the uncertainty associated with aquifer porosity, with this being the range of TDS concentrations that were then assigned to all MAR bores over the LOM.

The modelling indicates that changes in groundwater quality resulting from the proposed dewatering and MAR activities is anticipated to be fairly localised (i.e., <2 km in extent). This is demonstrated by both the simulated groundwater flow paths for the LOM and predicted salinity changes at the simulated observation points. Model predictions indicate that the key driver for groundwater salinity change is the proposed dewatering at Murray's Hill. This is predicted to result in increases to the dewatering discharge salinity as more saline water is drawn in from the valley areas. The subsequent re-injection of this more saline dewatering discharge into the Murray's West and Fridge / Horseshoe South MAR Borefields results in localised areas of increased groundwater salinity as well as subsequent increases to the combined

dewatering discharge, as the re-injected water in the east is recirculated towards the Fridge West and Fridge Hill mining areas later in the LOM.

Taking into account the uncertainty associated with aquifer porosity, the greatest changes in salinity outside of the mining areas are predicted in three areas:

- In the Murray's West MAR Borefield area, the TDS is predicted to increase from ~1,200 mg/L to between ~3,600 and 4,700 mg/L (for high and low porosity scenarios), recovering to between ~2,700 and 3,500 mg/L, upon the cessation of MAR in this area and the re-injection of fresher water to the adjacent Murray's Hill / Anticline Hill area.
- Down-slope from the Murray's Hill mining / MAR area, the TDS is predicted to increase from ~3,600 mg/L to between 4,400 and 5,600 mg/L (for high and low porosity scenarios), potentially exceeding the tolerance limit for cattle (i.e., 5000 mg/L). However, when the Murray's Hill / Anticline area is used for MAR, the TDS is predicted to reduce, reaching between ~3,300 and 4,300 mg/L by the end of mining.
- Down-slope from the Fridge / Horseshoe South MAR Borefield, the TDS is predicted to increase from ~2,300 mg/L to between 2,400 and 3,900 mg/L (for high and low porosity scenarios), with TDS at the end of mining predicted to range between 2,300 and 3,700 mg/L.

Predicted groundwater salinity beneath the claypan areas shows only minor fluctuations (<500 mg/L TDS) throughout the LOM.

The excavation and exposure of PAF materials in the pit walls is not anticipated and groundwater contamination from other potential sources such as waste rock dumps or spills is anticipated to be low risk, being managed by on-going monitoring and adaptive management. Furthermore, the risk of re-injection water becoming acidic or contaminated is low as this water will be sourced predominantly from ex-pit dewatering bores on the southern, down-dip side of the pits, rather than in-pit sump pumping.

7.1.2 Predicted Impacts Post-Mining

HanRoy intend to backfill the pits post-mining to above the pre-mining groundwater level. Modelling indicates the majority of groundwater level recovery has occurred during the LOM as the maximum depths of mining are reached prior to the end of mining. In particular, the western areas of Murray's Hill and Anticline Hill, which were mined (and dewatered) first and subsequently used for MAR have predicted water levels near to pre-mining elevations at the end of the LOM (i.e., at mine closure). As the Horseshoe South area is the last area used for MAR, groundwater levels in the nearby Horseshoe West mining area are recovering from mounding during the closure predictions (i.e., post-mining).

The modelling indicates a rapid recovery of groundwater levels post-mining, with predicted groundwater levels reported to recover to within 0.1 m of pre-mining levels within 10 years of the cessation of mining, at all mining areas, MAR areas and regional simulated observation points (GWC 2024).

The backfilling of the pits at the completion of mining eliminates any post-mining increases in groundwater salinity caused by evaporation from the pit lake surfaces, however, modelling of post-mining groundwater quality has not been conducted to date.

7.1.3 Management Measures

An environmental risk assessment has been undertaken relating to groundwater changes and their associated risk ratings, before and after the application of mitigation measures (Appendix A). A detailed discussion of the proposed management measures is provided in the Water Management Plan (HanRoy 2024), with key management measures summarised below:

- Surplus water managed via MAR (i.e. via re-injection bores, repurposed dewatering bores and / or in-pit infiltration) to:
 - Limit the extent of drawdown from the immediate mining area (accepting recirculation of groundwater).
 - Limit the potential for the saline interface to rise as a result of hydrostatic changes in the broader cone of depression.
- Comprehensive baseline and operational monitoring of groundwater levels and groundwater quality to monitor impacts relating to dewatering and MAR; inclusive of on-going monitoring outside of the area of impact to provide further baseline data, thereby allowing differentiation between seasonal and mining-related changes. As the tolerance of vegetation to groundwater level change is site specific and not easily determined, baseline and operational monitoring of both groundwater levels and vegetation health is of particular importance for the areas identified as being at risk of exposure to shallow groundwater levels.
- Operation of multiple MAR areas to allow flexibility of injection and periods of recovery (i.e., reduced injection in one area and increased in another) if required due to groundwater level or groundwater quality triggers being observed.
- Review of dewatering rates if groundwater level or groundwater quality triggers are observed and cannot be managed by modifying the distribution of MAR.
- Backfilling of the pits at closure to allow groundwater levels to return to near pre-development conditions and eliminate further changes to groundwater salinity resulting from evaporation from pit lakes.

In addition to the above management measures, monitoring data will be regularly compared to model predictions and, as necessary, the numerical model can be re-calibrated to recorded responses and used to re-assess integrated groundwater management and mining scenarios.

7.2 Surface Water Impact Assessment and Management

The general management objectives for the Project relating to surface water are as follows:

- Maintain the existing hydrological regime as much as is practicable.
- Mitigate impacts on surface water quality from construction and operations by containing and treating impacted water on-site prior to release to the downstream environment.
- Reduce the risk of surface water having a significant impact on mining operations.

Surface water management measures to meet the above objectives have been proposed based on the following design philosophies:

- Clean water should be diverted around the disturbance footprints to the downstream environment to prevent contamination of clean water catchments (and therefore increase the volume of water which is required to be treated).
- Flood mitigation measures are required to prevent flood ingress to open pits and mine infrastructure areas.

- Surface water management infrastructure must incorporate measures to avoid excessive scour, erosion and sediment transport, and should be designed to prevent prolonged ponding following rainfall events.
- Contact runoff from mine disturbance areas (such as waste rock dump and pit runoff) will be contained and diverted to sediment control features for treatment prior to release of water downstream, subject to water quality being suitable for discharge.

A risk assessment was completed to identify the inherent risks of the Project to the hydrological environment without the incorporation of any surface water management measures. 2D flood modelling was conducted to identify surface water management measures (such as diversions and culverts) required to reduce the impact of the Project on the hydrological environment.

The Project development will reduce the catchment area which contributes surface water runoff to the Fortescue Valley. The predicted impact to the hydrological environment of the proposed Project has been assessed by:

- Comparing Baseline and LOM 2D flood model results to quantify changes to the predicted flood depths and velocities.
- Preparing a water balance model of Koojeeepindarranna and Gnalka Gnoona Claypans for pre-development and LOM runoff scenarios. The models were used to quantify the impacts on the claypan water levels, inundation durations and water quality (TDS) due to the development of the mine.

The residual risks of the Project to the hydrological environment were assessed taking into account the proposed mitigation measures and the results of the flood modelling and claypan water balance modelling. The residual risks were generally considered to be low with the following key points made with respect to hydrological change, surface water management and potential impacts on mapped vegetation:

- A Water Management Plan (HanRoy 2024) has been prepared and provides additional information on the surface water management measures proposed.
- The 2D flood modelling predicts the reduction in catchment due to the containment of runoff within the mine development areas that will cause a reduction in flood levels within some areas of the Fortescue Valley to the south of the Project. In particular, the areas of ponding within the Goodiadarrie Swamp immediately to the south of Anticline South, Fridge West, Fridge Central and Horseshoe South pits are predicted to have a reduction in flood levels up to 0.2 m following a 50% AEP rainfall event.
- Where flow is diverted around the mine development areas, some areas of the Fortescue Valley to the south of the Project are predicted to have increased flood levels.
- The modelling indicates that the mining development will have a greater effect on infrequent, large flow events than smaller, more frequent flow events. However, based on the water balance assessment of Fortescue Valley woodland vegetation communities completed by AQ2 (2024), more frequent, smaller events have been identified as having the highest importance for maintaining adequate plant available water to minimise vegetation drought stress (AQ2 2024), with the amount of time between effective rainfall events being the most important factor determining vegetation water supply, rather than the magnitude of these events.
- The predicted changes in flood levels following a 63% AEP rainfall event have identified:
 - A total area of approximately 25 ha subject to increased flood levels (>5 cm increase maximum flood height), comprising a mix of mulga dominated vegetation at the base of the alluvial fans and *E. victrix* woodlands proximal to an area of outcropping basement near the valley fringe.
 - A total area of approximately 310 ha subject to decreased flood levels (>5 cm decrease maximum flood height). These areas largely comprise the Stony Flats EHU, which is blanketed in fine depositional sediments with patchy vegetation dominated mulga and scattered *E. victrix* in southern portions that transition into the Loamy Flats EHU.

- The vegetation types predicted to be exposed to hydrological change are widespread across the Fortescue Valley and do not contain critical habitat (as defined in Section 3.3) for EPBC listed threatened fauna species.

The claypan water balance quantified impacts to the claypans during a small, medium and a large inundation event. The impacts are considered negligible and are summarised as follows:

- Reductions in claypan water level were predicted to range between nil to 0.022 m. Note that the water levels in the Koodjeepindarranna Claypan were only impacted if the water level in the Gnalka Gnoona Claypan exceeded the height of the divide between the two claypans (402.9 mRL).
- Inundation duration was predicted to decrease in the order of days for large and medium events, with negligible change in inundation duration predicted for the small events.
- Only a marginal change in TDS between the model scenarios.
- None of the above changes should result in any significant impact to the claypans' ability to provide habitat to support MNES/migratory birds.

8. REFERENCES

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**APPENDIX A
SURFACE WATER &
GROUNDWATER RISK ASSESSMENTS**

Table A1: Likelihood Criteria

| Rating | Likelihood Factor | Descriptor | Description | Frequency | Probability |
|--------|-------------------|----------------|--|---|-----------------------------|
| 5 | 30 | Almost Certain | The event is expected to occur in most circumstances | May occur multiple times within 12 months | >91% chance of occurrence |
| 4 | 20 | Likely | The event will probably occur in many circumstances | May occur once per year | 61-90% chance of occurrence |
| 3 | 12 | Possible | The event is expected to occur at some time | May occur once in 5 years | 41-60% chance of occurrence |
| 2 | 7.5 | Unlikely | The event could credibly occur at some future time | May occur once in 10 years | 10-40% chance of occurrence |
| 1 | 5 | Rare | The event may occur only in special circumstances | May occur once during life of mine | <10% chance of occurrence |

Table A2: Consequence Criteria

| Environmental Factor | Slight | Minor | Moderate | Major | Severe |
|----------------------|---|---|--|--|--|
| Biodiversity | Direct impact to fauna (does not include conservation significant, priority or threatened fauna species). | Localised impact (<24 hours recovery time) to land or water providing habitat for threatened flora or fauna species or a mangrove community OR Medium term impact (<3 months recovery time) to land or water providing habitat for flora and fauna that can be remediated within 3 months | Long term impact (>5 years recovery time) to land or water that provides habitat for flora and fauna OR Medium term impact (<3 months recovery time) to land or water providing habitat for threatened flora or fauna species or a mangrove community OR Direct impact to individual flora/fauna of threatened species | Permanent or irreversible widespread impact to land or water that provides habitat for flora and fauna OR Long term impact (>5 years recovery time) to land or water providing habitat for threatened flora or fauna species or a mangrove community OR Irreversible impact to scheduled, listed or declared rare and/or threatened species of flora or fauna (>5 individuals) | Permanent or irreversible widespread impact to land or water providing habitat for threatened flora or fauna species or a mangrove community |
| Water Resources | Local impact to water that can be remediated within 24 hours. | Localised impact (<24 hours recovery time) to land or water providing habitat for threatened flora or fauna species or a mangrove community OR Medium term impact (<3 months recovery time) to land or water providing habitat for flora and fauna that can be remediated within 3 months | Long term impact (>5 years recovery time) to land or water that provides habitat for flora and fauna OR Medium term impact (<3 months recovery time) to land or water providing habitat for threatened flora or fauna species or a mangrove community OR Direct impact to individual flora/fauna of threatened species | Permanent or irreversible widespread impact to land or water that provides habitat for flora and fauna OR Long term impact (>5 years recovery time) to land or water providing habitat for threatened flora or fauna species or a mangrove community OR Irreversible impact to scheduled, listed or declared rare and/or threatened species of flora or fauna (>5 individuals) | Permanent or irreversible widespread impact to land or water providing habitat for threatened flora or fauna species or a mangrove community |

| Environmental Factor | Slight | Minor | Moderate | Major | Severe |
|---------------------------------|--|---|--|--|--|
| Land and Soils | Local impact to land or water that can be remediated within 24 hours. | Localised impact (<24 hours recovery time) to land or water providing habitat for threatened flora or fauna species or a mangrove community OR Medium term impact (<3 months recovery time) to land or water providing habitat for flora and fauna that can be remediated within 3 months | Long term impact (>5 years recovery time) to land or water that provides habitat for flora and fauna OR Medium term impact (<3 months recovery time) to land or water providing habitat for threatened flora or fauna species or a mangrove community OR Direct impact to individual flora/fauna of threatened species | Permanent or irreversible widespread impact to land or water that provides habitat for flora and fauna OR Long term impact (>5 years recovery time) to land or water providing habitat for threatened flora or fauna species or a mangrove community OR Irreversible impact to scheduled, listed or declared rare and/or threatened species of flora or fauna (>5 individuals) | Permanent or irreversible widespread impact to land or water providing habitat for threatened flora or fauna species or a mangrove community |
| Rehabilitation and Mine Closure | Site is safe, stable and non-polluting and post land use is not adversely affected | The site is safe, all major landforms are stable, and any stability or pollution issues are contained and require no residual management. Post-mining land use is not adversely affected. | The site is safe, and any stability or pollution issues require minor, ongoing maintenance by end land-user | The site cannot be considered safe, stable or non-polluting without long-term management or intervention. Agreed end land-use cannot proceed without ongoing management. | The site is unsafe, unstable and/ or causing pollution or contamination that will cause an ongoing residual affect. The post-mining land use cannot be achieved. |

Table A3: Risk Matrix

| Risk Matrix (5 x 5) | | | | | | | |
|----------------------------|----------|-----|----------------------------|----------------|------------------|------------------|------------------|
| RHH Risk Evaluation Matrix | | | Likelihood Rating | | | | |
| | | | Rare | Unlikely | Possible | Likely | Almost Certain |
| | | | 1 | 2 | 3 | 4 | 5 |
| | | | Residual Risk Rating (RRR) | | | | |
| Consequence/Impact | Factors | 5 | 7.5 | 15 | 20 | 30 | |
| Severity Level | Severe | 10 | High (50.00) | High (75.00) | Extreme (150.00) | Extreme (200.00) | Extreme (300.00) |
| | Major | 5 | Medium (25.00) | Medium (37.50) | High (60.00) | Extreme (100.00) | Extreme (150.00) |
| | Moderate | 2 | Low (10.00) | Medium (15.00) | Medium (30.00) | Medium (40.00) | High (60.00) |
| | Minor | 1 | Low (5.00) | Low (7.50) | Medium (15.00) | Medium (20.00) | Medium (30.00) |
| | Slight | 0.5 | Low (2.50) | Low (3.75) | Low (7.50) | Low (10.00) | Medium (15.00) |

Table A4: Risk Assessment – Surface Water

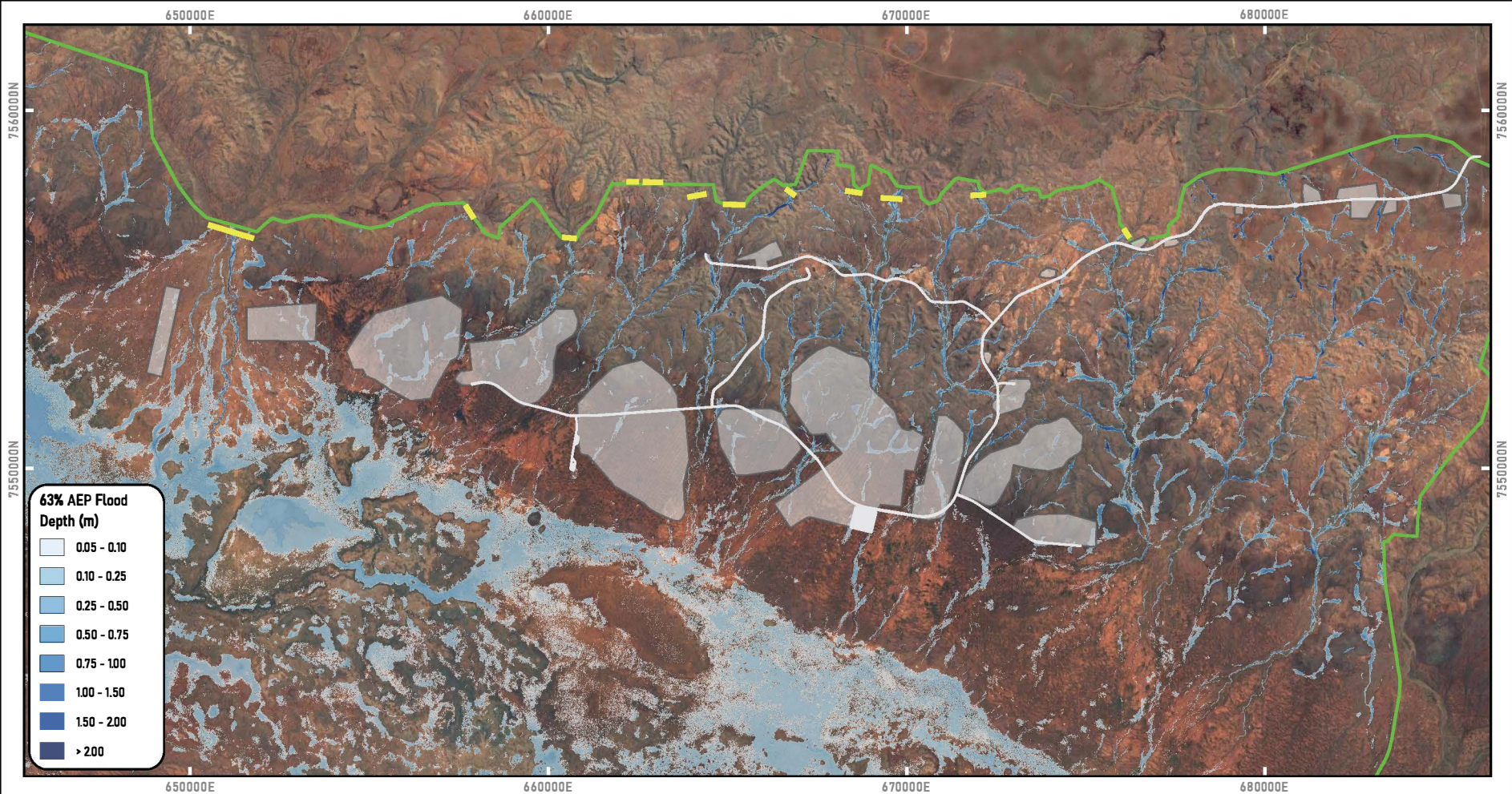
| Risk Pathway/Unwanted Event | Description of Impact | Phase(s) Unwanted Even likely to occur | Inherent Risk | | | | Risk Treatments | Phase(s) Treatments to be implemented | Residual Risk | | |
|---|--|--|---------------|------------|-------------|----------------|---|---------------------------------------|---------------|------------|-------------|
| | | | Consequence | Likelihood | Risk Rating | Data Certainty | | | Consequence | Likelihood | Risk Rating |
| Water Resources | | | | | | | | | | | |
| Reduction of water to downstream environment | Runoff collected within, and ponding upstream of, the pit, waste dumps, stockpiles and borrow pits will reduce the runoff to the downstream environment, resulting in areas of water shadowing. This may impact the vegetation in the downstream environment. | Construction / Operations / Closure | Major | Likely | E-100 | High | <ul style="list-style-type: none"> Diversions around mine disturbance and development areas. With proposed mitigation measures, there is an estimated reduction of 10% in the catchment area of the Gnalka Gnoona Claypan, if no water from the pits/waste dumps reports downstream. The Koodjeepindarranna Claypan catchment area is reduced by <0.5% and the combined claypan catchment area is reduced by 2%. Flood modelling comparisons of predicted baseline and LOM water distributions from small recurrence events (such as the 50% AEP) indicate that the reduction in water levels within the Fortescue Valley within these rain shadow areas is limited to approximately 0.1m. Refer to Appendix D. Water balance modelling of the claypan water levels indicate that the reductions in catchment areas result in only a negligible impact on the hydroperiod (how long they hold water) and water levels of the claypans. Runoff collected from pits, waste dumps and stockpiles will be contained and released to the environment following sediment treatment. | Construction / Operations / Closure | Slight | Possible | L-7.5 |
| Reduction of water to downstream environment | Water shadowing on the downstream side of road and rail embankments (and pipeline installations) caused by ponding and potential redirection and concentration of surface water flows through culverts along their alignments. | Construction / Operations | Moderate | Likely | H-60 | High | <ul style="list-style-type: none"> Culverts positioned to allow flow of surface water across linear infrastructure areas. Flood modelling comparisons of the predicted baseline and LOM water distributions from the small recurrence events (such as the 50% AEP) indicate reductions in flood depths on the downstream side of linear infrastructure are less than 0.1m. Refer to Appendix D. Burial of pipeline at drainage lines/ creek crossings to prevent disruption to flows Raise pipelines at regular intervals to allow local surface water runoff to flow downstream | Construction / Operations | Slight | Rare | L-2.5 |
| Reduction of water to downstream environment | Diversion of drainage lines around development areas and into a different downstream drainage line | Construction / Operations / Closure | Minor | Possible | M-15 | High | <ul style="list-style-type: none"> All diversions to be returned back to the same downstream catchment/drainage path where possible. Flood modelling comparisons of baseline and LOM water distribution from small recurrence events (such as the 50% AEP) indicate that the reduction in water levels within the Fortescue Valley within these rain shadow areas is limited to approximately 0.1m. Refer to Appendix D. | Construction / Operations / Closure | Slight | Rare | L-2.5 |
| Increased inundation of water on upstream side of development areas | Blockage of drainage lines may result in prolonged inundation in areas where it may not have occurred previously. This may lead to vegetation health impacts due to water logging and changes to the vegetation composition of communities. Likely to be limited in extent to local area upstream of disturbance footprints. | Construction/ Operations/ Closure | Moderate | Likely | H-60 | High | <ul style="list-style-type: none"> Diversion of drainage lines around disturbance areas. | Construction / Operations / Closure | Slight | Rare | L-2.5 |
| Water quality impacts (sediment) | OSA face failure due to erosion along waste dump toe leading to sediment reporting to Fortescue Valley and claypans | Construction / Operations / Closure | Major | Unlikely | M-20 | Medium | <ul style="list-style-type: none"> Diversions around mine disturbance areas to protect the toe of the waste rock dumps. Diversions required for closure to have flood damage resilience for up to 1:10,000 yr event. | Construction / Operations / Closure | Slight | Rare | L-2.5 |

| Risk Pathway/Unwanted Event | Description of Impact | Phase(s) Unwanted Even likely to occur | Inherent Risk | | | | Risk Treatments | Phase(s) Treatments to be implemented | Residual Risk | | |
|----------------------------------|---|--|---------------|------------|-------------|----------------|--|---------------------------------------|---------------|------------|-------------|
| | | | Consequence | Likelihood | Risk Rating | Data Certainty | | | Consequence | Likelihood | Risk Rating |
| Water quality impacts (sediment) | Ongoing sediment release to downstream environment from frequent rainfall events leading to increased sediment load to Fortescue Valley and claypans | Construction / Operations | Moderate | Likely | H-60 | High | <ul style="list-style-type: none"> Containment of sediment laden runoff from pits and waste rock dumps and stockpile areas and passing this runoff through sediment basins prior to release downstream. | Construction / Operations | Minor | Rare | L-3.75 |
| Water quality impacts (sediment) | Ongoing sediment release to downstream environment from frequent rainfall events leading to increased sediment load to Fortescue Valley and claypans | Closure | Moderate | Likely | H-60 | High | <ul style="list-style-type: none"> Closure landform designs, revegetation of landform slopes and armouring as required. | Closure | Minor | Rare | L-3.75 |
| Water quality impacts (chemical) | Dust suppression application impacting on local fauna/vegetation | Construction / Operations | Minor | Possible | M-15 | Low | <ul style="list-style-type: none"> Dust suppression operations to be managed to prevent over-watering of roads. Road spoon drains to prevent dust suppression runoff to surrounding areas. Vegetation health monitoring adjacent to roads | Construction / Operations | Moderate | Rare | L-10 |
| Water quality impacts (chemical) | Runoff from within mine development areas containing pollutants such as hydrocarbons or metals etc. entering local waterways and downstream Fortescue Valley and claypans | Construction / Operations | Moderate | Likely | M-40 | Medium | <ul style="list-style-type: none"> Local runoff management practices deployed within plant and mining areas as outlined in the Roy Hill Environmental Management System, including: <ul style="list-style-type: none"> Containment of runoff and wastewater at washdowns, workshops etc and passed through an oil/water separator with re-use of runoff water within the process prioritised. Deployment of spill kits to clean up local oil spills immediately when they occur. Ongoing monitoring of groundwater and surface water for potential contaminants which could occur from the mining process. | Construction / Operations | Moderate | Rare | L-10 |
| Water quality impacts (chemical) | Dewatering / MAR pipeline burst resulting in spill of water with elevated salinity. | Operations | Major | Possible | H-60 | High | <ul style="list-style-type: none"> Appropriate (conservative) design of transfer piping and pumping systems, particularly where they cross the Fortescue Valley including: <ul style="list-style-type: none"> pressure rating of pipeline high pressure and low flow protection settings on the transfer system leak detection systems to shut off pumping in the event of pipeline burst and operator warnings in the event of pipeline leaks burial of pipeline sections at drainage lines/ creek crossings to prevent widespread surface discharge of leaks routine inspection and maintenance | Operations | Minor | Unlikely | L-7.5 |

Table A5: Risk Assessment - Groundwater

| Risk Pathway/Unwanted Event | Description of Impact | Phase(s) Unwanted Event likely to occur | Inherent Risk | | | | Risk Treatments | Phase(s) Treatments to be implemented | Residual Risk | | |
|---|---|---|---------------|------------|-------------|----------------|--|---------------------------------------|---------------|------------|-------------|
| | | | Consequence | Likelihood | Risk Rating | Data Certainty | | | Consequence | Likelihood | Risk Rating |
| Water Resources | | | | | | | | | | | |
| Drawdown related to pit dewatering | Groundwater levels will be drawn down. This may impact stygofauna habitat and other groundwater users in the area (i.e., station bores for livestock and water supplies for nearby Aboriginal communities). No groundwater-dependent vegetation has been identified in the area. | Operations / Closure | Moderate | Likely | M-40 | High | <ul style="list-style-type: none"> Excess water is to be injected into the groundwater system thereby limiting the extent of drawdown from the immediate mining area (accepting recirculation of groundwater). Comprehensive baseline and operational monitoring of groundwater levels in and around areas of dewatering and nearby groundwater users that may be impacted. Provision of water supply to “unduly affected” groundwater users. Backfilling of the pits at closure will allow groundwater levels to return to near pre-development conditions. Identification of stygofauna outside of the impact area. | Operations / Closure | Moderate | Likely | M-40 |
| Change in groundwater flow direction related to pit dewatering | As a result of dewatering, more saline groundwater from the valley area will be drawn towards the pit areas and the saline interface may rise in the broader cone of depression. This may impact stygofauna habitat and other groundwater users in the area (station bores for livestock). | Operations | Moderate | Unlikely | M-15 | High | <ul style="list-style-type: none"> Groundwater modelling predictions suggest that changes to groundwater salinity resulting from dewatering are modest with respect to beneficial use and stygofauna habitat. MAR should reduce the potential hydrostatic changes in the broader cone of depression. | Operations | Moderate | Unlikely | M-15 |
| Groundwater mounding resulting from MAR | Groundwater will mound in areas of aquifer MAR. Mounding will reduce potential troglofauna habitats. If groundwater mounds into the root zone for extended periods of time, this will have a detrimental impact on the vegetation. Mounding may also result in the surface expression of groundwater which, in the claypan areas, or at the break of slopes down-gradient from MAR areas. This could result in salinisation of the freshwater surface features. Potential impact on aesthetic and cultural heritage values. | Operations | Moderate | Possible | M-30 | Medium | <ul style="list-style-type: none"> Water from in-pit sump pumping will not be re-injected without appropriate treatment for removing sediment. Comprehensive baseline and operational monitoring of groundwater levels in MAR areas. Reduction of MAR if required. Multiple MAR areas to allow flexibility of MAR and periods of recovery (ie reduced MAR in one area and increased in another). Review dewatering and mine schedule, if required. | Operations | Minor | Unlikely | L-7.5 |
| Change to groundwater quality resulting from MAR | Due to the variable groundwater salinity across the project area, MAR will change the groundwater quality in the MAR areas. This may impact stygofauna habitats and other groundwater users (station bores for livestock and water supplies for nearby Aboriginal communities). | Operations | Moderate | Possible | M-30 | Medium | <ul style="list-style-type: none"> Groundwater modelling predictions suggest that changes to groundwater salinity resulting from MAR are modest with respect to beneficial use and stygofauna habitat and of limited extent (<2 km). Comprehensive baseline and operational monitoring of groundwater quality in and around MAR areas and nearby groundwater users that may be impacted. Provision of water supply to “unduly affected” groundwater users. | Operations | Moderate | Unlikely | M-15 |
| Change in groundwater flow direction related to MAR | Groundwater mounding in MAR areas will result in local changes to groundwater flow directions. This may result in water quality changes beyond the immediate MAR areas which may impact stygofauna habitats and other groundwater users (station bores for livestock and water supplies for nearby Aboriginal communities). | Operations | Moderate | Possible | M-30 | Medium | <ul style="list-style-type: none"> The location of MAR sites near to the mining area, limits the spatial extent of changes to the groundwater system. Groundwater modelling predictions suggest that changes to groundwater salinity resulting from MAR are modest with respect to beneficial use and stygofauna habitat. Comprehensive baseline and operational monitoring of groundwater quality in and around MAR areas and nearby groundwater users that may be impacted. Provision of water supply to “unduly affected” groundwater users. | Operations | Moderate | Unlikely | M-15 |
| Contamination of groundwater from waste rock dumps / spills etc | Potential for pollutants such as hydrocarbons or metals to reach the groundwater system. Potential toxicity to biodiversity and deterioration of shallow aquifer salinity. | Operations | Moderate | Unlikely | M-15 | Moderate | <ul style="list-style-type: none"> Efficient water management during operations, dewatering abstraction is predominantly ex-pit, prior to inflow to the pit therefore reduced risk of contaminating water for MAR. Water from in-pit sump pumping will not be re-injected without appropriate treatment. Comprehensive baseline and operational monitoring of groundwater quality. | Operations | Moderate | Rare | L-10 |

**APPENDIX B
BASELINE FLOOD MODELLING**



63% AEP Flood Depth (m)

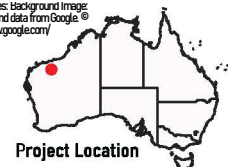
- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Legend

- Model Inflow
- Rain On Grid Model Boundary
- Proposed Haul Road
- Surface Water Containment Area

-Predicted maximum flood depths are from the simulation period of a 2D HEC RAS model developed using LIDAR data from 2023, excluding depths less than 0.05m.
 -The purpose of the model was to simulate hydrological conditions within, and immediately downstream of, mine development areas associated with the Mulga Downs Project.
 -Inflow hydrographs were input around the boundary of the model and rain on grid calculations used to simulate runoff across the model domain.
 -Flood depths upstream of the inflow boundary conditions are not valid.
 -Depths of ponded water within the valley floor (e.g., in the claypans) are likely to be underpredicted as not all runoff from within the model will have drained by the end of the simulation period
 -Maximum water levels resulting from rainfall-runoff (modelled depths) and claypan storage (contour) are unlikely to occur simultaneously as they will be driven by different magnitude and duration rainfall events.
 -Outflow water depths along the north-east of the model boundary are not valid.

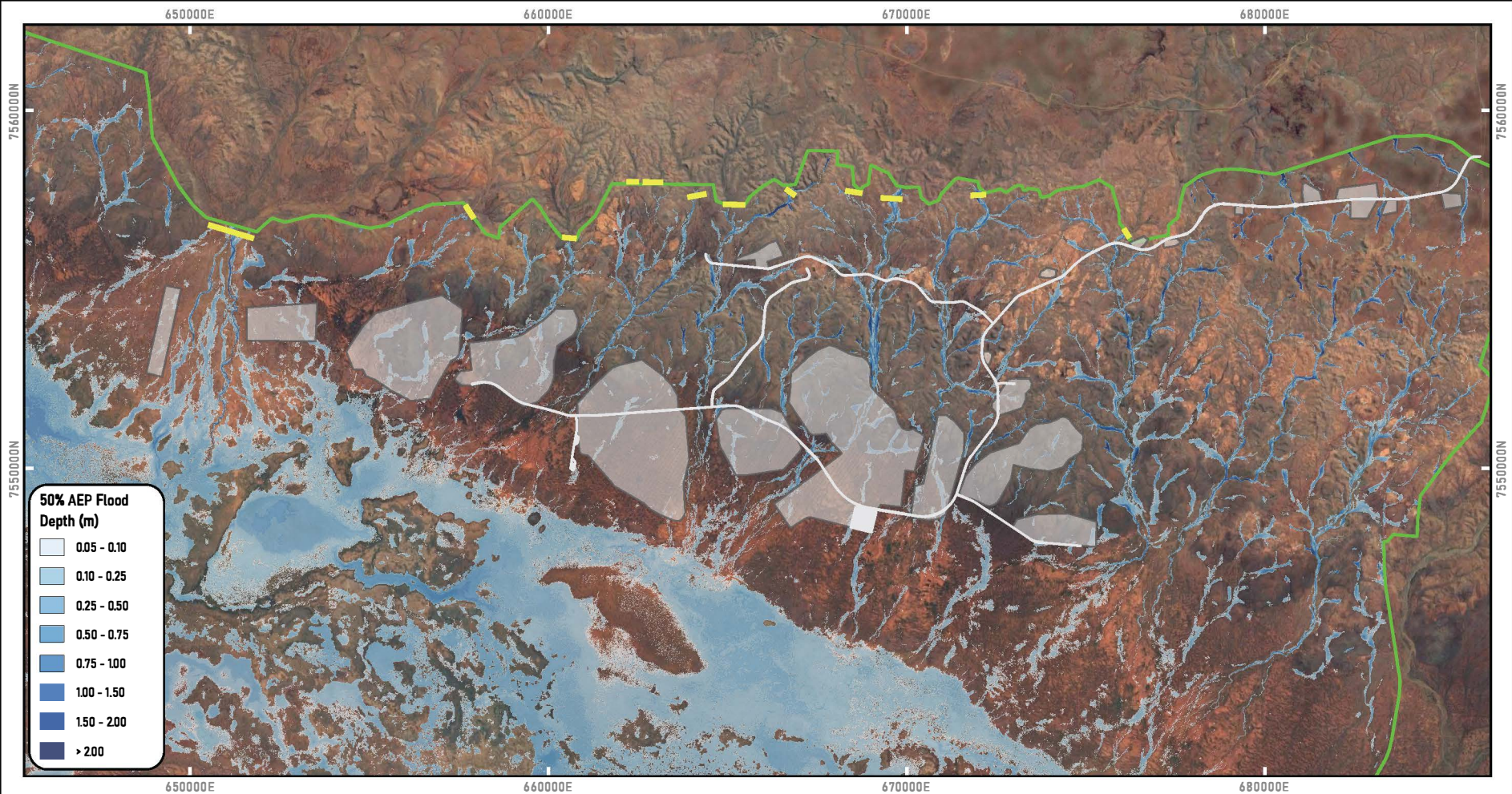
Data sources: Background Image: Base map and data from Google. <https://www.google.com/>



AQ2

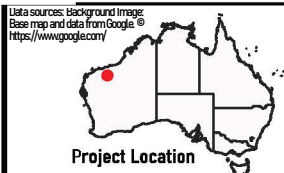
**Hydrology Figure B1
 Baseline Scenario
 63% AEP Flood Depth**

2 4 km
 GDA94 / MGA zone 50



2 4 km
GDA94 / MGA zone 50

*Predicted maximum flood depths are from the simulation period of a 2D HEC RAS model developed using LIDAR data from 2023, excluding depths less than 0.05m.
 *The purpose of the model was to simulate hydrological conditions within, and immediately downstream of, mine development areas associated with the Mulga Downs Project.
 *Inflow hydrographs were input around the boundary of the model and rain on grid calculations used to simulate runoff across the model domain.
 *Flood depths upstream of the inflow boundary conditions are not valid.
 *Depths of ponded water within the valley floor (e.g., in the claypans) are likely to be underpredicted as not all runoff from within the model will have drained by the end of the simulation period.
 *Maximum water levels resulting from rainfall-runoff (modelled depths) and claypan storage (contour) are unlikely to occur simultaneously as they will be driven by different magnitude and duration rainfall events.
 *Outflow water depths along the north-east of the model boundary are not valid.



AQ2
 Hydrology Figure B2
 Baseline Scenario
 50% AEP Flood Depth