# Macraes Phase Four

## Surface Water and Groundwater Assessment

OceanaGold (New Zealand) Limited

02 September 2026

→ **The Power of Commitment**

*Golden Bar Pit Lake*

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# Executive summary

OceanaGold (New Zealand) Limited ("OGNZL") currently undertakes open pit and underground gold mining operations at the Macraes Operation located at Golden Point Road, Macraes Flat, East Otago. As part of their ongoing operations, OGNZL continually review the remaining life of the Macraes Operation in light of updated knowledge of the gold resource and the economics of mining.

The Macraes Phase Four Project ("MP4" or "the Project") seeks to extend the life of mining at the Macraes Operation until at least 2039. The Project, which will enable ongoing gold production at a rate of approximately 130,000 ounces per annum, is identified as a Listed Project in Schedule 2 of the Fast-track Approvals Act 2024 ("FTAA") as a project providing significant national or regional benefits.

The Macraes Operation began operations in 1990 and currently comprises two operational open cast pits (Innes Mills and Coronation North), several former operational pits (Deepdell North, Coronation, Frasers, Golden Bar Pits), two underground mines - Frasers Underground (FRUG) – now closed and Golden Point Underground (GPUG), and a processing plant. Waste rock is placed both in pit and at a number of waste rock stacks (WRSs) located around the open pit margins. Tailings from processed ore is currently stored in the Frasers Pit (FTSF), with the Tipperary Tailings Storage Facility (TTTSF) nearing capacity, and three further Tailings Storage Facilities (TSFs), Mixed Tailings Impoundment (MTI) and the SP10/11 Tailings Storage Facility (SP10/SP11) now inactive.

Future operation of the site through the proposed MP4 includes the following key developments:

- Open pit extensions at Golden Bar, Coronation, Coronation North, and Innes Mills.
- Underground mine expansion through further development of the Golden Point Underground mine ("GPUG").
- Tailings management, including:
  - Construction of the Frasers Tailings Storage Facility ("FTSF") Stage 3 and
  - Hydraulic mining and relocation of tailings from the Mixed Tailings Impoundment ("MTI"), Southern Pit Option 10 TSF ("SP10"), and Southern Pit Option 11A TSF ("SP11") to the FTSF.
- Waste rock disposal, including increased storage capacity within open pits and at existing waste rock stacks at Coronation, Coronation North, Innes Mills, Golden Bar, Golden Point, and Frasers

To support the application, significant water quality and flow mitigation measures including the construction of physical infrastructure and implementation of management practices and mine design refinements are proposed with the purpose of reducing long-term water management risks. These measures include:

- Construction of seepage capture drains and toe bunds;
- Establishment and operation of a water treatment plant;
- Construction of the consented Camp Creek and Coal Creek augmentation dams;
- Ongoing monitoring and water treatment of pit lakes;
- Implementation of a flushing regime (where indicated by periphyton monitoring programs); and
- Improvements to current and future WRS construction methodology.

The focus of this assessment is surface water and groundwater cumulative effects of the proposed project elements (together with the existing consented site) within the Mare Burn, Deepdell and the Waikouaiti River North Branch (NBWR) catchments. As a cumulative assessment, it includes consideration of all the aforementioned mine elements associated with the project development, existing effects (from existing consented activities), and future effects (from existing consented activities that have yet to be realised). Cumulative water quality effects further down catchment within the Shag River are also considered.

**Groundwater Assessment**

Three 3D numerical groundwater models have been developed using MODFLOW-USG (flow modelling code) and MODFLOW-USG-TRANSPORT (for solute transport modelling code). The 3D models have been used to assess groundwater inflow into the existing and proposed expanded pits during dewatering as well as during groundwater recovery for a period of 400 years. The three separate models cover the distinct geographical areas within the operational footprint and include models for the Golden Bar Mining Area, the Coronation Mining Area and the

Central Mining Area (including the Frasers and Innes Mills Pits and the TSFs). The models have been calibrated to reflect the current mine status before undertaking model predictions. In addition, 2D modelling has been undertaken using SEEP/W to estimate seepage volumes through specific waste rock stacks (WRSs) where the risk of relatively undiluted seepage discharge to surface water is considered high i.e. Frasers South WRS to Murphys Creek.

The results of the 3D groundwater modelling suggest that during dewatering of the pits and underground workings, groundwater discharge to some local streams and creeks will reduce; however, these reductions are expected to represent a relatively small proportion of the total groundwater contribution to stream flows for the majority of the creeks. For Deepdell Creek (to DC08) and its tributary ephemeral streams, the predicted reduction in groundwater discharge is calculated to be 1.5 L/s (a 3.4% decrease compared to the existing conditions modelled groundwater discharges).

Groundwater flow and drawdown effects associated with current and proposed mining activities are predicted to remain largely localised around the existing and proposed pit extensions and underground workings, with limited propagation across the wider groundwater system. On this basis, adverse drawdown effects on non-OGL groundwater bores are considered unlikely. Seepage (from WRSs, TSFs and Pit Lakes) is expected to move within the weathered and fractured schist and be captured in silt ponds, pit sumps, seepage capture drains, and/or report directly to the receiving surface water and groundwater environment.

Groundwater contaminant plume modelling (conservatively illustrated using sulphate due to its low potential for attenuation within the groundwater system and existing elevated nature in some receiving surface water bodies as a result of past mining activity associated with Macraes Operation) has been undertaken within the 3D groundwater models to quantify the timeframe and sulphate flux reporting to the receiving surface water and groundwater environment. Modelling results indicate that sulphate plumes are generally constrained by the relatively low-permeability schist groundwater system and tend to migrate through the weathered and fractured schist and near-surface groundwater pathways toward local receiving environments, mine water management infrastructure, seepage capture systems, silt ponds and pit lakes. These estimates have subsequently been utilised to inform both adopted mitigation measures and the cumulative assessment within WBM. Existing consented groundwater takes, existing bores and proposed bores were reviewed against the maximum predicted extent of the modelled sulphate plume. This review indicates that these groundwater receptors are not expected to be intersected by the predicted plume extent, and adverse effects on groundwater users are therefore considered unlikely.

A density-dependent brine transport assessment was undertaken to simulate the injection of a brine solution near the base of the FRUG within the groundwater recovery modelling framework. Modelling results indicate that the predicted plume remains at depth and is not expected to daylight at any major river and/or any tributary of these rivers.

**Surface Water Assessment**

An existing sitewide Goldsim Water Balance Model (WBM) for the site has been utilised to estimate future impacts on the receiving water quality as a result of mining and rehabilitation activities. Key updates to the WBM include revised catchment boundaries and landforms to reflect both the current and future developments of site; pit lake groundwater inflows and outflows and seepage estimates from the groundwater modelling undertaken; revised pit lake and seepage water quality estimates as provided; and recalibration of the WBM utilising updated flow and water quality monitoring data. The water balance assessment informs predicted overflow timeframes for the pit lakes upon closure, capture and treatment requirements, and surface water quality at key compliance locations within the receiving surface water environment to enable comparison with the proposed water quality compliance criteria.

The modelled pit lakes (formed in Golden Bar Pit, Coronation Pit, Coronation North Pit and the Innes Mills Pit) are predicted to overflow following the cessation of dewatering activities after a median modelled timeframe of 58, 23, 64 and 67 years respectively. Overflows will be directed to the Golden Bar Creek (Golden Bar Pit), Mare Burn (Coronation North Pit), and Deepdell Creek (Coronation Pit and Innes Mills Pit) and will contribute contaminant a post dosing residual mass to the receiving surface water environment in the post closure phase.

Seepage capture and subsequent treatment and final capping of the waste rock stacks progressively during the active mining stage is modelled to significantly reduce contaminant loads reporting to the receiving surface water when implemented. It is also proposed that improved operational management practice be implemented to reduce overall WRS infiltration rates through the active mining phase. The outcomes of this are not captured within the modelled results presented in this report.

An active water treatment plant (WTP) using reverse osmosis (RO) technology and pretreatment systems is proposed to be constructed to treat captured mine seepage water prior to discharging to the receiving environment. The WTP is estimated to treat an average of approximately 45 L/s of captured seepage waters on closure, waters that would otherwise contribute significantly to the contaminant load within the receiving surface water environment. This volume is modelled to decrease by nearly half to 23 L/s within 10 years following site closure. The modelled WTP has high contaminant removal rates and results in a discharge water quality that generally offers an improvement to water quality and flow regimes near the Macraes Operation, such that both the capture of seepage water and discharge of treated water offer positive water quality effects.

Modelling illustrates that when mitigation measures are combined with the operational augmentation dams, that the proposed surface water quality consent conditions will be met in most cases with modelled results illustrative of the effective implementation of the mitigation measures during the operational phase of the mine and into closure. There are some exceptions to this with modelled increases in concentrations and/or modelled risk of exceedance of the proposed water quality limits noted for some contaminants of concern during both the mining and closure phases.

During mining, uncaptured seepage contributes significantly to modelled copper non-compliances within the Mare Burn at compliance location MB01 and modelled zinc exceedances within the Waikouaiti River North Branch at compliance locations MC01 and NBWRRF. This is a result of existing high infiltration rates to the Frasers, Trimbells and Coronation North WRSs. These infiltration rates (and resultant uncaptured seepage volumes) are significantly reduced with appropriate capping (proposed at closure) and the installation of the capture drains (proposed during the mining phase). In addition, modelled copper and Nitrate-N concentrations are overrepresented at compliance locations MB01 and NBWRRF respectively compared to the current baseline data suggesting that there are biogeochemical processes occurring within this catchment that are directly influencing the downstream concentrations of these elements. Modelled concentrations and non-compliance projections (where applicable) are therefore not supported by the current in-stream dataset for Copper and Nitrate-N at these respective locations and are likely a result of the mass conservative nature of the WBM.

During the closure phase, non-compliances are generally significantly reduced compared to modelled mining phase compliance exceedances and this is a reflection of the successful capping and rehabilitation of the WRSs at closure and the reduction in the uncaptured seepage volume (and mass) reporting to the receiving surface water environment. Remaining modelled exceedance of the proposed compliance limits are largely associated with the pit lake overflows. It is considered that adaptive management (via treatment) of pit lake water quality and representation of revised treatment outcomes in the WBM has the potential to significantly reduce these modelled exceedances before these pit lakes are discharged to the environment. There are also potential long-term management solutions allowing control of the lake discharges as a contingency measure if deemed necessary for receiving water quality outcomes.

In summary, the proposed development together with the outlined mitigation measures can be undertaken with a likely low risk of exceeding the proposed surface water compliance criteria assuming ongoing monitoring and applied adaptive management is carried out through the operational and closure phases. The modelled exceedances are a reflection of both the conservative nature of the some of the modelled inputs and the stochastic combination of ‘worst case’ conditions. The highest modelled concentrations and low-level modelled exceedances can be considered a relatively low risk of being realised in some instances. Appropriate performance monitoring, trigger values and implementation of actions provide an appropriate means to manage exceedance risk.

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# Abbreviations

| Acronym | Full Term |
|---|---|
| **General Acronyms** | |
| AV | Aesthetic Value (with reference to drinking water criteria) |
| AWBM | Australian Water Balance Model |
| BF | Backfill |
| CHD | Constant Head Boundaries |
| DD Creek | Deepdell Creek |
| DGV | Default guideline value |
| DRN | MODFLOW Drain |
| DXF | Autocad File Format |
| EOY | End of year |
| FTAA | Fast-track Approvals Act 2024 |
| GHB | MODFLOW General Head Boundary |
| GHD | GHD New Zealand Limited |
| GWV | Groundwater Vistas software |
| GW | Groundwater |
| GWM | Groundwater model |
| HMSZ | Hyde Macraes Shear Zone |
| HMTV | Hardness modified trigger value |
| IG | Irrigation Guideline (with reference to water quality criteria |
| Kh | Horizontal hydraulic conductivity |
| Kz | Vertical hydraulic conductivity |
| Kx | Horizontal hydraulic conductivity in x direction |
| Ky | Horizontal hydraulic conductivity in y direction |
| L1, Ln | Groundwater Model layer 1, Model layer n |
| LOM | Life of mine |
| MAV | Maximum acceptable value (with reference to drinking water criteria) |
| MEEA | Murphys Ecological Enhancement Area |
| MGPG | Macraes Grid Projection |
| MIKE-DHI | Hydraulic Modelling Software |
| MODFLOW-USG | Groundwater flow modelling code – Unstructured Grid |
| MODFLOW-USG-TRANSPORT | Solute transport modelling code |
| MP3, MPIII | Macraes Phase Three Project (previously consented) affecting the Central Mining Area at the Macraes Operation |
| MP4, MPIV | The project described in Schedule 2 of the Fast-track Approvals Act 2024 and to which this assessment relates. |
| NBWR | Waikouaiti River North Branch |
| NZTM | New Zealand Transverse Mercator |
| OGNZL, OGL | OceanaGold New Zealand Limited |
| PED | Potential evaporation deficit |

| Acronym | Full Term |
|---|---|
| RCH | MODEFLOW Recharge |
| RCP | Representative concentration pathways |
| RHOP | Round Hill Open Pits project |
| RIV | MODFLOW River |
| RL | Reduced level / relative level |
| RMS | Root mean square |
| RO | Reverse Osmosis water treatment process |
| SCD | Seepage capture drains |
| SEEP/W | Geostudio SEEP/W -2D finite element numerical modelling software |
| SRMS | Square root mean square |
| TSF | Tailings Storage Facility |
| TV | Trigger value |
| USGS | United States Geology Survey |
| VWP | Vibrating Wire Piezometer |
| WBM | Water balance model {and contaminant mass transport} |
| WRS | Waste rock stack |
| WTP | Water Treatment Plant |
| **Mine Features** | |
| CN, CN4, CN5 | Coronation North Pit and Stages |
| CNWRS | Coronation North Waste Rock Stack |
| CO, CO5, CO6, CO7, CO8 | Coronation Pit and stages |
| FRBF | Frasers Pit backfill embankment |
| FRUG | Frasers Underground Mine |
| FTSF | Frasers Tailings Storage Facility |
| GB, GB2, GB3 | Golden Bar Pit and Stages |
| GBWRS | Golden Bar Waste Rock Stack |
| GPUG | Golden Point Underground Mine |
| GPUG ext | Golden Point Underground Mine extension |
| IM, IM11, IM12, IM13 | Innes Mills Pits and Stages |
| IMOP | Innes Mills Open Pit |
| MTI | Mixed Tailings Impoundment |
| MWMS | Mine Water Management System |
| RH | Round Hill Pit |
| SP10 | Southern Pit Stage 10 |
| SP11 | Southern Pit Stage 11 Tailings Storage Facility |
| TTTSF | Top Tipperary Tailings Storage Facility |
| TWRS | Trimbells WRS |
| **Elements / Compliance Parameters** | |
| Ammoniacal-N | Not defined in source documents |
| As, As(III), As(V) | Arsenic species, As(V) concentrations |
| CaCO3 | Calcium Carbonate |

| Acronym | Full Term |
|---|---|
| Cl | Chloride |
| Cu | Copper |
| DOC | Dissolved organic carbon |
| Fe | Iron |
| HCN | Un-ionised Hydrogen Cyanide |
| NH4+ | Ammoniacal Nitrogen (in this context) |
| NO3- | Nitrate Nitrogen |
| NTU | Nephelometric Turbidity Units |
| Pb | Lead |
| SIN | Soluble inorganic nitrogen |
| TSS | Total suspended solids |
| WAD | Weak acid dissociable {cyanide} |
| **Compliance and Monitoring Locations (Surface Water)** | |
| CJ01 | Cranky Jims Creek 01 |
| DC08 | Deepdell Creek 08 |
| GB02 | Golden Bar 02 |
| HC01 | Highlay Creek |
| MB01 | Mare Burn 01 |
| MB02 | Mare Burn 02 |
| MC01 | Murphys Creek 01 |
| MC02 | Murphys Creek 02 |
| NB03 | Waikouaiti River North Branch 03 |
| NBWRGR | Waikouaiti River North Branch at Gifford Road |
| NBWRRF | North Branch Waikouaiti River at Ross Road Ford |
| Shag at LR | Shag River at Loop Road |
| Shag at McC | Shag River at McCormicks Creek |
| TC01 | Tipperary Creek 01 |

# 1. Introduction

OceanaGold (New Zealand) Limited ("**OGNZL**") currently undertakes open pit and underground gold mining operations at the Macraes Operation located at Golden Point Road, Macraes Flat, East Otago. As part of their ongoing operations, OGNZL continually review the remaining life of the Macraes Operation in light of updated knowledge of the gold resource and the economics of mining.

Reflecting recent exploration success and optimisation work, together with higher gold prices, the Macraes Phase Four Project ("**MP4**" or "**the Project**") seeks to extend the life of mining at the Macraes Operation until at least 2039. The Project, which will enable ongoing gold production at a rate of approximately 130,000 ounces per annum, is identified as a Listed Project in Schedule 2 of the Fast-track Approvals Act 2024 ("**FTAA**") as a project providing significant national or regional benefits.

To support the development of the substantive application for the Project, OGNZL has engaged GHD to provide an assessment of the Project's potential effects on groundwater and surface water and, to the extent required, identify any necessary management and operation measures to address any such effects.

The scope of this report is outlined in Section 1.3.

## 1.1 Site Location and Description

OGNZL owns and operates the Macraes Operation at Macraes, approximately 30 km northwest of Palmerston in the Otago Region. The Macraes Operation is the largest gold mine in New Zealand and, since commissioning in 1990, has produced more than 6 million ounces of gold.

Macraes Flat is situated on an elevated plateau at approximately 500 m above sea level. The plateau is flanked by the Taieri Ridge to the northwest, Shag Valley and Horse Range to the east, and the coastal hills and extinct volcanic cones of Palmerston and Waikouaiti to the southeast. Macraes Road provides access to Macraes Flat and the Macraes Operation, connecting to State Highway 85 to the east and State Highway 87 (SH87, the Middlemarch–Hyde Road) to the west.

The environment within and surrounding the Macraes Operation has been shaped by historic and current mining activities. Figure 1.1 shows the arrangement of the major mine features at the Macraes Operation. In summary, the current components of the Macraes Operation include:

- Numerous open pits (both operational and non-operational);
- Two underground mines (Frasers, now closed, and Golden Point, which is actively mined);
- Waste rock stacks at various stages of operation and rehabilitation;
- A network of haul roads and general mine service tracks;
- A Processing Plant;
- Five tailings storage facilities (three inactive, one active but nearing capacity, and one under construction and currently receiving tailings);
- An extensive network of water management infrastructure, including diversion drains, silt ponds, sumps, pit lakes, and freshwater storage reservoirs;
- Two consented but not yet constructed water storage reservoirs (Camp Creek Dam and Coal Creek Dam); and
- Associated infrastructure supporting ongoing operations, including district roads, powerlines, workshops, offices, and associated water and amenity facilities.

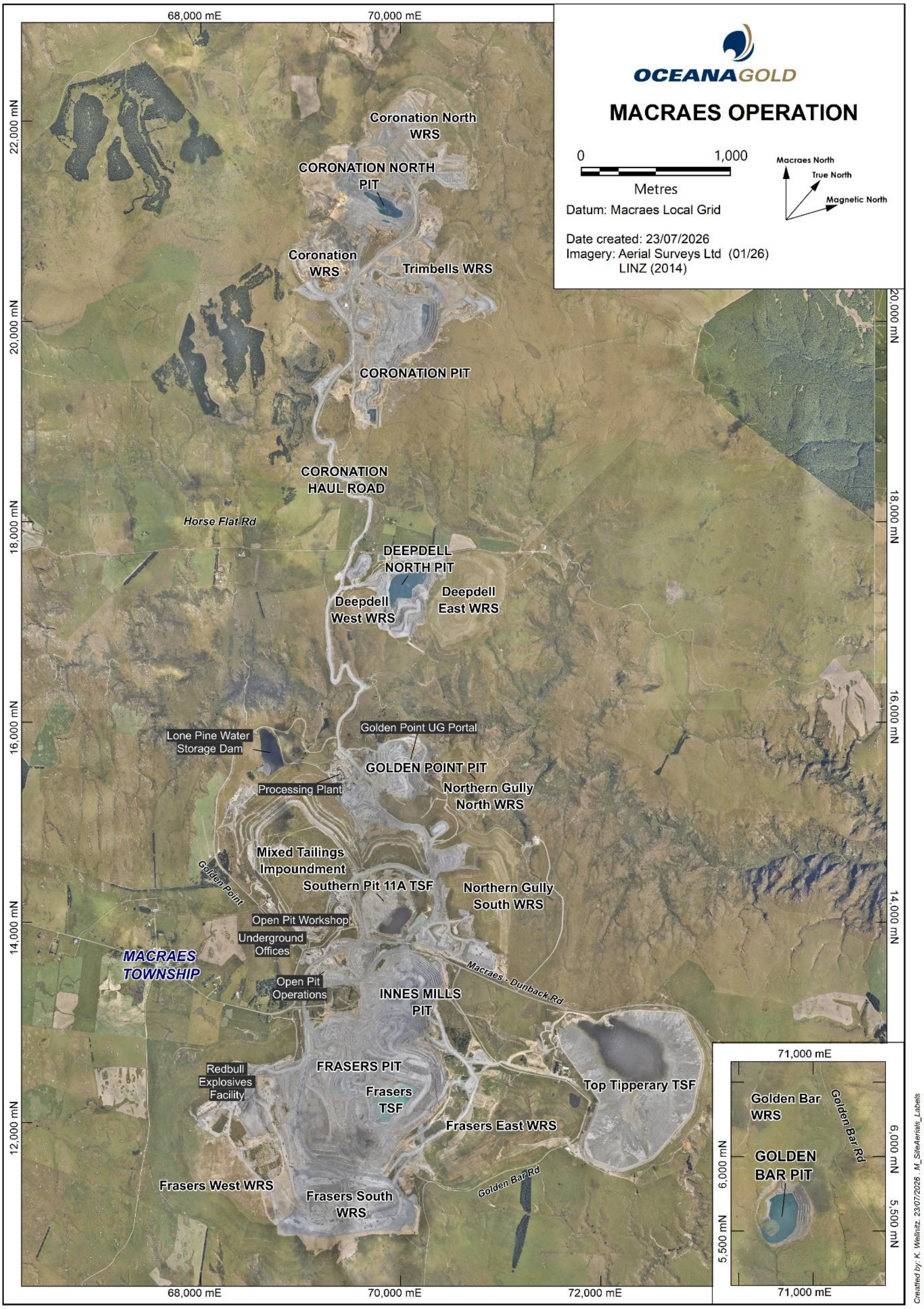


*Figure 1.1 Existing site layout at the Macraes Operation as of July 2026 (Source: OGL)*

## 1.2 Purpose of this Report

The purpose of this report is to present the results of the groundwater and surface water modelling associated with OGNZL's proposed Macraes Phase 4 (MP4) project to support a substantive application for approvals under the Fasttrack Approvals Act 2024. Assessing the potential effects on groundwater and the receiving surface water bodies is the key objective of this report.

## 1.3 Scope and Limitations

### 1.3.1 Scope of works

GHD New Zealand Limited (GHD) has been engaged by OGNZL to assess the surface and groundwater effects associated with the Macraes Phase 4 project. This report has been prepared in line with the GHD proposal dated 3 November 2025 and subsequent variations to that scope and presents the findings of the surface water and groundwater studies associated with the project.

The modelling scope and extents include:

- Groundwater dewatering as well as groundwater recovery and its effects associated with the proposed pit extensions.
- Surface water modelling encompassing pit lake filling curves and receiving surface water bodies surrounding the site.
- The water balance for the site and contaminant mass transport effects from the proposed pits, WRSs, GPUG and FTSF extensions.

The focus of this assessment is surface water and groundwater cumulative effects of the proposed:

- Open pit extensions at Golden Bar, Coronation, Coronation North, and Innes Mills.
- Underground mine expansion through further development of the Golden Point Underground mine ("GPUG").
- Tailings management, including:
  - Construction of the Frasers Tailings Storage Facility ("FTSF") Stage 3 and
  - Hydraulic mining and relocation of tailings from the Mixed Tailings Impoundment ("MTI"), Southern Pit Option 10 TSF ("SP10"), and Southern Pit Option 11A TSF ("SP11") to FTSF.
- Waste rock disposal, including increased storage capacity within open pits and at existing waste rock stacks at Coronation, Coronation North, Innes Mills, Golden Bar, Golden Point, and Frasers

As a cumulative assessment, it includes consideration of all the aforementioned mine elements for MP4 and includes consideration of activities both consented and under application where it is likely that those consents will be given effect as part of the MP4 development.

### 1.3.2 Limitations

*This report: has been prepared by GHD for OceanaGold (New Zealand) Limited and may only be used and relied on by OceanaGold (New Zealand) Limited for the purpose agreed between GHD and OceanaGold (New Zealand) Limited as set out in section 1 of this report.*

*GHD otherwise disclaims responsibility to any person other than OceanaGold (New Zealand) Limited arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible. . Without limiting the foregoing, this report is intended to support OceanaGold (New Zealand) Limited Limited's application under the Fast-track Approvals Act 2024 and may be relied upon by the Expert Panel and relevant administering agencies for the purposes of assessing the application.*

*The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.*

*The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.*

*The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 1.4 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.*

*The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.*

*Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.*

*GHD has prepared the surface and groundwater models ("Model") for, and for the benefit and sole use of, OceanaGold (New Zealand) Limited to support the MPIV project and must not be used for any other purpose or by any other person.*

*The Model is a representation only and does not reflect reality in every aspect. The Model contains simplified assumptions to derive a modelled outcome. The actual variables will inevitably be different to those used to prepare the Model. Accordingly, the outputs of the Model cannot be relied upon to represent actual conditions without due consideration of the inherent and expected inaccuracies. Such considerations are beyond GHD's scope.*

*The information, data and assumptions ("Inputs") used as inputs into the Model are from publicly available sources or provided by or on behalf of the OceanaGold (New Zealand) Limited, (including possibly through stakeholder engagements). GHD has not independently verified or checked Inputs beyond its agreed scope of work. GHD's scope of work does not include review or update of the Model as further Inputs becomes available.*

*The Model is limited by the mathematical rules and assumptions that are set out in the Report or included in the Model and by the software environment in which the Model is developed.*

*The Model is a customised model and not intended to be amended in any form or extracted to other software for amending. Any change made to the Model, other than by GHD, is undertaken on the express understanding that GHD is not responsible, and has no liability, for the changed Model including any outputs.*

*GHD has prepared this report on the basis of information provided by OceanaGold (New Zealand) Limited and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.*

*This report has been produced for New Zealand consenting purposes only. Information contained herein must not be relied on for investment purposes.*

## 1.4 Assumptions

This document has been produced for New Zealand consenting purposes only. Information contained herin must not be relied on for investment purposes.

GHD has relied upon data (project timeline and schedule, shapefiles, volumes and material properties) provided by OGNZL to inform this assessment, we have assumed that the data is correct and representative of the groundwater and surface water environment. GHD has also relied upon the information presented in previous assessments. These sources are referenced through the report.

### 1.4.1 Groundwater Modelling Limitations and Assumptions

The results of numerical models are inherently dependent on the level of detail represented in the model and parameter uncertainty. Therefore, modelled effects are subject to uncertainty and may differ from actual conditions. The following assumptions were made:

– Modelling results presented in this report are based on the mine plans at the time of the assessment.
– The largest and deepest excavations were modelled for the estimated mining timeframes (section 2.2) for the dewatering models.
– The production schedules and plans are an estimate of the LOM plan and assumptions have been made regarding the end of year (EOY) surfaces and proposed timeline.
– Waste rock deposited has the same hydrogeological properties as other waste rock material across the Macraes Operation.
– Drain boundary and increased hydraulic conductivity around FRUG and around GPUG was incorporated into the current conditions and dewatering models by applying boundary conditions and hydrogeological properties to elements reflecting the FRUG and GPUG current extent. For the dewatering and recovery runs the drain boundaries applied for FRUG are removed. The drain boundaries applied for GPUG are removed for the recovery runs.
– Future additional data, refinement of these assumptions and of the adopted parameter values by further calibration would help reduce predicted uncertainties and will improve accuracy of the model outputs.
– Additional assumptions and limitations of the modelling undertaken are detailed throughout the report.
– Strains associated with the GPUG are maintained at a low level such that cracking is not induced between workings and surface water features

### 1.4.2 Surface Water Modelling Limitations and Assumptions

– Discharge to the receiving waters from pit dewatering during mining operations is not represented in the water quality outcomes. These waters are recycled within the mine water management system and reused on site within the 'closed' processing plant water circuit.
– Intermittent seepage from historic mine adits has been observed in the vicinity of Golden Point. It is assumed that the backfilling of Golden Point Pit will also include measures to control seepage through these workings in the long term and as such, this seepage has not been included in the modelling undertaken.
– Rehabilitation of waste rock surfaces is undertaken progressively and completed promptly on completion of mining unless features are held in interim management in which case measures are implemented to reduce infiltration rates.
– TSS and turbidity levels discharging to the receiving environment are managed using appropriately sized sediment retentions ponds and other sediment and erosion protection measures. These water quality compliance measures are not assessed in this assessment.
– During the mining phase all waters within the mine water management system are managed on site and remain within a closed system. For example, water from the tailings impoundments (including captured seepage) is recirculated and re-used for mine operations. Losses of these waters to the environment is through either uncaptured seepage to ground or evaporation.
– Water quality sources as outlined in Appendix E offer a true representation of the long-term water quality outcomes for the site, and do not reduce with time, unless explicitly modelled.
– All contaminants are assumed to be conservatively transported within both the groundwater and surface water environments on a mass balance basis.
– Following the mine closure period, it is assumed that provision is made for infrastructure to capture and treat all remaining seepage flows from TSF underdrains and discharge is done in a manner that does not adversely affect the receiving surface water environment.
– Operational water requirements such as water required for hydraulic mining are not considered within the WBM, since those are a closed internal loop system.
– All proposed mitigation measures outlined in this report are fully implemented based on the proposed timeline.

# 2. Project Description

## 2.1 Overview

The Project is made up of the following proposed key activities:

– **Open pit extensions** at Coronation, Coronation North, Innes Mills, and Golden Bar**.**
– **Underground mine** expansion through further development of the Golden Point Underground mine **(“GPUG”).**
– **Tailings management,** including:
  - Construction of the Frasers Tailings Storage Facility (“**FTS**F”) Stage 3 to accommodate a total tailings storage of up to 153 Mt; and
  - Hydraulic mining and relocation of tailings from the Mixed Tailings Impoundment (“**MTI**”), Southern Pit Option 10 TSF (“**SP10**”), and Southern Pit Option 11A TSF (“**SP11**”) to FTSF.
– **Waste rock disposal**, including increased storage capacity within open pits and at existing waste rock stacks at Coronation, Coronation North, Innes Mills, Golden Bar, Golden Point, and Frasers.
– **Water management infrastructure and operations**, including:
  - Construction of Camp Creek and Coal Creek water storage dams for flow and water quality management;
  - Construction, operation and maintenance of a Water Treatment Plant; and
  - Ongoing operation and maintenance of the Mine Water Management System (“**MWMS**”).
– **Infrastructure and roading works**, including:
  - Realignment of Macraes Road in two stages; and
  - Relocation of the Open Pit Mining Workshop.
– **Ecological enhancements**, including establishment of:
  - Murphys Ecological Enhancement Area (“**MEEA**”) near Murphys Creek, including predator fencing, access tracks, and site facilities;
  - Mt Highlay restoration area;
  - Cranky Jims Link shrubland enhancement area;
  - Murphys Link tussock protection area; and
  - Additional compensation measures for residual ecological impacts.
– **Mine closure and rehabilitation activities**, including rehabilitation of mining landforms, creation of pit lakes, dry capping of tailings storage facilities, and revegetation in accordance with closure objectives.

An overview of the proposed activities which make up the Project is shown in Figure 2.1 below.

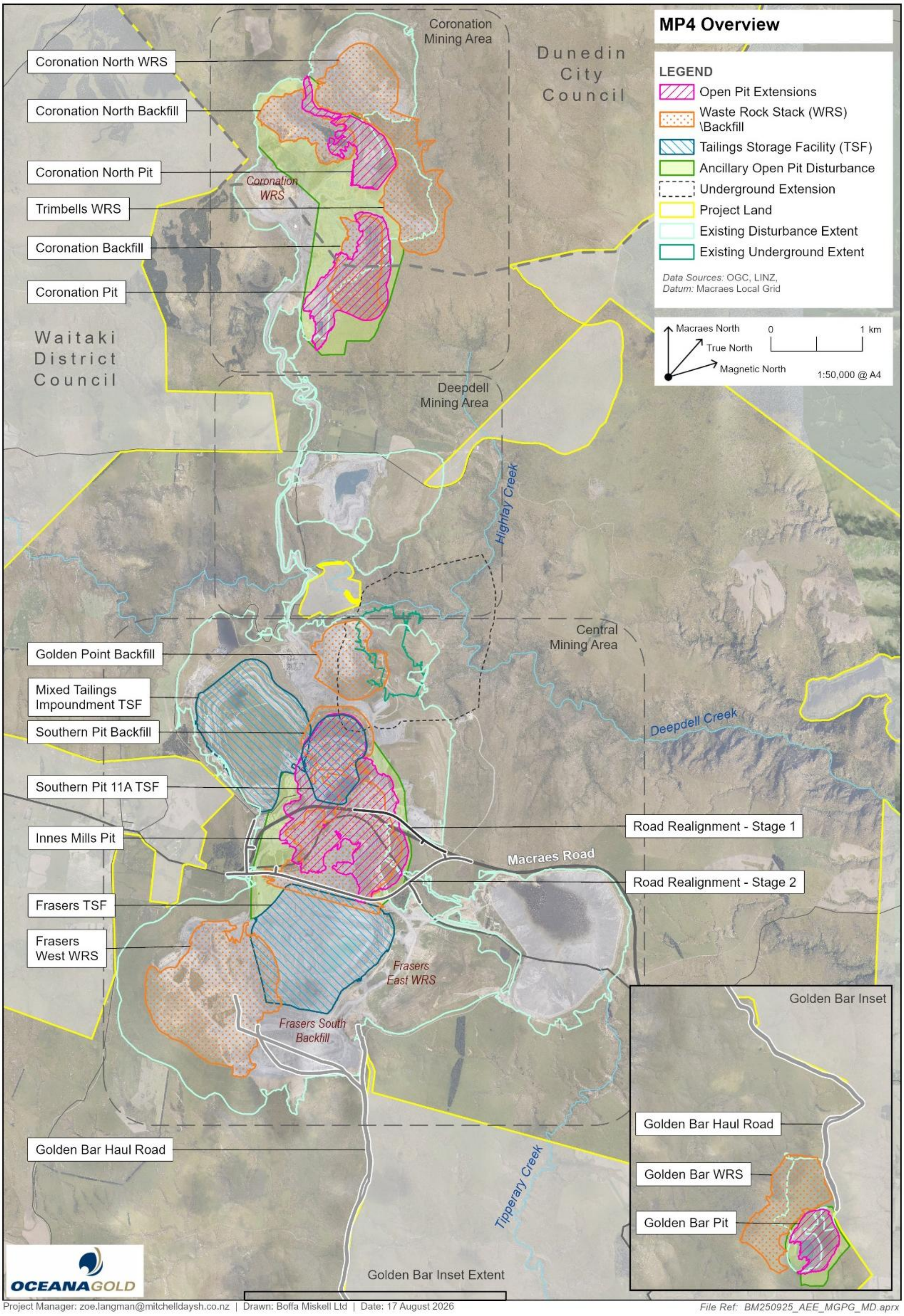


*Figure 2.1 MP4 Overview Plan (Source OGL, 2026)*

## 2.2 Indicative Project Timeline

The indicative project timeline for MP4 is outlined in Figure 2.2. The project is not being progressed in stages. Rather, all activities that comprise the MP4 project are included in this substantive application. Those activities are anticipated to occur across a period of 13 years, with OGNZL proposing to commence the MP4 project as soon as the necessary approvals are obtained.

The timeframes as outlined in Figure 2.2 have been used in groundwater modelling, surface water modelling and assessment of effects. The bullet points below are an indicative timeline for the various project components that has been assumed to inform the cumulative assessment as presented. It should not be relied upon explicitly for determining consent terms or lapse periods. It is noted that where future dates are presented through out this report, these dates are generally consistent with an **assumed Project commencement in July 2027.**

The activities described herein are expected to be generally sequenced as follows:

– The continuation of Innes Mills Pit mining from Year 1 to Year 12;
– The continuation of Coronation Pit mining from Year 2 to Year 6;
– Relocation of tailings from Southern Pit TSF and MTI from Year 2 to Year 12 to facilitate mining of Innes Mills Stage 13 (IM13);
– The continuation of Golden Bar Pit mining mostly in Year 3 and in Year 7;
– The continuation of GPUG mining from Year1 to Year 10;
– The continuation of Coronation North mining from Year 1 to Year 2 and then from Year 7 to Year 10;
– Associated replenishment of stockpiles throughout the MP4 mine life; and
– Full site rehabilitation to commence in Year 11 and be completed by approximately end of Year 13.

Mine planning is fluid at complex multi-pit operations such as the Macraes Operation. Precise timing of activities depends on a range of factors and operational requirements may facilitate changes to the sequencing of some activities. Figure 2.2 shows the anticipated sequencing of the proposed MP4 activities across the life of the project.

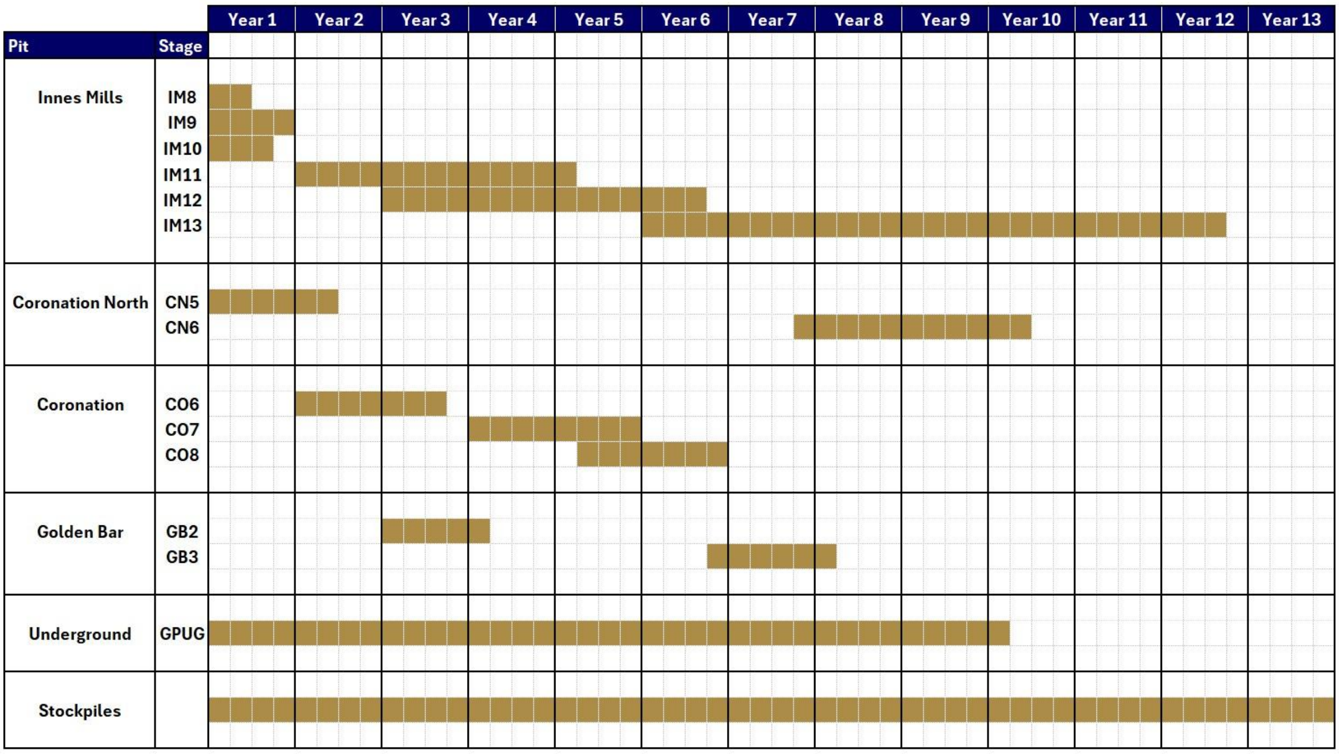


*Figure 2.2 Anticipated sequencing of MP4 activities (Project Description, OceanaGold, 2026)*

## 2.3 Innes Mills Open Pit Extension

MP4 proposes a further extension to the north, east and west into the Southern pit area (IM11 to IM13) to enable the recovery of downdip ore and stockwork ore. The proposed extensions (illustrated in Figure 2.3) will result in an overall increase to the Innes Mills Pit footprint of approximately 49 ha.

The key activities required to facilitate the full mining of IM13 are realignment of Macraes Road, relocation of all SP11 and SP10 tailings and up to 30m in height off the top of the MTI tailings, rerouting of powerlines, pipelines (water and tailings), pumpstations and relocation of the Open Pit Workshop..

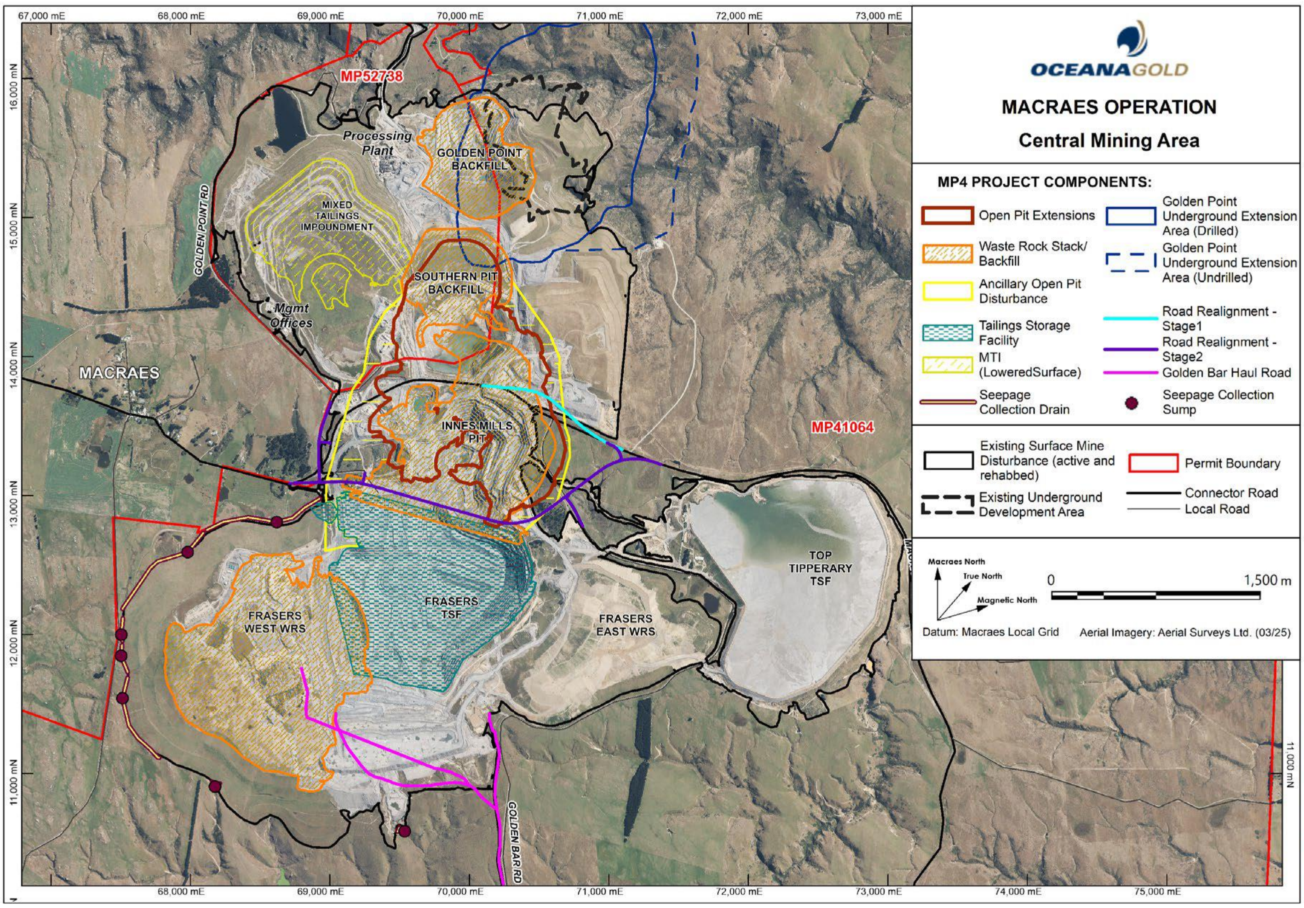


*Figure 2.3 Project components within the Central Mining Area (OceanaGold, 2026)*

## 2.4 Golden Bar Pit Extension

Golden Bar Pit is located approximately 10 km south of the Processing Plant. The proposed Golden Bar Pit extension consists of an approximate 340 m expansion to the east and northeast, as shown in Figure 2.4. The current Golden Bar Pit has a footprint of 14 ha. The open pit excavation will extend to within 50 m of Golden Bar Road. The proposed extension to the Golden Bar Pit will result in an overall increase to the pit footprint of approximately 15.2 ha increasing the total pit footprint to approximately 29.2 ha – an increase of 109%.

The Golden Bar pit was mined from 2004 – 2006 and has been partially rehabilitated to form a pit lake that is currently spilling water to a tributary of Murphys Creek, locally known as Golden Bar Creek.

There is a disused haul road running adjacent to Golden Bar Road on land owned by OceanaGold, which connects Golden Bar Pit to the wider Macraes Operation haul road network.

The Golden Bar Pit extension involves:

– Wildlife monitoring, salvage and translocation (as required);
– Establishment of temporary support infrastructure;
– Dewatering of the existing Golden Bar Pit and mining of the pit extension;
– Recommissioning of the private haul road;
– Expansion of the existing Golden Bar Waste Rock Stack (“GBWRS”); and
– Rehabilitation and closure.

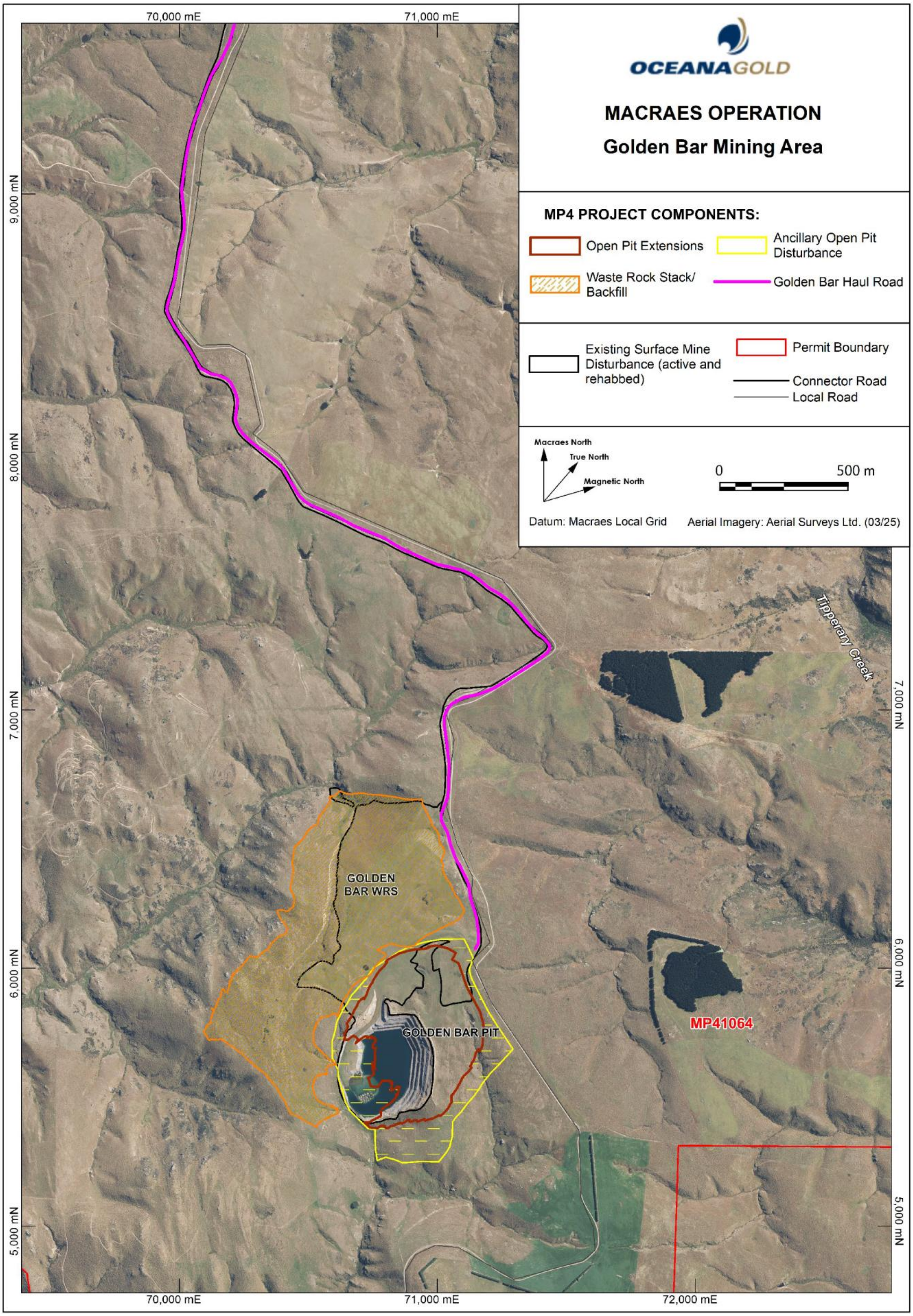


***Figure 2.4 Golden Bar open pit extension project areas (OceanaGold, 2026)***

# 2.5 Coronation and Coronation North Pit Extension

The Coronation and Coronation North Pits are located approximately 5 km north of the Processing Plant and are currently used as temporary water storage reservoirs as part of the MWMS.

The proposed Coronation Stage 6-8 Pits (CO6, CO7, CO8) consist of an approximately 560 m expansion to the southeast, as shown in Figure 2.5. The currently authorised Coronation Stage 5 (CO5) Pit has a footprint of 85 ha. The proposed extension to the Coronation Pit will result in an overall increase to the pit footprint of approximately 40 ha, increasing the total pit footprint to approximately 125 ha – an increase of 32%.

The proposed Coronation North Stage 6 Pit (CN6) consists of an approximately 205 m expansion to the southeast over predominantly tussockland and Trimbells waste rock stack, as shown in Figure 2.5. The currently authorised Coronation North Stage 5 (CN5) Pit has a footprint of 40 ha. The proposed extension to the Coronation North Pit will result in an overall increase to the pit footprint of approximately 17 ha, increasing the total pit footprint to approximately 57 ha – an increase of 29%.

The Coronation and Coronation North Pit extensions involve:

- Wildlife monitoring, salvage and translocation (as required);
- Dewatering of the existing pits and mining of the pit extension;
- Haulage of waste to, and partial backfilling of both pits;
- Haulage of ore to the Processing Plant along the Coronation haul road; and
- Rehabilitation and closure.

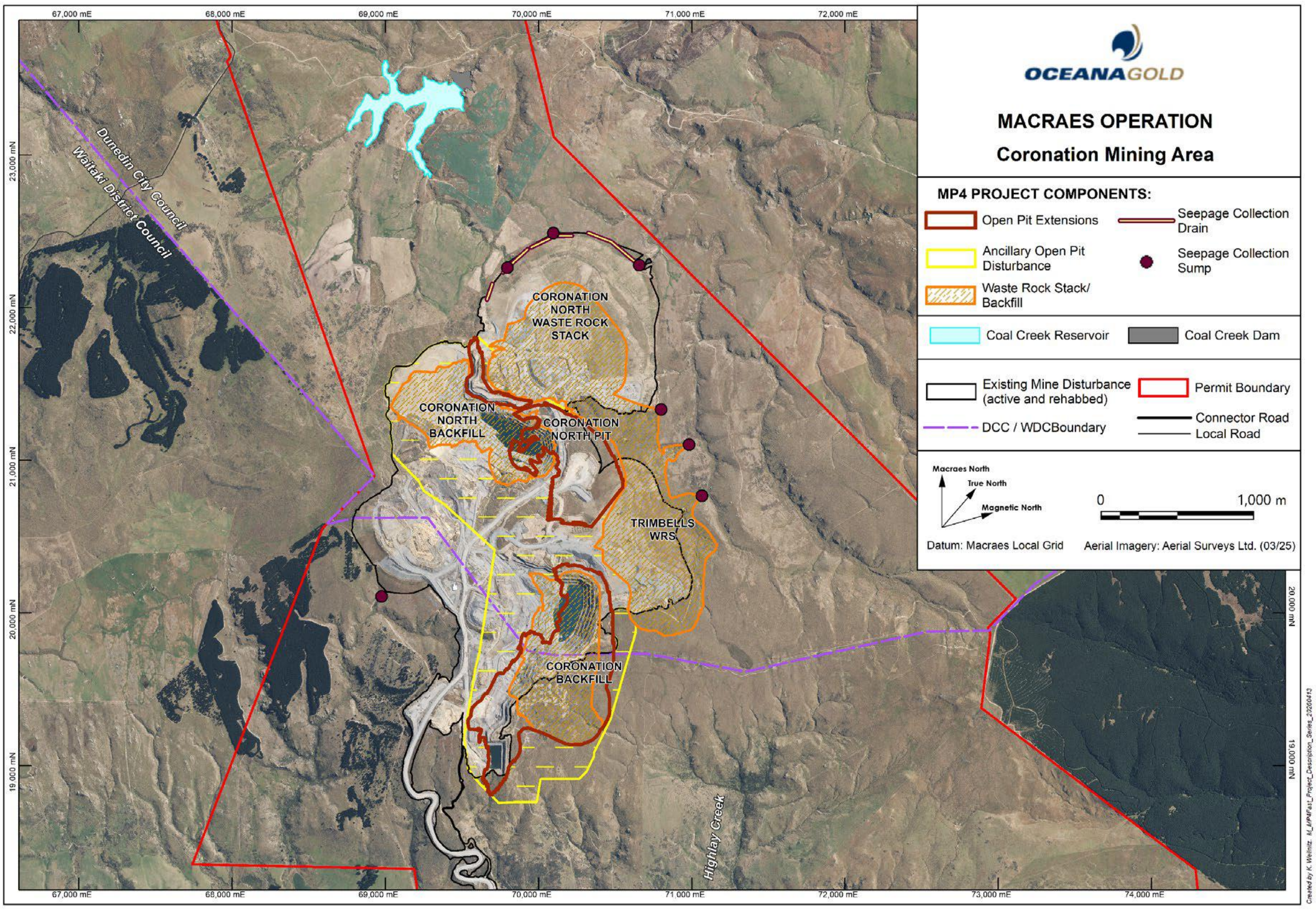


*Figure 2.5 Coronation and Coronation North Pit extension project areas (OGL, 2026)*

## 2.6 GPUG Extension

GPUG is an operating underground mine, commissioned in 2020, with surface access provided through two portals located on the eastern highwall of Golden Point Pit. As is standard practice for underground mining operations, ore reserves are subject to ongoing review, and mine development and extraction layouts are periodically refined to optimise the mine plan. The authorised and as-built layout is shown in Figure 2.6.

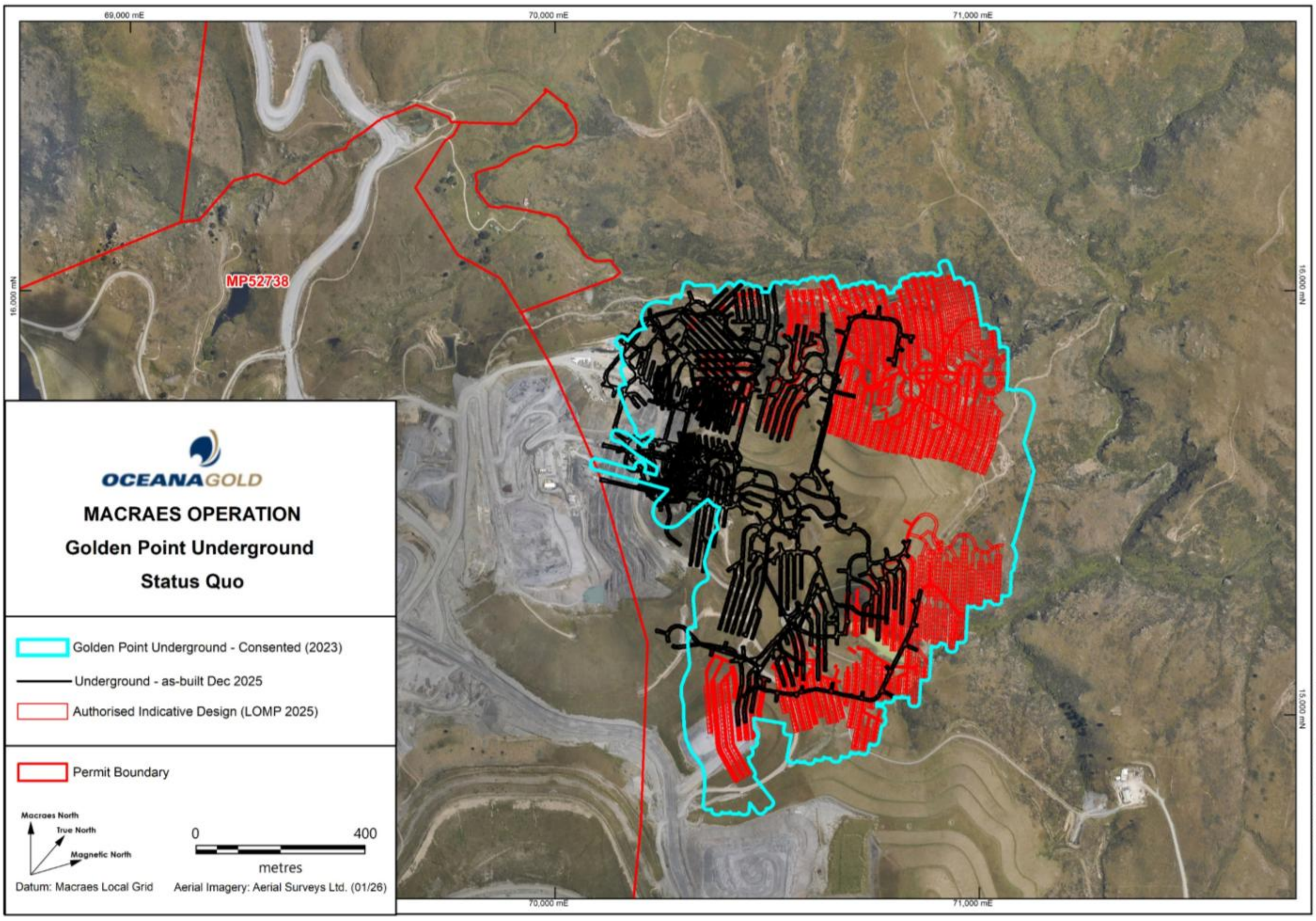


*Figure 2.6 GPUG as build (Dec 2025) and consent extent*

The proposed envelope of GPUG extension is shown in Figure 2.7. The depth of proposed workings within the currently unconsented area will vary from 440 mRL to -40 mRL (40 m below sea level) in the dark grey drilled envelope shown in Figure 2.7, and between about 220 mRL to -130 mRL for the undrilled envelop, with depth increasing as mining progresses eastwards.

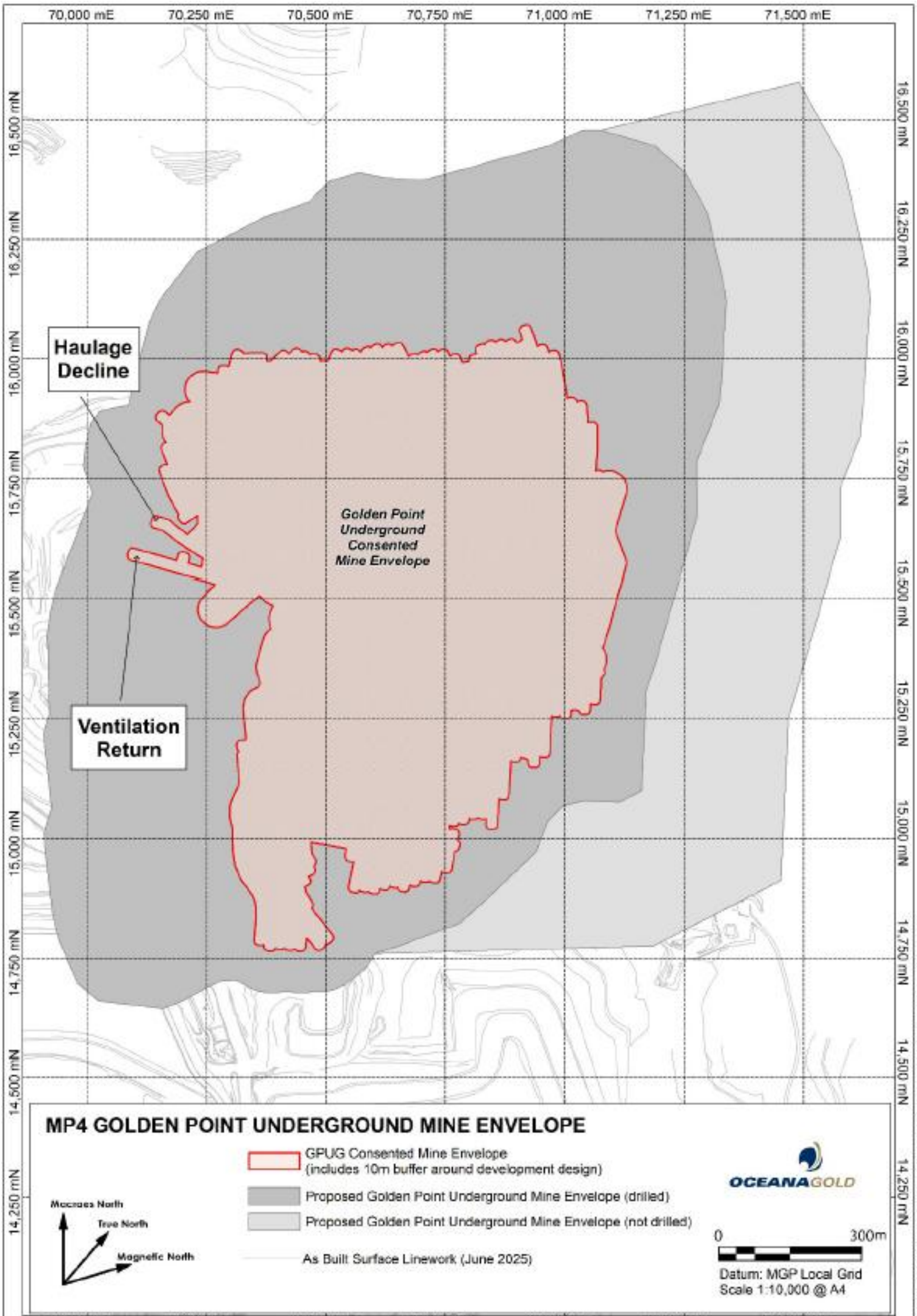


*Figure 2.7 Consented and proposed GPUG envelope of extent*

# 3. Site setting

The environmental conditions present at Macraes have been summarised in a number of previous reports written for the Macraes Operation MPIII resource consents and subsequent mine developments. This assessment has relied solely on existing data and previous reports made available by OGNZL. The following subsections present a short overview of the environmental setting across the Macraes Operation, as has been summarised in previous reports.

## 3.1 Topography / Surface Water

The topography of the wider Macraes site is driven by the geologic evolution of the region. Long term weathering and erosion of the underlying rock resulted in a distinctive low relief peneplain which is bounded by Waikouaiti River North Branch to the west, Deepdell Creek to the north, and Murphys Creek to the south. Deepdell Creek has been deeply incised into this erosional surface resulting in steep valley slopes and minimal alluvial deposition. In contrast, the NBWR is characterised by shallow relief, broad valleys and alluvial deposition.

The original topography has been altered from more than thirty years of mining and waste deposition. Mining has been generally aligned with the orientation of the major Hyde-Macraes Shear Zone (HMSZ) which is the primary structural feature that controlled the ore body development. Mining has altered portions of original catchments in the main Macraes Operation, but the primary streams and rivers surrounding the mining site remain in their pre-mining locations.

The Macraes Operation is located within the Shag River/Waihemo, Taieri and NBWR catchments as shown in Figure 3.1. The Shag River flows in a south-easterly direction and enters the ocean close to Matakaea. The NBWR flows in a southerly direction from the mine site and enters the ocean near Karitane. The Taieri River flows in a southerly direction to the ocean south of Dunedin. Land use within these catchments consists primarily of agriculture and forestry. Assessing this potential and the effect on these surface water bodies is the key objective of this report.

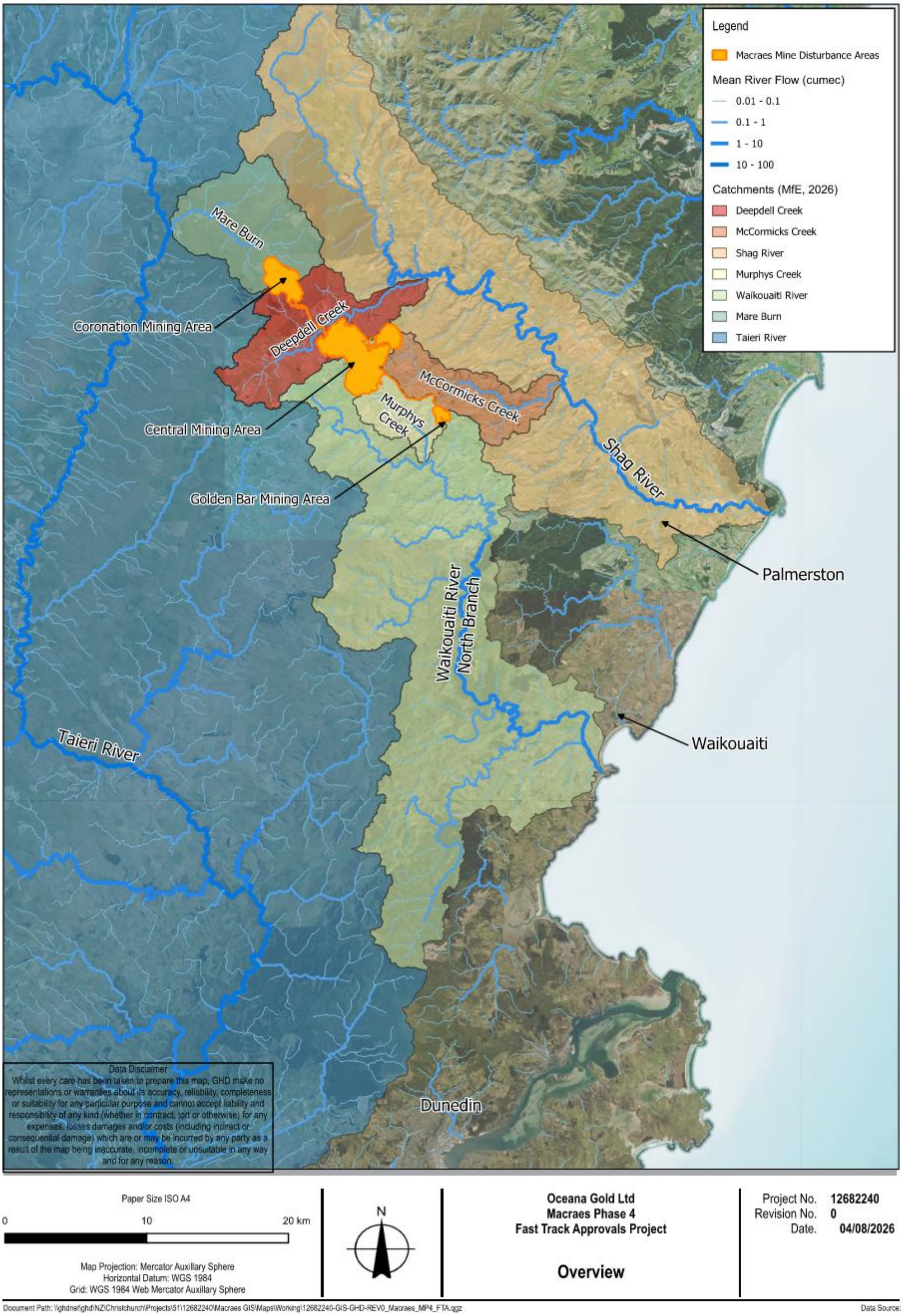


*Figure 3.1 Waikouaiti River North Branch (left) and Shag River / Waihemo (right) catchments*

## 3.2 Climate

The climate at Macraes is controlled predominantly by the mountains to the west of the site (Rock and Pillar Range) which act as a barrier to incoming weather systems from the west, leading to a fairly dry climate with limited precipitation. Climate data from the Macraes Operation has been provided from four locations, Macraes, Glendale, Deepdell and Golden Point stations. Deepdell and Golden point stations were installed to monitor rainfall at the Macraes Operation while Glendale is part of the national climate monitoring programme. Glendale station data spans from 1959 to 2013. Mean annual rainfall is approximately 664 mm/yr and evaporation (open pan) is 952 mm/yr, creating a climate that can often lead to moisture deficits.

Climate change considerations for the site consider the defined representative concentration pathways (RCPs) based on projected radiative forcing to 2100 (Van Vuuren et al. 2011). For long-term water management considerations at the Macraes Operation, RCP8.5 is adopted as a conservative climate change scenario because it represents a high-emissions, 'business as usual' pathway. Under this scenario, the site is expected to experience the following key outcomes:

- increased mean and maximum temperatures
- increased dry days (no precipitation) and evaporation with more severe and frequent droughts
- decrease in summer precipitation (December – February)
- increase in winter precipitation (June – August)
- increased mean precipitation concentrated on the extreme events
- increase in the potential evaporation deficit (PED)

This climate scenario is considered as a sensitivity test for long-term water management outcomes as presented in Section 6.3 with adjustments applied to rainfall and evaporation rates in the WBM. These adjustments are in addition to the stochastic data inputs that represent a wider range of hydrological conditions than represented in the measured data. Climate and climate change representation is further discussed in Appendix E within the context of surface water modelling.

## 3.3 Geology

Regionally, the geology is dominated by the Mesozoic-aged crystalline metamorphic rock of the Rakaia Terrane Otago Schist (CDM Smith, 2016). At Macraes, the ore body geology is dominated by the Hyde–Macraes Shear Zone, a broad, shallowly northeast-dipping structural corridor developed within the Otago Schist. There are three major northeast-southwest trending faults that are present across the Macraes Operation:

- The Deepdell Fault - aligned with Deepdell Creek.
- The Macraes Fault - intersects the northern end of Frasers Pit and extends out to Top Tipperary Creek forming the northern boundary of Frasers Underground Mine (FRUG).
- Unnamed Fault – aligned with Murphys Creek, south of Frasers Pit

The landscape at the site is dominated by widespread schist outcrop, with only a thin superficial cover of alluvium and colluvium, typically reported as up to about 1.8 m thick (Golder, 2011b) and is not considered to materially influence the regional groundwater flow system.

## 3.4 Hydrogeology

The hydrogeology at Macraes is characterised by a fractured-rock groundwater system hosted within the Otago Schist, with groundwater movement occurring predominantly through secondary permeability features such as fractures, foliations, shear zones and faults rather than through the intact rock matrix. Groundwater conditions are therefore expected to be influenced by the local structural framework, such as the Hyde–Macraes Shear Zone and the degree of weathering and faulting within the rock.

CDM Smith (2016) compiled a summary of historic hydraulic testing of schist undertaken at around the Macraes Operation originally sourced from Golder, 2011a. The raw data were reviewed in graphical format and the geometric mean (geomean) and averages from the CDM Smith summary are presented in GHD (2021 and 2024). Hydraulic conductivity values are ranging from 1E-05 m/s to 5E-09 m/s. Further testing, near GPUG, was undertaken by WSP (2023) and estimated hydraulic conductivity values generally in the same order of magnitude (or lower at depth) as those presented and used in previous assessments. Hydraulic properties for the waste rock and tailings are also presented in studies listed above. Hydraulic conductivity values used in groundwater modelling for waste rock is 1E-06 m/s and for tailings values are in the order of 1E-0.7 m/s. These values are in accordance to previous numerical studies undertaken for the project (Golder, 2011a, CDM Smith (2016), GHD (2021 and 2024)). The hydraulic properties assigned to the hydrostratigraphic units represented in the numerical models used for this assessment are described in Appendix A, Appendix B, Appendix C and Appendix D.

## 3.5 Waste Rock Stacks

Waste rock is the mined rock that contains insufficient ore to process economically. It is typically coarse in nature (gravel to boulders <1.5 m in diameter) and angular, due to the blasting process used to break down the schist. It is typically stacked and compacted historically in 15 to 20 m lifts. Details of the existing and future WRSs on site are provided in Table 3.1.

Note that the modelling does not separately represent low grade ore stockpiles as these are generally temporary in nature and are to be removed (processed) by closure. These stockpiles often form part of existing WRSs and are implicitly represented through their current effect on seepage water quality measurements and disturbance areas.

*Table 3.1 Waste Rock Stack Details*

| Waste Rock Stack | Commencement Date |
|---|---|
| Clydesdale (GBWRS) | 1/01/2003 |
| Coronation | 1/01/2014 |
| Coronation Backfill | 1/01/2027 |
| Coronation North | 1/01/2017 |
| Deepdell East | 1/10/2020 |
| Deepdell North | 1/01/2001 |
| Finger 11 (temporary low grade storage location) | 1/01/2010 |
| Frasers Backfill | 1/01/2023 |
| Frasers East (Closed and rehabilitated) | 1/01/2009 |
| Frasers South | 1/01/2005 |
| Frasers West | 1/01/2003 |
| Innes Mills Backfill | 1/01/2026 |
| Golden Point Backfill | 1/01/1995 |
| Mixed Tailings Impound (TSF embankment) | 1/01/1991 |
| Northern Gully (Closed and rehabilitated) | 1/01/1995 |
| Round Hill (Closed and rehabilitated) | 1/01/1995 |
| SP11 Impoundment (TSF embankment) | 1/01/2002 |
| Top Tipperary Impoundment (TSF embankment) | 1/01/2014 |
| Trimbells | 1/01/2020 |

## 3.6 Tailings Storage Facilities

Tailings are the residual material left after ore has been processed. The material typically comprises a slurry of water, sediment (silt with sand and clay sized particles), and traces of leftover additives used during processing. The tailings at Macraes often contain high concentrations of sulphate due to the presence of arsenopyrite in the sheared schist and the pressure oxidation process employed. After processing, tailings are deposited into the TSFs, grading out with coarse sediments settling out close to the deposition point. Details on the existing tailings facilities are provided in Table 3.2.

*Table 3.2 Tailings Storage Facilities*

| Tailings Storage Facility | Design Level (m) | Year Commissioned |
|---|---|---|
| MTI | 548 mRL (proposed reduction to 512 mRL) | 1991 |
| SP10 | 525 mRL (proposed removal) | 2002 |
| SP11A | 544 mRL (proposed removal) | 2006 |
| TTTSF | 570 mRL | 2013 |
| Frasers Pit | 425 mRL (proposed to average height 512.2 mRL) | 2025 |

# 4. Modelling Overview and Conceptual Site Models

This section provides an overview of how the groundwater and surface water modelling is undertaken, including an outline of the interactions between the various models applied in this assessment.

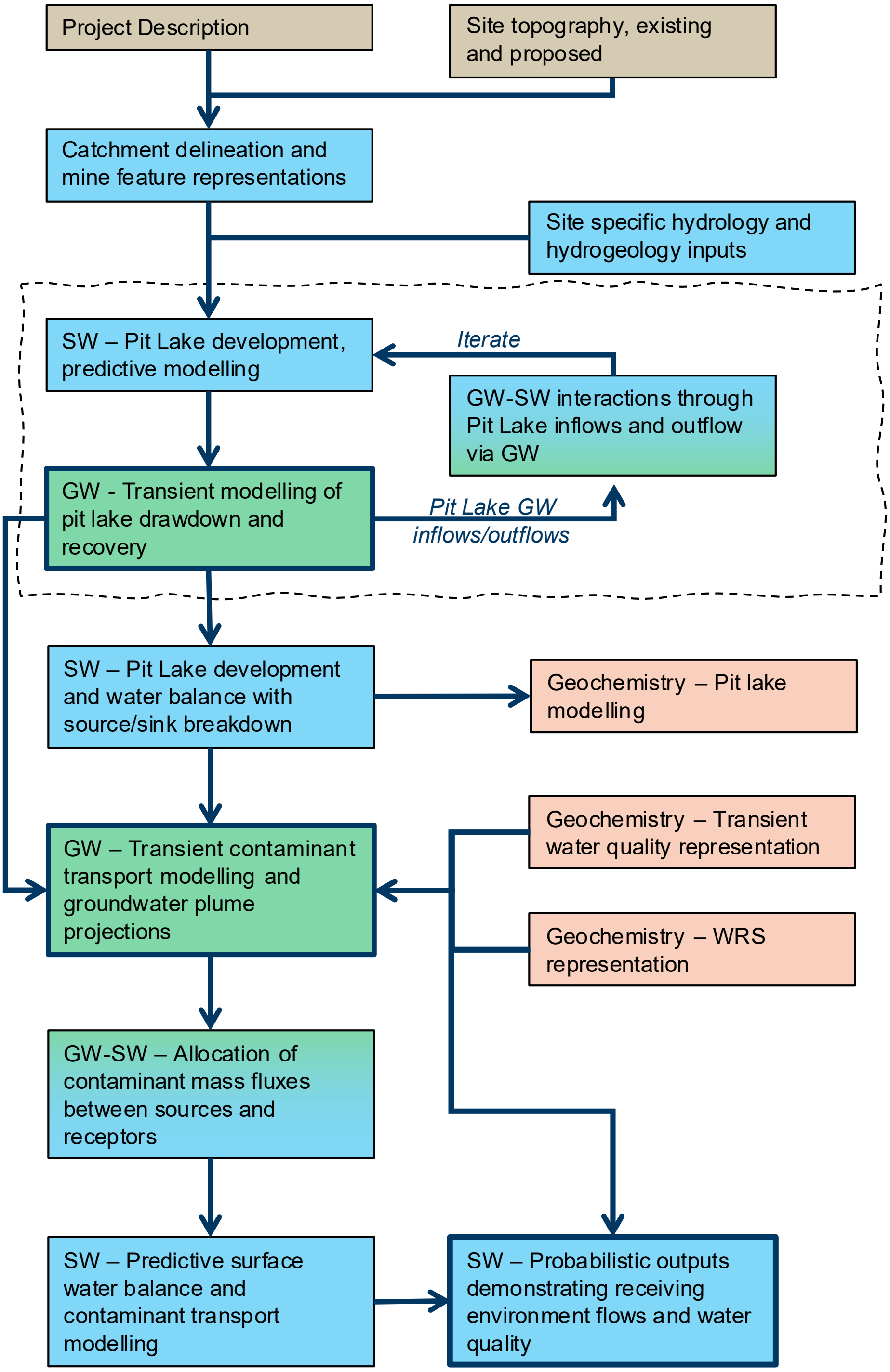


*Figure 4.1 Surface water and groundwater modelling workflow diagram*

The workflow diagram in Figure 4.1 provides a high-level description of the modelling approach taken and key interactions between the models developed for this project. The process includes:

1. Delineation of surface water catchments for mining phase and post closure phase of the project for representation in surface water modelling [**Appendix I**].
2. Development of site-specific hydrology inputs for groundwater and surface water modelling. [**Appendix E**]
3. Iterative process aligning pit lake filling rates based on surface water hydrology and groundwater inflows:
   a. Initial prediction pit lake filling rates based on surface water hydrology and groundwater inflows from prior studies.
   b. Modelling of the groundwater drawdown and post mining recovery with the lake levels set as boundary conditions (note that the groundwater model is split into three separate areas covering workings at (1) Golden Bar, (2) Coronation and Coronation North, and (3) Central area including Frasers, Innes-Mills and Golden Point) [**Section 5.2, Appendix A, Appendix B, Appendix C**].
   c. Redefining of groundwater inflows and outflows from the pit lake voids within the surface water model based on analysis of data generated in (b).
      - Outputs provide for revised net inflow and net outflow rates for use in surface water modelling.
   d. Revision of the pit lake filling rates predictions with the surface water model.
4. Determining the breakdown of cumulative water sources and sinks contributing to the pit lake development.
   - Outputs to form basis of pit lake geochemical modelling (as presented in MWM 2026c,d,e,f) [**Section 6.2, Appendix G**]
5. Groundwater contaminant transport modelling based on mine affected sources covering mine development to date and long-term future predictions of plume extents and contaminant release to surface water bodies. Source concentrations based on source term development by (MWM 2023, 2026b,d,e,f).
   - Outputs provide the basis for long-term transient contaminant fluxes between modelled nodes/features within the surface water model, supplementing the surface water contaminant transport modelling [**Section 5.2, Appendix A, Appendix B, Appendix C**].
6. Surface water contaminant transport modelling to determine water quality projections at compliance and monitoring sites in the receiving environment, assessed against the compliance criteria presented by Viridis (2026) [**Section 6.3**].

## 4.1 Conceptual Site Models

Figure 4.2, Figure 4.3 and Figure 4.4 represent conceptual site models for the three mining areas of Golden Bar, Coronation, and the central site from Frasers to Deepdell workings. The purpose is to show a schematic representation of the key features represented in the surface water and groundwater modelling, including key interactions between these models and to highlight the current conceptual understanding of water movement within and between the relevant mine elements, receiving surface and groundwater environment and key hydraulic pathways.

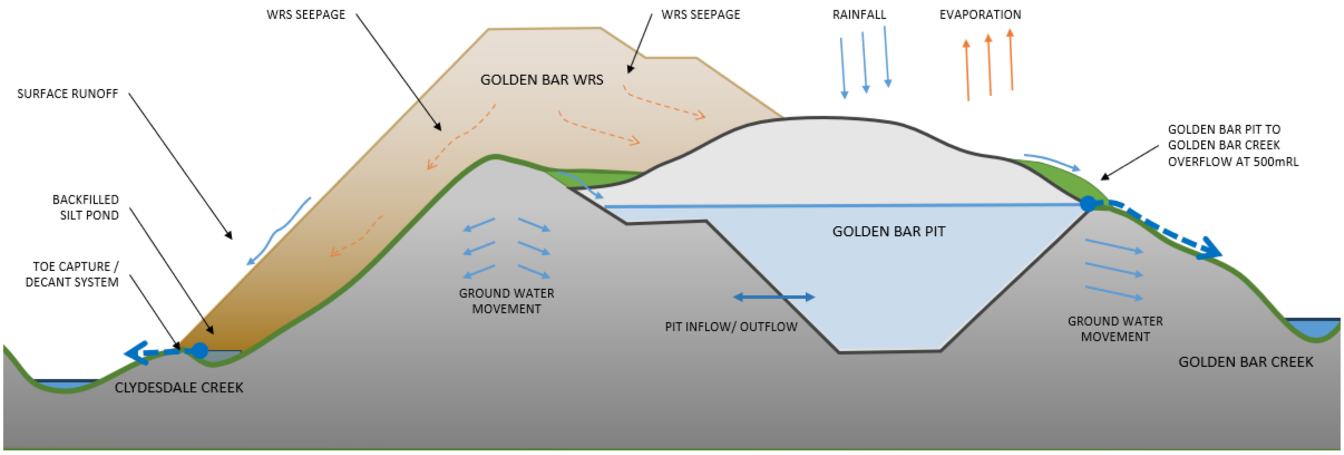


*Figure 4.2 Golden Bar conceptual site model*

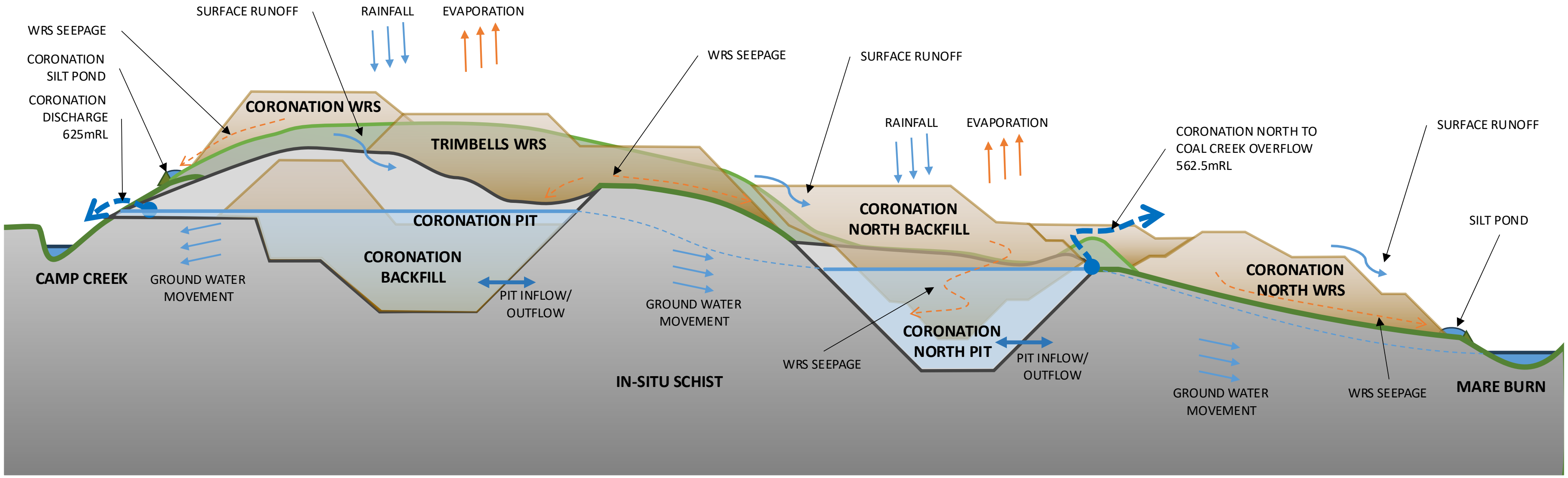


*Figure 4.3* *Coronation area conceptual site model*

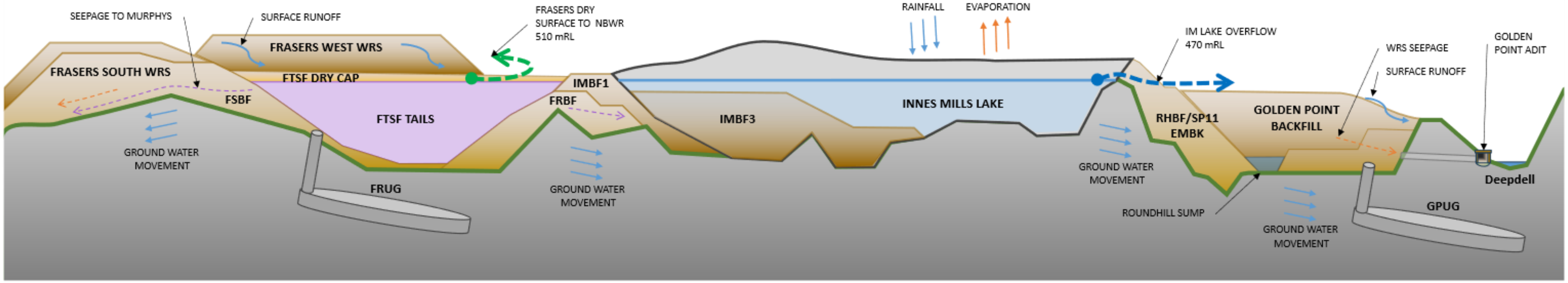


*Figure 4.4* *Central mine site conceptual site model*

# 5. Groundwater Modelling

## 5.1 Groundwater Modelling Approach

Three 3D numerical groundwater flow models have been set up for the Macraes site. One for the Golden Bar Mining Area, one for Coronation Mining Area and one for the Central Mining Area. The models have been set up using Leapfrog software and Groundwater Vistas using MODFLOW-USG (numerical modelling code) developed by the USGS. The objectives of the modelling are to:

– Simulate pre-mining conditions and existing /current conditions at the site (base case scenario)
– Predict pit inflow for the proposed expansions of the open pits and assess dewatering effects.
– Simulate groundwater recovery after the conclusion of the proposed expansion.
– Undertake solute transport modelling to assess existing conditions, proposed mining conditions and post-mining groundwater recovery using the solute transport modelling code (MODFLOW USG-TRANSPORT).

Details of the models set up, boundary conditions and model calibration are presented in Appendices A, B and C for the Golden Bar Mining Area, Coronation Mining Area and for the Central Mining Area respectively.

Furthermore, 2D modelling has been undertaken using SEEP/W to estimate seepage volumes through specific waste rock stacks (WRSs) where the risk of relatively undiluted seepage discharge to surface water is considered high i.e. Frasers South WRS to Murphys Creek. Details of these models are presented in Appendix D.

## 5.2 Groundwater Modelling Results

### 5.2.1 Golden Bar Mining Area

#### 5.2.1.1 Base Case Model (Existing Conditions)

Mining at the current Golden Bar Stage 1 pit started in 2004 and ceased in 2005, and the water level in the pit reached the current spill level (approximately 500 m RL) in 2018. Existing conditions have been simulated with a steady-state flow model.

Steady-state groundwater head contours (phreatic surface) for the base case model are presented in Figure 5.1. These contours provide a spatial representation of the simulated water table under existing conditions and illustrate the modelled groundwater flow pattern across the Golden Bar model domain. Groundwater flow generally follows topography and is diverted towards the dewatered pit

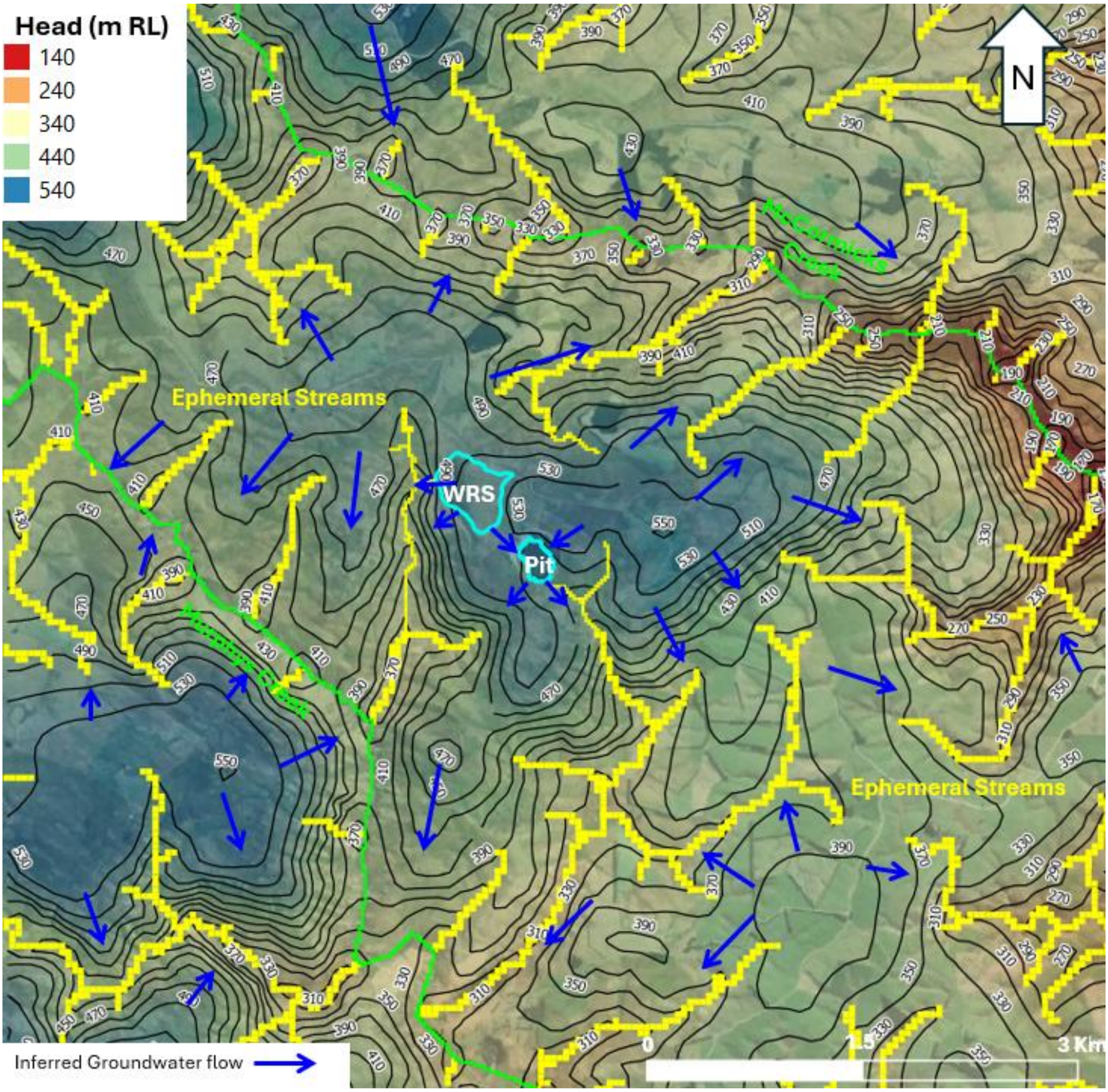


*Figure 5.1 Existing conditions steady-state modelled head contours (mRL) in model layer 1 and inferred groundwater flow direction (Golden Bar base case model).*

### 5.2.1.2 Proposed Mining - Dewatering of Golden Bar Pit

Proposed mining conditions for Golden Bar Stage 2 (GB2) and Stage 3 (GB3) have been simulated with a transient flow model assuming a total of 6 years of dewatering as per the indicative Macraes mining schedule (Figure 2.2). Throughout the simulation the greater and deeper extent of the proposed design has been adopted. This is a relative conservative assumption and is considered appropriate for assessing effects from pit dewatering.

Modelled groundwater head contours (in layer 1) at the end of the proposed 6-year dewatering period for both Stage 2 and Stage 3 are presented in Figure 5.2. The initial dewatering (emptying the pit) is not included in the sense that several months of pumping will be required to empty the pit. The simulated dewatering period starts once the pit is empty of water and has been excavated to the proposed design.

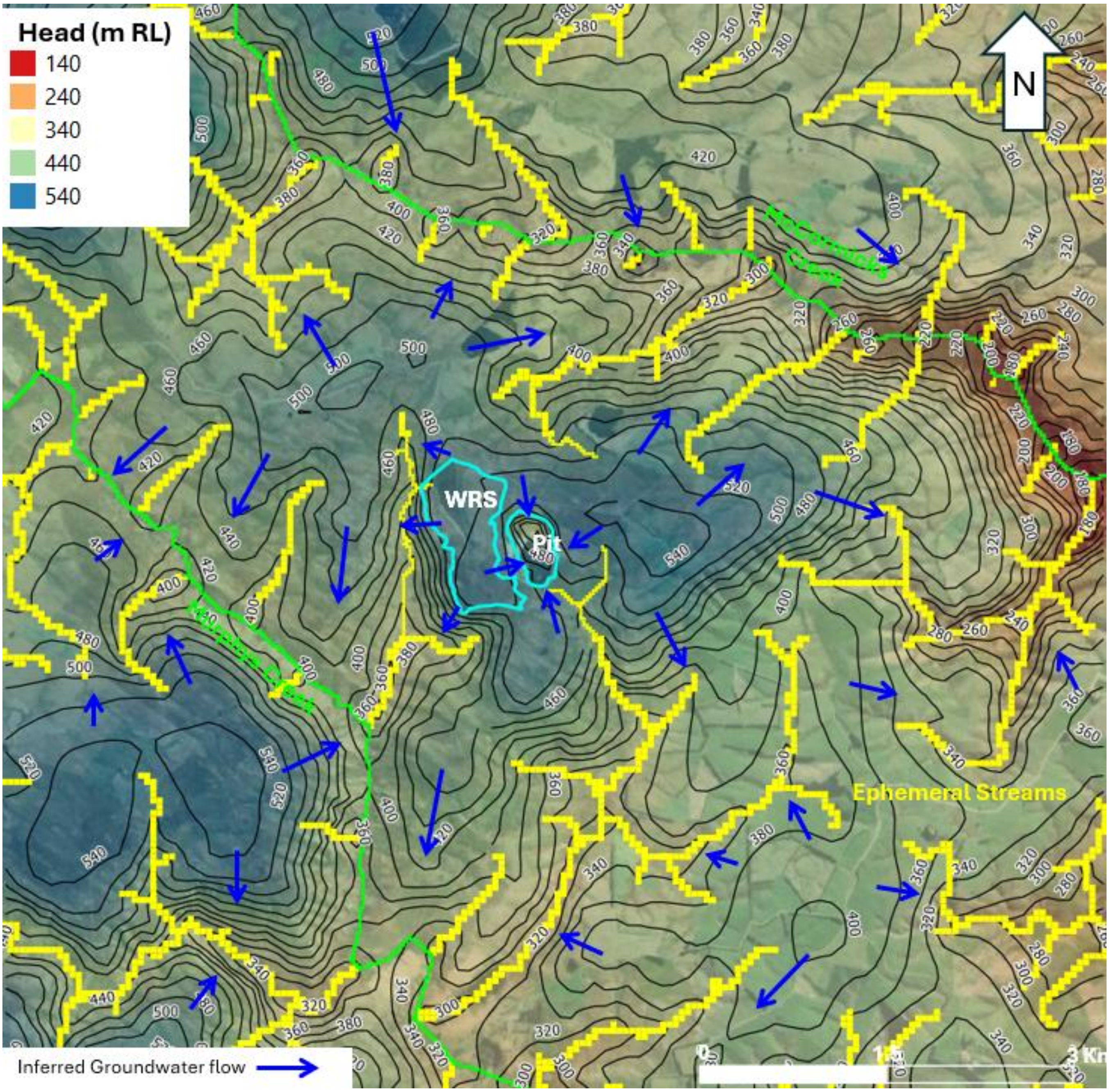


*Figure 5.2 Water table (m RL) and inferred groundwater flow at the end of dewatering for the pit expansion.*

Estimated dewatering rate (groundwater inflow) for the proposed expansion of the Golden Bar pit is presented in Figure 5.3. As presented in this figure, the dewatering rate (groundwater inflow) is estimated to range from 1.4 L/s (at the beginning) to 0.7 L/s (towards the end of dewatering), excluding the volume of water stored in the pit itself.

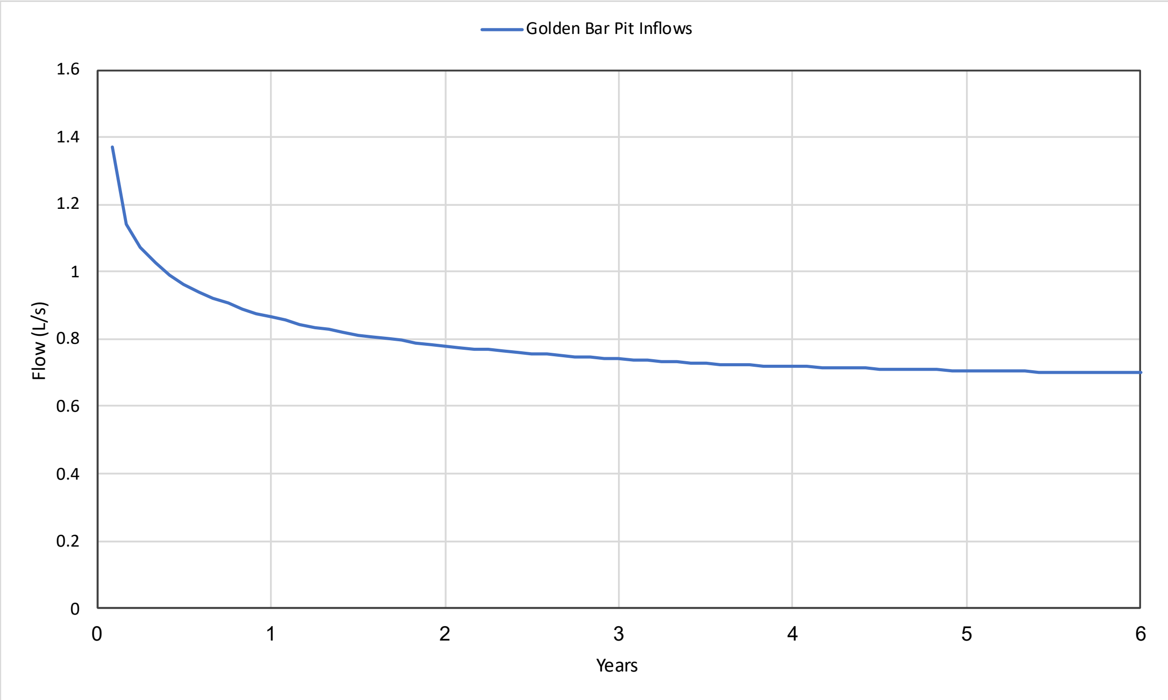


*Figure 5.3 Modelled dewatering rates (groundwater inflow only) for the proposed Golden Bar pit expansion*

Initial pit inflows are higher because dewatering first drains groundwater stored in the rock mass immediately surrounding the pit under a relatively steep hydraulic gradient. As groundwater levels decline and the local storage is depleted, the gradient toward the pit reduces and inflows into the pit decrease. The modelled pit groundwater inflows, were adopted as inputs to the surface water model for the pit lake filling assessment as detailed in Appendix G.

#### 5.2.1.2.1 Drawdown effects to surrounding creeks/streams

The simulated spatial extent of drawdown greater than 1m associated with dewatering of the proposed Golden Bar pit expansion is presented in Figure 5.4 and provides an indication of the likely area over which the water table is modelled to be affected during mining. Modelling results shown in Figure 5.4 indicate that drawdown greater than 1 m extends to approximately 800 m north, 500 m west, 700 m east, and 500 m south of the proposed pit.

The drawdown pattern is centred on the proposed pit and is interpreted to reflect the combined influence of pit depth, the relatively low hydraulic conductivity of the schist bedrock, and local variations in hydraulic gradients and groundwater flow pathways. There is a small increase in the groundwater table under the simulated Golden Bar WRS as a consequence of the increased recharge to the active WRS through this simulated period.

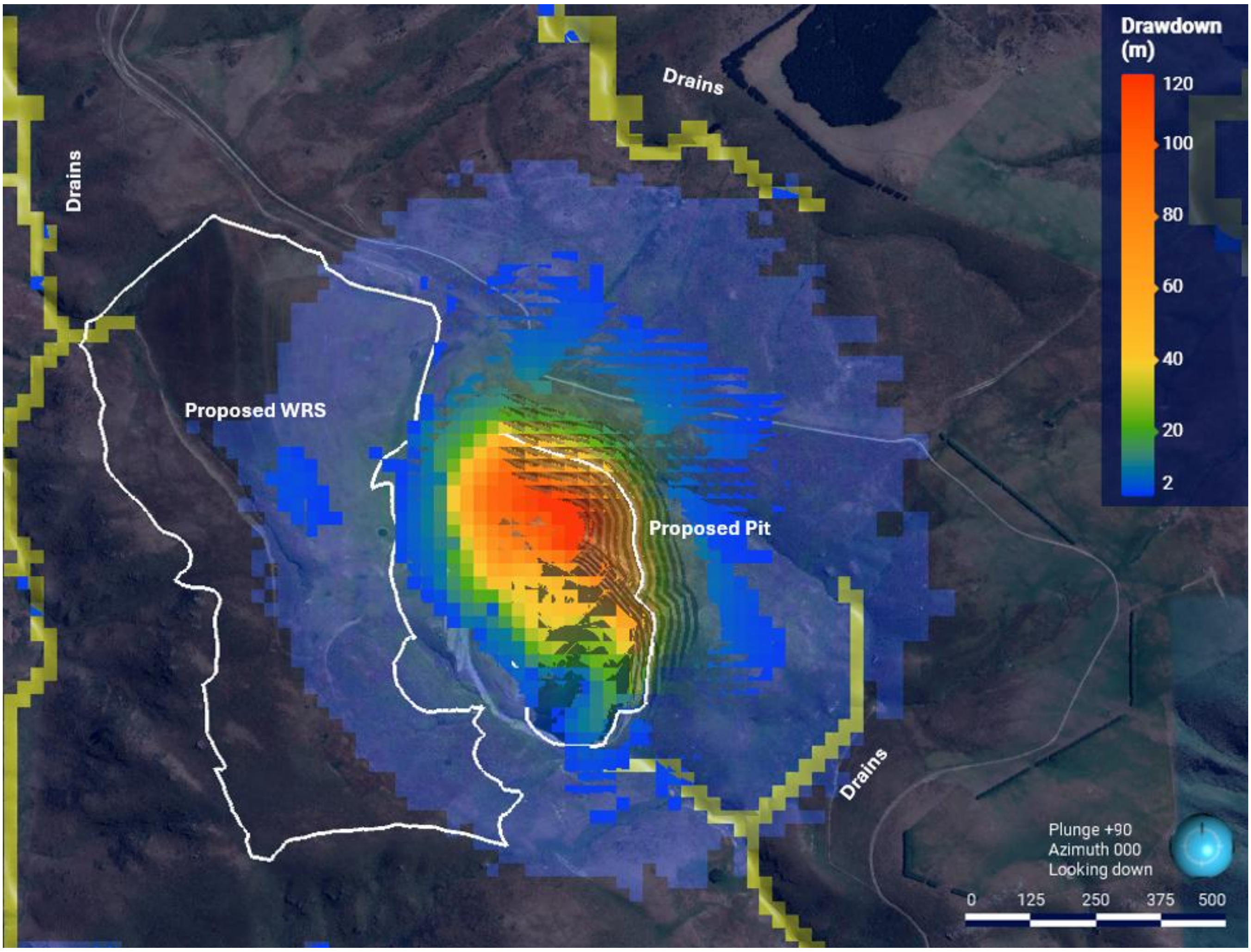


*Figure 5.4* ***Plan view of the extent of modelled drawdown greater than 1 m after 6 years of dewatering the proposed pit***

Modelling results indicate that pit dewatering is predicted to have a very small effect on groundwater contributions to McCormicks Creek and tributary ephemeral streams. The reduction is calculated to be less than 0.15 L/s relative to the modelled groundwater contributions to the base case (existing) conditions. This reduction represents less than 0.5% of the modelled existing conditions groundwater contribution of 39 L/s to McCormicks Creek and ephemeral streams discharging to it within the model domain as detailed in Appendix A.

Similarly, modelling results indicate a very small increase in groundwater discharge to the Murphys Creek and tributary ephemeral streams. The increase is estimated to be approximately 0.1 L/s relative to the modelled base case (existing) conditions representing approximately 0.2% of the modelled groundwater contribution of 44 L/s to Murphys Creek and ephemeral streams within the model domain as detailed in Appendix A. The increase is primarily attributable to the expanded WRS footprint, which has a higher recharge rate, and exceeds the influence of pit dewatering on groundwater discharge to the catchment.

These modelled results represent changes to the groundwater component of flow only, rather than total streamflow, which will also be influenced by rainfall runoff, catchment storage, seasonal variability and other surface water processes. A discussion of implications on surface water flows is contained in Appendix H.

The location of the existing and proposed groundwater bores[1] as well as consented groundwater takes[1] are shown in Figure 5.31 and Figure 5.32 with enlarged views shown in Attachment 2 of Appendix C. Groundwater modelling results indicate that groundwater drawdown associated with current and proposed mining activities is predicted to remain largely confined to areas close to the existing and proposed pit extensions and underground workings (Figure 5.31 and Figure 5.32). On this basis, adverse effects on groundwater levels in non-OGL groundwater bores are considered unlikely.

[1] **https://maps.orc.govt.nz/OtagoMaps/** accessed July 2026

### 5.2.1.3 Groundwater Recovery

Groundwater recovery was modelled for 400 years with the proposed Golden Bar pit-lake level modelled as a general head boundary condition. The head values for the boundary condition were derived from the surface water modelling results (refer Section 6.2). The head values applied with time were derived from the surface water modelling results (as detailed in Appendix G) and is also presented in Figure 6.2, with the overflow elevation at 500 mRL.

Modelled pressure head contours and inferred groundwater flow at the end of the recovery run in model layer 1 water table) are presented in Figure 5.5. Modelling results indicate that after approximately 60 years groundwater levels around the pit stabilise and pit lake has recovered to the overflow level (500 mRL).

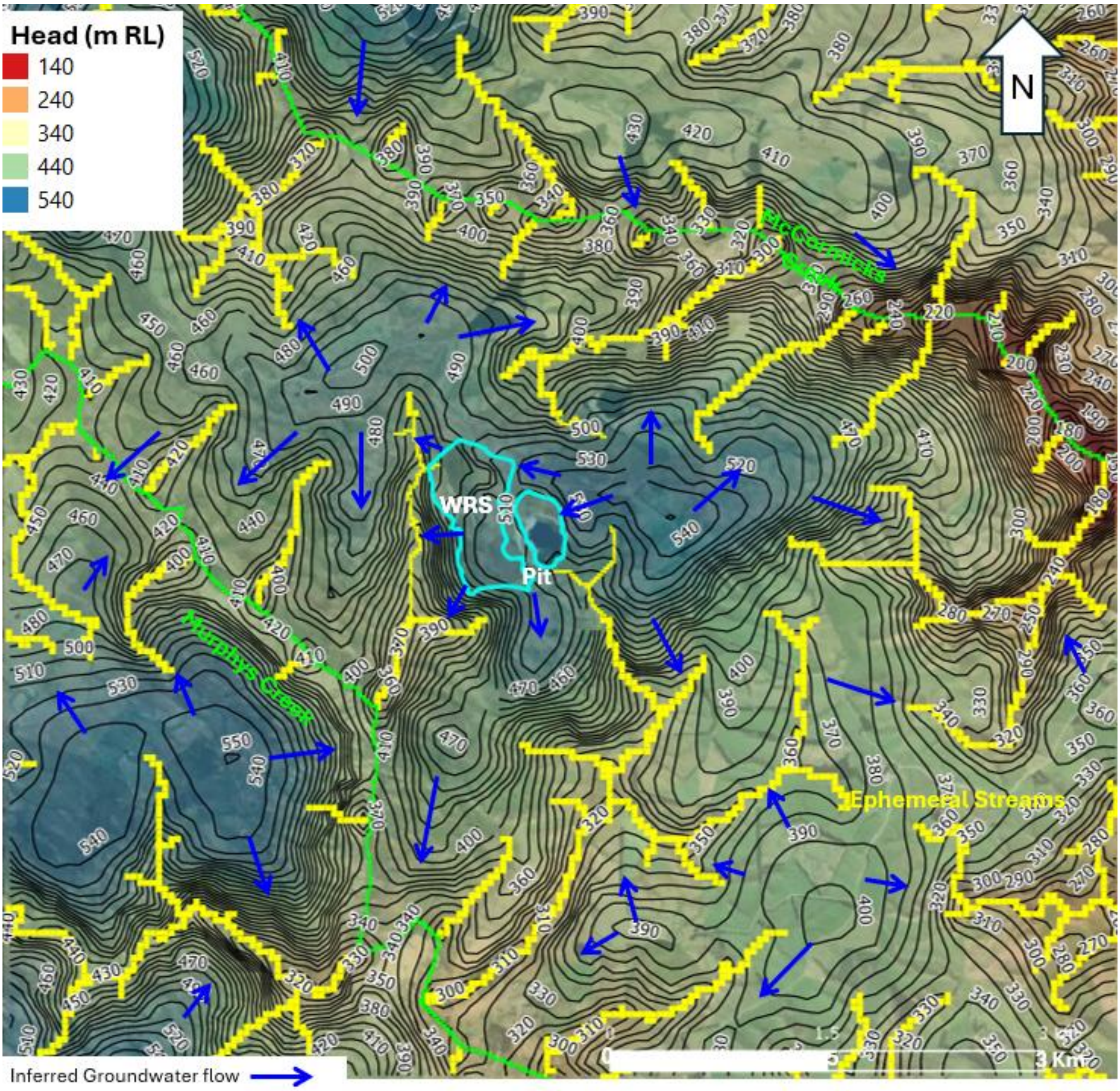


*Figure 5.5 Water table (mRL) and inferred groundwater flow at the end of 400 years of recovery.*

The modelling results indicate that groundwater flow from the Golden Bar Pit is generally directed toward Golden Bar Creek. Seepage from the WRS is predicted to flow mainly toward Murphys Creek, via its tributary Clydesdale Creek, with some flow paths also directed toward the Golden Bar pit lake.

#### 5.2.1.4 Contaminant Transport

Sulphate contaminant transport modelling was undertaken using the solute transport modelling code (MODFLOW USG-TRANSPORT) in the Existing Conditions, Dewatering and Recovery models. The input parameter values used are detailed in Appendix A. Sulphate has been modelled due to its expected elevated concentration (relative to other key contaminants), its existing elevated nature in some receiving surface water bodies around the Macraes Operation as a result of mining activity, and its limited ability to attenuate within the groundwater system. It is therefore considered a conservative element with which to assess contaminant mobilisation and transport from the backfilled waste, WRSs and subsequent pit lakes to receiving surface water bodies via the groundwater system.

The horizontal extent of the predicted sulphate plume in Layer 1 is shown in Figure 5.6 to Figure 5.9 with enlarged views provided in Attachment 1 of Appendix A. The figures also display the location of the closest surface water compliance monitoring point for Murphy’s Creek to the plume, GB02. These figures provide a spatial summary of the modelled sulphate distribution in Layer 1 for the key stages of the assessment, under existing conditions, at the end of the 6-year dewatering phase, and at the end of the 400-year recovery simulation.

For consistency across the model outputs, the plume extent has been interpreted using the 10 mg/L sulphate concentration contour as the outer plume boundary. This concentration value was adopted as a practical indicator of plume extent because it is considered to be broadly compatible with background sulphate concentrations in Otago schist.

Modelling results indicate that:

- The predicted sulphate plume develops primarily from the Golden Bar WRS and Pit source areas and migrates along the interpreted groundwater flow paths (Figure 5.6 to Figure 5.9).
- Plume migration around the pit is constrained during dewatering by groundwater flow toward the pit, which acts as a hydraulic sink and locally captures groundwater and dissolved sulphate (Figure 5.7).
- The reduction in the modelled Layer 1 plume extent after 400 years (Figure 5.8), relative to the dewatering model (Figure 5.7), is attributed to the lower recharge rate applied to the rehabilitated WRS, which was reduced from 148 mm/year to 32 mm/year. The results indicate that seepage flow from the WRS toward McCormicks Creek in layer 1 is diminished. Figure 5.9 shows the sensitivity scenario where recharge of 128 mm/year is applied during the recovery period.
- The maximum horizontal extent of the plume is predicted to be approximately 1,200 m to the northeast of the source areas and approximately 900 m to the south of the source area.

The total modelled sulphate mass discharging to the Murphys Creek and McCormicks Creek catchments, including associated ephemeral streams, was estimated using the contaminant transport model in combination with simulated groundwater discharge across the surface water boundary conditions. These boundary conditions comprised river boundaries representing the main creeks and drain boundaries representing the ephemeral stream network discharging to them within the model domain extent.

At 400 years post-closure, the estimated sulphate flux is approximately 0.26 kg/day for the McCormicks Creek catchment and approximately 149 kg/day for the Murphys Creek catchment. These sulphate flux estimates have been represented in the surface water mass balance model presented in Appendix E.

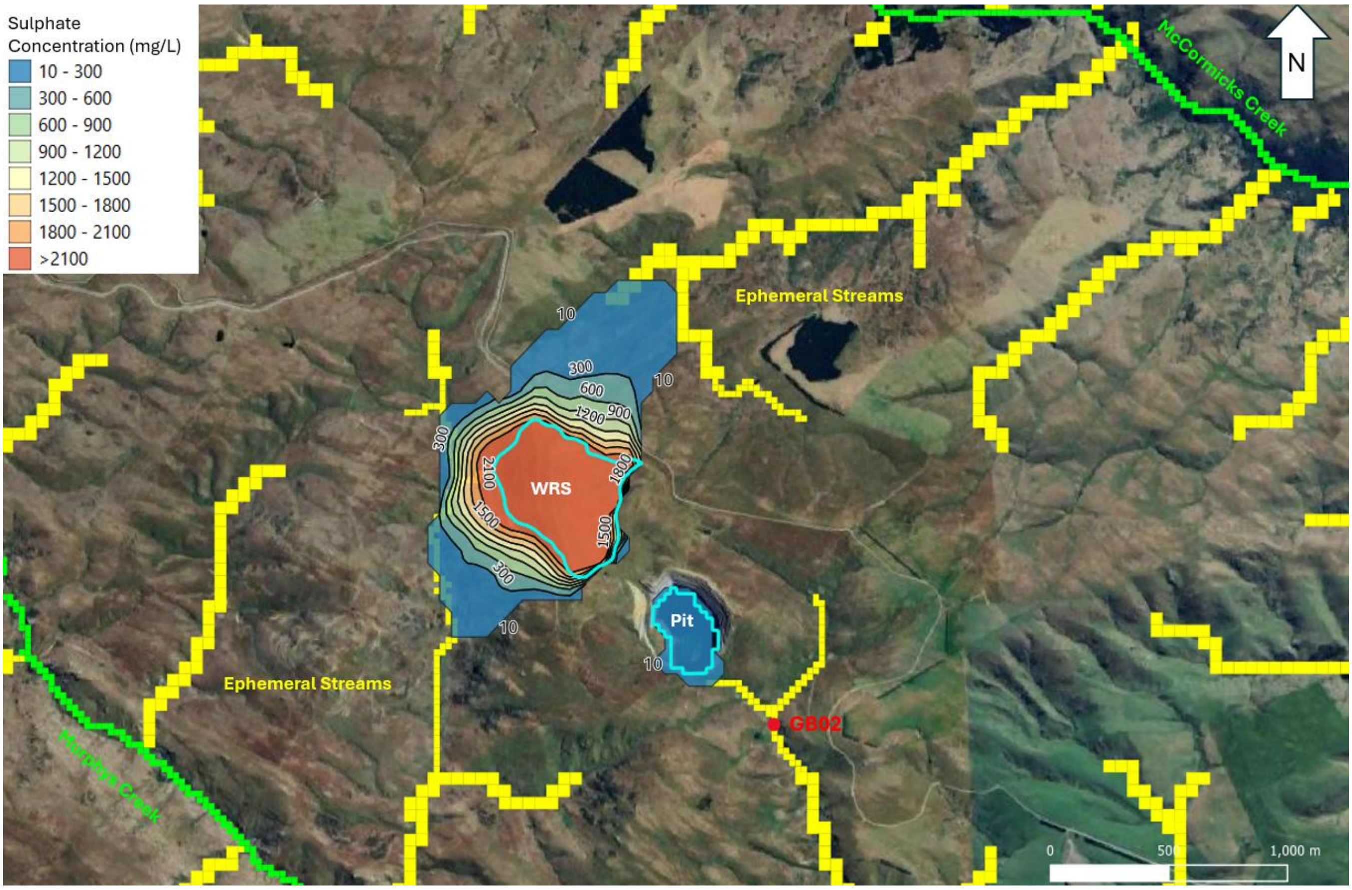


*Figure 5.6 Contour plot showing sulphate plume extent in Model Layer 1 for the existing conditions model*

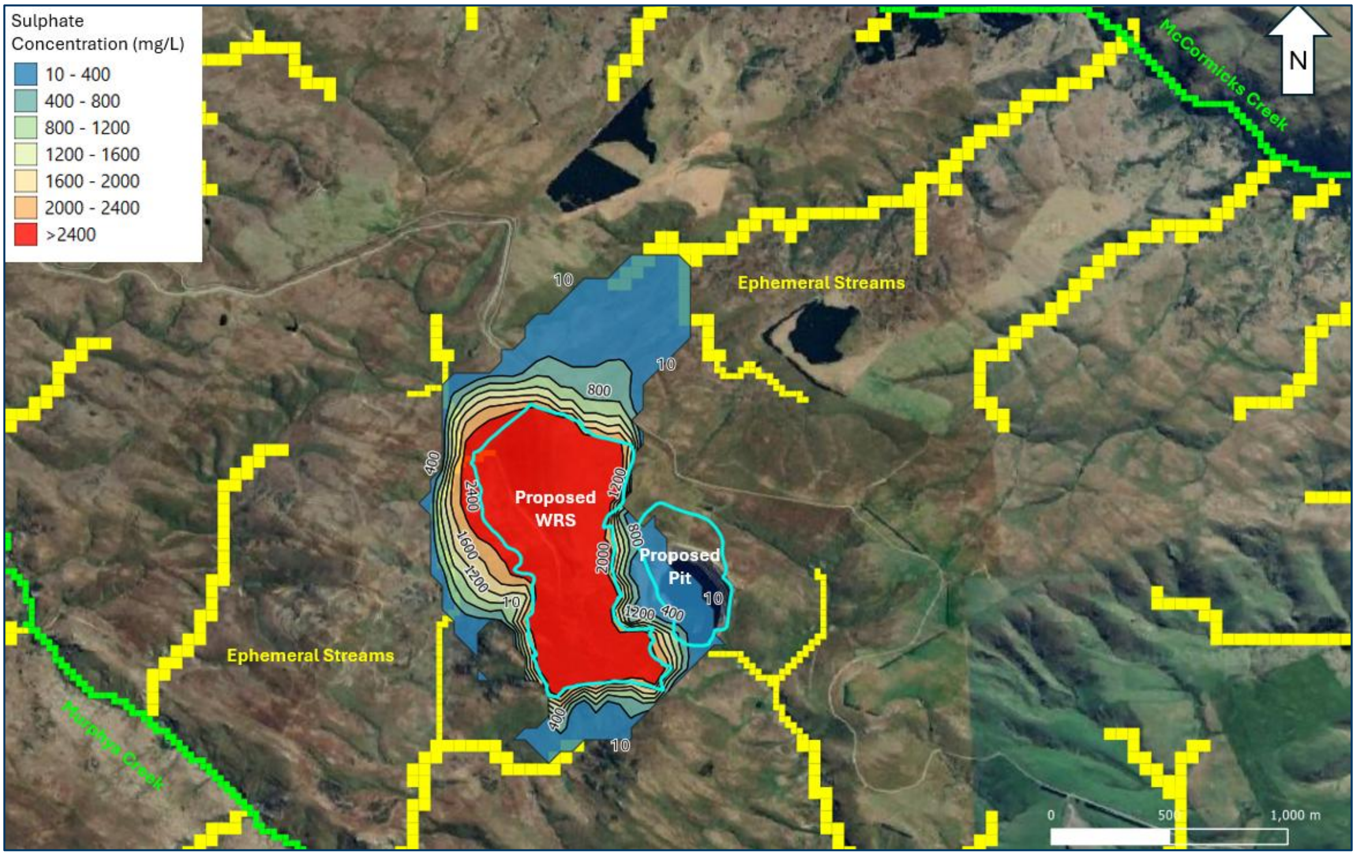


*Figure 5.7 Contour plot showing sulphate plume extent and the end of the dewatering model (6 years of dewatering) in model layer 1.*

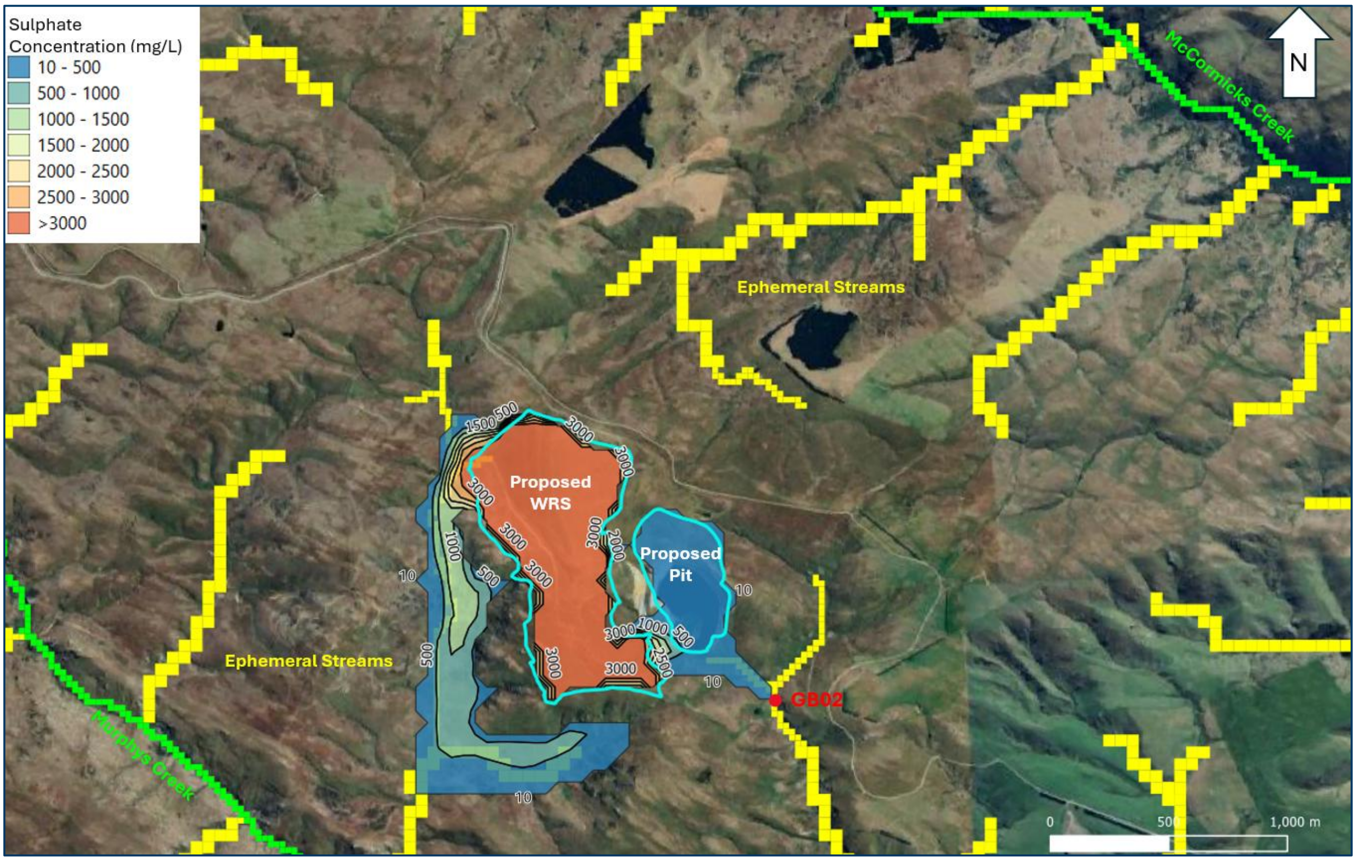


*Figure 5.8* *Contour plot showing sulphate plume extent and the end of the recovery model (400 years of recovery) in model layer 1.*

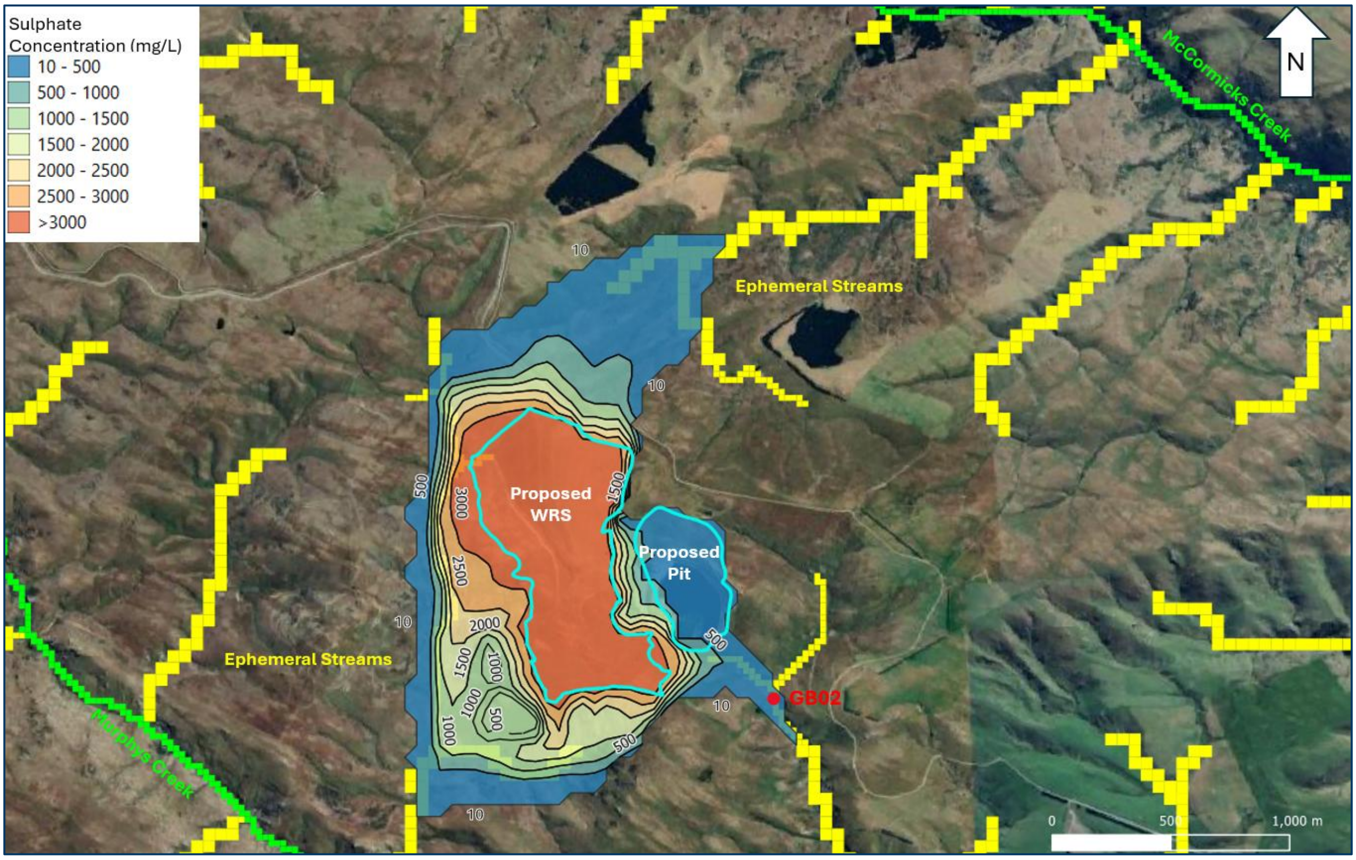


*Figure 5.9* *Contour plot illustrating the extent of the sulphate plume at the end of the recovery simulation (400 years) in model layer 1, assuming recharge within the waste rock stack of 128 mm/year (sensitivity scenario).*

## 5.2.2 Coronation Mining Area

### 5.2.2.1 Base Case Model (Existing Conditions)

Coronation Pit has been operational since 2014 and currently has a water level of approximately 597 m RL. The Coronation North Pit has been operating since 2017, with a current pit water level of approximately 502 m RL. Existing conditions were represented using a steady-state groundwater flow model based on 2025 topographic data. Steady-state water table contours of the existing conditions model are presented in Figure 5.10.

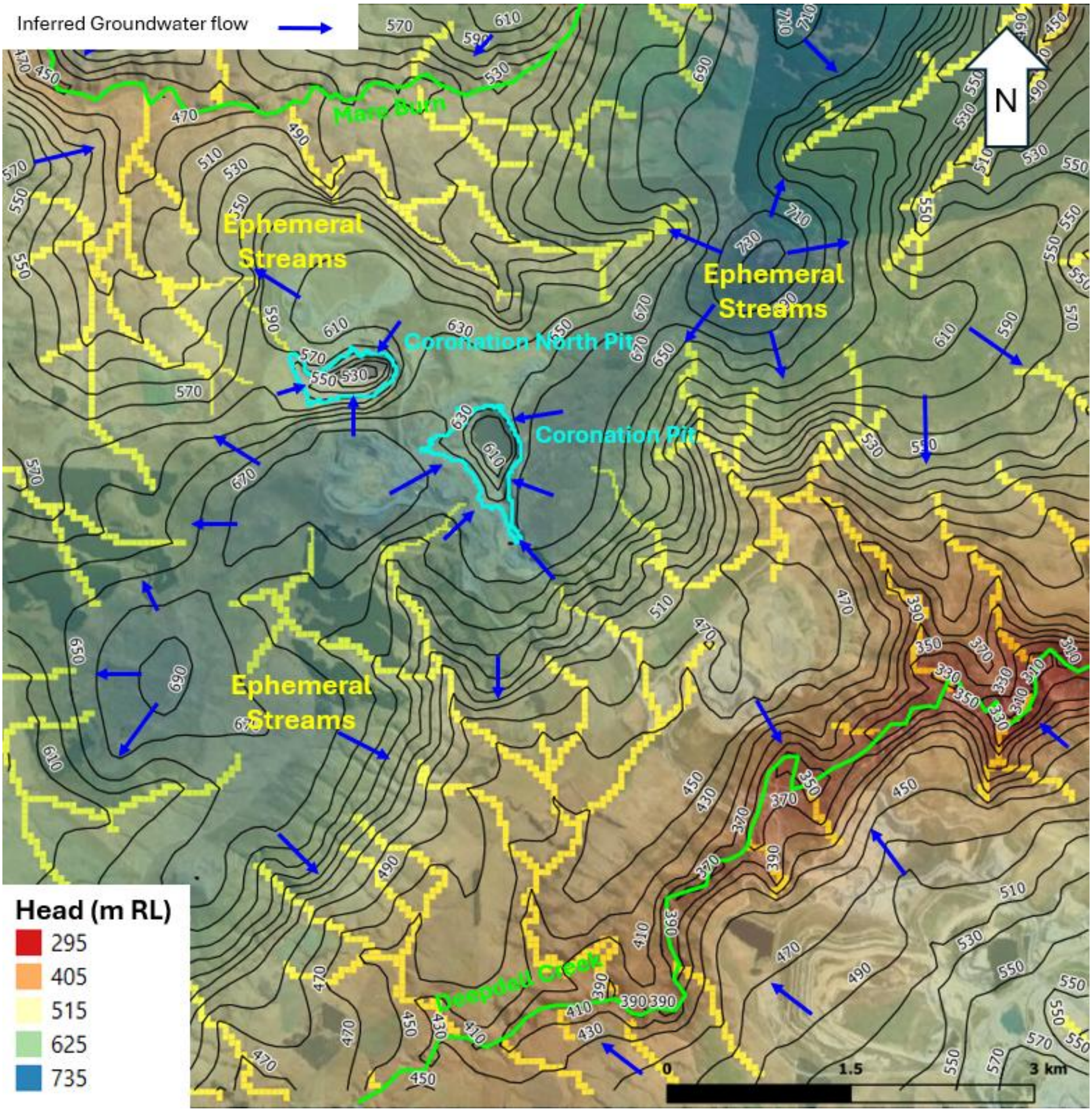


*Figure 5.10 Existing conditions steady-state modelled water table (m RL) and inferred groundwater flow (Coronation area model).*

#### 5.2.2.2 Proposed Mining Activities - Dewatering

Groundwater dewatering associated with the proposed Coronation Pit and Coronation North Pit extensions was assessed using two sequential numerical models. The first model simulated concurrent dewatering of both pits over a seven-year period. Simulated groundwater heads at the end of this period were used as initial conditions for a second model, which simulated continued dewatering of the Coronation North Pit only and the commencement of groundwater recovery within the Coronation Pit over a subsequent three-year period, consistent with the indicative Macraes mining schedule shown in Figure 2.2 .

For both dewatering simulations the greater and deeper extent of the proposed design for both pits were assumed throughout the dewatering period. This represents a conservative approach, as it maximises the duration and extent of dewatering effects and is therefore considered appropriate for assessment purposes. The simulated dewatering period starts once the pits are empty of water and have been excavated to the proposed design.

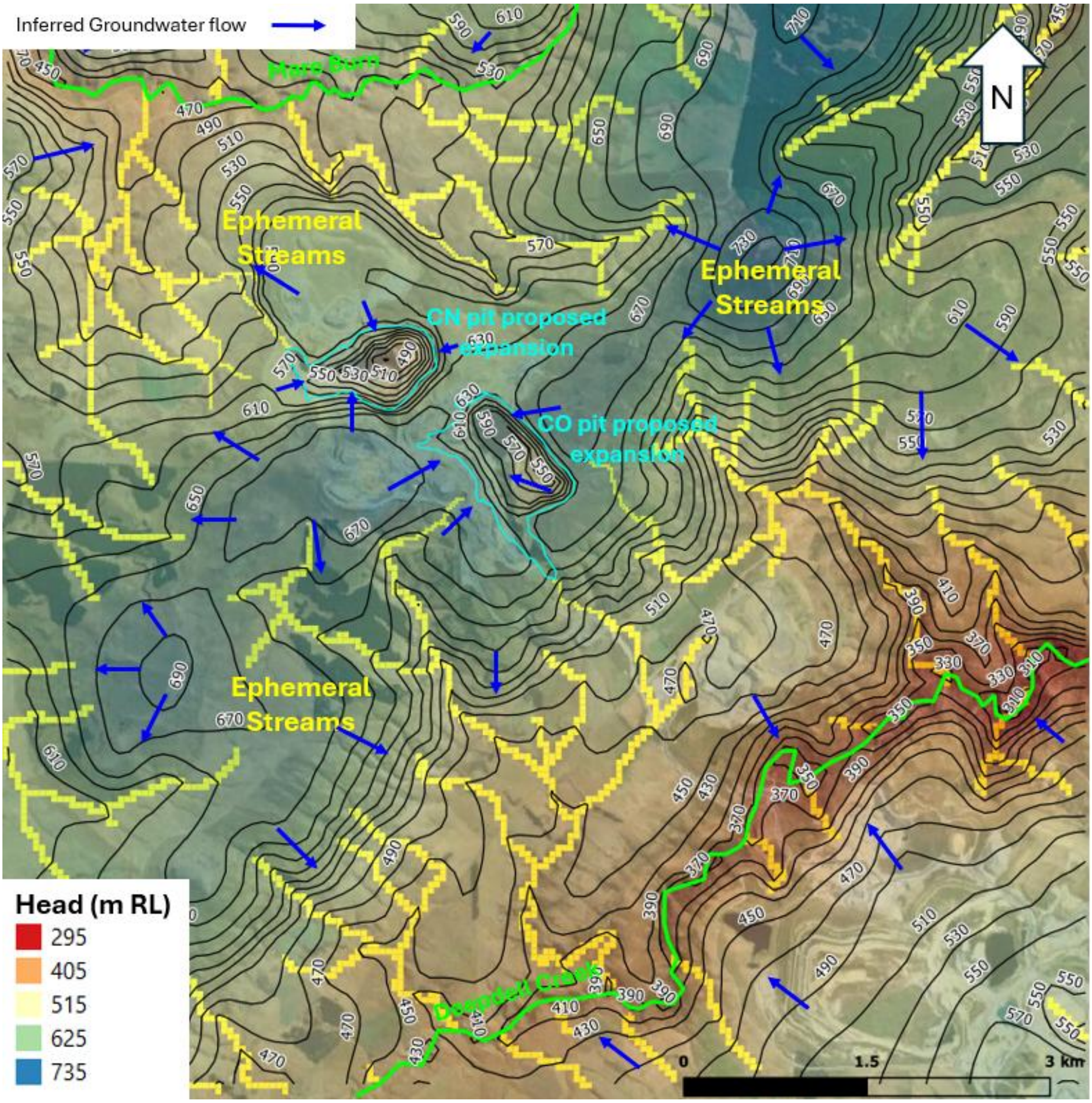


*Figure 5.11 Estimated water table and inferred groundwater flow after 7 years dewatering of the proposed pits.*

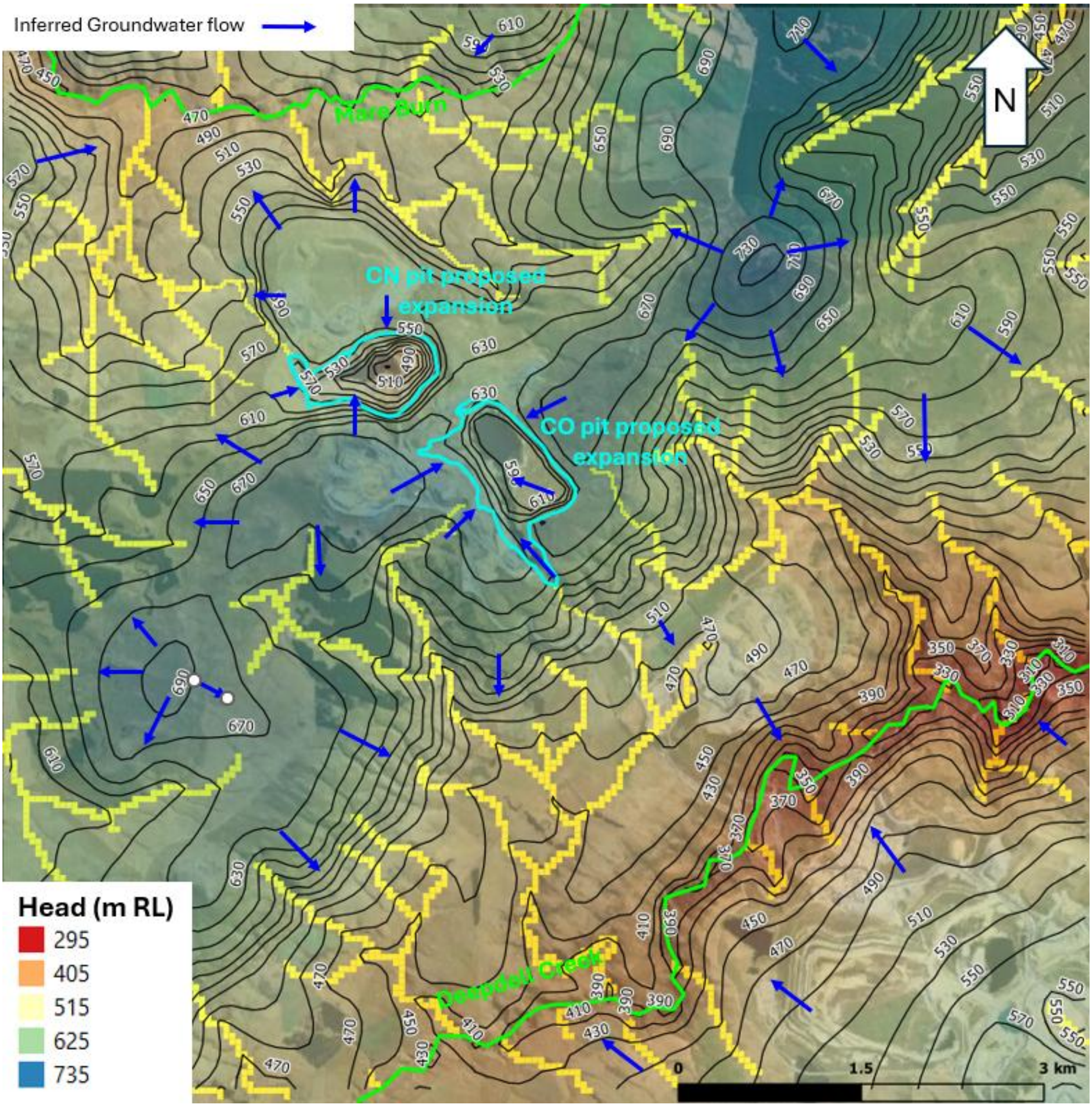


*Figure 5.12* ***Estimated water table and inferred groundwater flow at the end of the dewatering of Coronation North Pit (and 3 years into the recovery of Coronation Pit)***

Modelled groundwater head contours at the end of the dewatering of Coronation pit are presented in Figure 5.11, while the head contours at the end of the dewatering of Coronation North pit (and three years into the recovery of Coronation Pit) are presented in Figure 5.12.

Estimated dewatering rates (groundwater inflow) for the proposed expansion of the Coronation & Coronation North pits are presented in Figure 5.13. As presented in this figure, predicted groundwater inflows for the Coronation North pit decrease from approximately 7.3 L/s at the start of dewatering to approximately 2.4 L/s toward the end of the 7-year dewatering period. Predicted groundwater inflows for the Coronation North pit decrease from approximately 10.5 L/s at the start of dewatering to approximately 6.4 L/s toward the end of the 10-year dewatering period. As discussed in earlier sections, initial pit inflows are predicted to be higher because dewatering initially drains the groundwater stored within the rock mass that is excavated and immediately surrounding the pit, driven by the relatively steep hydraulic gradient created by excavation and pit dewatering.

These modelled pit groundwater inflows were adopted as inputs to the surface water model used to assess pit lake filling, as detailed in Appendix G.

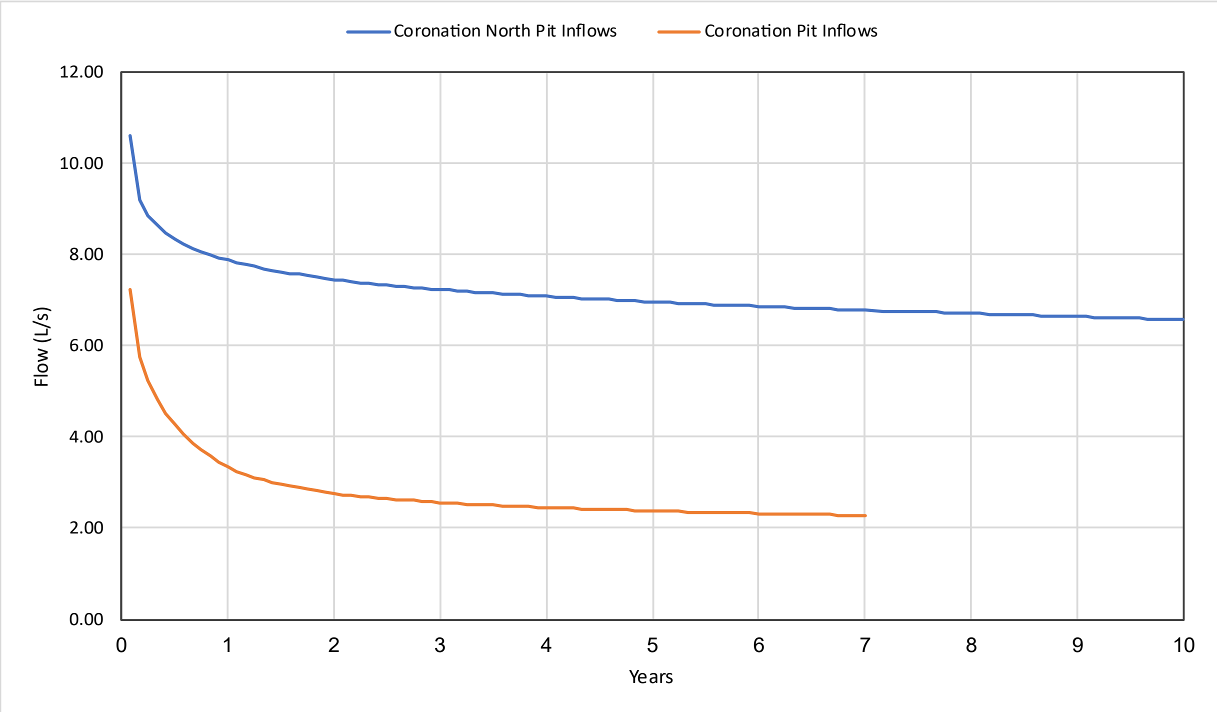


*Figure 5.13 Modelled dewatering rates for the proposed Coronation and Coronation North pits expansion*

#### 5.2.2.2.1 Drawdown effects to surrounding creeks/streams

The simulated spatial extent of drawdown greater than 1m associated with dewatering of the proposed Coronation and Coronation North pits expansion is presented in Figure 5.14 and Figure 5.15 and provides an indication of the likely area over which the water table is modelled to be affected during mining. Modelling results indicate that drawdown greater than 1 m is predicted to extend approximately 1,400 m to the northwest,1,000 m to the northeast, 700 m to the southwest, and 700 m to the southeast of the proposed pits area (Figure 5.14 and Figure 5.15).

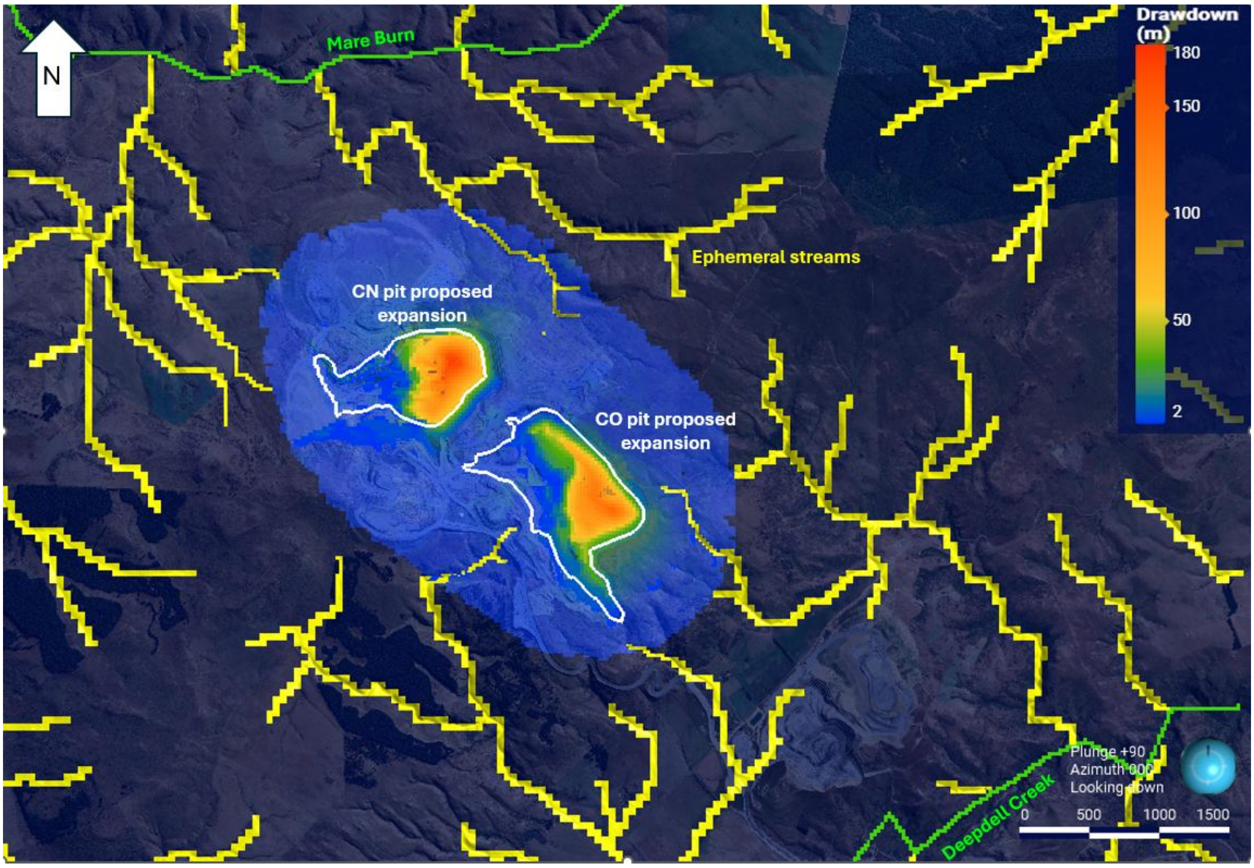


*Figure 5.14 Plan view of the extent of modelled drawdown greater than 1 m after 7 years of dewatering of the proposed pits (end of Coronation Pit dewatering)*

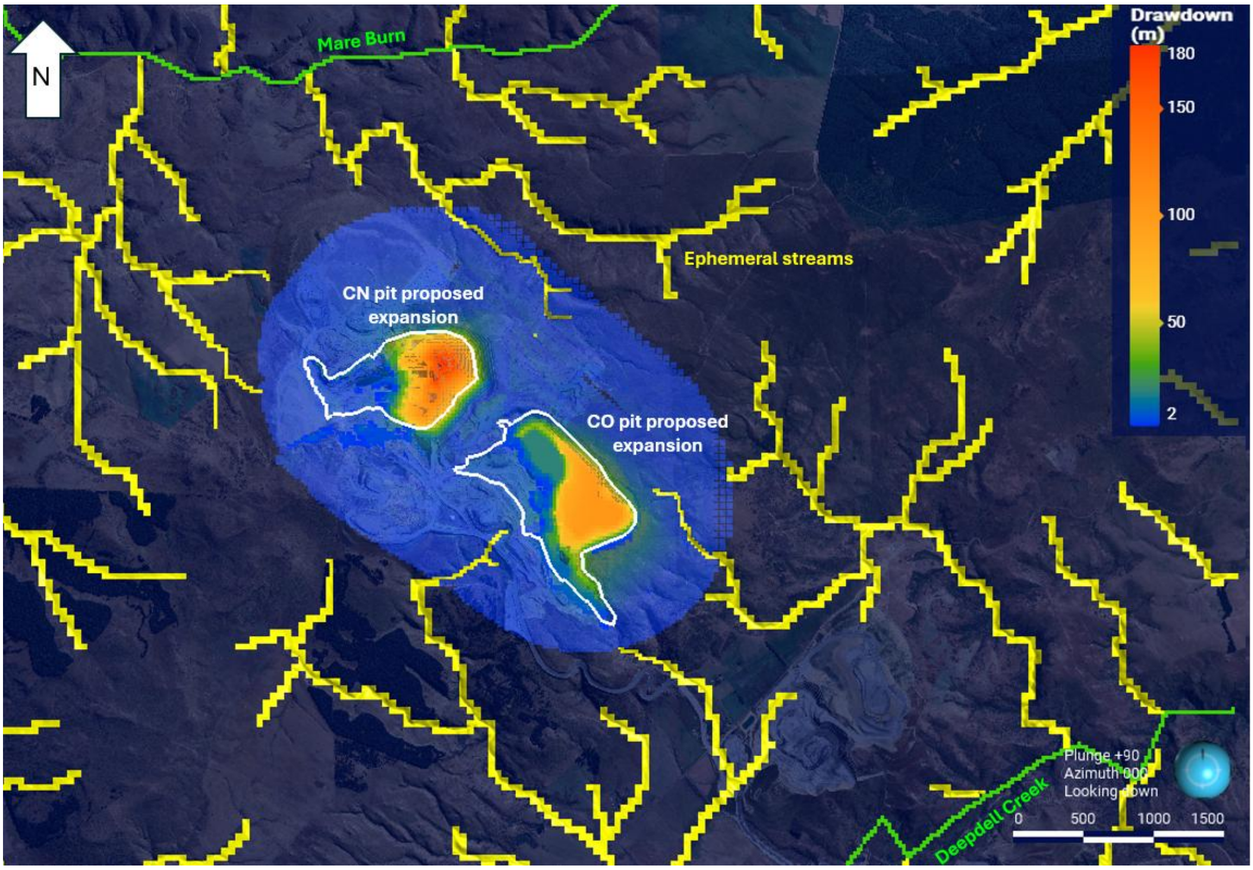


*Figure 5.15 Plan view of the extent of modelled drawdown greater than 1 m at the end of the dewatering of Coronation North Pit (and 3 years into the recovery of Coronation Pit)*

Modelling results indicate that pit dewatering is expected to have a very small increase on groundwater contributions to Mare Burn and tributary ephemeral streams.  The increase is estimated to be approximately 1 L/s relative to the modelled base case (existing) conditions representing approximately 3% of the modelled contribution of 33.9 L/s to Mare Burn and tributary ephemeral streams within the model domain as presented in Appendix B. The increase is primarily attributable to the expanded WRSs footprints, which have a higher recharge rate, and exceeds the influence of pit dewatering on groundwater discharge to the catchment.

For Deepdell Creek and its tributary ephemeral streams, the predicted change in groundwater discharge is estimated to be a reduction of approximately 0.6 L/s relative to the modelled groundwater contributions to the base case (existing) conditions. This reduction represents approximately 2% of the modelled existing conditions groundwater contribution of 27.2 L/s to Deepdell Creek and tributary ephemeral streams across the model domain, as presented in Appendix B.

As noted above these results are representing changes to the groundwater component of flow only, rather than total streamflow, which will also be influenced by rainfall runoff, catchment storage, seasonal variability and other surface water processes. A discussion of implications on surface water flows is contained in Appendix H.

The location of the existing and proposed groundwater bores[2] as well as consented groundwater takes[1] are shown in Figure 5.31 and Figure 5.32 with enlarged views shown in Attachment 2 of Appendix C. Groundwater modelling results indicate that groundwater drawdown associated with current and proposed mining activities is predicted to remain largely confined to areas close to the existing and proposed pit extensions and underground workings (Figure 5.31 and Figure 5.32). On this basis, adverse effects on groundwater levels in non-OGL groundwater bores are considered unlikely.

#### 5.2.2.3 Groundwater Recovery

Groundwater recovery was modelled for 400 years with the proposed Coronation and Coronation North pit-lake levels modelled as a general head boundary condition. The head values for the boundary condition were derived from the surface water modelling results (refer Section 6.2). The head values applied with time (Figure 6.4 and Figure 6.6) were derived from the surface water modelling results and details are presented in Appendix G. The overflow elevation at 563 m RL for Coronation North pit and 625 m RL for Coronation pit.

Seepage capture drains are proposed to be installed at the toe of Coronation North WRS to capture seepage generated from percolation through the WRS.  The seepage capture drains will comprise a series of trenches connecting to collection sumps, intercepting WRS seepage before it enters surface water. Collected seepage will be pumped from the sumps to a water treatment facility or for use onsite within the mine water management system. The concept design for the seepage capture drains is included in “Macraes Phase 4 FTA Project. Engineered Seepage Capture Drain – Concept Design Report, GHD (2026a), with an excerpt shown below in Figure 5.16. These seepage capture drains are presented in the groundwater model as drain boundaries located immediately north of the Coronation North WRS, consistent with the mine design intended to intercept and manage potentially contaminated seepage originating from the waste rock stack.

[2] **https://maps.orc.govt.nz/OtagoMaps/** accessed July 2027

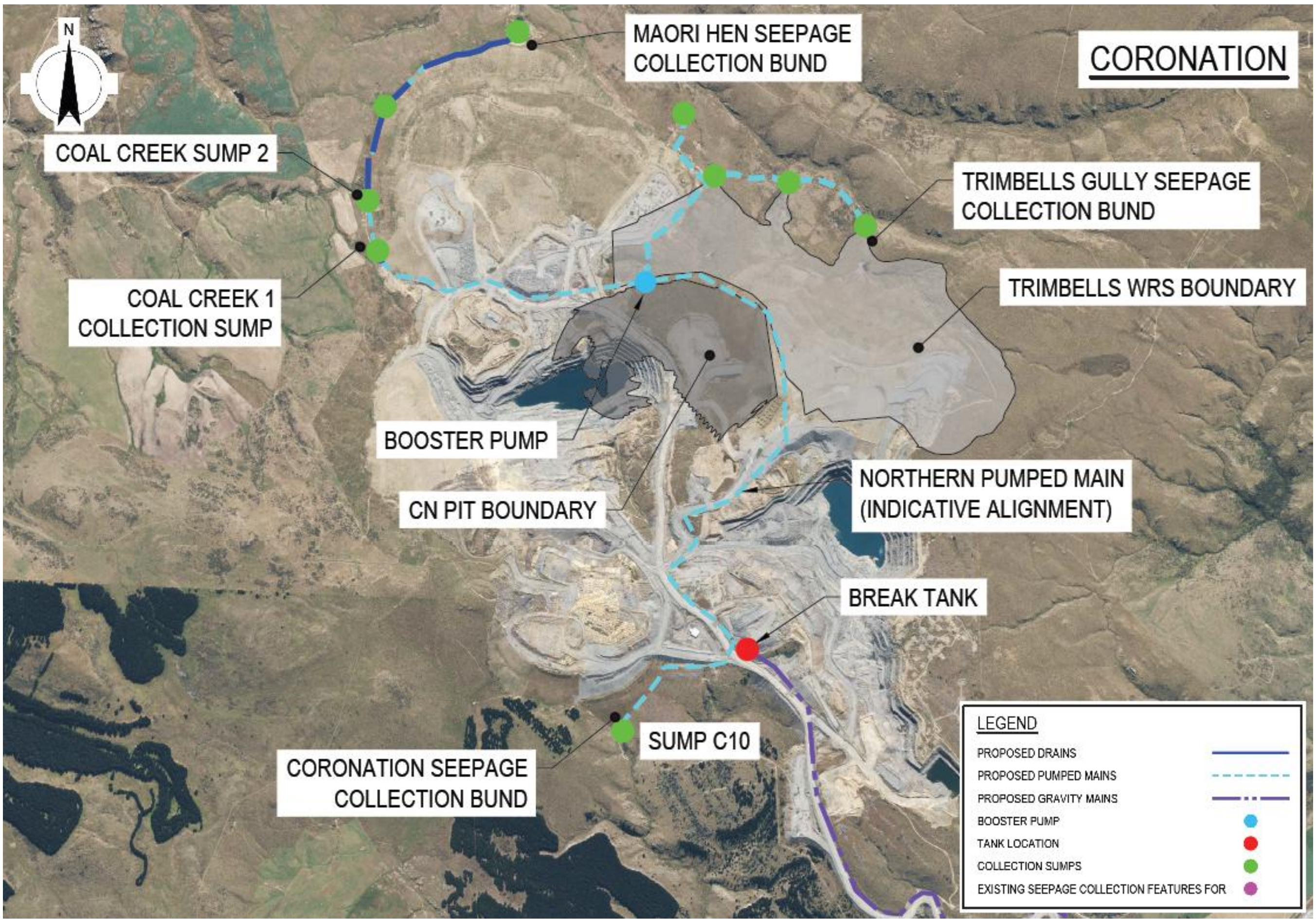


***Figure 5.16 Coronation North WRS seepage capture drains location plan (not in scale), GHD, 2026a***

Modelled pressure head contours at the end of the recovery run in model layer 1 are presented in Figure 5.17. Modelling results indicate that groundwater levels surrounding the Coronation and Coronation North pits are predicted to stabilise approximately 20 m to 35 m below existing-condition levels about 150 years after mining ceases. This indicates that the pit lakes will continue to act as hydraulic sinks under long-term post-closure conditions.

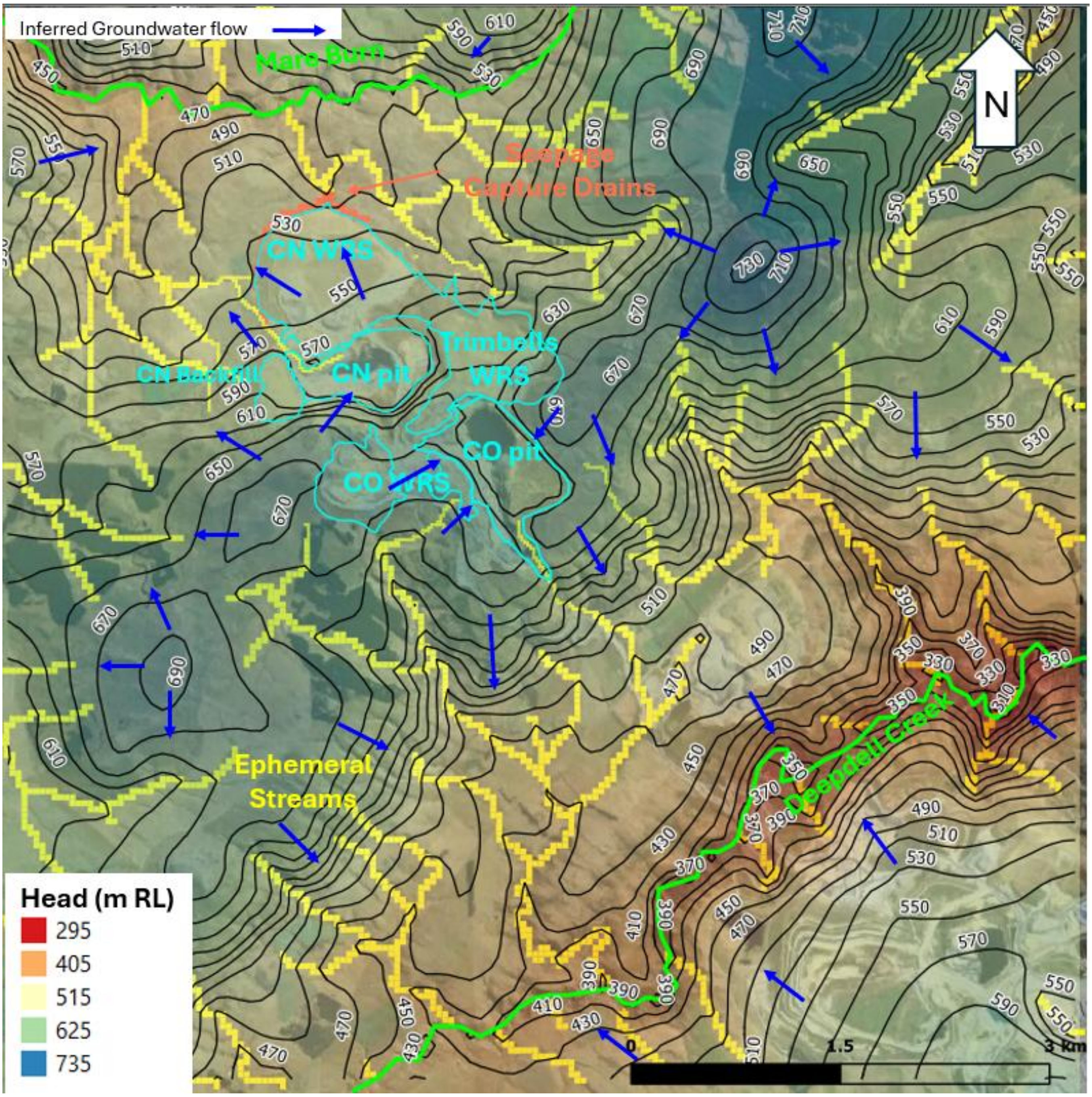


*Figure 5.17 Water table (mRL) and inferred groundwater flow direction at the end of 400 years of recovery.*

#### 5.2.2.4 Contaminant Transport

Sulphate contaminant transport modelling was undertaken using the solute transport modelling code (MODFLOW USG-TRANSPORT) in the Existing Conditions, Dewatering and Recovery models. The input parameter values used are detailed in Appendix B.

Consistent with the approach adopted for the Golden Bar model, sulphate has been used as the representative contaminant for transport modelling. This reflects its expected elevated concentration relative to other key contaminants, its existing elevated occurrence in some receiving surface water bodies around the Macraes Gold Project as a result of mining activity, and its limited potential for attenuation within the groundwater system. It is therefore considered a conservative element with which to assess contaminant mobilisation and transport from the backfilled waste, WRSs and subsequent pit lakes to receiving surface water bodies via the groundwater system.

The extent of the predicted sulphate plume for the existing conditions, dewatering and recovery models are shown in Figure 5.18 to Figure 5.22 with enlarged views provided in Attachment 2 of Appendix B. These figures provide a spatial summary of the modelled sulphate distribution for the key stages of the assessment, including under existing conditions, at the end of the dewatering phase, and at the end of the 400-year recovery simulation. A sensitivity analysis was undertaken by increasing recharge from 32 mm/year to 128 mm/year to evaluate the effect of higher recharge rates on plume behaviour during the recovery run and the results are presented in Figure 5.22.

For consistency across the model outputs, the plume extent has been interpreted using the 10 mg/L sulphate concentration contour as the outer plume boundary. This concentration value was adopted as a practical indicator of plume extent because it is considered to be broadly compatible with background sulphate concentrations in schist.

Modelling results indicate that:

- The predicted sulphate plume develops primarily from the WRSs source areas and migrates along the interpreted groundwater flow paths (Figure 5.18 to Figure 5.22).
- Plume migration around the pits, particularly the Coronation Pit, is limited during the dewatering phase by groundwater flow towards the pit voids. Acting as hydraulic sinks, the pits locally capture groundwater and dissolved sulphate, thereby constraining plume migration (Figure 5.19 and Figure 5.20).
- Application of a recharge rate of 32 mm/year to the rehabilitated WRSs results in a reduced Layer 1 sulphate plume extent after 400 years (Figure 5.21) relative to the base-case and dewatering recharge rates of 224 mm/year for the Coronation North Waste Rock Stack and 128 mm/year for all other WRSs (Figure 5.22).
- The maximum horizontal extent of the plume is predicted to be approximately 1,500 m to the northwest of the source areas and approximately 1,400 m to the south of the source area.

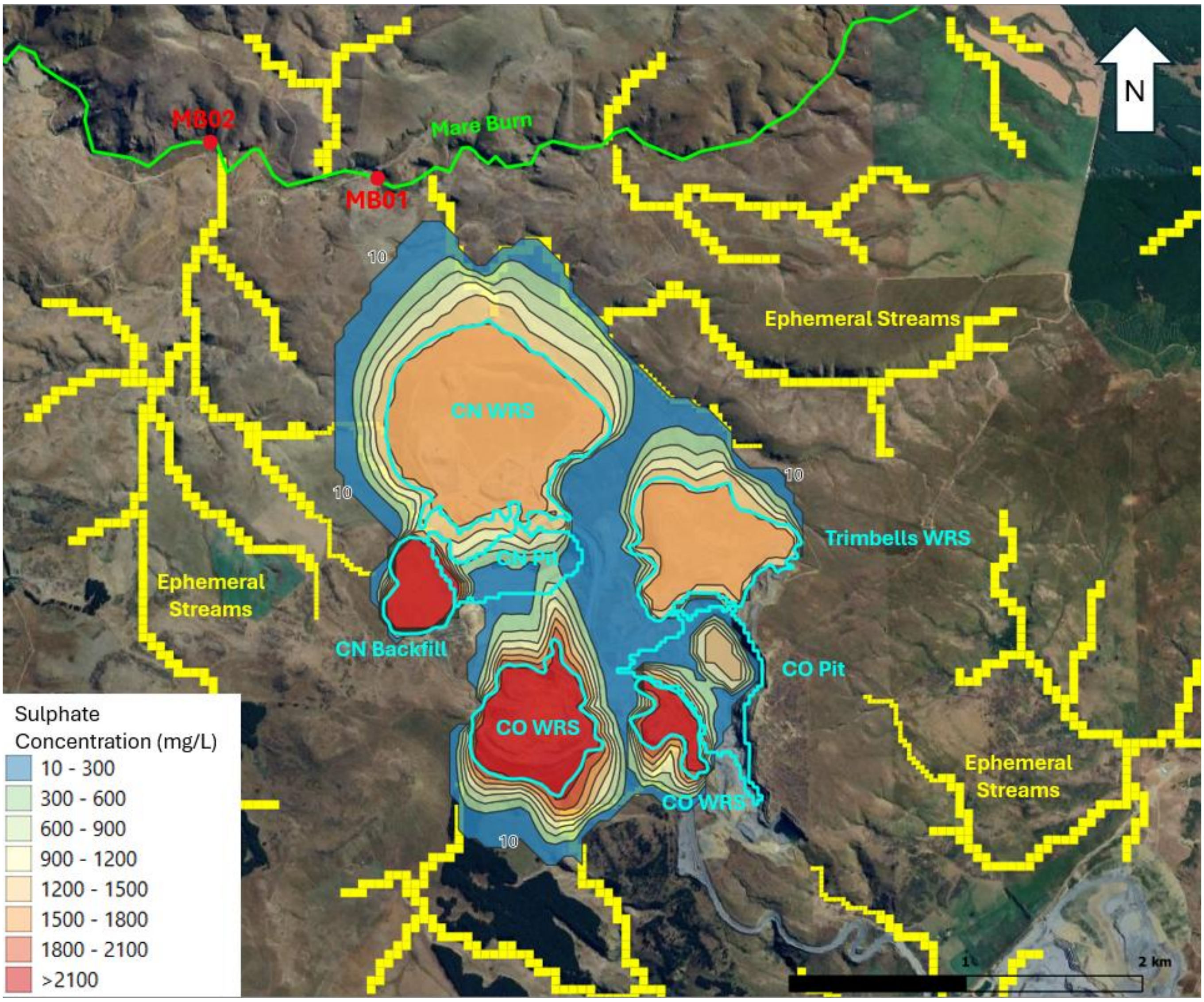


*Figure 5.18* ***Contour plot showing sulphate plume extent in Model Layer 1 for the existing conditions model.***

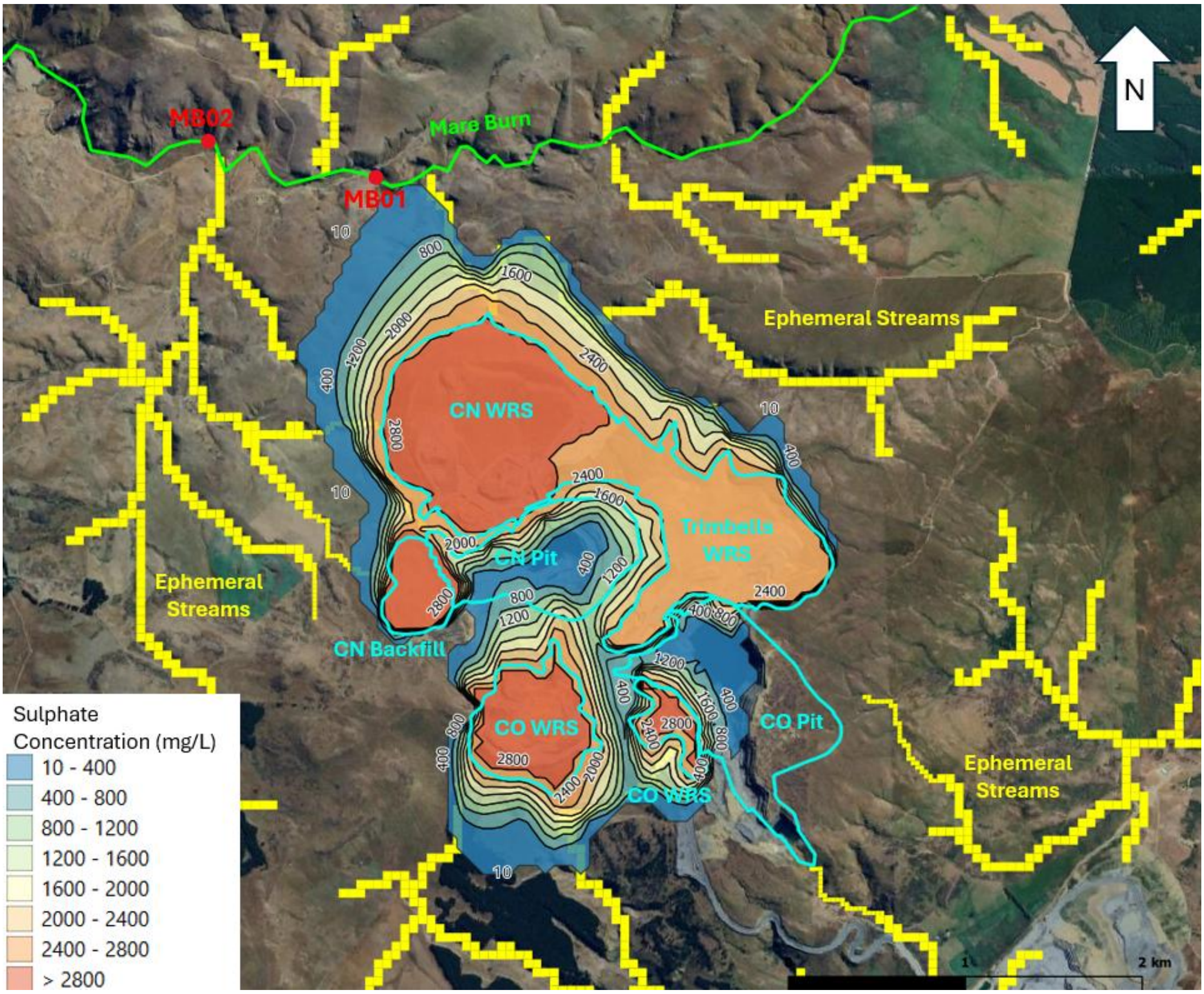


*Figure 5.19 Contour plot showing sulphate plume extent at the end of the Coronation Pit dewatering model in model layer 1.*

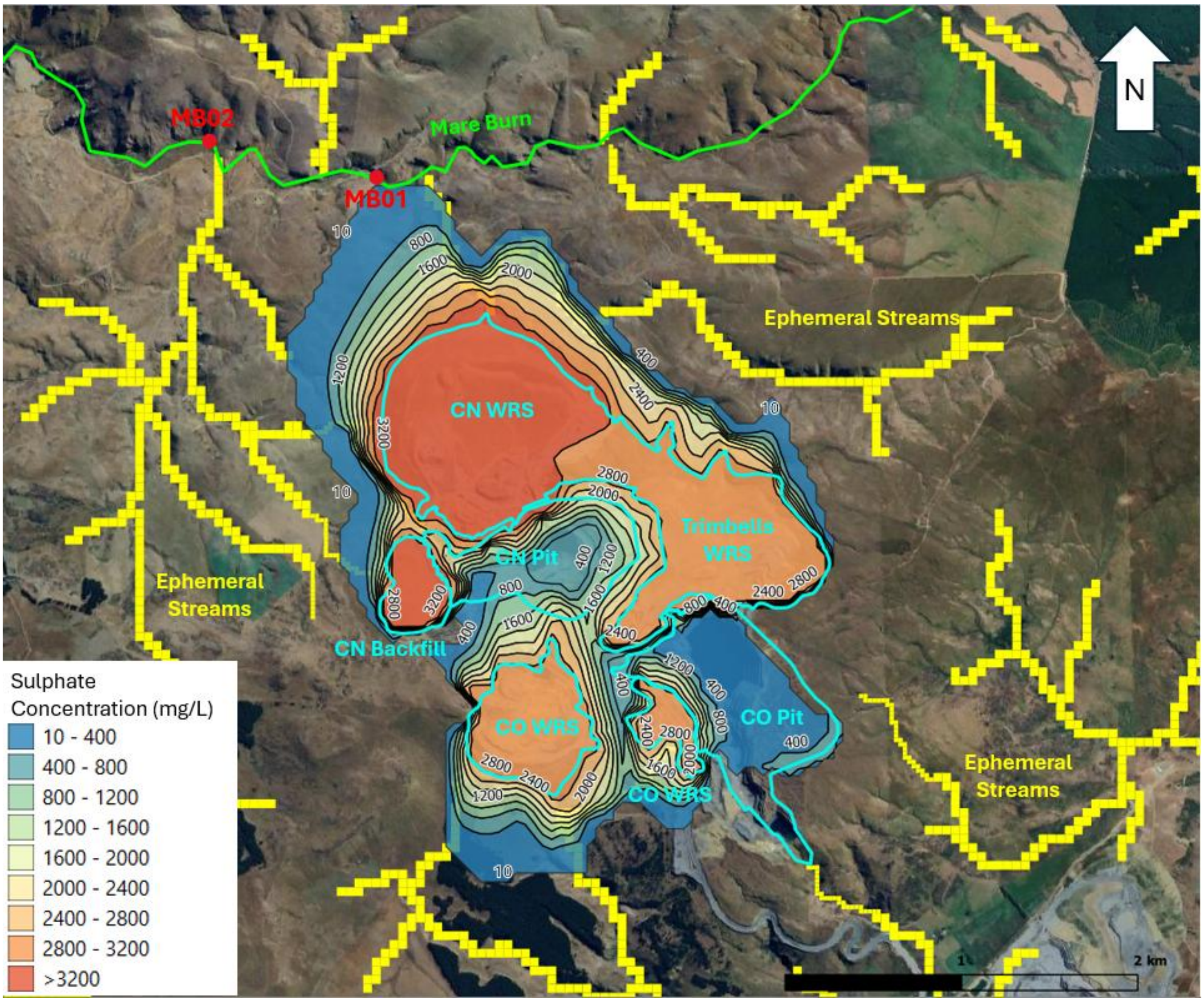


*Figure 5.20* **Contour plot showing sulphate plume extent at the end of the Coronation North Pit dewatering (and 3 years into the recovery of Coronation Pit) model in model layer 1.**

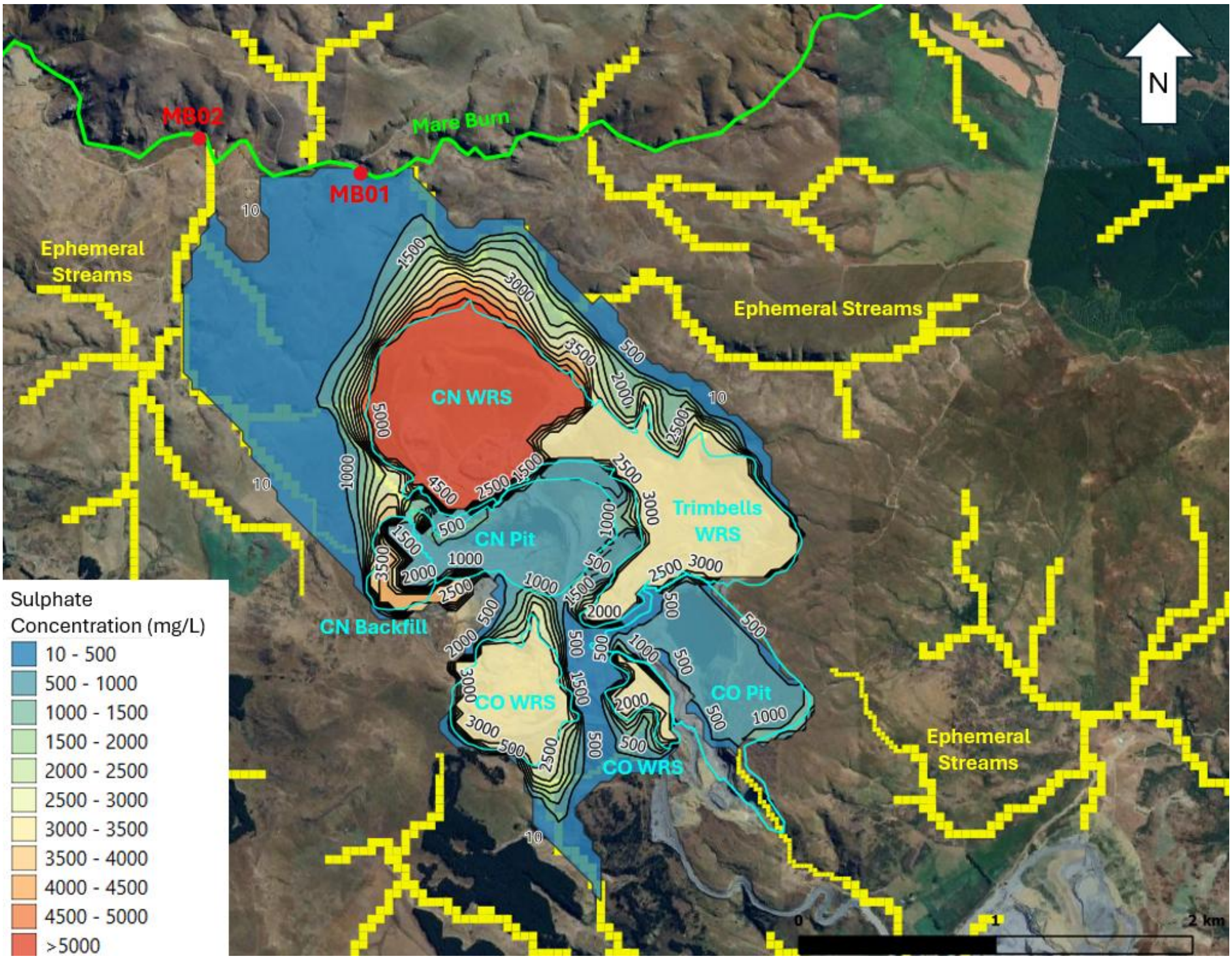


*Figure 5.21* *Contour plot showing sulphate plume extent at the end of the recovery model (400 years of recovery) in model layer 1.*

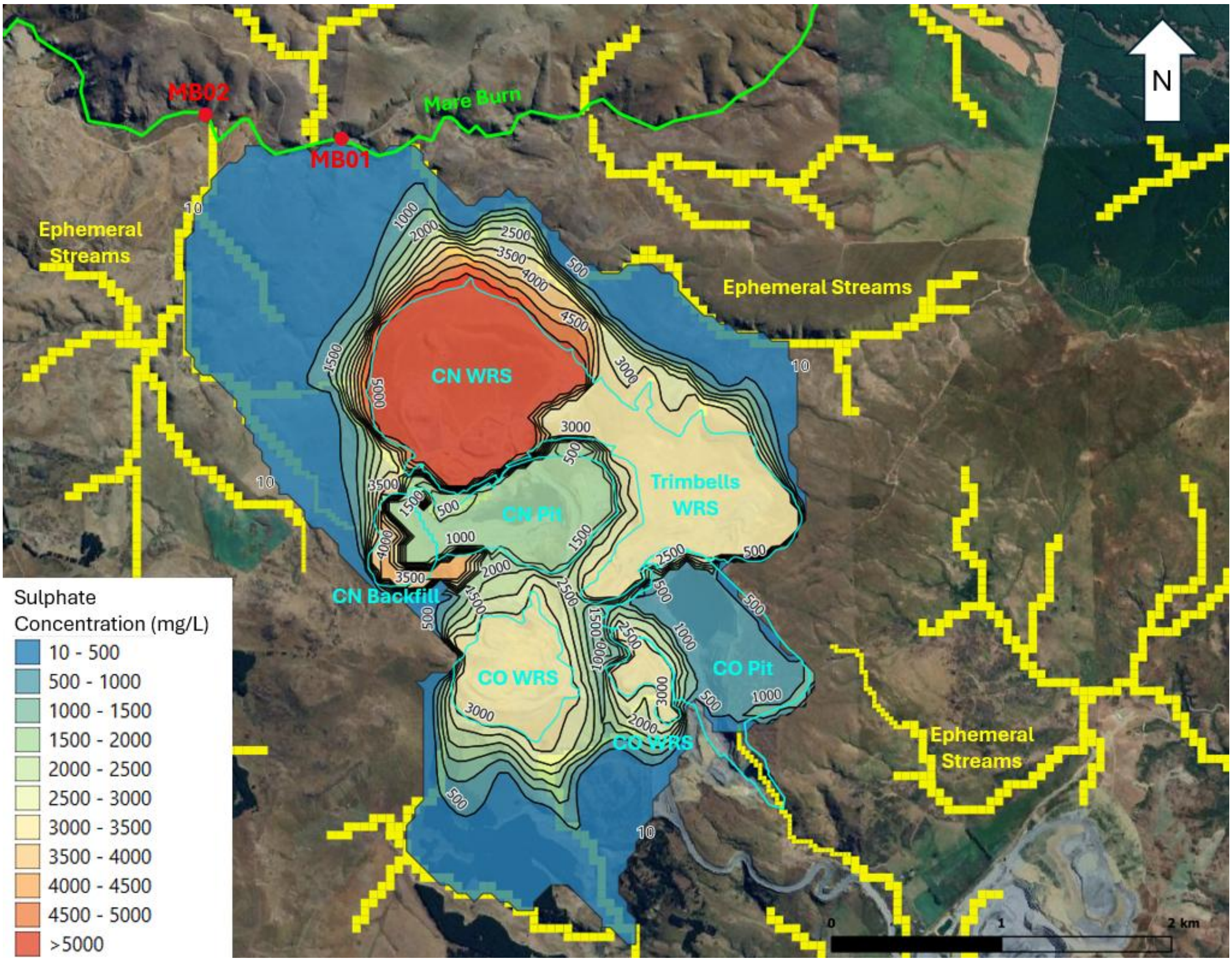


*Figure 5.22* ***Contour plot showing the extent of the sulphate plume at the end of the recovery simulation (400 years) in model layer 1, assuming recharge within the waste rock stack of 128 mm/year (sensitivity scenario).***

The total modelled sulphate mass discharged to the seepage capture drains, Mare Burn Creek catchment, and Deepdell Creek catchment (catchments defined in Appendix B) was estimated by combining contaminant transport model results with simulated flows across surface-water boundaries, including river boundaries representing the creeks and drain boundaries representing the ephemeral streams and seepage capture drains.

At 400 years post-closure, the seepage capture drains are predicted to intercept approximately 531 kg/day of sulphate. Over the same period, the estimated sulphate flux to the Mare Burn Creek catchment (including both streams and rivers) is approximately 402 kg/day, while the Deepdell Creek catchment is estimated to receive approximately 68 kg/day.

## 5.2.3 Central Mining Area – Frasers / Innes Mills and GPUG extensions

### 5.2.3.1 Base Case Model (Existing Conditions)

Existing conditions were represented using a steady-state groundwater flow model based on 2025 topographic data. Hydraulic parameters and boundary conditions applied to represent the mining features are detailed in Appendix C. Steady-state water table contours of the existing conditions model are presented in Figure 5.23 with an enlarged view of the Frasers - Innes Milles and Golden Point pits shown in Figure 5.24. Groundwater flow generally follows topography and is diverted towards the dewatered pits and underground workings.

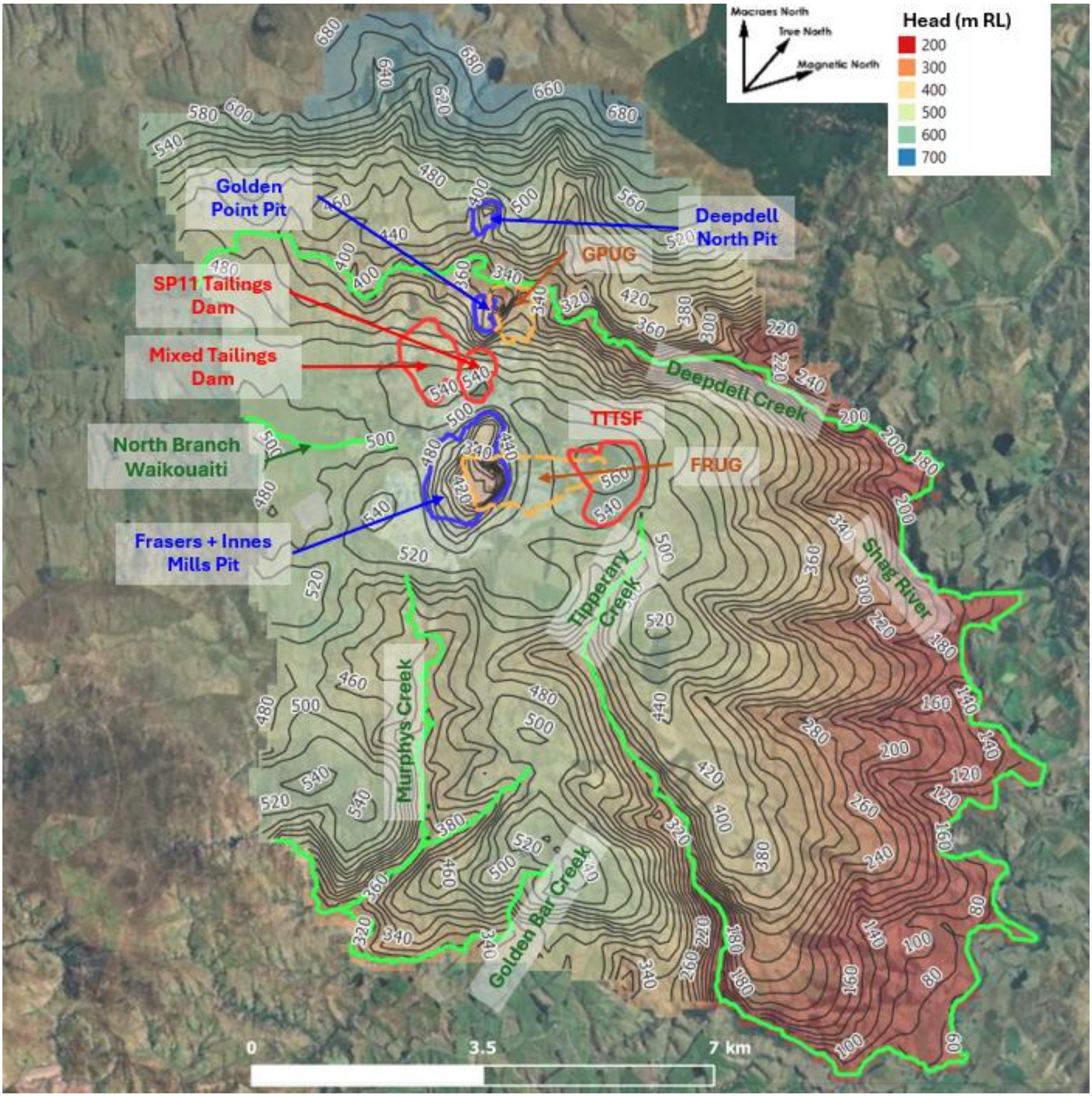


*Figure 5.23 Existing conditions steady-state modelled head contours (mRL) in model layer 1*

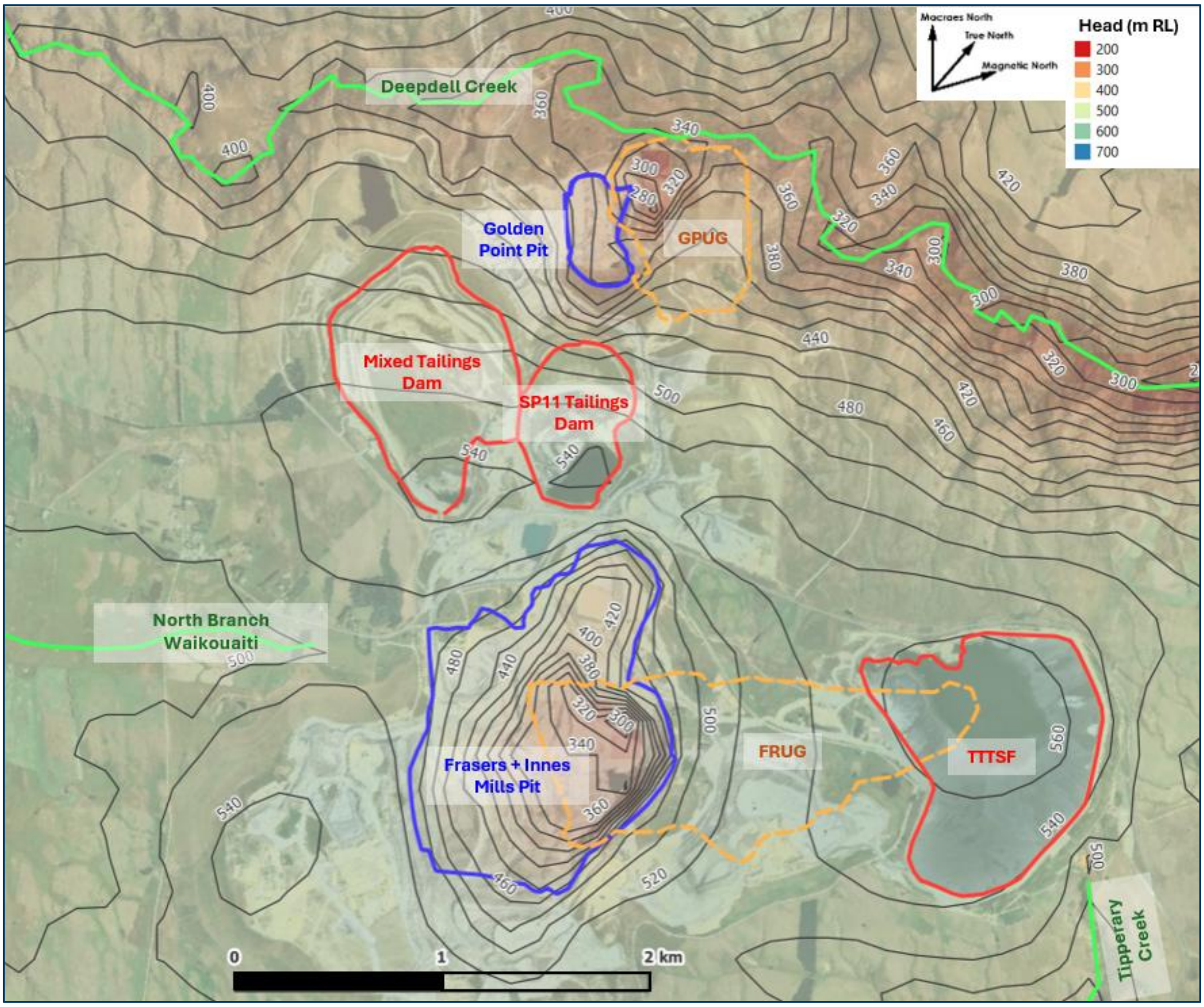


*Figure 5.24 Enlarged view of steady state water table contours zoomed near proposed mining*

A south to north cross section through selected site features, showing the predicted water table in Layer 1 for the existing conditions is provided in Attachment 4 of Appendix C.

### 5.2.3.2 Proposed Mining Activities - Dewatering

Pit dewatering was simulated using drain boundary conditions applied throughout the operational periods of the Innes Mills Pit and GPUG, including during their proposed expansions. Continuous dewatering of the Golden Point Pit was also simulated, as this pit must remain dry to allow continued access to the GPUG. Relative to the steady-state existing conditions model, several additional changes were incorporated, including: a general head boundary was assigned to the Deepdell North Pit to represent its current level and future recovery of the pit lake. A general head boundary was introduced within the proposed Frasers Tailings structure (to be placed over the Frasers Pit) to simulate the deposition of saturated material in that area concurrent with the expansion of the Innes Mills Pit. General head boundary values were derived from surface water modelling results. To provide a conservative assessment, the simulation spans 11 years, consistent with the indicative mining schedule. For the dewatering simulation, the greater and deeper extent of the proposed design for both the Innes Mills pit and GPUG extension were assumed throughout the dewatering period. This represents a conservative approach, as it maximises the duration and extent of dewatering effects and is therefore considered appropriate for assessment purposes.

Modelled head contours at the end of dewatering (end of IM pit and GPUG dewatering) are plotted in Figure 5.25. A south to north cross section through selected site features, showing the predicted water table in Layer 1 for the existing conditions, at the end of dewatering period (11 years of dewatering), and at the end of the recovery model (400 years), is provided in Attachment 4 of this Appendix.

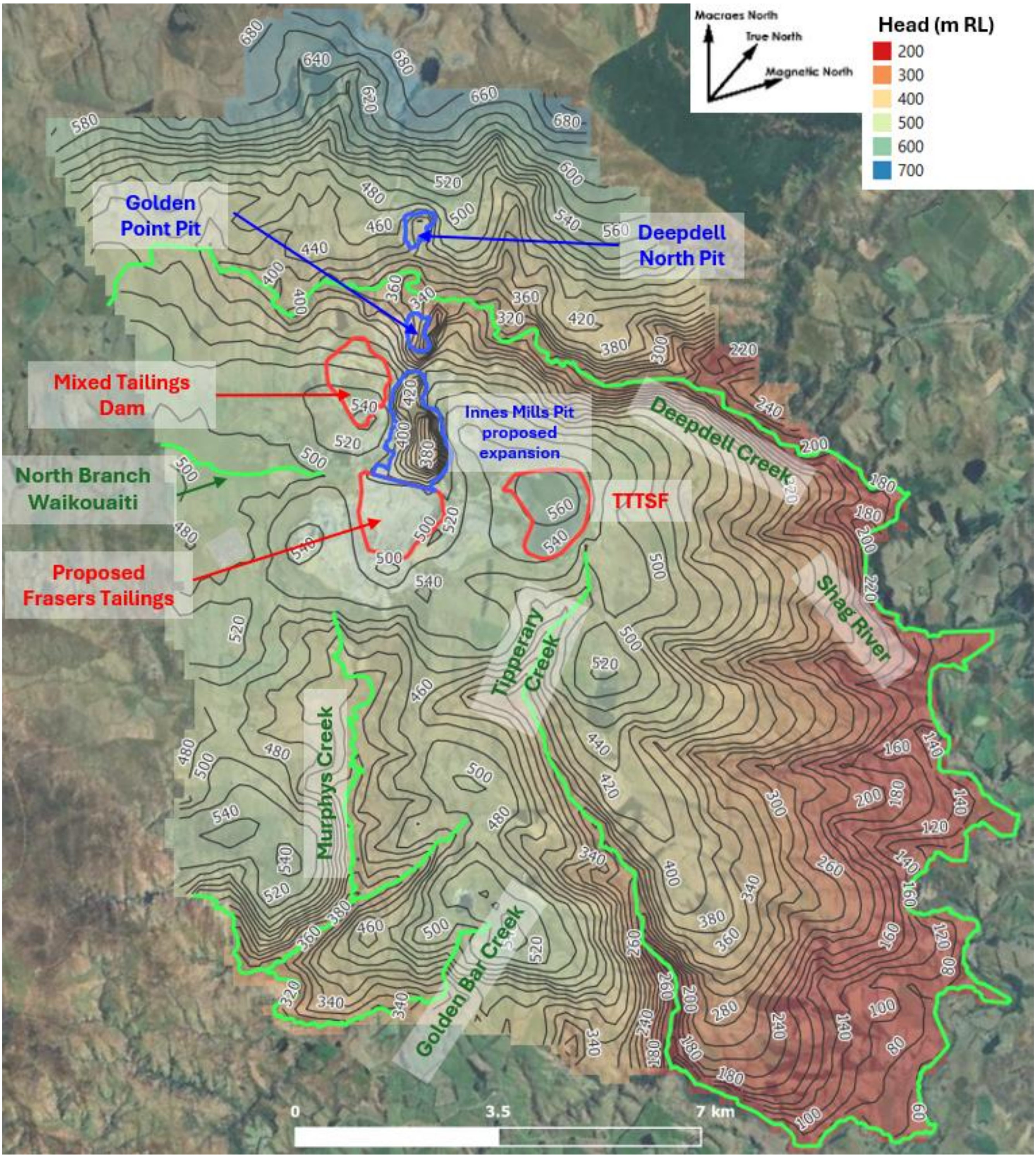


*Figure 5.25 Modelled water table contours at the end of dewatering*

Furthermore, in Section 5.2.3.3 of this report Figure 5.35, Figure 5.36 and Figure 5.37 show the pressure head (existing conditions, at the end of 11 years dewatering and 30 years into the recovery run) in layer 10 that represent the model layer containing the base of the FRUG and GPUG workings as represented in the groundwater model.

Modelling results indicate that dewatering of GPUG is lowering the pressure heads within the deeper model layers. This is consistent with measurements from vibrating wire piezometers (VWPs) installed near Deepdell Creek in 2022, which show drawdown responses in the deeper groundwater system (OGNZL, 2025). The location of the VWPs and associated monitoring data are shown in Figure 5.26 and Appendix J. Monitoring data from the deep vibrating wire piezometers (VWPs) installed in all four drillholes, at depths ranging from approximately 170 m bgl to 266 m bgl, indicate groundwater drawdown of approximately 95 m to 150 m.

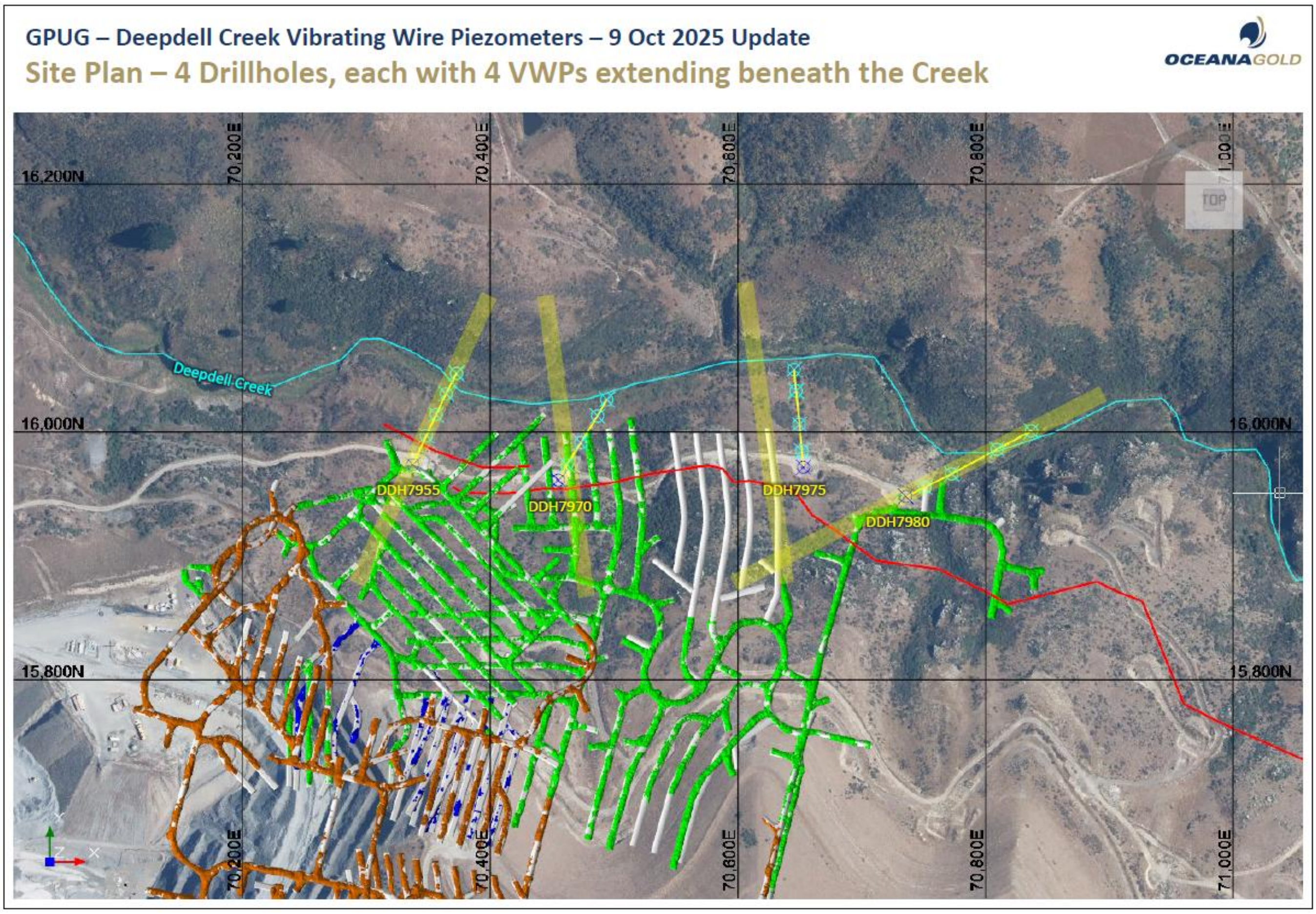


*Figure 5.26 GPUG – Deepdell Creek VWPs – 4 drillholes with 4 VWPs extending beneath the creek (OGNZL, 2025)*

Estimated dewatering rates (groundwater inflow) for the proposed GPUG extension including groundwater flows into the existing GPUG workings are presented in Figure 5.27. As presented in this figure, the predicted groundwater inflows for the GPUG extension decrease from approximately 196 L/s at the start of dewatering to approximately 22 L/s towards the end of the 11-year dewatering period. The initial high inflow is interpreted to reflect the model setup, in which the full GPUG extension is represented from the start of the predictive simulation rather than sequentially developed through time. This approach assumes rapid dewatering of the excavated and surrounding rock mass. In practice, the mine develops from near the highpoint, progressively extending down with time therefore, the inflow rates predicted towards the end of the modelled sequence are considered more representative of expected operational conditions. Dewatering rates from the current development of the GPUG mine support this interpretation (See Section 4.1 in Appendix C).

Estimated dewatering rates (groundwater inflow) for the proposed expansion of the Innes Mills pit are presented in Figure 5.28. The modelled pit inflows decline from approximately 12 L/s to a minimum of around 2.6 L/s at year 6, then rise to approximately 14.6 L/s by year 11. The initial decline reflects the instantaneous dewatering of the excavated pit material and the depletion of groundwater storage around the pit and the reduction of the hydraulic gradient toward the pit. The subsequent increase is driven by the recovery of the groundwater level in the adjacent Frasers Tailings facility. As the tailings phreatic surface rebuilds, the hydraulic gradient toward the pit increases, producing growing lateral seepage.

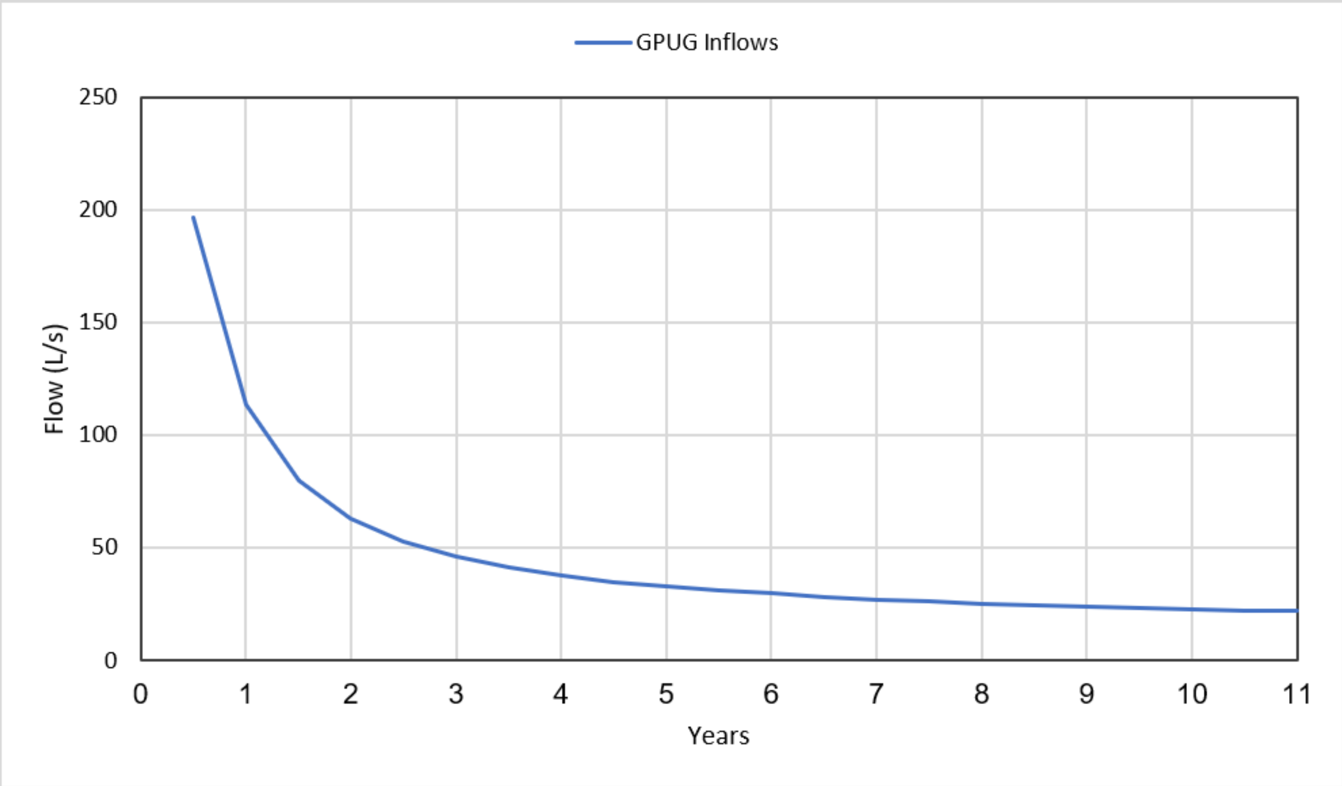


*Figure 5.27 Modelled dewatering rates for the proposed GPUG extension*

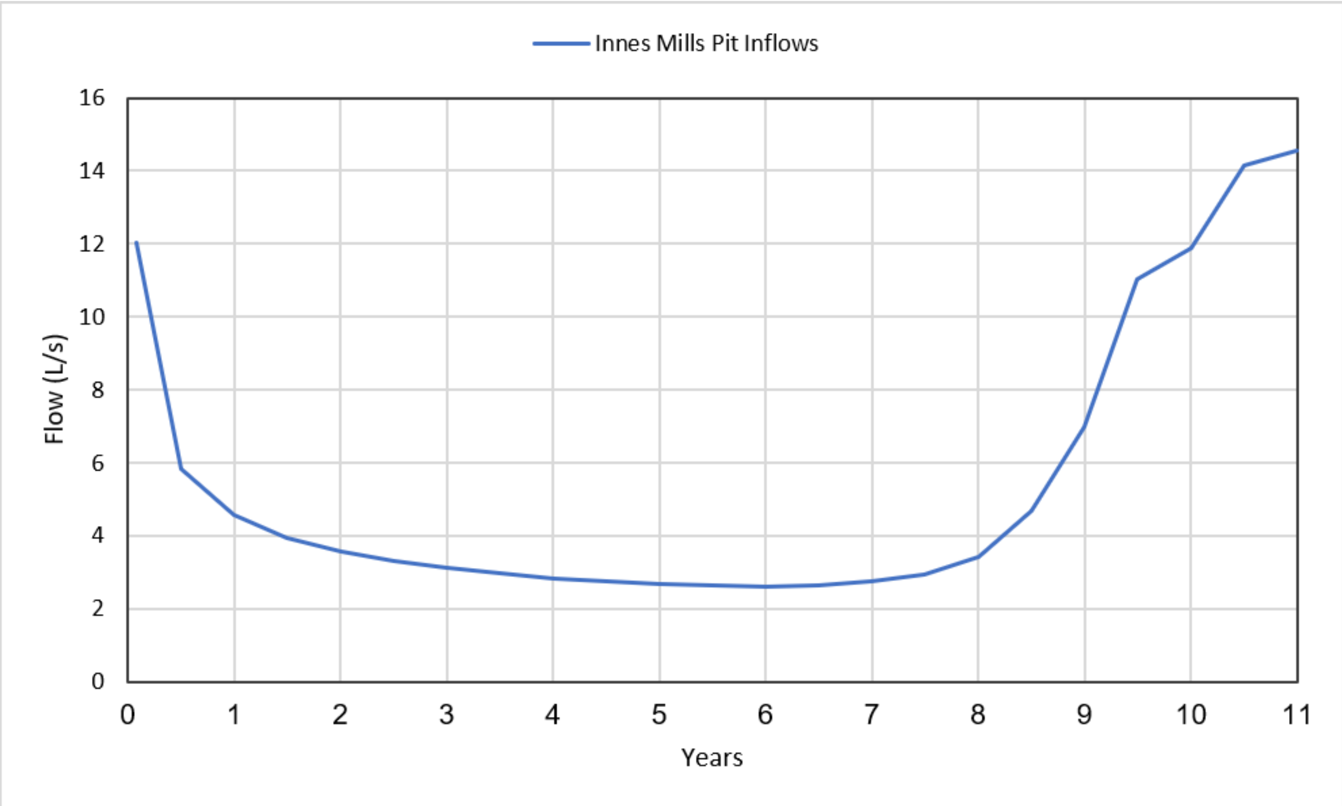


*Figure 5.28 Modelled dewatering rates for the proposed Innes Mills pit expansion*

#### 5.2.3.2.1 Drawdown effects to surrounding creeks/streams

Modelling results indicate that drawdown greater than 1 m in layer 1 is predicted to extend approximately 3,900 m to the northeast of the proposed Innes Mills Pit area (5.29).

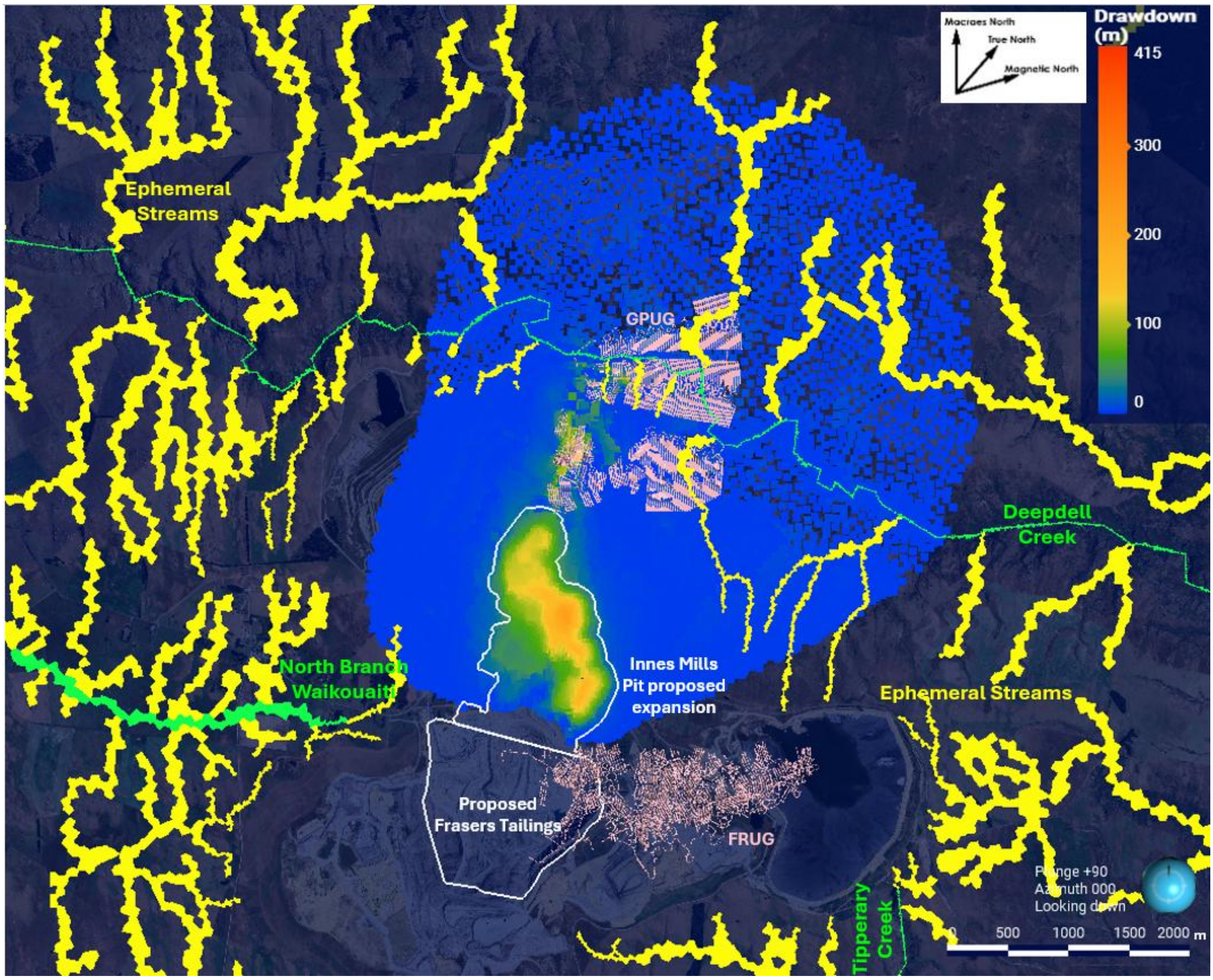


*Figure 5.29 Modelled extent of drawdown greater than 1 m after 11 years of dewatering of the proposed Innes Mills pit and GPUG extension*

The creeks in the Macraes site are perennial watercourses running dry for short periods in late summer (measured flow data are shown in Appendix E). Deepdell Creek is interpreted to be a gaining stream, receiving groundwater discharge and associated baseflow contributions along much of its length. Consistent with this interpretation, Deepdell Creek has been characterised as having relatively low baseflows while exhibiting rapid and pronounced runoff responses to storm events, resulting in short-duration peak flows following rainfall (Golder, 2011).

WSP Golder (2022) estimated the average groundwater-derived baseflow contribution to Deepdell Creek over the period from 1 January 1991 to 31 December 2015 to be approximately 38.2 L/s, equivalent to a specific discharge of 0.92 L/s/km² representing 32% of total creek flow. WSP Golder (2023) assessed dewatering effects associated with the Golden Point Underground (GPUG) mine in isolation from other existing and proposed mining-related dewatering activities. Their model predicted total groundwater inflows to the GPUG workings to be expected rates ranging between approximately 2.5 and 3 L/s, only a small proportion of which was attributable to the modelled GPUG extension (Figure 5.30). The WSP Golder (2023) modelling therefore focused solely on the GPUG mining extent and its associated groundwater drawdown effects. Under this scenario, their model predicted a reduction in groundwater-derived baseflow to Deepdell Creek of 0.24 to 0.54 L/s.

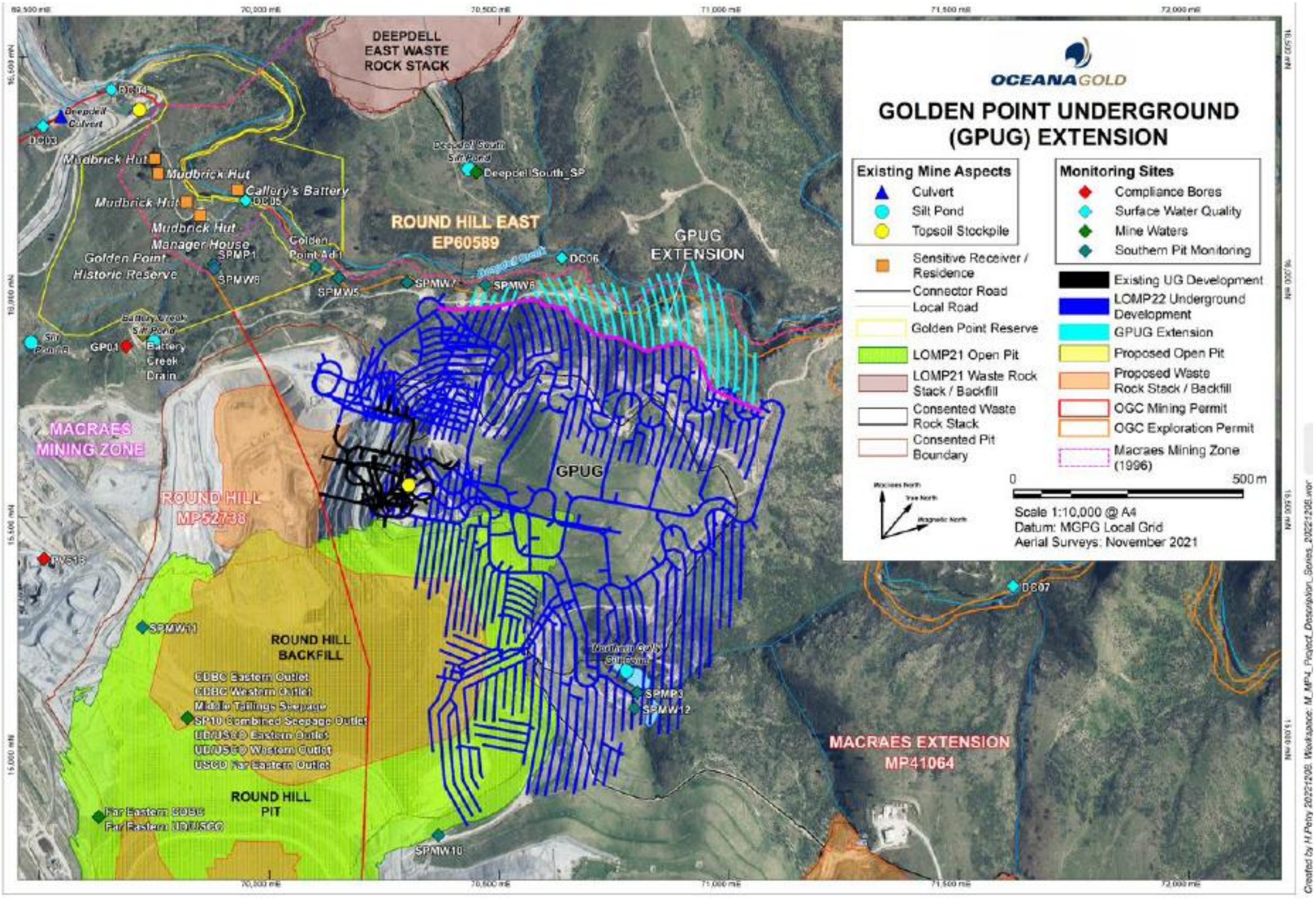


*Figure 5.30 GPUG extension (OGL, 2022 2020a) – Figure 1 in WSP Golder, 2023 report*

To assess the potential effects of dewatering of Innes Mills and GPUG extension to the surrounding creeks, modelled groundwater outflows to surface water under existing conditions were compared with those predicted by the dewatering model. Details on the division of catchments Appendix C. The catchments were delineated to correspond with key compliance points, surface water monitoring nodes and surface water monitoring programs. The modelled changes of groundwater contribution to the creeks due to dewatering of the pits and GPUG are presented in Table 5.1.

*Table 5.1 Reduction of groundwater contribution to streams during dewatering*

| Catchment - creeks and tributary streams | Modelled groundwater flow to creeks and tributary streams - Existing Conditions model (L/s) | Modelled groundwater flow to creeks and tributary streams - Dewatering model (L/s) | Modelled change of groundwater contribution due to dewatering (L/s) | % of change in groundwater contribution |
|---|---|---|---|---|
| Deepdell Creek to DC08 | 42.3 | 40.8 | 1.5 | 3.4% decrease |
| NBWRRF (Waikouaiti River North Branch - Ross Road Ford) | 10.3 | 10.2 | 0.1 | <0.5% decrease |
| Murphys and Golden Bar Creek | 37.6 | 37.8 | 0.2 | 0.6% increase* |
| Tipperary Creek | 65.2 | 65.1 | 0.1 | <0.5% decrease |
| Shag River | 29.2 | 29.1 | 0.1 | <0.5% decrease |
| Notes | *Associated with the water level increase in FRUG and in the proposed Frasers Tailings structure | | | |

##### 5.2.3.2.2 Drawdown effects on existing groundwater users

The location of the existing and proposed groundwater bores[3] as well as consented groundwater takes[1] are shown in Figure 5.31 and Figure 5.32 with enlarged views shown in Attachment 2 of Appendix C. Groundwater modelling results indicate that groundwater drawdown associated with current and proposed mining activities is predicted to remain largely confined to areas close to the existing and proposed pit extensions and underground workings (Figure 5.31 and Figure 5.32). On this basis, adverse effects on groundwater levels in non-OGL groundwater bores are considered unlikely.

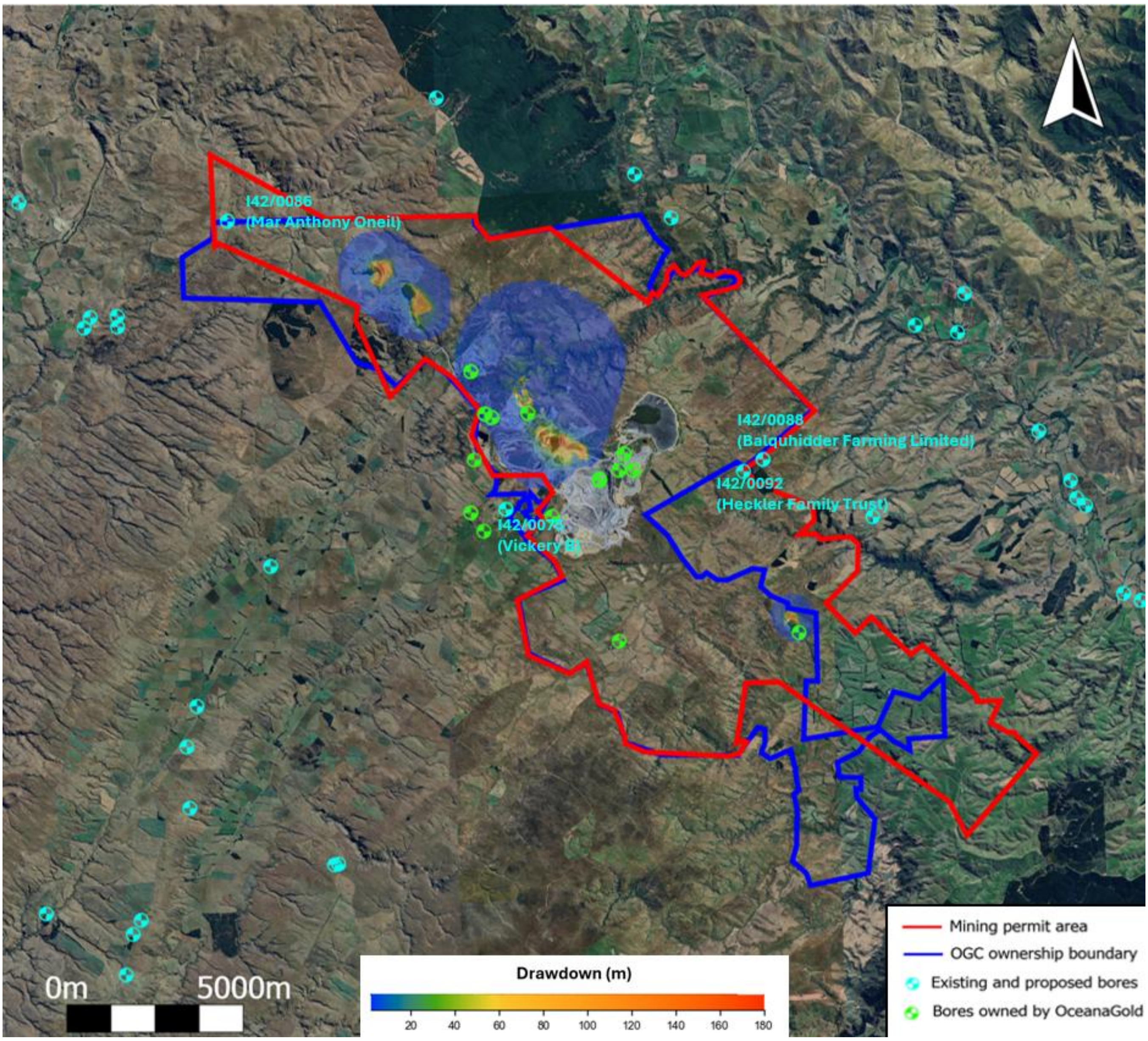


*Figure 5.31 Existing and proposed bore locations (ORC, 2027) and extent of modelled drawdown greater than 1 at the end of dewatering for all three mining areas*

[3] https://maps.orc.govt.nz/OtagoMaps/ accessed July 2027

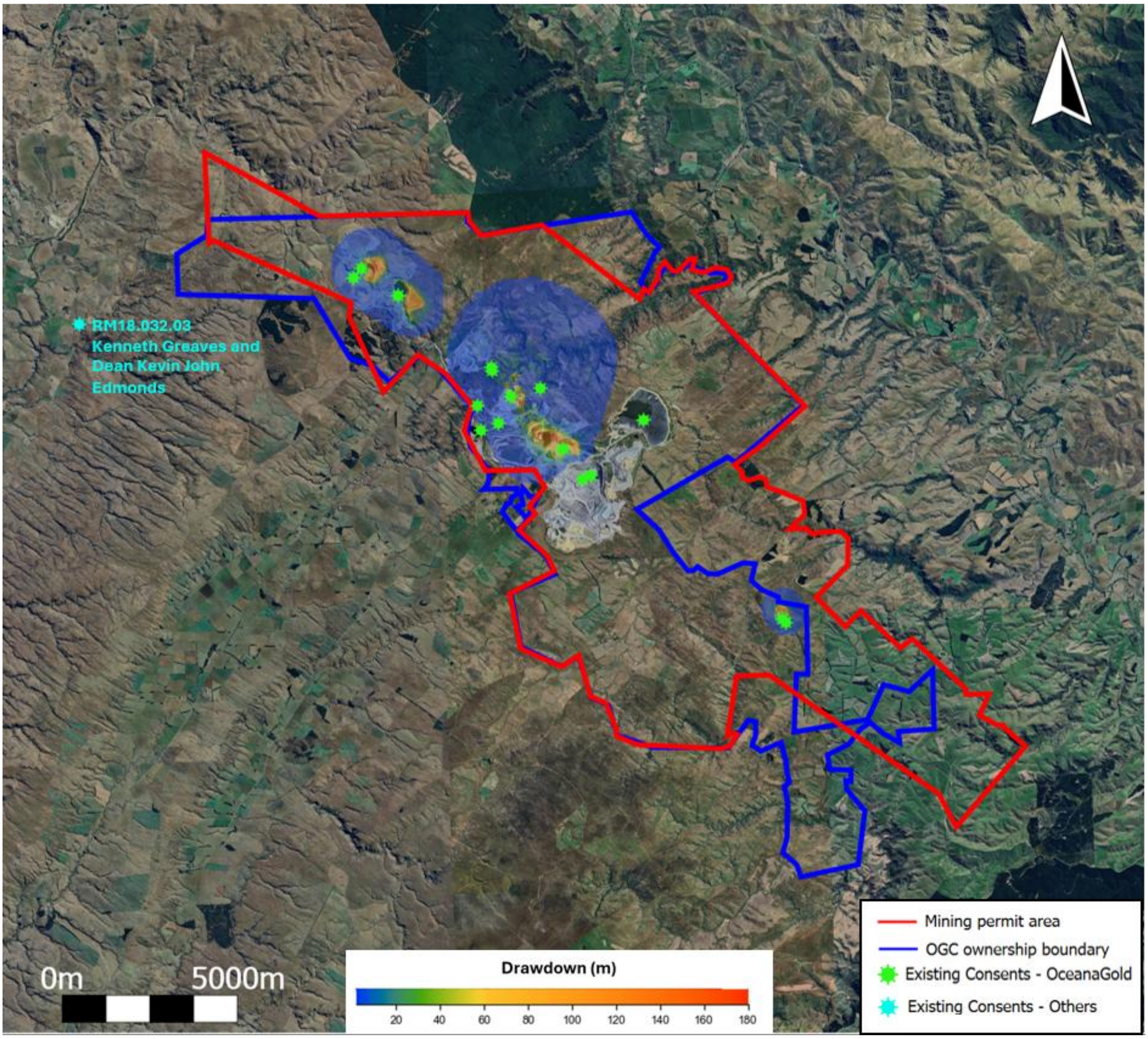


*Figure 5.32* *Current groundwater take consents (ORC 2027), and extent of modelled drawdown greater than 1 at the end of dewatering for all three mining areas*

### 5.2.3.3 Groundwater recovery

Groundwater recovery was simulated over a 400-year period, with the proposed Innes Mills Pit lake represented as a general head boundary (GHB) condition, alongside the continuation of recovery in the Deepdell North Pit and the proposed Frasers Tailings structure, both also simulated as GHB conditions. The head values assigned to these boundary conditions were derived from the water balance model (WBM) used to estimate pit lake filling rates and long-term equilibrium water levels (refer Section 6.2). This model also incorporated the addition of a proposed waste rock stack (WRS) backfill within the Golden Point Pit, as well as a proposed WRS backfill to the south of the proposed Innes Mills Pit expansion, applied following the completion of dewatering operations for that pit.

Seepage capture drains are proposed at several locations across the area, with the most significant structures planned around the Frasers West and East WRSs (toe-bund) (refer to Figure 5.33). The seepage capture drains will comprise a series of trenches connecting to collection sumps, intercepting WRS seepage before it enters surface water. Collected seepage will be pumped from the sumps to a water treatment facility or for use onsite within the mine water management system. The concept design for the seepage capture drains is included in “Macraes Phase 4 FTA Project. Engineered Seepage Capture Drain – Concept Design Report, GHD (2026a). The seepage capture drains have been modelled as drain boundaries at their proposed locations, consistent with the mine design intended to intercept and manage potentially contaminated seepage originating from the waste rock stack.

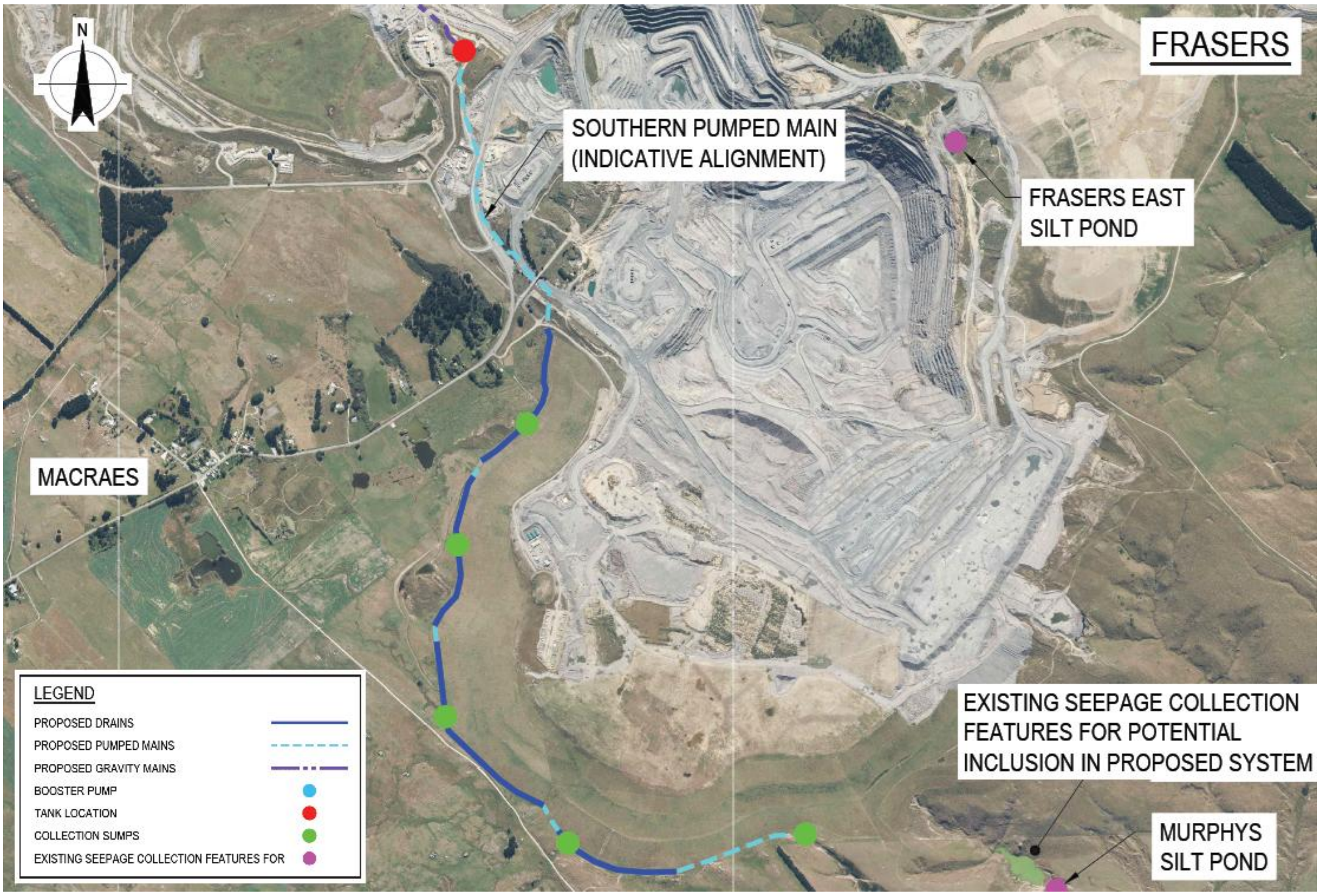


***Figure 5.33 Proposed seepage capture drains and toe bunds – Frasers Area (GHD 2026a., (not to scale)***

The modelled pressure head contours at the end of the recovery run are shown in Figure 5.34. A south to north cross section through selected site features, showing the predicted water table in Layer 1 for the existing conditions, at the end of dewatering period (11 years of dewatering), and at the end of the recovery model (400 years), is provided in Attachment 4 of Appendix C.

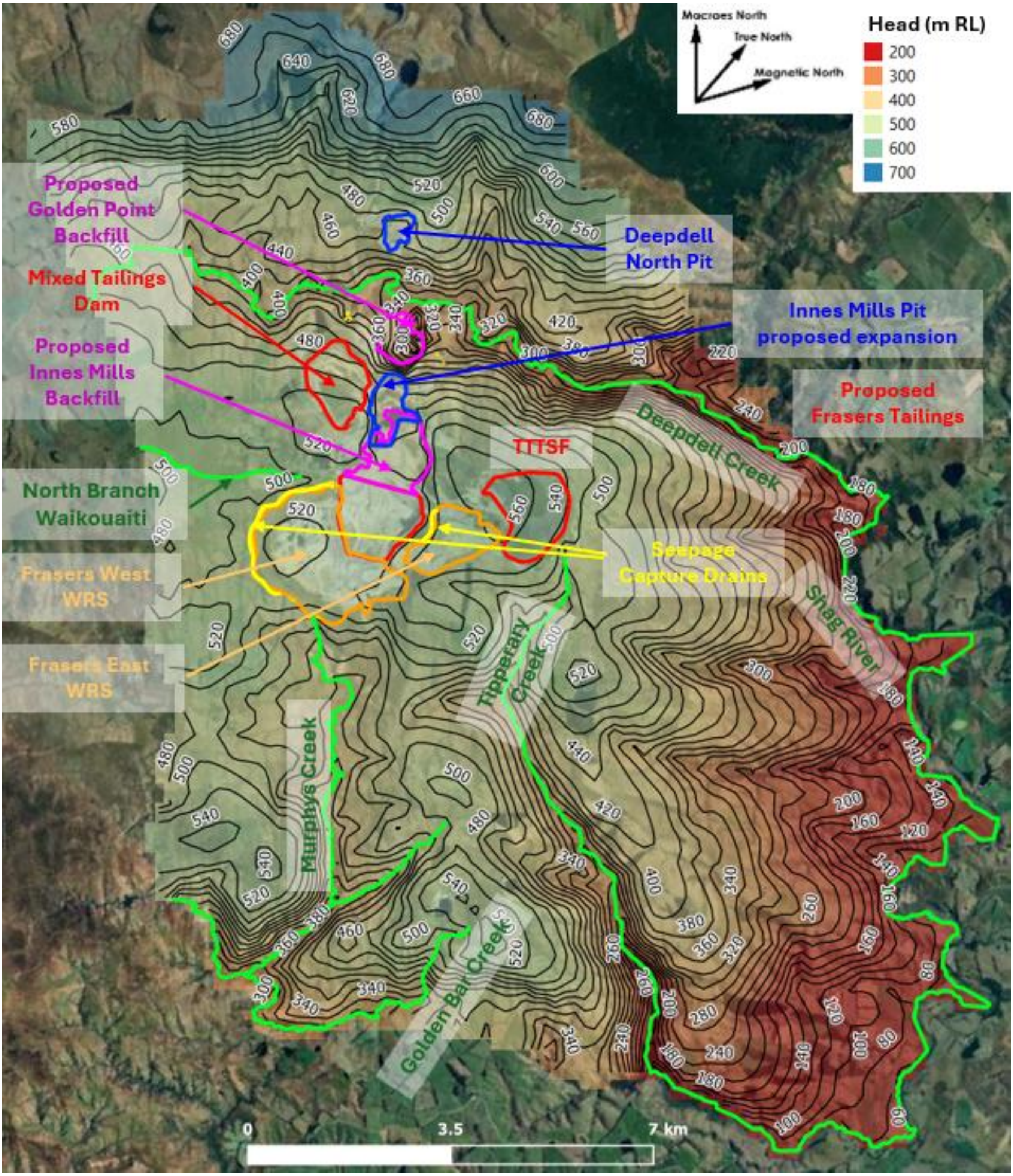


*Figure 5.34 Water table at the end of the recovery run after 400 years.*

Figure 5.35 to Figure 5.37 present cross sections of the modelled pressure head in Layer 10 along the FRUG and GPUG alignments existing conditions, at the end of 11 years dewatering (GPUG) and 30 years into the recovery model simulation. Layer 10 corresponds to the model layer containing the base of the FRUG and GPUG workings as represented in the groundwater model.

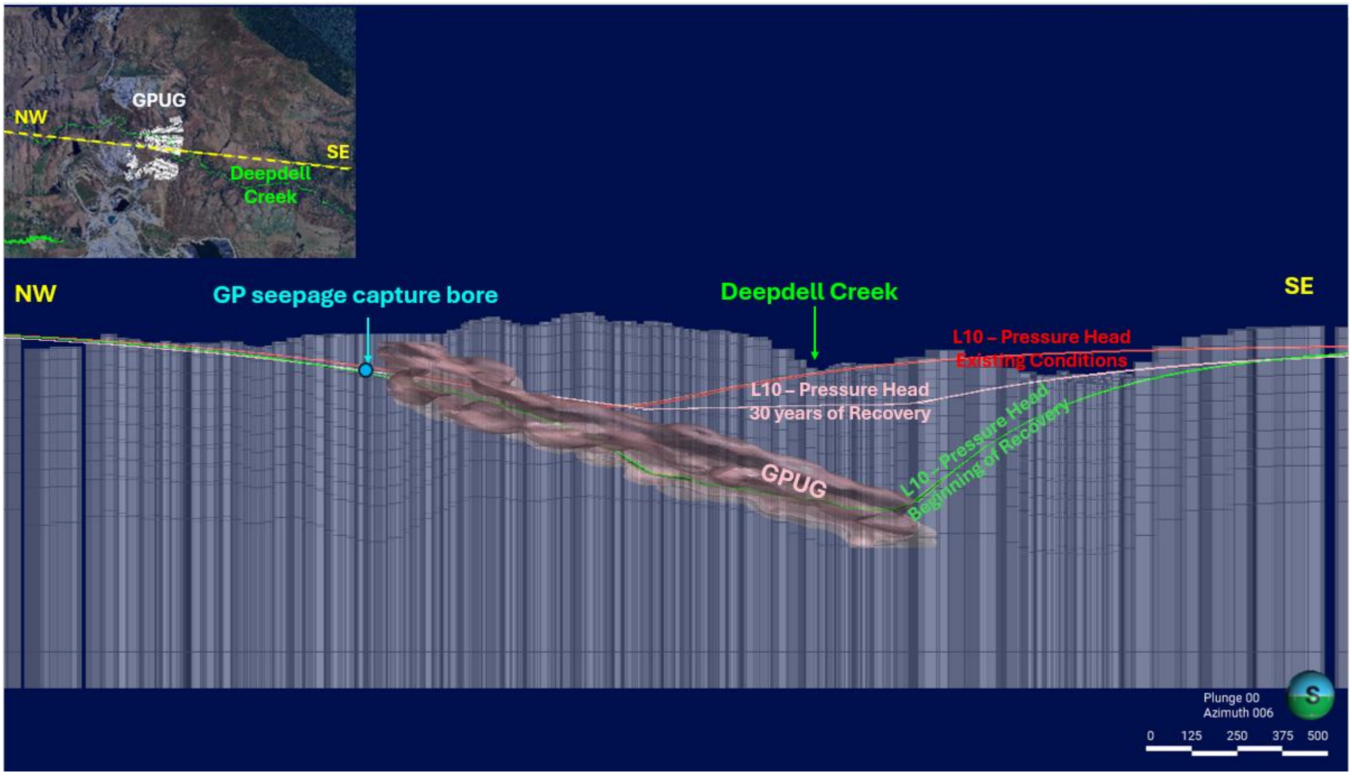


*Figure 5.35 Northwest-Southeast cross section through GPUG, showing pressure heads in layer 10 - existing conditions, at the end of 11 years dewatering and 30 years into the recovery run.*

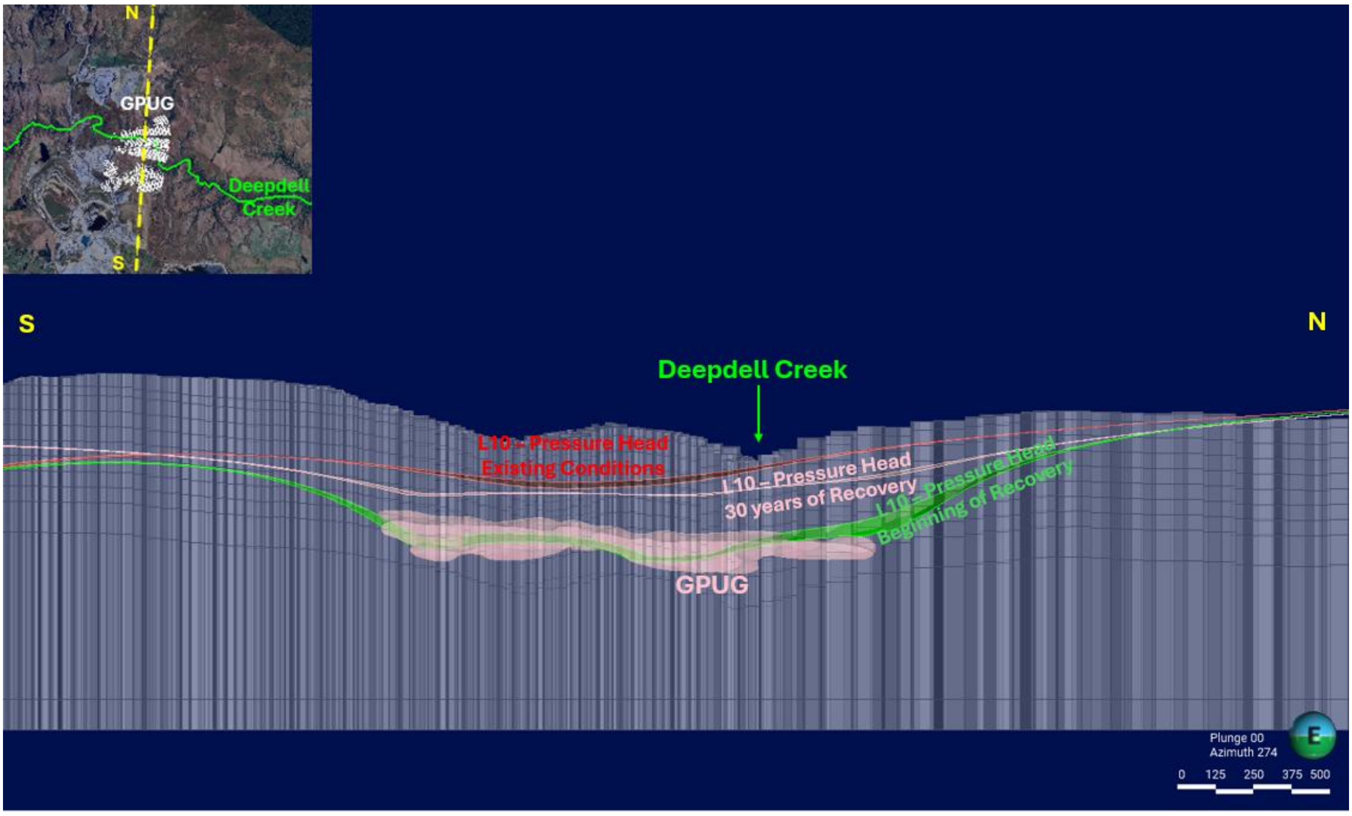


*Figure 5.36 South-North cross section through GPUG, showing pressure heads in layer 10 - existing conditions, at the end of 11 years dewatering and 30 years into the recovery run.*

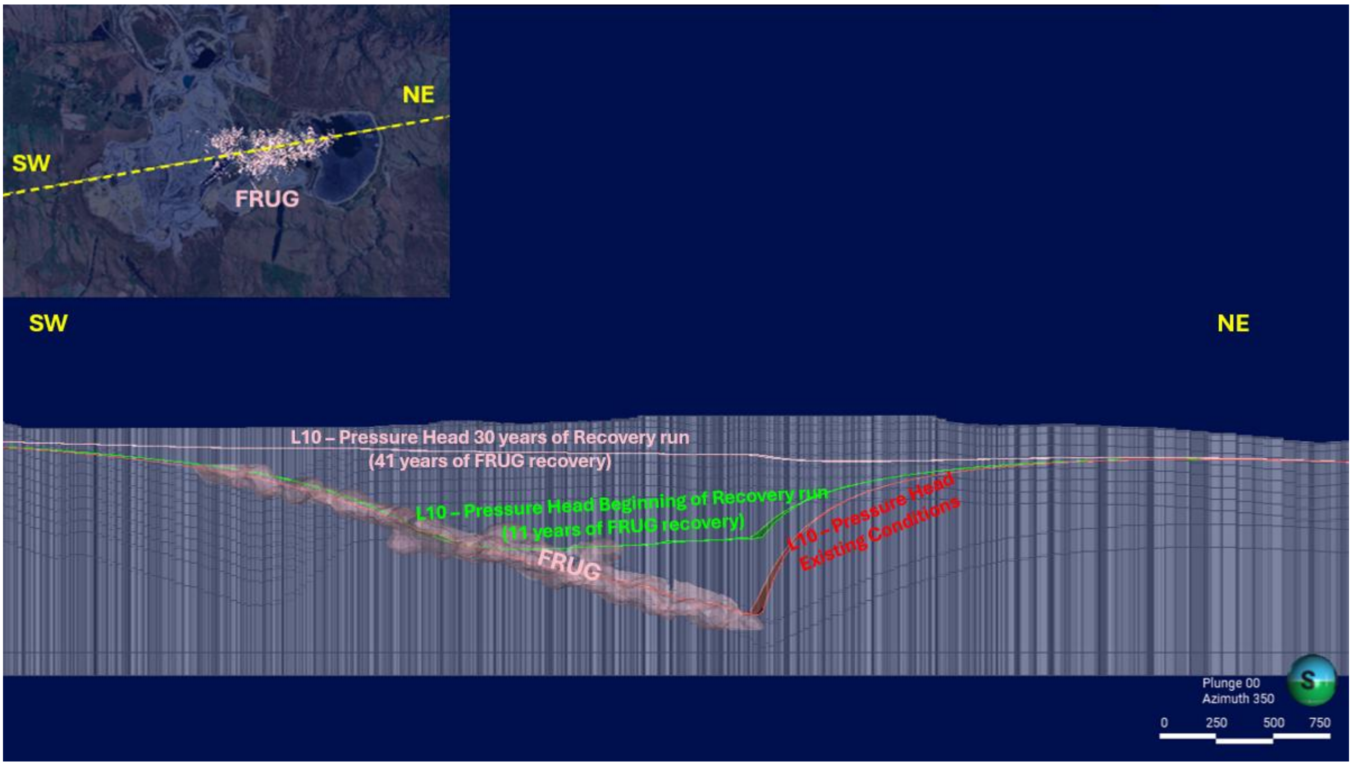


***Figure 5.37*** ***Southwest-Northeast cross section through FRUG, pressure heads in layer 10, existing conditions, at the end of 11 years dewatering and 30 years into the recovery run.***

In Figure 5.35 to Figure 5.37 the pressure head lines for intermediate stage recovery periods show flat gradients above sections of the underground workings. These flat gradients reflect the modelled water pressures within partially flooded underground workings where groundwater recovery is still progressing.

#### 5.2.3.4 Contaminant Transport

Sulphate contaminant transport modelling was undertaken using the solute transport modelling code (MODFLOW USG-TRANSPORT) in the Existing Conditions, Dewatering and Recovery models. Assumptions and input parameter values used are detailed in Appendix C.

Consistent with the approach adopted for the Golden Bar and Coronation Area models, sulphate was selected as the representative contaminant for transport modelling because it is expected to occur at elevated concentrations relative to other key contaminants, is already elevated in some receiving surface water bodies around the Macraes Gold Project as a result of mining activity, and has limited attenuation potential within the groundwater system. It is therefore considered a conservative element with which to assess contaminant mobilisation and transport from the backfilled waste, WRSs and subsequent pit lakes to receiving surface water bodies via the groundwater system.

The adopted sulphate concentrations are presented in Section 5.3 of Appendix C. For consistency across the model outputs, the plume extent has been interpreted using the 10 mg/L sulphate concentration contour as the outer plume boundary. This concentration value was adopted as a practical indicator of plume extent because it is considered to be broadly compatible with background sulphate concentrations in schist.

The extent of the predicted sulphate plume is shown in Figure 5.38 to Figure 5.40 for existing, dewatering and recovery conditions. The predicted sulphate plume extent in model layer 1 for existing conditions is shown in Figure 5.38. The existing conditions modelled sulphate results were compared with recently measured sulphate concentrations in existing groundwater monitoring wells within the Macraes site (Appendix J). The comparison shows that modelled sulphate concentrations for the existing-conditions model (with very few exceptions) are higher than measured concentrations, providing a relatively conservative basis for the initial sulphate concentrations adopted in the dewatering and groundwater recovery model runs. The location of the monitoring wells used and the difference between modelled versus measured sulphate concentrations for each well is detailed in Appendix C.

The predicted plume extents for the dewatering and recovery models, are presented in Figure 5.39 and Figure 5.40, respectively. Enlarged views and the predicted plume extent in deeper model layers are provided in Attachment 3 of Appendix C.

Comparison of the existing conditions, dewatering and recovery results, shows that sulphate plume distribution is as expected primarily controlled by mine-related source areas and local groundwater flow pathways. Dewatering causes localised modifications to plume geometry near the pits and underground workings, while the recovery simulations indicate gradual long-term plume migration under recovering groundwater conditions.

Figure 5.41, Figure 5.42 and Figure 5.43 present cross sections showing the modelled sulphate plume extent along the FRUG and GPUG alignments at the end of the 400-year recovery simulation. Furthermore, a south–north cross section through selected main key site features, showing the modelled sulphate plume, is provided in Attachment 4 of Appendix C.

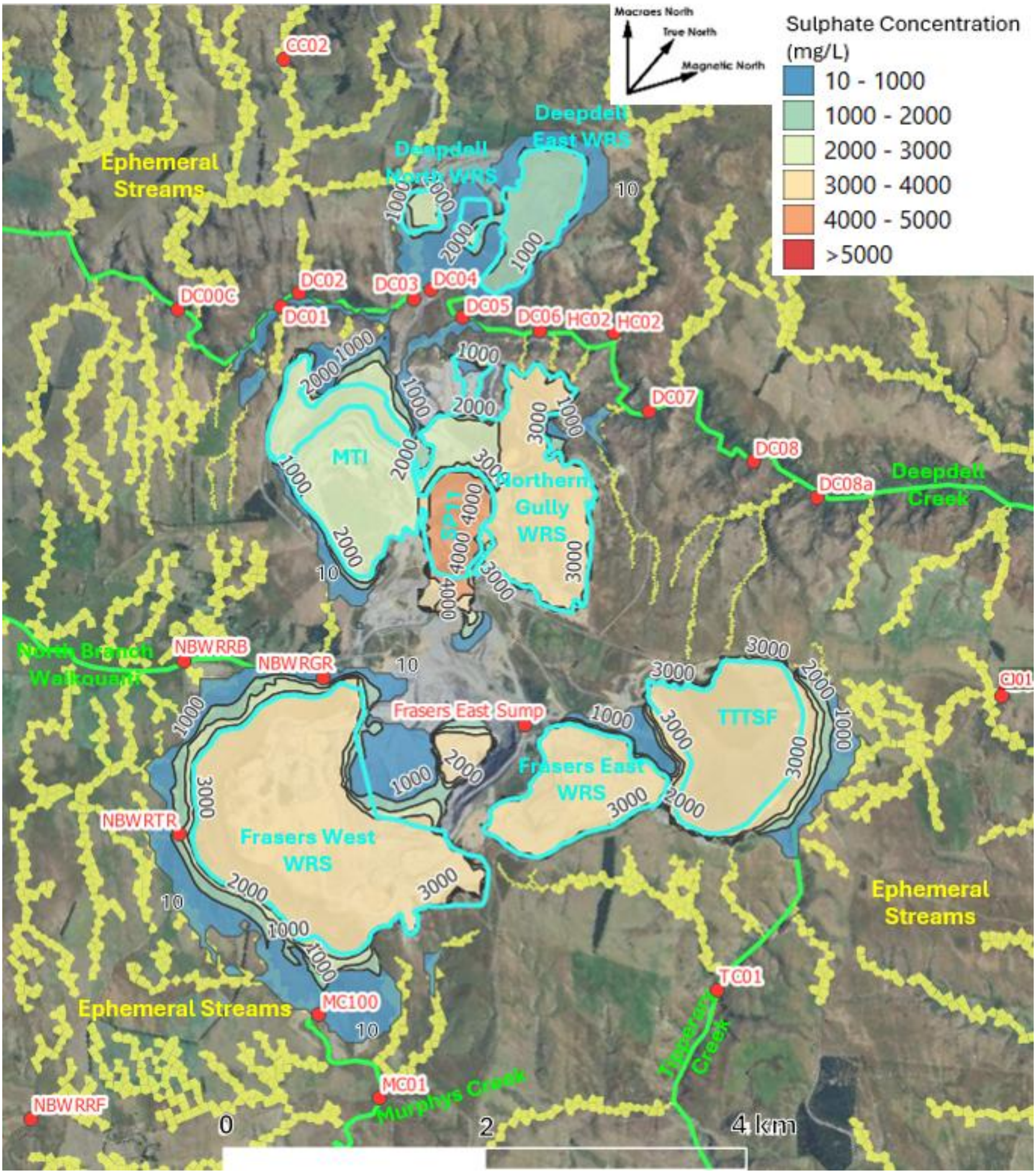


*Figure 5.38 Modelled sulphate plume extent in Model Layer 1 for the existing conditions model.*

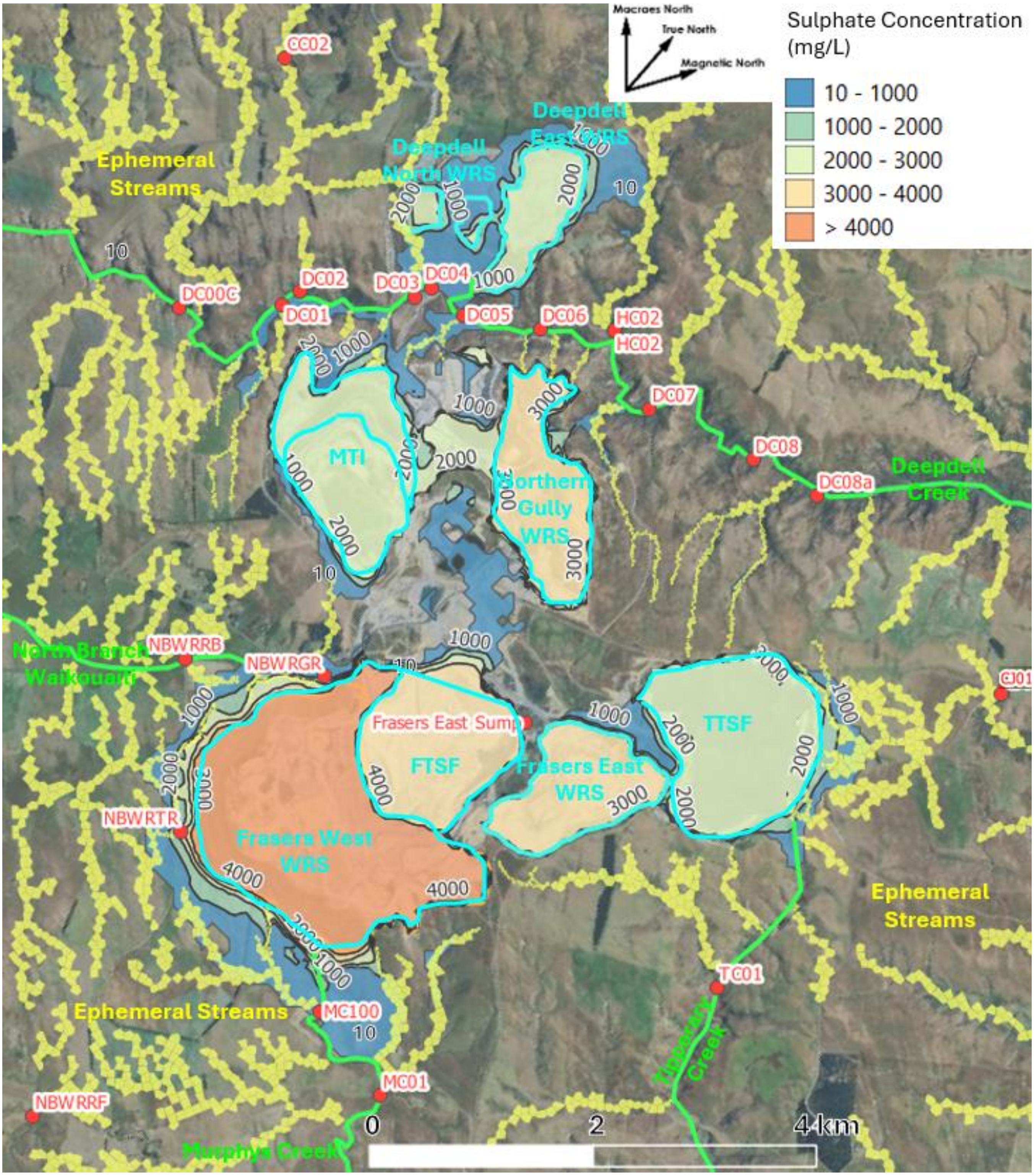


*Figure 5.39* *Modelled sulphate plume extent in Model Layer 1 at the end of Innes Mills Pit and GPUG dewatering.*

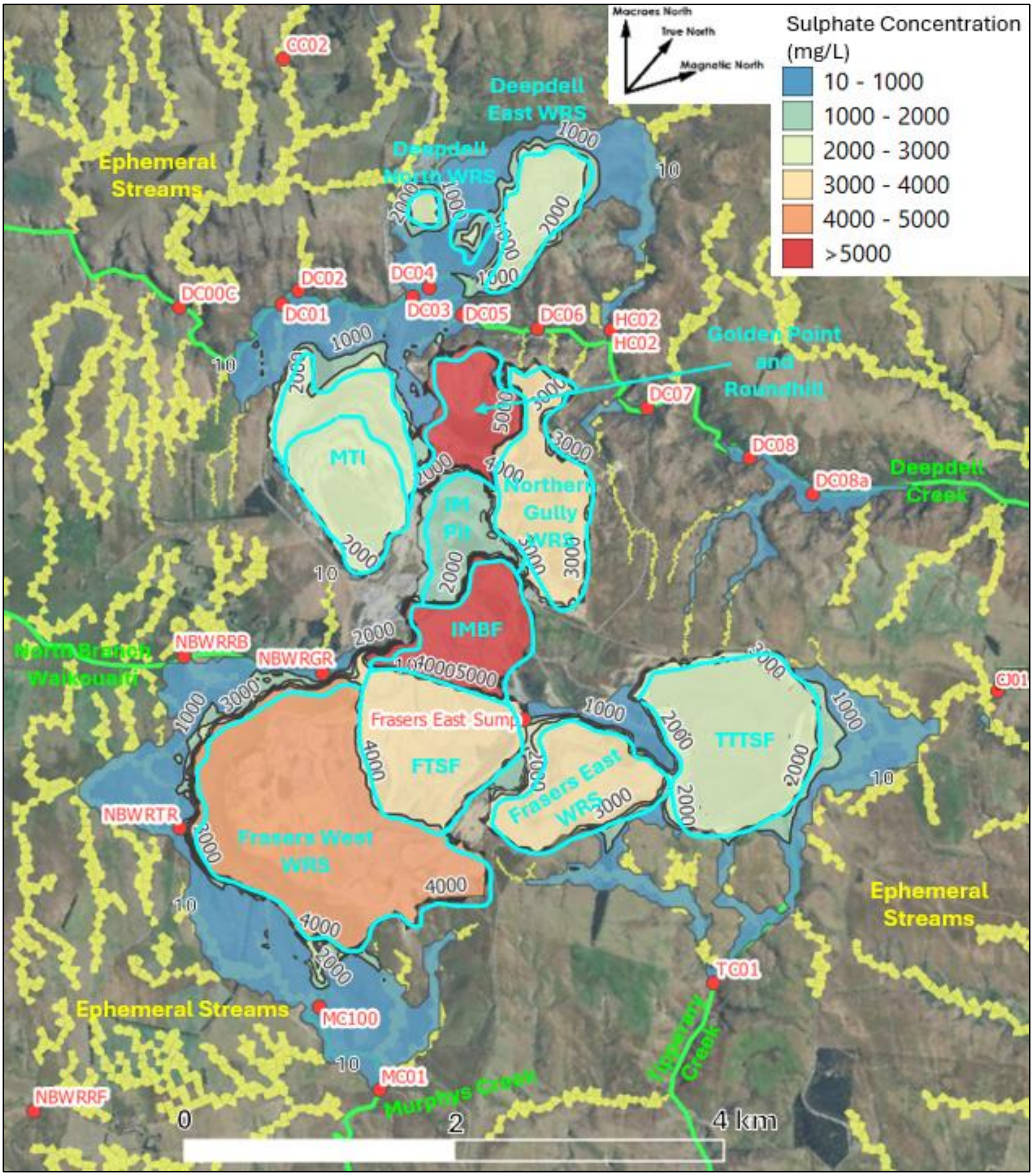


*Figure 5.40 Modelled sulphate plume extent at the end of the recovery model (400 years of recovery) in model layer 1.*

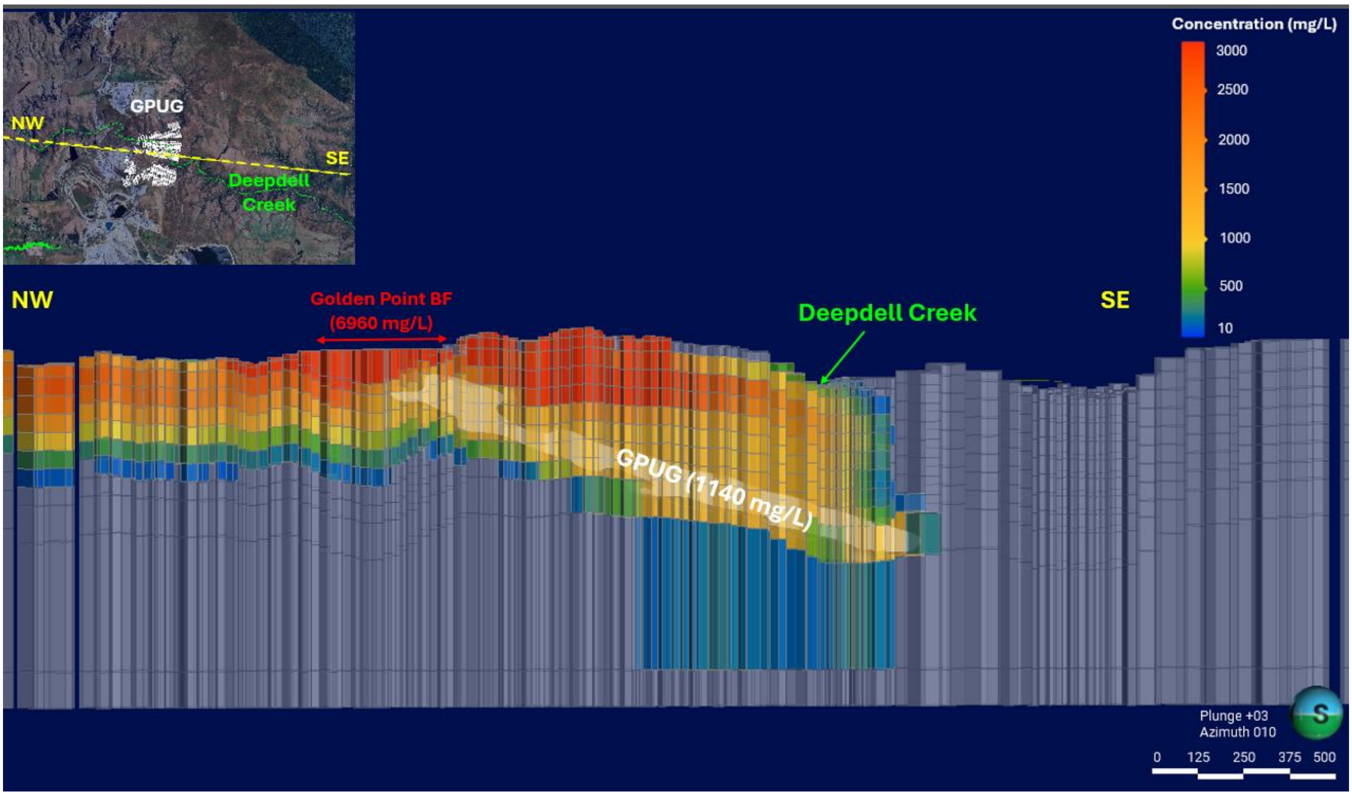


*Figure 5.41 NW – SE oriented cross section through GPUG showing sulphate plume extent*

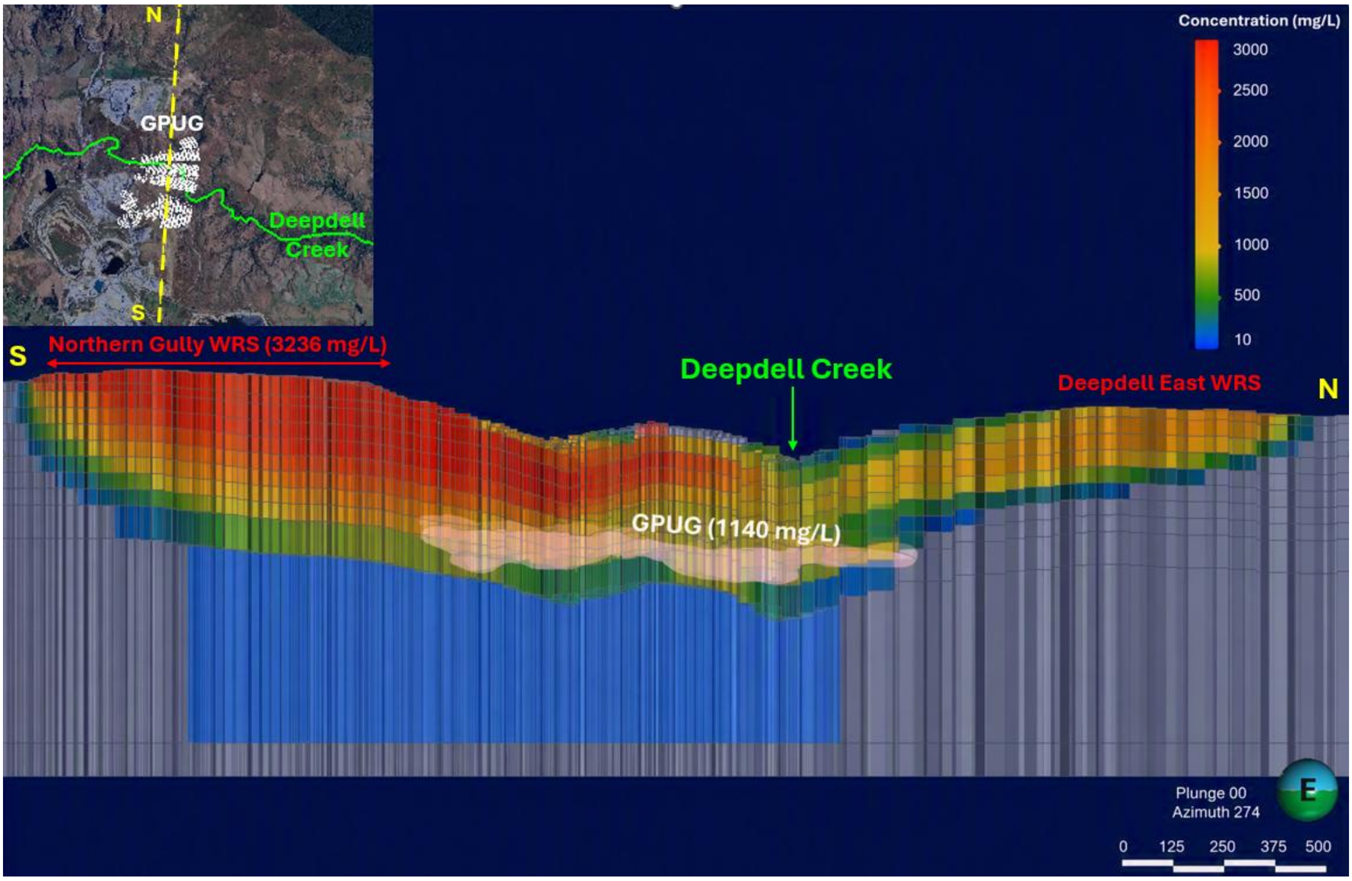


*Figure 5.42 N – S oriented cross section through GPUG showing sulphate plume extent*

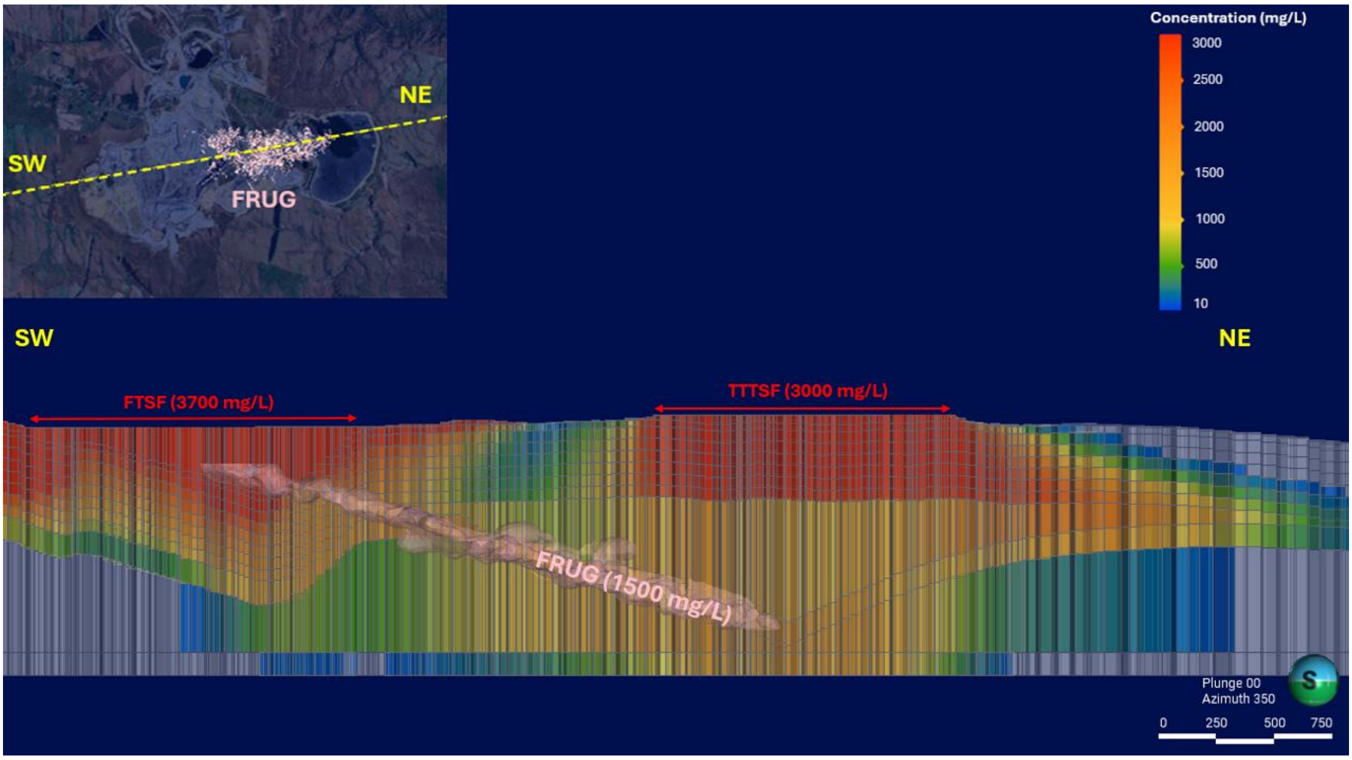


*Figure 5.43 NW – SE oriented cross section through FRUG showing sulphate plume extent*

The total modelled sulphate mass discharged to the catchments (i.e. representing uncaptured seepage mass that is not intersected by seepage interceptions drains) was estimated by combining contaminant transport model results with simulated flows across surface-water boundaries, including river boundaries representing the creeks and drain boundaries representing the ephemeral streams and seepage capture drains. The catchments were delineated to correspond with key compliance points, surface water monitoring nodes and surface water monitoring programs (Figure 5.44). Predicted results for the 400-year post-closure period including modelled mass captured by the seepage capture drains are summarised in Table 5.2 provides the modelled sulphate fluxes reporting to surface water bodies as reported at selected surface water modelling nodes (Appendix E). and they are not cumulative fluxes. These fluxes represent the sum of groundwater discharges upstream of each node and are not presented as cumulative fluxes in this table. The results are compared to the WBM generated seepage mass with the comparison detailed in Appendix F.

*Table 5.2 Estimated sulphate flux at surface water compliance monitoring points - 400 years post-closure*

| Catchment | Sulphate flux (kg/day) |
|---|---|
| Deepdell Creek- DC04 | 125.6 |
| Deepdell Creek - DC07 | 131 |
| Deepdell Creek - DC08 | 34 |
| North Branch Waikouaiti River Ross Road Ford (NBWRRF) | 109 |
| North Branch Waikouaiti River - NB03 | <1 |
| Murphys Creek - MC02 | 309 |
| Tipperary Creek - TC01 | 220 |
| Cranky Jims Creek - CJ01 | 85 |
| Shag River at Loop Road | <1 |
| Shag River at McCormicks | 8 |
| Seepage capture drains | 868 |

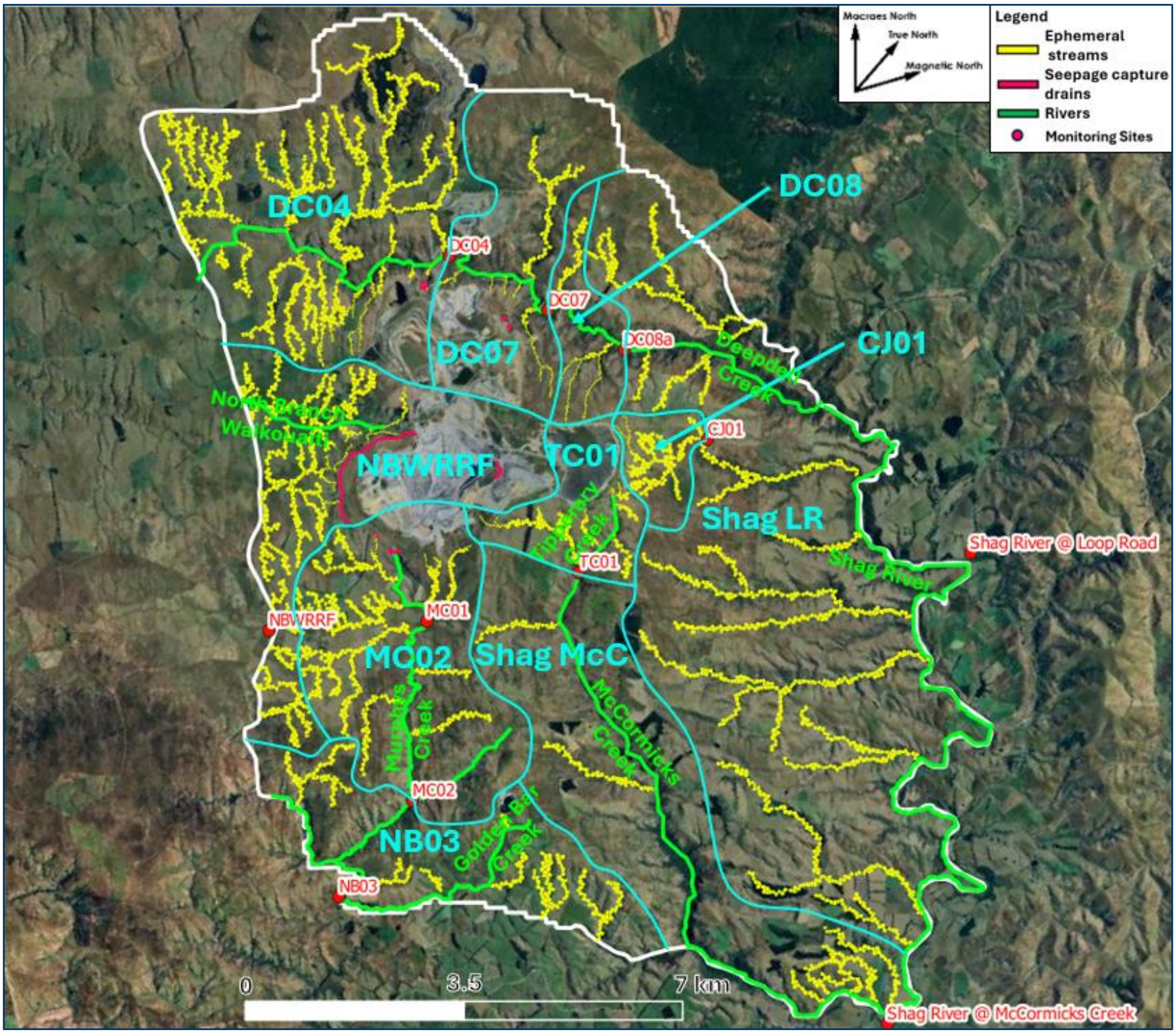


*Figure 5.44* ***Catchments with respect to surface water compliance monitoring points analysed for the contaminant transport model results***

Existing consented groundwater takes[4], existing bores and proposed bores[2] were reviewed against the maximum predicted extent of the modelled sulphate plume as shown in Figure 5.45 and Figure 5.46 respectively (enlarged figures are shown in Attachment 2 of Appendix C). This review indicates that these groundwater receptors are not expected to be intersected by the predicted plume extent, and adverse effects on groundwater users are therefore considered unlikely.

[4] **https://maps.orc.govt.nz/OtagoMaps/** accessed July 2027

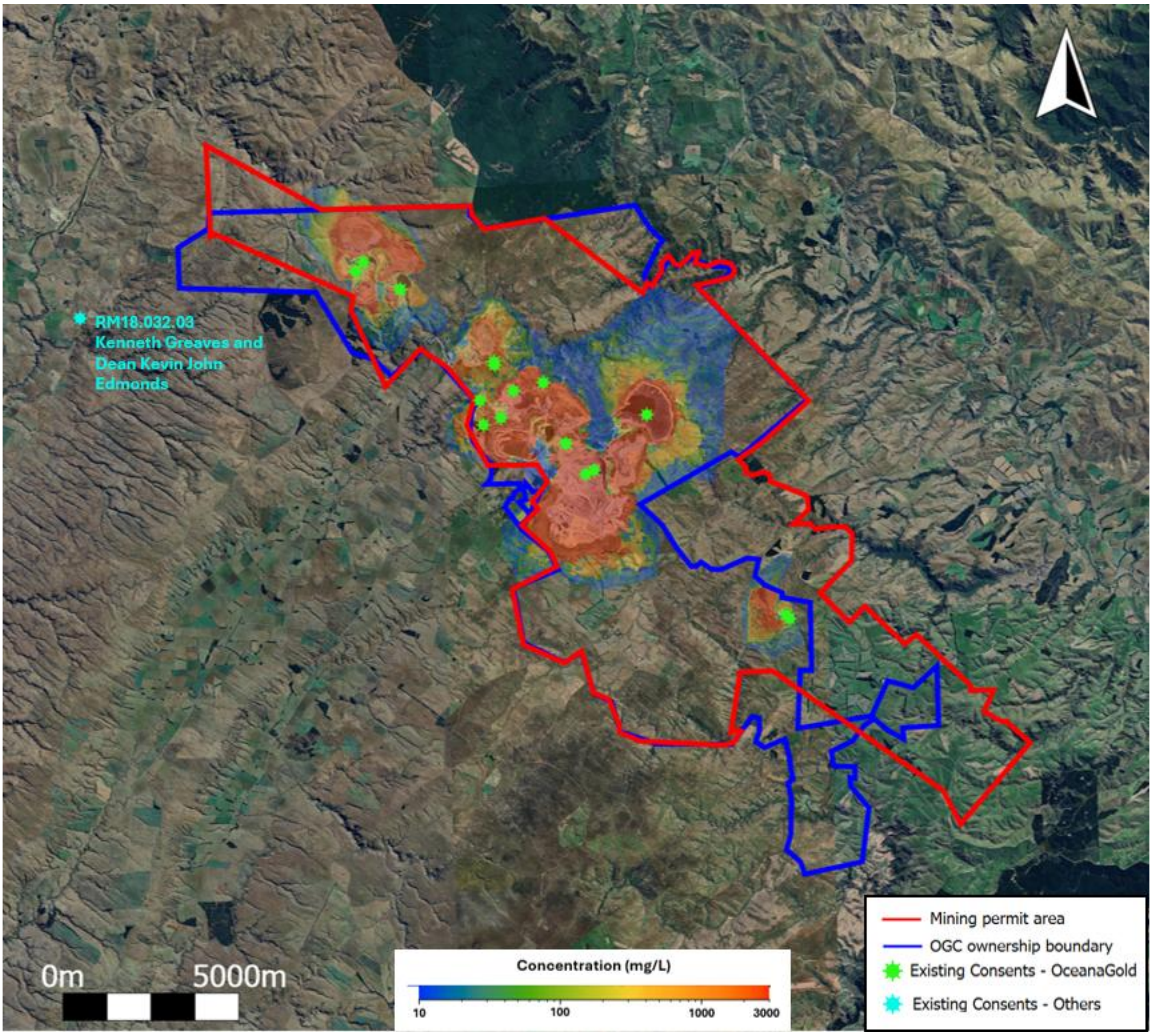


*Figure 5.45* ***Existing groundwater consented takes and maximum sulphate plume extent at the end of the recovery model (400 years of recovery)***

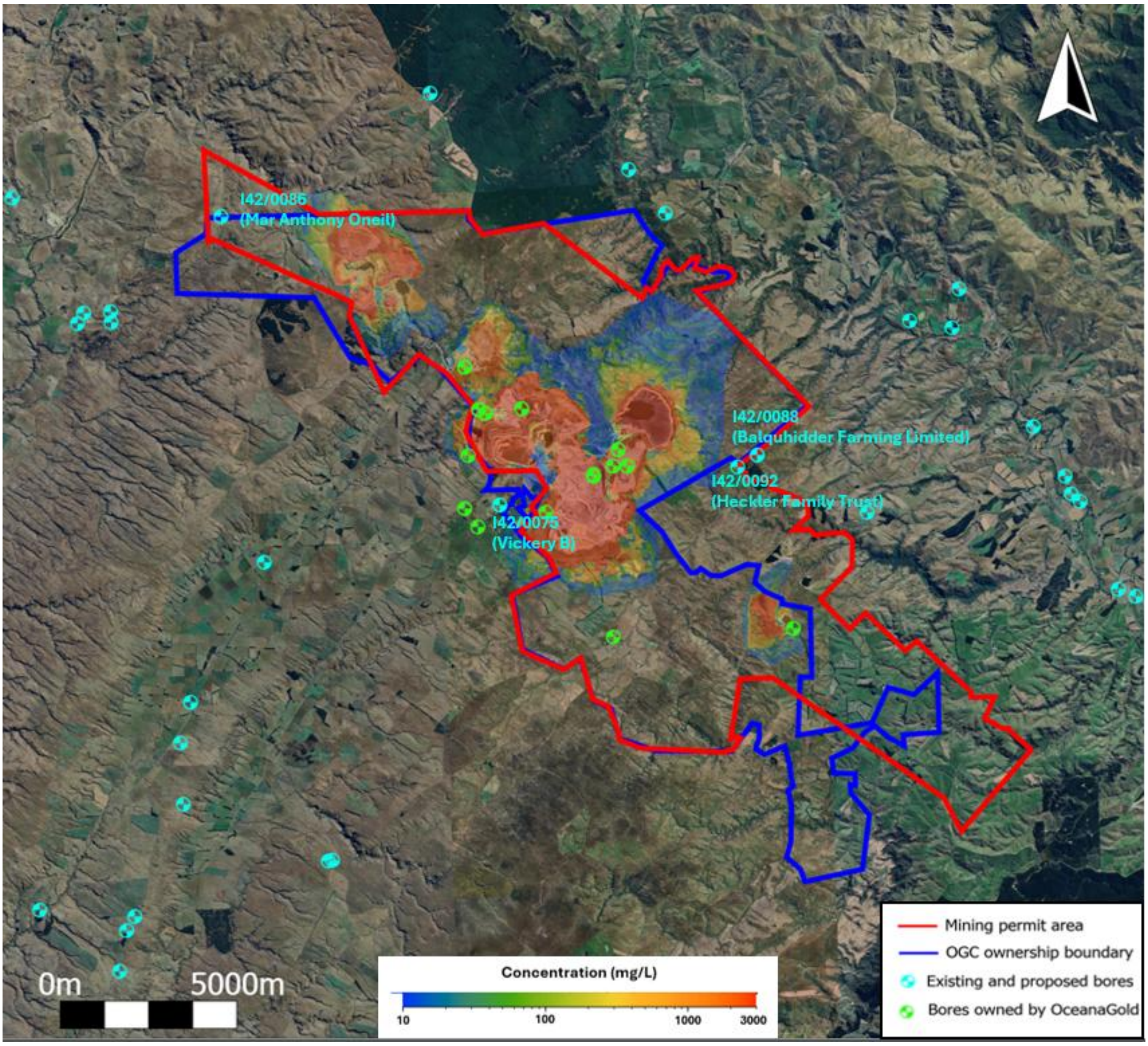


*Figure 5.46 Existing and proposed groundwater bores and maximum sulphate plume extent at the end of the recovery model (400 years of recovery)*

### 5.2.3.5 Brine Disposal Option - FRUG

As discussed in Appendix F of this report, water treatment considered for the site includes an active water treatment plant (WTP) operating through the mining period and into the future to treat water prior to discharge to the environment, reducing contaminant mass load discharges from the site. A two-stage water treatment process including pre-treatment through lime dosing and settling, followed by a reverse osmosis (RO) treatment process is proposed and detailed in Process Flow (2026a). A concentrated brine is generated as a by-product of the RO process that requires long term management. To assess a potential disposal option, density-dependent groundwater modelling was undertaken to evaluate the behaviour of brine injected into the FRUG workings.

The recovery model discussed above was adapted using the density-dependent transport modelling code MODFLOW USG-TRANSPORT to simulate the injection of a brine solution in the FRUG workings. The simulation represented brine injection through a well screened at approximately -260 m RL, near the deepest point of the FRUG workings. The density-dependent formulation was used to account for the higher density of the injected brine relative to the surrounding groundwater and to evaluate its long-term migration under post-closure groundwater recovery conditions. Brine with a relative concentration of 1 representing 100% brine and 0%

freshwater or other mine water was the only constituent modelled. Additional parameters and assumptions used for this modelling are detailed in Appendix C.

Figure 5.47, Figure 5.48 and Figure 5.49 show the predicted extent of the brine plume associated with disposal within FRUG after 400 years of continuous injection of 3.45 Ls of brine. For the purposes of this assessment, the plume was defined as the area containing relative brine concentrations between 1% (equivalent to 99% freshwater) and 100% (pure brine).

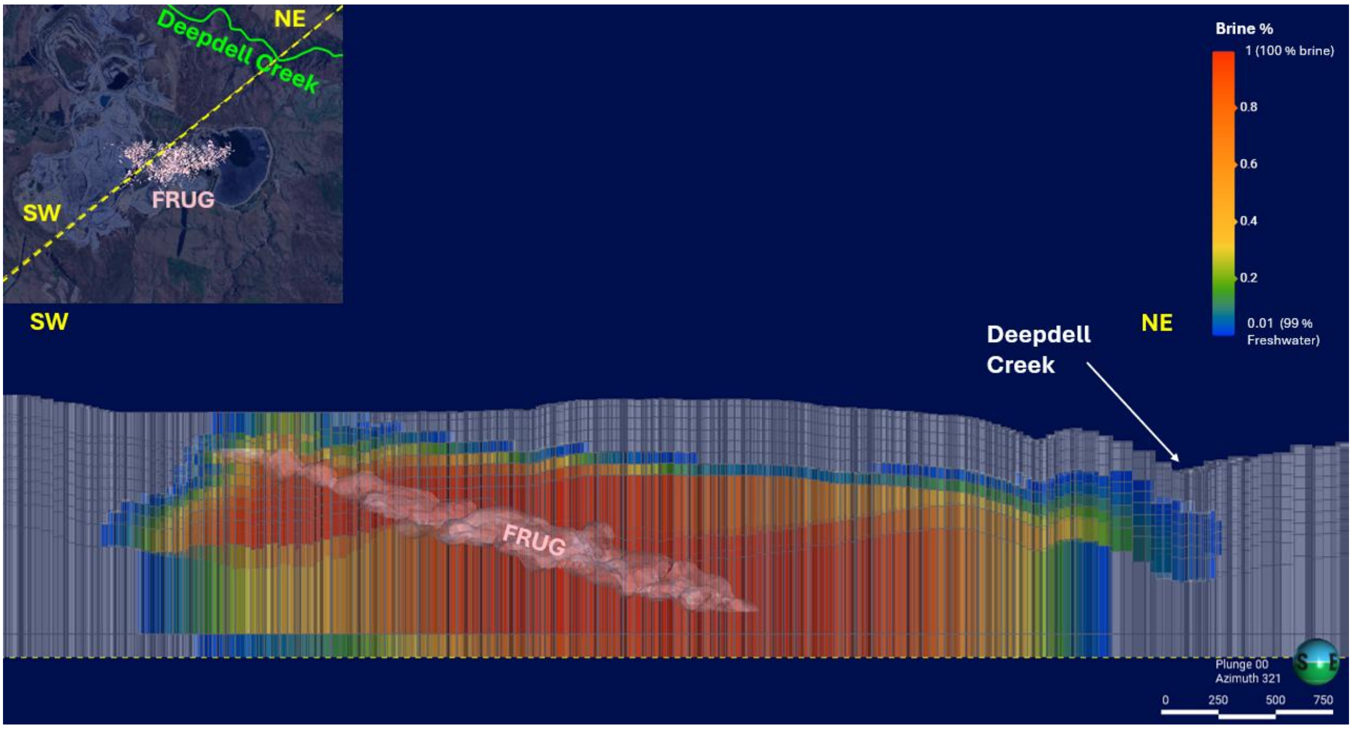


*Figure 5.47 Section view showing the predicted brine plume extent between FRUG and Deepdell Creek.*

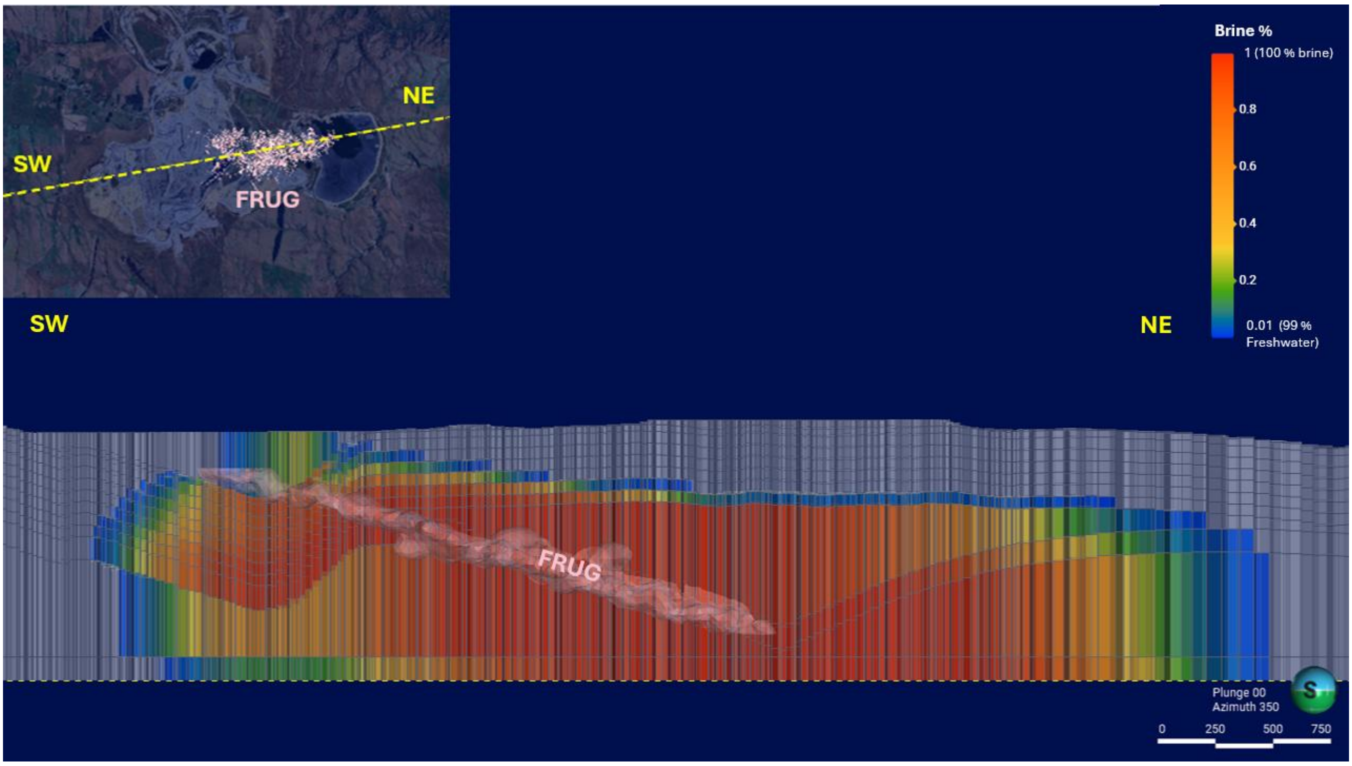


*Figure 5.48 Longitudinal section view showing the predicted brine plume extent along FRUG.*

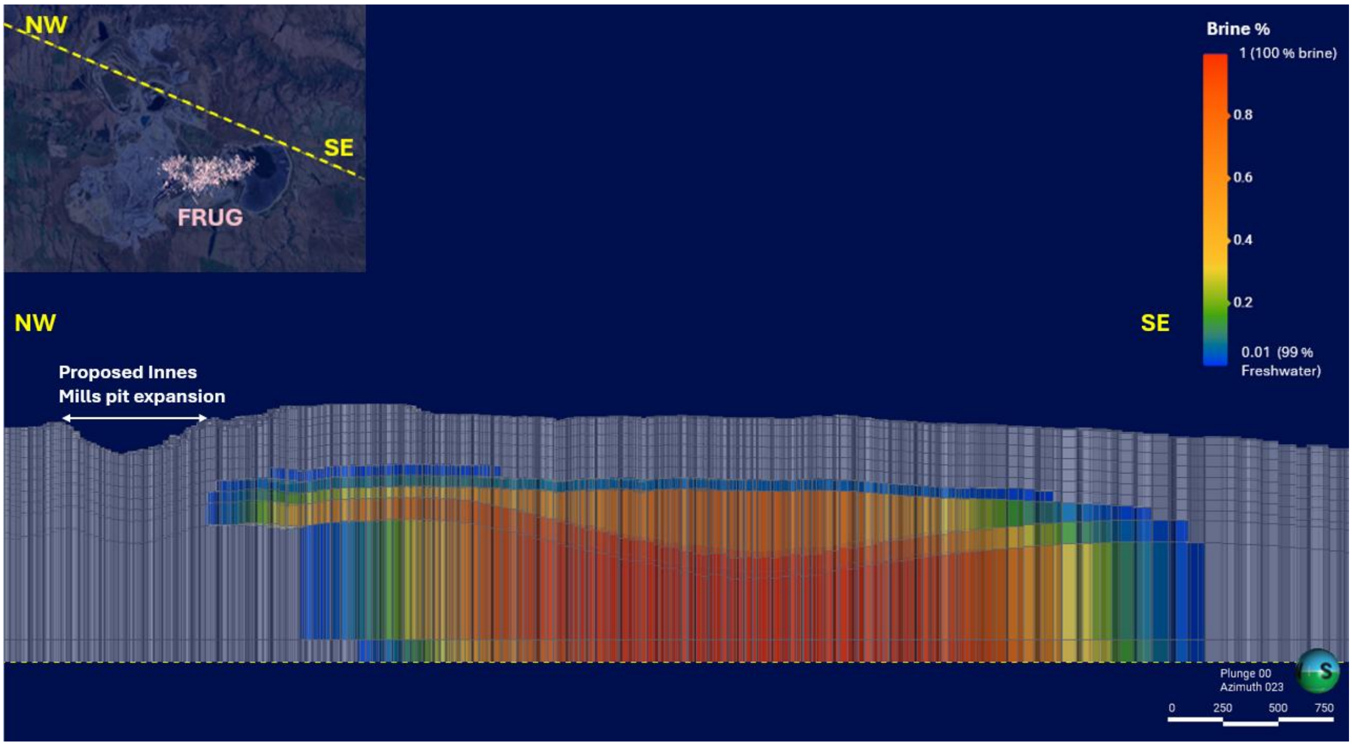


*Figure 5.49* ***Section view showing the predicted brine plume extent near the proposed Innes Mills Pit expansion.***

The model results indicate that the predicted plume extends approximately 5,000 m from southwest to northeast and approximately 4,700 m from north to south (Figure 5.50). Model results also indicate that the plume is not predicted to daylight at any major creeks and/or any tributary of these creeks. Instead, it is expected to remain at depth, approximately 65 m below the bed of Deepdell Creek and more than 260 m (Figure 5.47) below the streambed of Tipperary Creek.

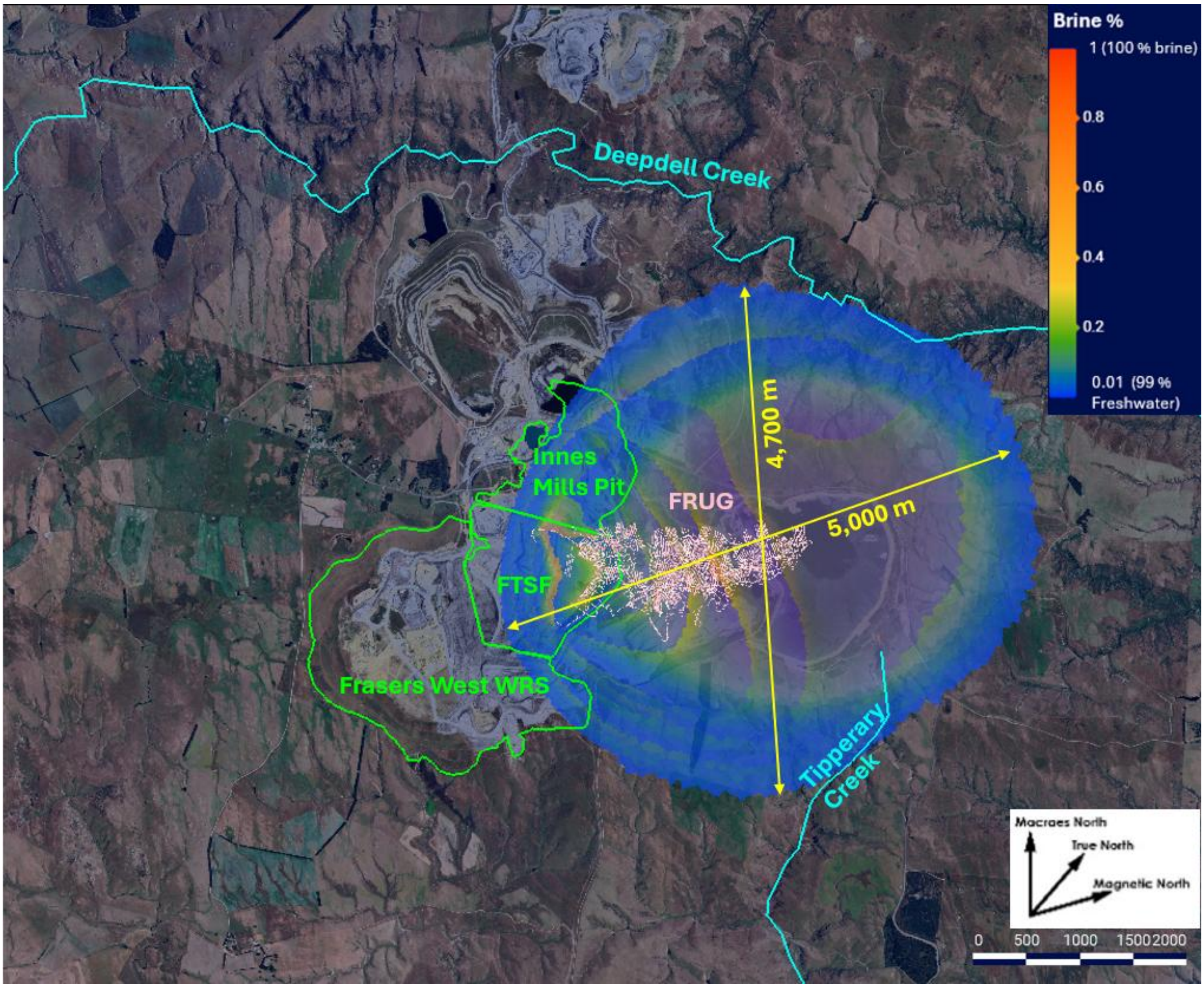


*Figure 5.50 Plan view showing the predicted brine plume extent.*

## 5.3 Targeted Seepage Modelling

Seepage modelling was undertaken using Geostudio 2025.1.1 SEEP/W finite element numerical modelling software for specific waste rock stack (WRS) areas. This section provides a summary of the detailed reporting presented in Appendix D.

### 5.3.1 Golden Point Assessment

Historic mine workings associated with the Golden Point Battery are present near Deepdell Creek. A significant proportion of the historic workings have been removed as the Golden Point and Round Hill pits were developed. However, some historic workings remain between Deepdell Creek and the Golden Point WRS, including adit shafts connecting the pit void and banks of the Deepdell Creek. Seepage has been observed discharging from one of these historic adits near Deepdell Creek. No recent monitoring data are available; however, observations by site staff, indicate that seepage occurs and/or increases when the Roundhill sump water level exceeds 347 m RL (for reference the Deepdell Creek is approximately 330-335 mRL adjacent to this area). Seepage rates have not been measured directly, but during a site visit in March 2024 GHD staff estimated the discharge to be approximately 1-2 L/s.

The Golden Point and Round Hill pit voids are an area of the mine that will receive poor quality mine water seeping from existing and proposed pit backfill material, existing embankments and seepage from the proposed Innes Mills Lake. Current operational practice is to dewater from the Round Hill sump (see Figure 5.51), to avoid seepage losses to Deepdell Creek via the historic adit. If left unmanaged post closure, mine affected water would seep through the adits to Deepdell Creek and degrade surface water quality.

Appendix D presents model set up and assumptions to test potential water management options in this area suitable for closure. In summary, it was found that plugging the adits or constructing low permeability barriers between the pit void and Deepdell Creek was unlikely to achieve the desired water management outcomes (i.e. reduce seepage flows and concentrations from Golden Point pit to Deepdell Creek). These methods could raise the groundwater levels within the pit backfill (reducing potential contaminant load generation) and reduce flows to Deepdell when compared to a do-nothing base case. However, the likely outcome would be undesirable contaminant fluxes through the in-situ schist wall. Moreover, performance monitoring of the system could be challenging with unknown outcomes at mine closure. The resulting mitigation measure is to install bore pumps through the Golden Point Backfill to capture seepage waters accumulating within the pit and maintain water levels such that flows through the adits are avoided long term. This system and management of the captured water is described in Appendix F and implemented in the WBM.

Aligning with this implemented mitigation measure, the Central Mining Area GWM includes dewatering drains at two locations within Golden Point Backfill (refer Section C-3.3, in Appendix C). In practice, this seepage capture system is likely to consist of up to four bores (a pair in each location) installed within the pit backfill to allow for operational contingency.

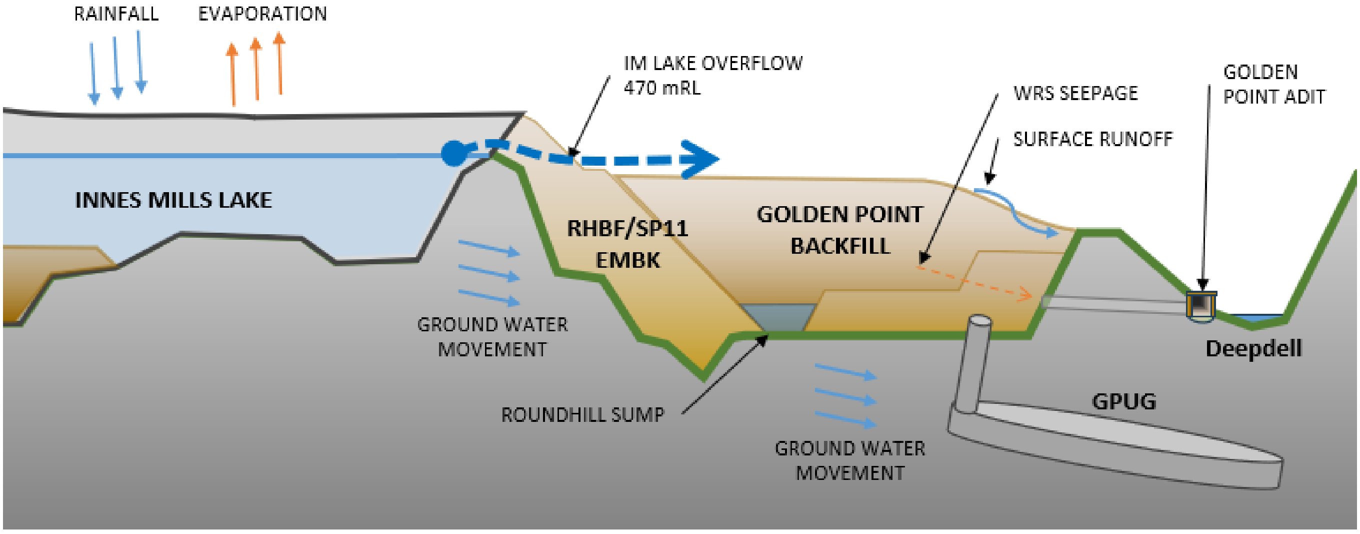


*Figure 5.51* ***Schematic of future scenario relating to seepage model area***

## 5.3.2 Frasers – Murphys Creek Assessment

Frasers South WRS is located to the south and east of Frasers Pit. Part of the WRS overlies a former channel of Murphys Creek. When this channel was backfilled, it is understood that the method of placement (end tipping) resulted in coarser material being concentrated in low points, such as the Murphys Creek channel. The proposed Frasers Tailing Storage Facility (FTSF) will have a tailings level above the invert of the Murphys Creek, therefore there is potential for seepage to preferentially follow the historical channel flow path, as conceptualised in Figure 5.52.

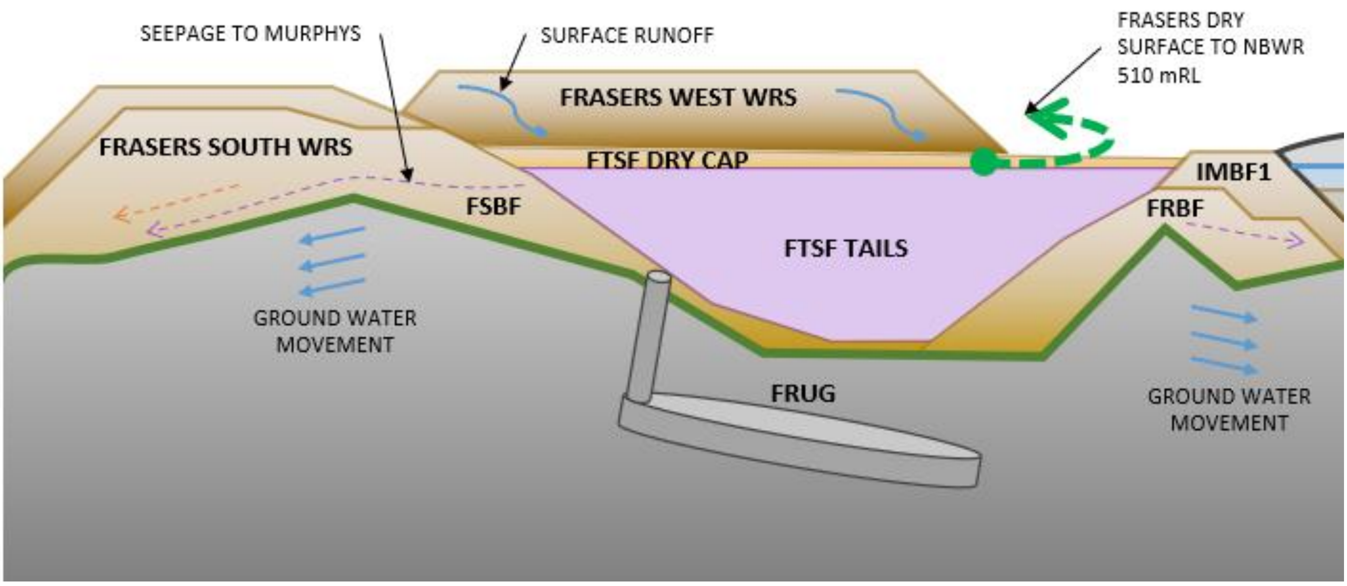


*Figure 5.52* ***Schematic of FTSF and seepage to Murphys Creek silt pond***

Seepage modelling has been undertaken along a transect from FTSF along the former Murphy Creek channel through the base of the Frasers South WRS. The transect, extending ~3 km, is not a linear cross section, but represents the low point beneath the waste rock stack to provide a conservative estimate seepage from the FTSF through the base of the waste rock stack. The intent of modelling is to estimate the seepage through this path only, seepage through the WRS from rainfall recharge is excluded from this assessment (and is captured separately within the site water balance model).

The modelling assumes fully saturated tailings to a level of 520 m RL at the end of tailings disposal. Over time it is expected that the saturation level will drop as the tailings drain (following capping), therefore three additional scenarios were modelled to simulate tailing saturation levels of 510, 500 and 495 m RL. Tailings seepage via the Murphys channel flow-path is expected to be negligible below a saturation level of ~490 m RL as the water level drops below the channel invert.

The results of the modelling are summarised in Table 5.3. The model flow rate, per metre, has been scaled by 100 m, representing the approximate width of the channel valley.

*Table 5.3 Seepage results summary - Murphys*

| Tailings saturation level | Seepage rate via Murphys Creek flow path |
|---|---|
| 520 m RL | 3.3 L/s |
| 510 m RL | 1.9 L/s |
| 500 m RL | 0.8 L/s |
| 495 m RL | 0.4 L/s |

### 5.3.3 Seepage Capture Drains

Seepage capture drains (SCD) are proposed to be installed at the toe of some WRSs to capture seepage generated from percolation through the WRS. The SCD will comprise a series of trenches connecting to collection sumps, intercepting WRS seepage before it enters surface water. Collected seepage will be pumped from the sumps to a water treatment facility or for use onsite within the mine water management system during operation. The concept design for the SCD is included in Macraes Phase 4 FTA Project. Engineered Seepage Capture Drain Concept Design Report, GHD (2026a), a typical cross section detail shown in Figure 5.53. The drains will comprise:

– Slotted drainage pipe connecting to a sump
– Trench filled with drainage aggregate (gravel)
– Low permeability cap/plug at the top of the trench to prevent surface water ingress

Seepage modelling was undertaken to simulate the SCD concept design and to assess alternative design scenarios. Modelling was undertaken at two representative locations:

– Coronation North WRS – representing a WRS located on a hilly area where surface runoff and seepage are directed towards incised channels; and
– Frasers West WRS – representing an area of moderate natural relief, adjacent to wetlands and surface water features.

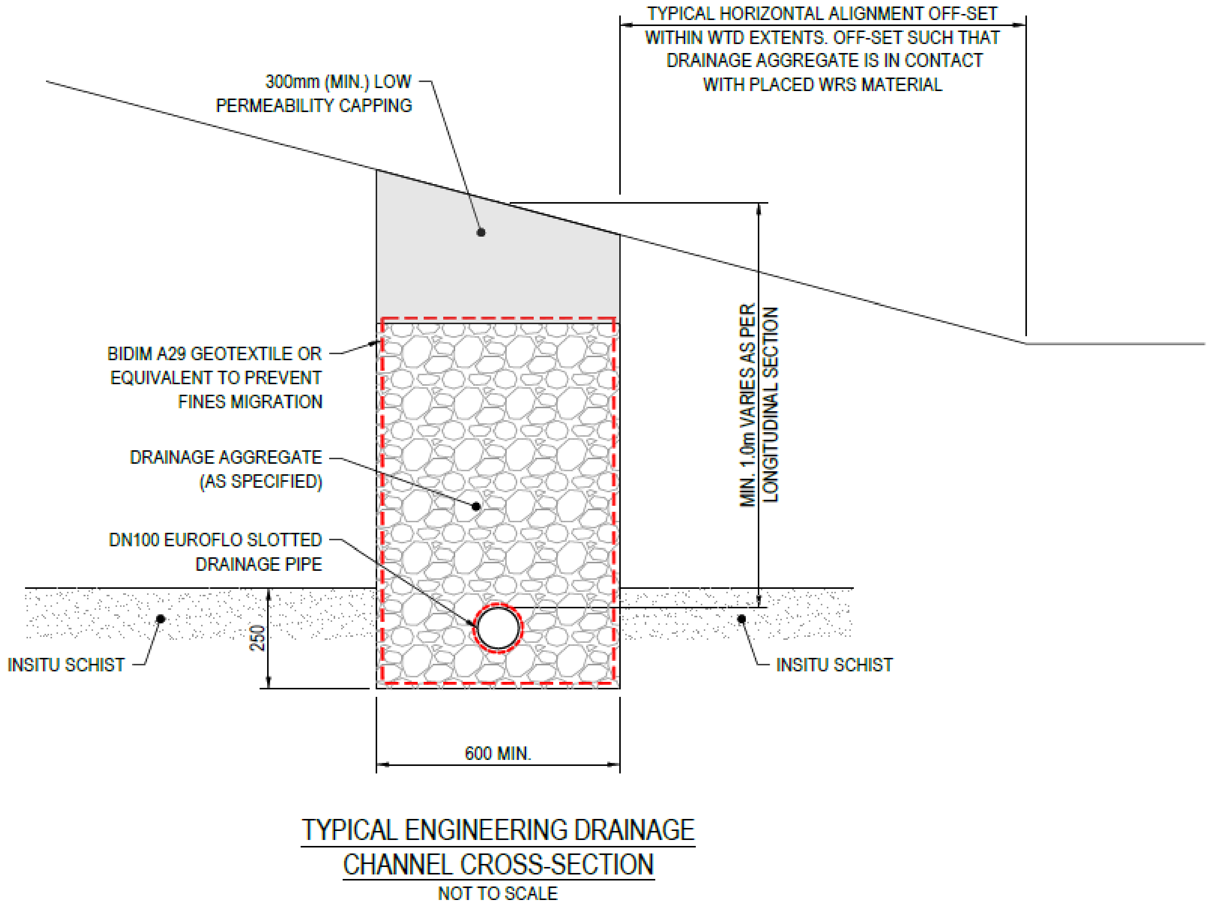


*Figure 5.53 Typical cross section detail of a seepage capture drain (GHD, 2026a)*

### 5.3.3.1 Coronation North WRS

The Coronation North WRS seepage modelling focussed on the depth of the SCD and the general positioning of the drain in relation to the WRS. The following scenarios were modelled:

– SCD installed within (under) the WRS footprint – depths: 1 m, 2 m, 3 m and 4 m
– SCD installed at toe of the WRS – depths: 2 m and 4 m

The modelling indicates that the position of the seepage capture drain within the WRS footprint is important to reduce the risk of seepage breakout. The model simulated seepage breakout from the WRS when the drain is positioned at the toe of the WRS. In contrast, where the seepage capture drain was installed within the WRS footprint, with waste rock excavated and then backfilled above the drain (Figure 5.53), it did not result in seepage breakout. These results indicate that installing the drain within the WRS footprint generally provides a more effective seepage control configuration than positioning the drain at the toe. Specific site investigations will be required to confirm vertical and horizontal alignment to meet the design intentions.

Although the modelled flow rates did not vary significantly between the different drain-depth scenarios, the deeper drain configurations resulted in lower groundwater levels at the base of the WRS. In contrast, the 1 m drain scenario produced a groundwater level closer to the ground surface, indicating a greater potential for seepage breakout. On that basis, it is recommended that SCD are either installed at least 1.5 m below ground level (and excavated into the underlying schist) or installed further back into the WRS footprint.

The flow paths function of SEEP/W was used to track the path of a drop of water falling on the WRS as rainfall through the WRS and into groundwater. The majority of flow paths terminated in the SCD indicating that the drains are effective at intercepting seepage from the WRS. However, the model did show some flow paths entering the underlying groundwater system within the schist bedrock. These effects are modelled in the Coronation mining area 3D groundwater model (Appendix B).

#### 5.3.3.2 Frasers West WRS

Wetland areas at the base of the Frasers West WRS have developed following placement of the WRS and are likely to be fed by seepage from the WRS toe. Seepage models were developed along a transect extending from the Frasers West WRS northwards across a valley (including toe seepage/ wetlands) and a tributary of the North Branch of the Waikouaiti River. One existing-conditions scenario and five future scenarios were modelled:

– Base case - SCD installed – depth of 2 m, 3 m and 4 m
– Higher permeability topsoil layer (on valley floor) – SCD installed at depths of 2 m, 3 m and 4 m
– Higher water level in WRS – SCD installed at depths of 2 m, 3 m and 4 m
– Low permeability liner installed on valley side of SCD trench –SCD installed at depths of 2 m, 3 m and 4 m
– SCD with liner and high permeability topsoil – SCD installed at depths of 2 m, 3 m and 4 m

Although modelling results indicate that the proposed SCD are effective at intercepting seepage from the WRS, a portion of the seepage is likely to flow through groundwater toward the North Branch Waikouaiti River channel and/or through deeper groundwater flow paths. Most of the modelled scenarios simulate ponding of water at surface interpreted as diffuse seepage expression at the ground surface. Although the modelled depth of ponding is lower than under the existing conditions scenario, the results suggest minor seepage at the WRS toe. In some scenarios, the ponding was limited to surface depressions or former channels.

In summary the modelling indicates:

– The difference in flow rate between the 2, 3 and 4 m deep SCD is small as the main inflow is via the connection to the WRS at the top of the drain. However, the modelling results indicate that the groundwater drawdown is greater with a deeper SCD. The modelled extent and depth of surface ponding is less with a deeper SCD due to the lower groundwater level.
– The models include a upgradient constant head boundary representing a WRS saturated thickness of 1 m (ie groundwater level is 1 m above the top of the schist). If the groundwater level is higher (Scenario 4) flow rates are expected to be higher than modelled in the base case scenario.
– Scenarios 5 and 6 included a low permeability liner on the downgradient side of the SCD. The presence of a liner had little effect on flow rates and groundwater levels, as a result of the already low hydraulic conductivity of the surrounding schist. It is understood that topsoil is removed prior to placement of the WRS. However, if the SCD was installed (or partially installed) within more permeable topsoil or alluvium, a liner may be required to reduce groundwater ingress from the valley alluvium into the SCD.

## 5.4 Groundwater Assessment summary

Three 3D numerical groundwater flow models have been set up for the Macraes site one for the Golden Bar area, one for Coronation area and one for the Central Area. The models were developed to represent the current conceptual understanding of the groundwater system and to assess the potential groundwater effects associated with the proposed expansions of the open pits and underground workings. The modelling incorporated interactions between existing mine voids, proposed pit expansions, waste rock storage areas, tailings facilities and groundwater systems to provide a cumulative assessment of groundwater effects.

The assessment considered existing groundwater conditions, groundwater inflows during the proposed dewatering period, the potential effects of pit and underground workings dewatering on groundwater contributions to nearby surface water features, post-mining groundwater recovery over a 400-year period, and contaminant (sulphate) transport from the pits and associated WRSs source areas.

Groundwater modelling results indicate that the extent of groundwater effects from dewatering of the proposed pits and underground working extensions is generally localised around the mining areas. Modelled groundwater inflows and drawdown extent around the proposed mining areas are summarised in Table 5.4.

*Table 5.4 Summary of modelled dewatering rates and groundwater level drawdown*

| Mining feature extensions - Dewatering | Groundwater Inflows | Extent of modelled drawdown (<1m) from the extension of pit |
|---|---|---|
| **Golden Bar Mining Area**<br>**Golden Bar pit** | 1.4 L/s at the start of dewatering to 0.7 L/s toward the end of the 6-year dewatering period | 800 m north, 500 m west,<br>700 m east and 500 m south |
| **Coronation Mining Area:**<br>Coronation pit<br><br>Coronation North pit | 7.3 L/s at the start of dewatering to approximately 2.4 L/s towards the end of the 7-year dewatering period<br><br>10.5 L/s at the start of dewatering to approximately 6.4 L/s towards the end of the 10-year dewatering period | 1,000 m to the northwest,<br>850 m to the northeast,<br>800 m to the southwest, and<br>700 m to the southeast |
| **Central Mining Area:**<br>Innes Mills Pit<br><br>GPUG | 12 L/s to a minimum of around 2.6 L/s at year 6, then rise to approximately 14.6 L/s by year 11.<br><br>196 L/s at the start of dewatering to approximately 22 L/s towards the end of the 11-year dewatering period | 3,900 m to the northeast<br>1,500 m to the west<br>2,500 m to the east |

Modelling results indicate that dewatering for the proposed pit and underground workings extensions will reduce groundwater discharge to some local streams and creeks; however, these reductions are expected to represent a relatively small proportion of the total groundwater contribution to stream flows for the majority of the creeks.

A summary of the results representing changes to the groundwater component of flow only discharging to surface water is presented in Table 5.5 and in Table 5.6.

*Table 5.5 Summary of groundwater discharge rate changes to surface water for Golden Bar and Coronation Mining Areas*

| Dewatering | Reduction in groundwater discharge to McCormicks Creek | Reduction in groundwater discharge to Murphys Creek | Reduction in groundwater discharge to Mare Burn | Reduction in groundwater discharge to Deepdell Creek |
|---|---|---|---|---|
| Golden Bar Pit extension | ~0.15 L/s<br>decrease of less than 0.5% | ~0.1 L/s,<br>*increase of ~ 0.2% | | |
| Coronation Pit and Coronation North Pit extensions | | | ~1 L/s<br>*increase of ~ 3% | 0.6 L/s<br>decrease ~ 2% |
| Notes | *Attributed to the expanded WRSs footprints that have been modelled with a higher recharge rate | | | |

*Table 5.6 Summary of groundwater discharge rate changes to surface water for Central Mining Area*

| Dewatering | Deepdell Creek (DC08) | NBWRRF (Waikouaiti River North Branch - Ross Road Ford) | Murphys and Golden Bar Creek | Tipperary Creek | Shag River |
|---|---|---|---|---|---|
| Innes Mills Pit and GPUG extensions | 1.5 L/s<br>3.4% decrease | 0.1 L/s<br><0.5% decrease | 0.2 L/s<br>0.6% increase* | 0.1 L/s<br><0.5% decrease | 0.1 L/s<br><0.5% decrease |
| Notes | *Associated with the water level increase in FRUG and in the proposed Frasers Tailings structure | | | | |

Groundwater modelling results indicate that groundwater drawdown associated with current and proposed mining activities is predicted to remain largely confined to areas close to the existing and proposed pit extensions and underground workings (Figure 5.31 and Figure 5.32). On this basis, adverse effects on groundwater levels in non-OGL groundwater bores are considered unlikely.

Following completion of mining, groundwater recovery was simulated for a period of 400 years using pit lake levels derived from the surface water balance modelling (pit lake filling curves). Modelling results indicate that groundwater levels will progressively recover after cessation of dewatering and pit lake formation. However, local groundwater levels and flow patterns are expected to remain influenced by the post-closure landforms, including pit lakes acting as groundwater “sinks”, backfilled voids, TSFs and WRSs.

Contaminant transport modelling was undertaken using sulphate as the primary contaminant indicator because it is expected to occur at elevated concentrations, is already present in some receiving waters due to historic mining activities, and has limited attenuation potential within the groundwater system. The contaminant transport modelling forms part of an integrated groundwater–surface water assessment, where groundwater-derived contaminant fluxes are used as inputs to the receiving water quality models.

Modelling results indicate that sulphate plumes are generally constrained by the relatively low-permeability schist groundwater system and tend to migrate through the weathered and fractured schist and near-surface groundwater pathways toward local receiving environments, mine water management infrastructure, seepage capture systems, silt ponds and pit lakes. During dewatering, plume migration is influenced by local drawdown around the active pits and underground workings, with drawdown and associated transport effects generally limited to areas relatively close to the proposed mining extensions.

Modelled sulphate fluxes from the groundwater transport models were subsequently used as inputs to the surface water quality model. During recovery, plume migration continues over long timescales, but the results do not indicate widespread expansion of contaminant plumes beyond the modelled local receiving catchments. Existing consented groundwater takes, existing bores and proposed bores were reviewed against the maximum predicted extent of the modelled sulphate plume. This review indicates that these groundwater receptors are not expected to be intersected by the predicted plume extent, and adverse effects on groundwater users are therefore considered unlikely. Overall, the contaminant transport results provide a relatively conservative basis for assessing long-term groundwater-to-surface-water contaminant contributions and for informing mitigation, monitoring and adaptive management requirements.

Targeted seepage modelling was undertaken to supplement the regional-scale groundwater flow and transport models where more localised assessment of seepage pathways and mitigation performance was required. The targeted assessments focus on seepage from the Golden Point area, seepage pathways from the Frasers area toward Murphys Creek, and the performance of proposed seepage capture drains associated with key waste rock stack areas. Modelling results indicate that seepage generated from the assessed waste rock stack and backfill areas is expected to move predominantly through shallow, weathered schist and near-surface flow pathways before reporting to existing mine water management infrastructure, silt ponds, seepage capture drains, or local surface water receiving environments. The targeted modelling supports the inclusion of seepage capture drains and related water management measures as important controls for reducing uncaptured seepage and contaminant mass reporting to Deepdell Creek, Murphys Creek, and the wider receiving water environment.

A density-dependent brine transport assessment was undertaken to simulate the injection of a brine solution near the base of the FRUG within the groundwater recovery modelling framework. Modelling results indicate that the predicted plume remains at depth and is not expected to daylight at any major river and/or any tributary of these rivers. The predicted brine plume extends approximately 5,000 m from southwest to northeast and approximately 4,700 m from north to south, remaining approximately 65 m below the bed of Deepdell Creek and more than 260 m below the bed of Tipperary Creek. These results indicate that the injected brine is expected to remain within deeper groundwater pathways and is unlikely to directly intersect major surface-water receptors.

The proposed Camp Creek and Coal Creek augmentation dams have not been explicitly represented in the dewatering or groundwater recovery model runs. These dams are intended to provide augmentation flows to Deepdell Creek and the Mare Burn catchments, respectively, during low-flow periods, when receiving-water dilution capacity is reduced and the potential influence of uncaptured seepage on water quality compliance is greatest. Their proposed operation is described in Appendix F. As the dams function primarily as surface-water flow augmentation measures, rather than controls on groundwater flow or contaminant transport, their inclusion in the groundwater model would not be expected to materially alter the predicted extent of groundwater plumes or the estimated groundwater contributions to receiving streams. Their principal effect is instead represented within the receiving water quality assessment, through increased dilution and improved compliance resilience during critical low-flow conditions.

Climate change has not been explicitly included in the groundwater recovery simulations, and the groundwater predictions should be regarded as baseline-condition estimates subject to climate-related uncertainty. The projected shift toward wetter winters, drier summers and more episodic heavy-rainfall events may alter the temporal distribution of recharge. This implies that groundwater recharge may become more seasonally concentrated and episodic, rather than changing uniformly through time (WDC, 2023). Applying eastern Otago climatic drivers using the national methodology of Mourot et al. (2022) indicates that the mean rainfall-recharge response for Otago is relatively small; however, the direction and magnitude of change are uncertain, with projected changes spanning approximately ±0.4 mm/day.  Therefore, although there may be some potential implications for seasonal groundwater levels and groundwater contributions to streams these effects are expected to be most relevant to the timing and variability of groundwater discharge, rather than to the overall direction of groundwater flow or the broad spatial extent of modelled plumes. Considering the low-permeability nature of the Macraes schist groundwater system and the relatively small but uncertain mean recharge response indicated by regional climate-recharge assessments, the groundwater-related results remain suitable for assessing long-term groundwater recovery and plume behaviour, provided they are interpreted with recognition that future recharge may become more episodic and seasonally variable than represented in the model.

In conclusion predicted groundwater drawdown effects are generally localised around the proposed mining areas, groundwater inflows are moderate and manageable, and post-mining groundwater recovery is expected to occur over time as pit lakes develop and the groundwater system re-establishes equilibrium. Long-term contaminant transport requires ongoing consideration within the broader mine water monitoring and management framework.

# 6. Surface Water Modelling

Surface water modelling has been undertaken to estimate future impacts on receiving surface water quality as a consequence of the project and to assess compliance against the recommended surface water quality criteria as outlined in Viridis (2026). Proposed mitigation measures have been incorporated as appropriate, with many of the proposed mitigation measures (as outlined in detail in Appendix F) a result of early model iterations which showed elevated and unacceptable risk (in terms of compliance against the proposed standards). The surface water model has enabled the conceptual testing of various scenarios to determine if the proposed mitigation measures are both beneficial (in terms of reducing modelled risk) while also considering the practical nature of their implementation and operation. The model is deliberately structured so that where uncertainty exists in the input data, a conservative approach is applied. The nature of the model therefore deliberately combines uncertainty (and hence conservatism) in a manner that highlights the key areas of remaining risk rather than mask them.

## 6.1 Global Inputs / Modelling Approach

### 6.1.1 Model Introduction

GHD have previously developed the site wide water balance model (WBM) for OGNZL operations at the Macraes Gold Mine. The WBM has been carried out using the GoldSim software package which is designed to run Monte Carlo simulations for probabilistic analysis of dynamic systems (refer to **www.goldsim.com**). Over time this WBM has been developed and updated to incorporate subsequent site changes, additional monitoring data and to assess surface water quality impacts of specific projects at Macraes with the results utilised to support the consenting of the specific projects. This work has been previously documented in the following GHD documents:

- GHD 2020. GPUG Cumulative Effects Assessments. Report prepared for Oceana Gold (New Zealand) Ltd
- GHD 2021. TTTSF Crest Raise. [RL 560-568 m RL] Surface and Groundwater Assessment. Report prepared for Oceana Gold (New Zealand) Ltd
- GHD 2022a. TTTSF Crest raise. [RL 568-570 m RL] Surface Water and Groundwater Assessment. Report prepared for Oceana Gold (New Zealand) Ltd.
- GHD 2022b. Frasers Co-disposal Surface Water and Groundwater Assessment. Report prepared for Oceana Gold (New Zealand) Ltd, 10 November 2022.
- GHD 2023a. Golden Point Underground Extension ‐ Analytical Assessment of Effect on Deepdell Creek. P. Prepared for Oceana Gold (New Zealand) Ltd, 12 October 2023
- GHD 2023b. Continuity Consent Project (CCP). Surface and Groundwater Assessment. Report prepared for Oceana Gold (New Zealand) Ltd, 04 December 2023.
- GHD (2024a). Macraes Phase IV. Coronation – Surface and Groundwater Assessment
- GHD (2024b). Macraes Phase IV. Golden Bar – Surface and Groundwater Assessment
- GHD (2024c). Macraes Phase IV. Stage 3 – Surface and Groundwater Assessment

The construction, calibration, and input data of the current Goldsim WBM are documented throughout the above assessments and detailed in Appendix E.

Key updates to the WBM which have been implemented for the Macraes Phase 4 FTA project include:

- Revised catchment boundaries and landforms to reflect both the current and future developments of site.
- Revised WRS seepage quantity and quality estimates.
- Revised uncaptured seepage estimates from groundwater modelling as defined in Section 5 of this report
- Revised Pit Lake water quality estimates.
- Recalibration of model utilising updated flow and water quality monitoring data.

– Revised Pit Lake groundwater interactions within the pits based on inflow/outflow relationships presented in Section 5 of this report.

### 6.1.2 Water Quality and Flow Mitigation Measures

Proposed mitigation measures are outlined in detail in Appendix F.

The measures include physical infrastructure and management practices to be implemented, and mine design refinements that have been made through project refinement for the purpose of reducing long-term water management risks. The measures can be broadly grouped into the following categories:

– Monitoring
– Cover Systems
– Low flow augmentation
– Seepage Capture
– Water Treatment

The proposed implementation timeline is outlined in Figure 6.1 and requires improved monitoring of surface water and groundwater to be implemented during the early phases of the project, along with detailed design and construction of physical water management features to take place including:

– Construction of seepage capture drains and toe bunds,
– Implementation of a water treatment plant,
– Construction of the Camp Creek and Coal Creek augmentation dams,
– Improvements to current and future WRS construction methodology and management practices to minimise infiltration rates,
– Ongoing monitoring and water treatment of pit lakes through ferric chloride dosing for managing arsenic and dissolved metals concentrations, and
– Implementation of a flushing regime (where indicated by periphyton monitoring programs).

The implementation timeline also indicates the assessment phases applied for surface water modelling, these are described further in Section 6.3.1.

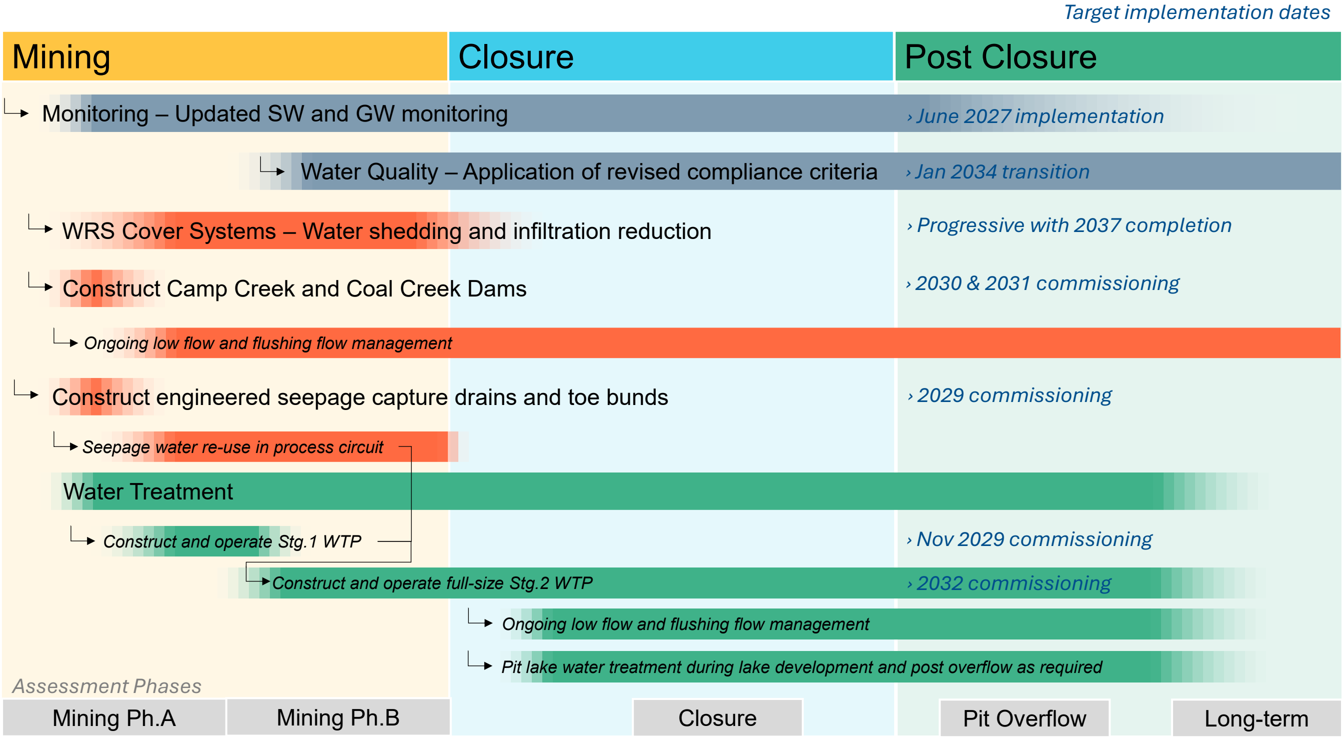


*Figure 6.1 Water quality and flow mitigations implementation timeline*

The proposed mitigation measures are included within the WBM (where applicable) with the commissioning and implementation broadly defined by phase in Figure 6.1. The dates aligning to the defined reporting assessment phases are outlined in Table 6.1.

## 6.1.3 Groundwater Model and Surface Water Model Interactions

### 6.1.3.1 Pit inflow/outflows

Groundwater inflows and outflows from the recovering pit lakes are calculated within the Groundwater model based on a series of assumed recovering pit lake water levels. These inflows and outflows are utilised in the WBM to inform the timeframe for pit water recovery and to inform the relative proportion of different water sources (both inputs and outputs) during the recovery phase. The WBM predicted recovery curve is then utilised within the groundwater model to provide head values for the applied boundary conditions over time.

### 6.1.3.2 Surface water drawdown

Surface water drawdown is predicted within the groundwater models as a result of dewatering and summarised in Table 5.5 and Table 5.6. These decreases are not specifically applied to the WBM as the modelled reductions are expected to represent a relatively small proportion of the total groundwater contribution to stream flows. Once more, the groundwater model is based on average climatic conditions. Therefore, applying the modelled predicted surface water drawdown against low flow conditions within the WBM is considered overly conservative.

### 6.1.3.3 Captured and Uncaptured Seepage mass

Captured and uncaptured seepage mass is estimated within the groundwater contaminant transport models. This mass is compared to the WBM generated seepage mass with the comparison detailed in Appendix F. There is generally a close relationship between the estimated masses within both models, with generally higher mass discharge represented in the WBM. This higher mass representation in the WBM is attributed to the groundwater model representing the storativity of contaminants in the ground as the plume develops (ie. a portion of the total basal flow is buffered in this storage and will not be represented in the groundwater model mass discharge calculation) and increased WRS surface area representation within the WBM in some cases (ie. some surface catchments are assumed to shed water towards the WRS increasing potential seepage flow through the WRS). Overall, the WBM is considered a conservative representative of seepage mass discharge to both captured locations (silt ponds and seepage collection drains) and uncaptured locations (the receiving surface water environment).

# 6.2 Pit Lake Development

Details on the modelling and results for all site pit lakes are outlined in Appendix G.

The WBM has been applied to estimate filling rates and cumulative water inflows and outflows for the Golden Bar, Coronation, Coronation North and Innes Mills Pit Lakes. Long-term equilibrium levels for each Pit Lake have been estimated, with each filling curve showing the minimum, 5$^{th}$ percentile, 25$^{th}$ percentile, mean, median, 75$^{th}$ percentile, 95$^{th}$ percentile and maximum modelled lake levels. Modelled predicted inflows and outflows are provided on an annualised mean basis. The filling curves and annualised inflows (broken down by source) are provided here in summary.

## 6.2.1 Golden Bar Pit

The modelled pit lake filling curve and the modelled annualised water inflows for the Golden Bar Pit are presented in Figure 6.2 and Figure 6.3 respectively. The pit level recovery commences in 2034 and a median filling time of 58 years is modelled, reaching the overflow at 500 mRL in approximately 2091.

The corresponding annualised water balance shows total runoff is highest initially where lake levels are low and pit wall area (which contributes to the runoff) is relatively large. As the lake level rises, the proportion of direct rainfall increases as the pit walls are saturated and runoff decreases. WRS seepage and groundwater make up a much smaller proportion of the total inflow. Groundwater inflows are highest at lower pit lake levels before reducing and remaining relatively constant before and after the pit lake reaches the overflow level. Evaporation is the dominant outflow during pit lake filling until the overflow level is reached.

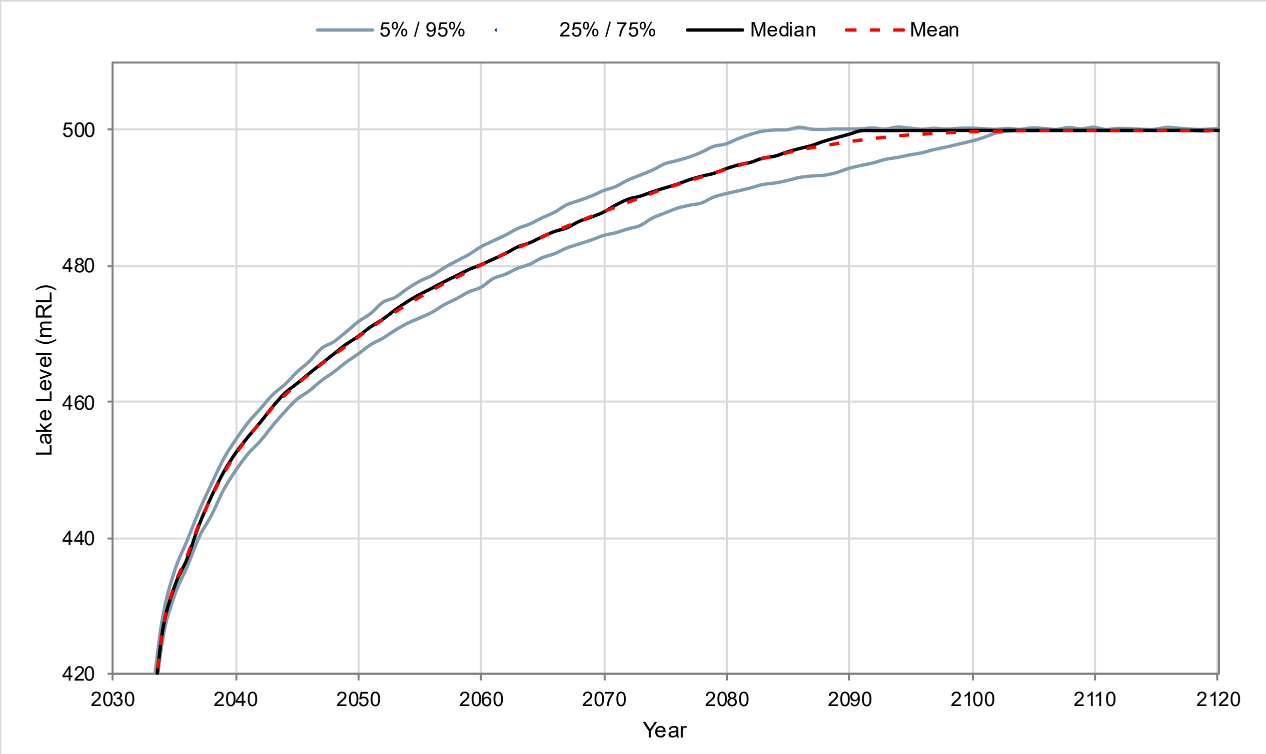


*Figure 6.2* ***Golden Bar Pit Lake filling curve***

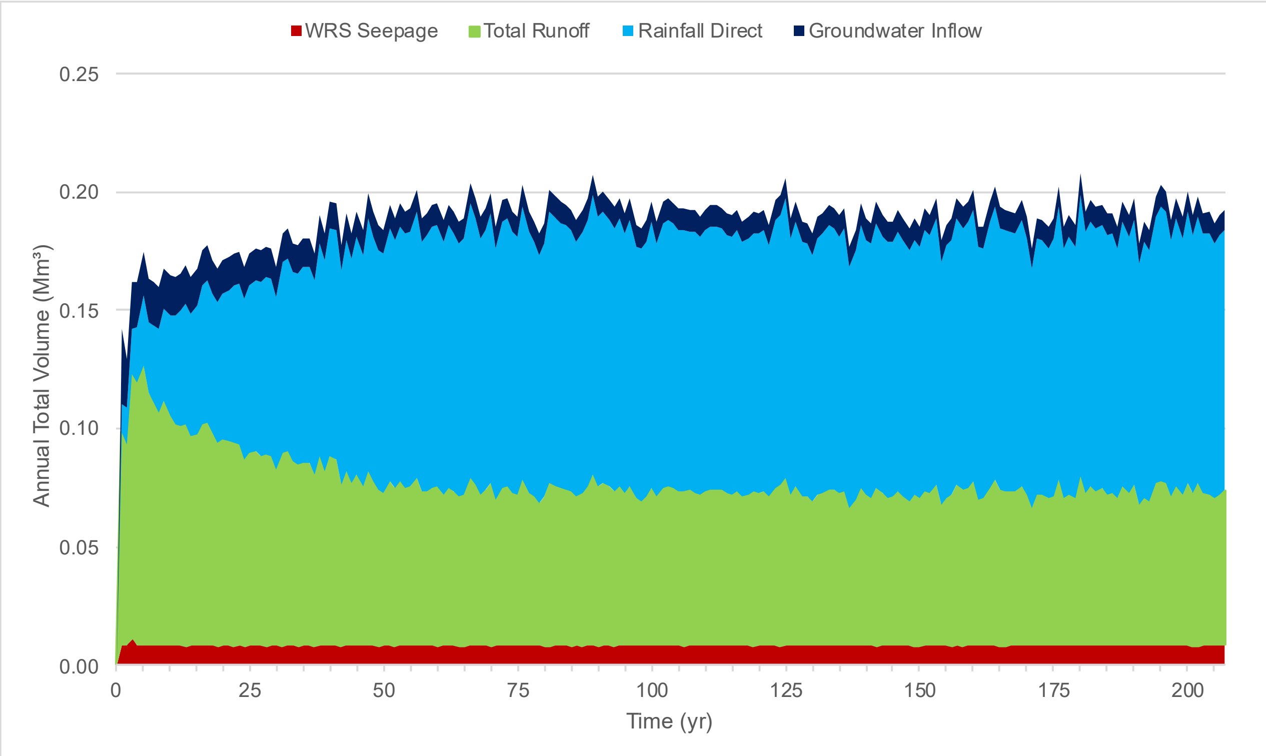


*Figure 6.3* ***Golden Bar Pit annualised water inflows***

## 6.2.2 Coronation Pit

The modelled pit lake filling curve and the modelled annualised water inflows for the Coronation Pit are presented in Figure 6.4 and Figure 6.5 respectively. The pit water level initially rises rapidly through the backfill, occupying available void space before the fill rate begins to slow at 595 mRL as groundwater inflow rates reduce. At 620 mRL the pit lake level rises above the backfill which corresponds to the sharp increase in pit lake surface area. The filling slows over the last 5 m due to the large volume available and greater surface area for evaporative losses. The median fill time is 23 years reaching the overflow at 625 mRL in approximately 2055.

The corresponding annualised water balance shows initially inflows are high except for direct rainfall as there is no visible lake surface over the backfill material other than localised ponding. When the pit lake rises above the level of the backfill, a sharp increase in rainfall and drop-off in runoff is noted as the pit lake begins to form. Note that modelling does not include coronation backfill (COBF) being in place immediately following cessation of dewatering; the initial steep rise in seepage inflows is attributed to the addition of the backfill. Evaporation is the dominant outflow once the pit lake has formed until the overflow level is reached.

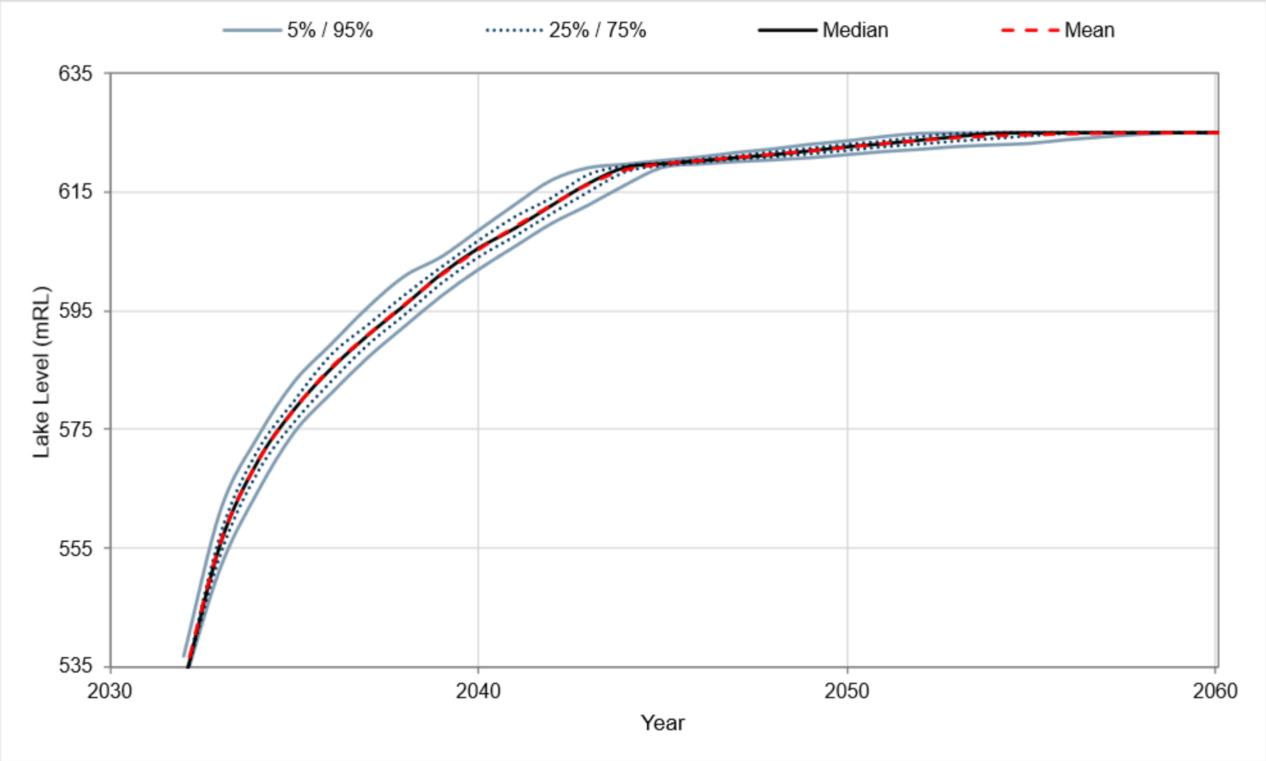


***Figure 6.4 Coronation Pit Lake filling curve***

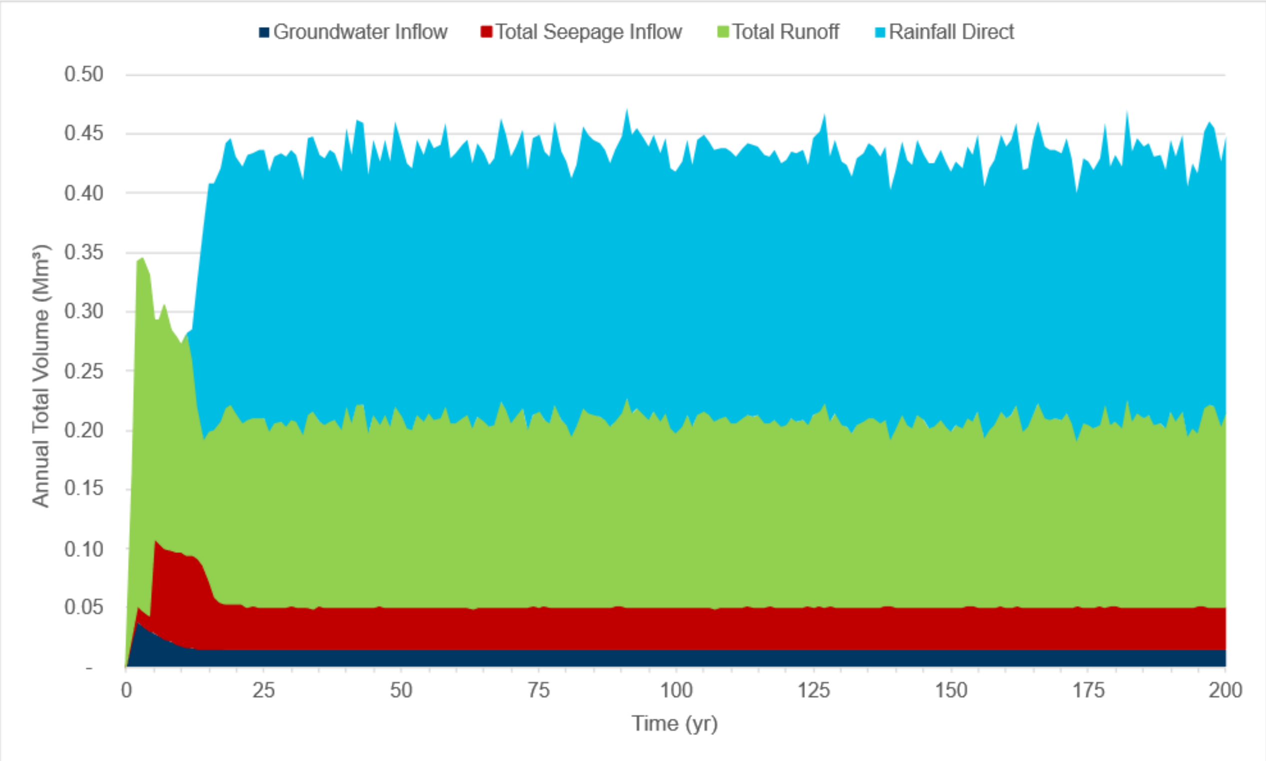


***Figure 6.5 Coronation Pit annualised water inflows***

## 6.2.3 Coronation North Pit

The modelled pit lake filling curve and the modelled annualised water inflows for the Coronation North Pit are presented in Figure 6.6 and Figure 6.7 respectively. The WBM estimates a median filling time of approximately 64 years, reaching the overflow level of 562.5 mRL in 2099.

The corresponding annualised water balance shows total runoff inflows are high before the pit lake surface develops. As the pit lake level rises, direct rainfall inflows increase with the larger surface area before stabilising at the maximum pit lake level. Evaporation is the dominant outflow until the overflow level is reached.

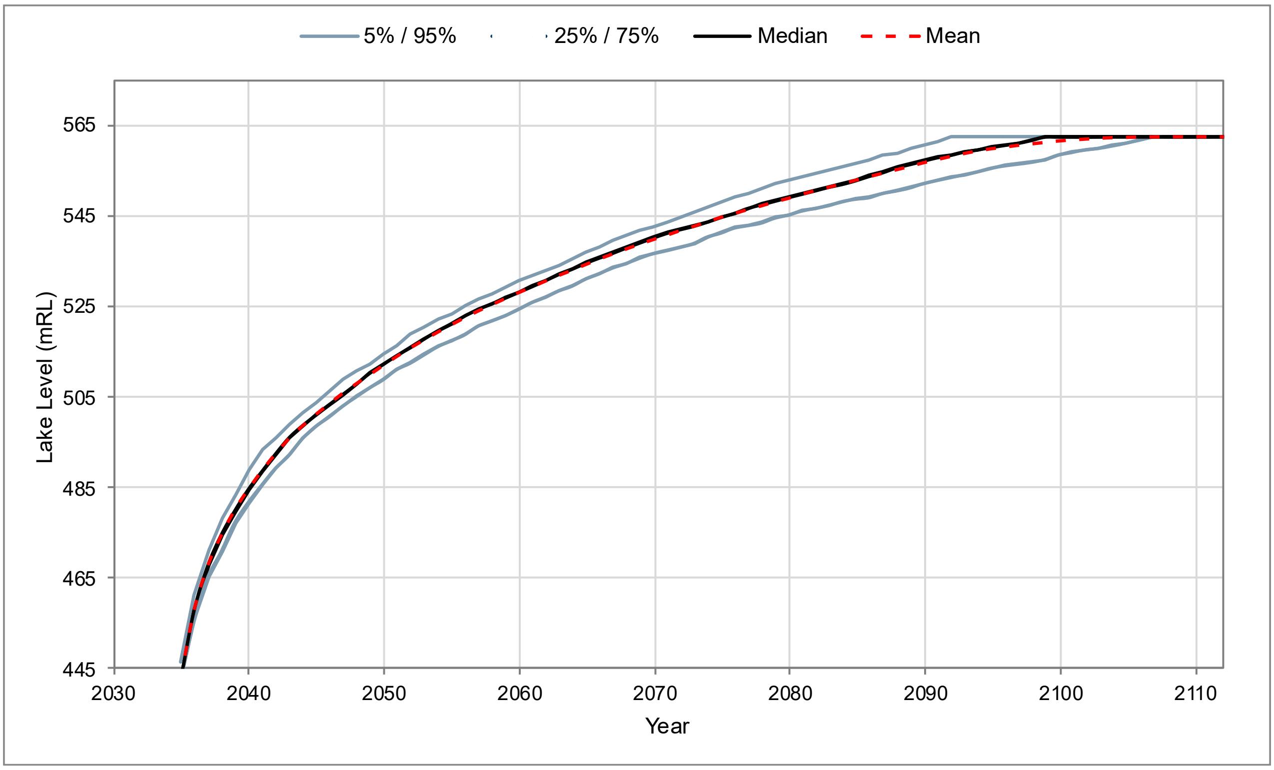


*Figure 6.6 Coronation North Pit Lake filling curve*

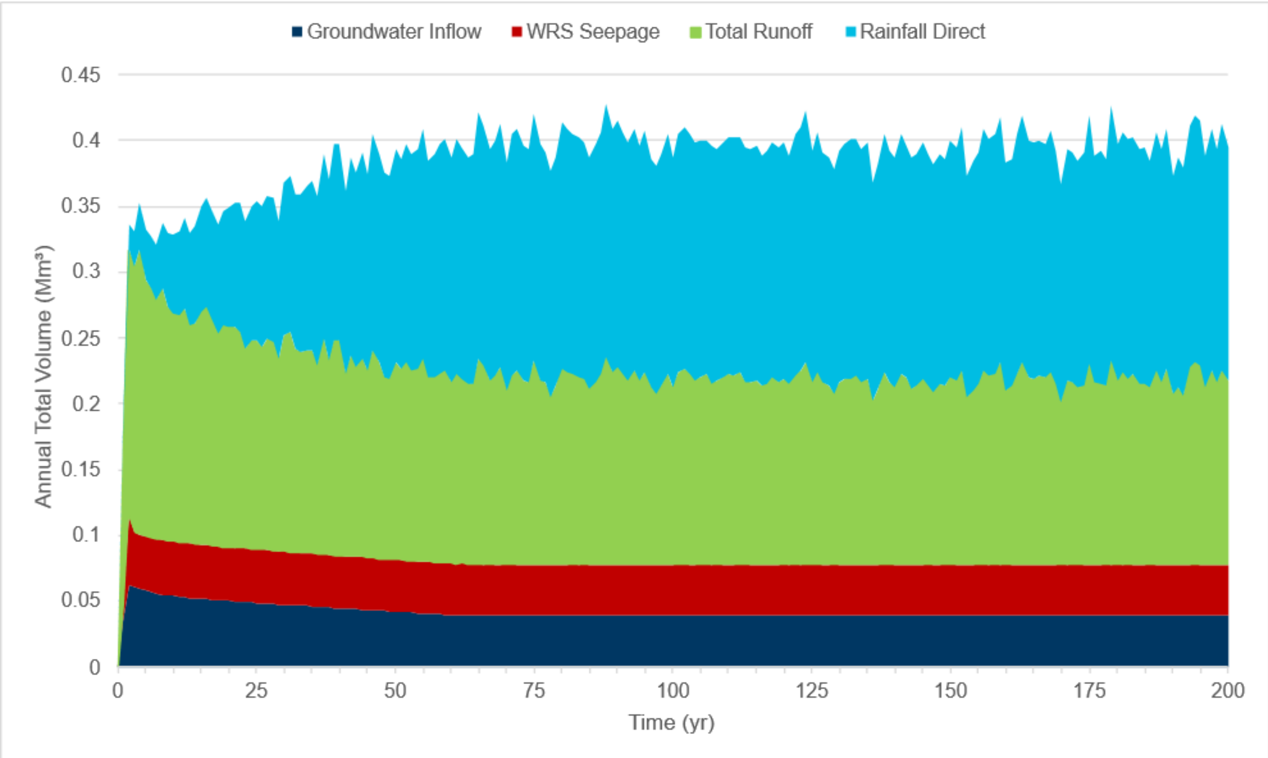


*Figure 6.7 Coronation North Pit annualised water inflows*

## 6.2.4 Innes Mills Pit

The modelled pit lake filling curve and the modelled annualised water inflows for the Innes Mills Pit are presented in Figure 6.8 and Figure 6.9 respectively. The median pit lake filling time is predicted to be approximately 62 years with the pit lake overflow level of 473 mRL being reached in approximately 2098.

The corresponding annualised water balance shows total runoff inflows are high before the pit lake surface is developed. Once the backfill is saturated and the pit lake surface becomes active, runoff decrease inversely to the direct rainfall. Direct rainfall increases with the widening pit lake surface area until the final level is reached after approximately 67 years. There is initially a high loss to groundwater due to the lowered groundwater table immediately surrounding the pit, which reduces as the water table recovers. Evaporation then becomes the dominant outflow from the pit lake until the overflow is reached.

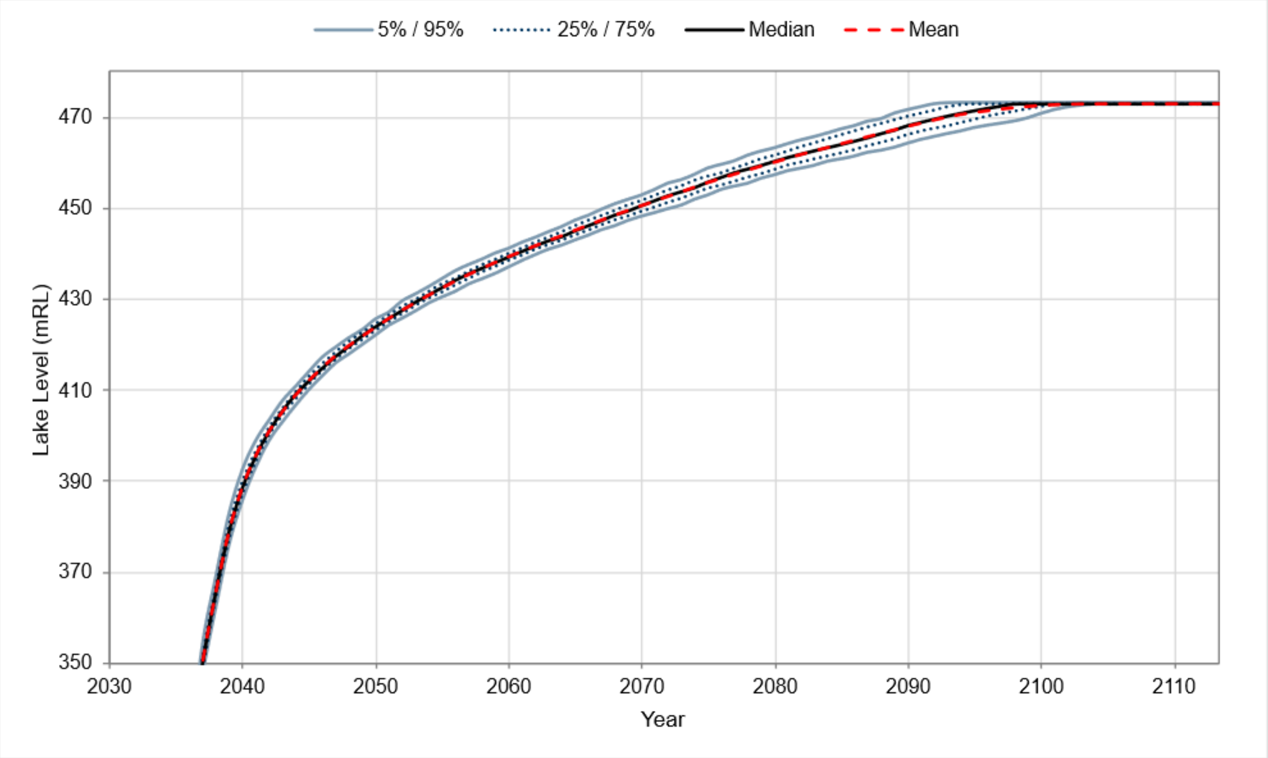


***Figure 6.8 Innes Mills Pit Lake filling curve***

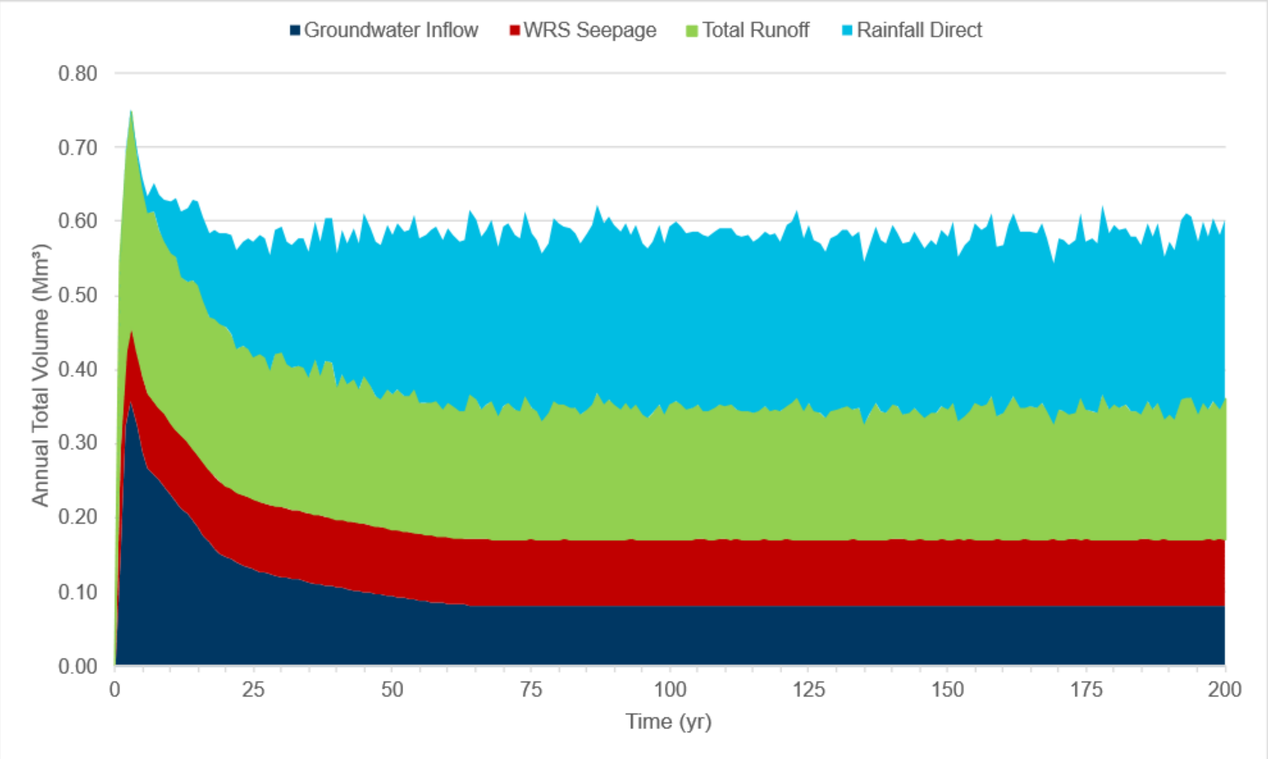


***Figure 6.9 Innes Mills Pit annualised water inflows***

## 6.3 Surface Water Modelling Results

The detailed WBM results are presented in Appendix H. They are presented in terms of the key receiving surface water catchments (Mare Burn, Deepdell Creek and Waikouaiti North Branch) and their respective compliance monitoring locations as well as the Shag River down hydraulic gradient of the site.

The surface water compliance monitoring locations are illustrated in Figure 6.10.

Captured seepage waters and treatment requirements through the active treatment are presented separately as are the modelled results for the Camp Creek and Coal Creek freshwater dams which provide augmentation water to the Deepdell Creek and Mare Burn catchments respectively during low flow periods.

This section describes surface water modelling results, broken down into the following key sections:

– Section 6.3.1 – outlining the modelled scenarios and time horizons,
– Section 6.3.2 – outlining the flow and concentration statistics at key modelling nodes,
– Section 6.3.3 – evaluating the modelled results against the proposed compliance criteria at the compliance locations,
– Section 6.3.4 – describing the sensitivity testing against potential long-term climate change outcomes,
– Section 6.3.5 – describing the WTP operation and flows, and
– Section 6.3.6 – describing the operation of the Camp Creek and Coal Creek augmentation dams

**Notes to reader** on descriptors used throughout this section:

– "**Non-compliance**" – refers to predicted failure to meet the specific compliance criteria for a given compliance monitoring location. Typically, this is represented as a percentage (%) value describing the total portion of modelling outcomes within a certain period failing to meet the compliance criteria.

  E.g.:

  - a non-compliance of 1% with respect to **acute compliance criteria** describes 1% of daily modelled outcomes being higher than the compliance value. This would correspond to 37days over a ten-year period being non-compliant. When considering monthly compliance sampling this would represent approximately one measured sample in 10 years being above the compliance value
  - a non-compliance of 1% with respect to **chronic compliance criteria** can be a little more nuanced. Where the chronic criteria allow for two monthly samples in a 12-month rolling period to be above the trigger value, the 1% non-compliance can be representative of three samples being above the trigger value in one 12-month period over 100 years. It may also be representative of one- two monthly samples being above the trigger every year for 100 years, with one 12-month window containing three samples exceeding the trigger.

– "**Exceedance**" or "**Probability exceedance**" – refers to a statistical measure describing the portion of time a particular measure is exceeded. E.g. a 90% flow exceedance of 10 L/s would mean that on 90% of modelled days, the flow rate was above 10 L/s.
– "**Trigger exceedance**" – refers to a value being above the defined trigger values in Viridis (2026). In the case of chronic trigger values, this does not represent a non-compliance statistic. In the case of acute trigger values, the exceedance would be equivalent to the non-compliance metric.

### 6.3.1 Modelled Scenarios

The WBM runs a Monte-Carlo simulation, producing multiple model iterations with a daily timestep for a duration of 200 years (with each phase reporting statistics from between 50 and 100 hydrological cycles). To allow this information to be presented without unnecessary complexity, results are presented based on five key time horizons as outlined in Table 6.1. These time horizons (project phases) look to capture key milestones in the mine water management and site hydrology of the site with a specific focus on mining phase versus closure phase, implementation of mitigation measures and overflow of the pit lakes formed.

The following practical considerations are noted in reference to these model result reporting phases:

- The start date for MP4 is represented as 01/01/2027, however, in practice this would align with commencement of activities defined in the MP4 project. Subsequent dates would shift with this start date when making comparisons with modelled outcomes.
- The key feature of the WBM that would be affected by a change in these dates is the representation of WRS seepage concentrations, which develop with time. There is significant variability included in the modelling for these concentrations, such that timeline adjustments by a few years is not expected to materially affect the modelled outcomes.
- Mining Phase B is represented as commencing in 2033 for the purpose of reporting WBM results, whereas in practice the proposed transition period to the revised water quality compliance regimes is seven years. This date choice is for representation of modelling results only. It considers that implementation of mitigation measures in the model can have a near on immediate impact, whereas in practice there will be a delay before the benefits are fully realised. Hence, the time delay between commissioning of the mining phase mitigations and the implementation of the proposed water quality compliance regimes.
- Modelling represents mining extending to the end of 2036 (end Mining Phase B). This is a function of most mine activities affecting receiving water outcomes being completed and minor changes to the Project schedules through the development of the modelling framework. The reporting phases are considered to be representative of expected outcomes before the transition to the revised compliance criteria (Mining Phase A), and from implementation of the criteria to closure as defined in the Project description (Mining Phase B).

***Table 6.1 Reporting phases***

| Phase | Date Start: | Date End: | Description |
|---|---|---|---|
| Mining Phase A | 1/01/2027 | 30/12/2032 | Nominal commencement of MP4 through to commissioning of key mining phase mitigations as outlined in Appendix F and implementation of proposed compliance criteria.<br>Compliance assessment though this phase is based on existing compliance criteria.<br>Representative of the MP4 Project through to transition to the proposed water quality compliance criteria. |
| Mining Phase B | 1/01/2033 | 30/12/2036 | Nominally defined from commissioning of key mining phased mitigation measures through to completion of active mining, prior to closure phase rehabilitations being implemented.<br>Compliance assessment is based on the proposed compliance criteria.<br>Representative of the MP4 Project from implementation of the proposed water quality compliance criteria to end of active mining. |
| Closure | 1/01/2045 | 31/12/2054 | Defined approximately one decade post closure, where all mitigation measures are implemented and functioning, with WRS seepage water quality reaching peak concentrations and capping improvements fully realised in seepage flow rates. |
| Pit Overflow | 1/01/2100 | 31/12/2109 | Defined to be where all pit lakes are overflowing to the receiving water courses and coincides with the early stages of Coronation North pit lake and Innes Mills pit lake overflows where concentrations of some parameters are at peak predictions. |
| Long Term | 1/01/2210 | 30/12/2219 | Defined to represent long term steady state responses based on assumed model inputs. |
| Long term with climate change | 1/01/2210 | 30/12/2219 | Defined to represent long term steady state responses based on assumed model inputs adapted for climate change scenarios |

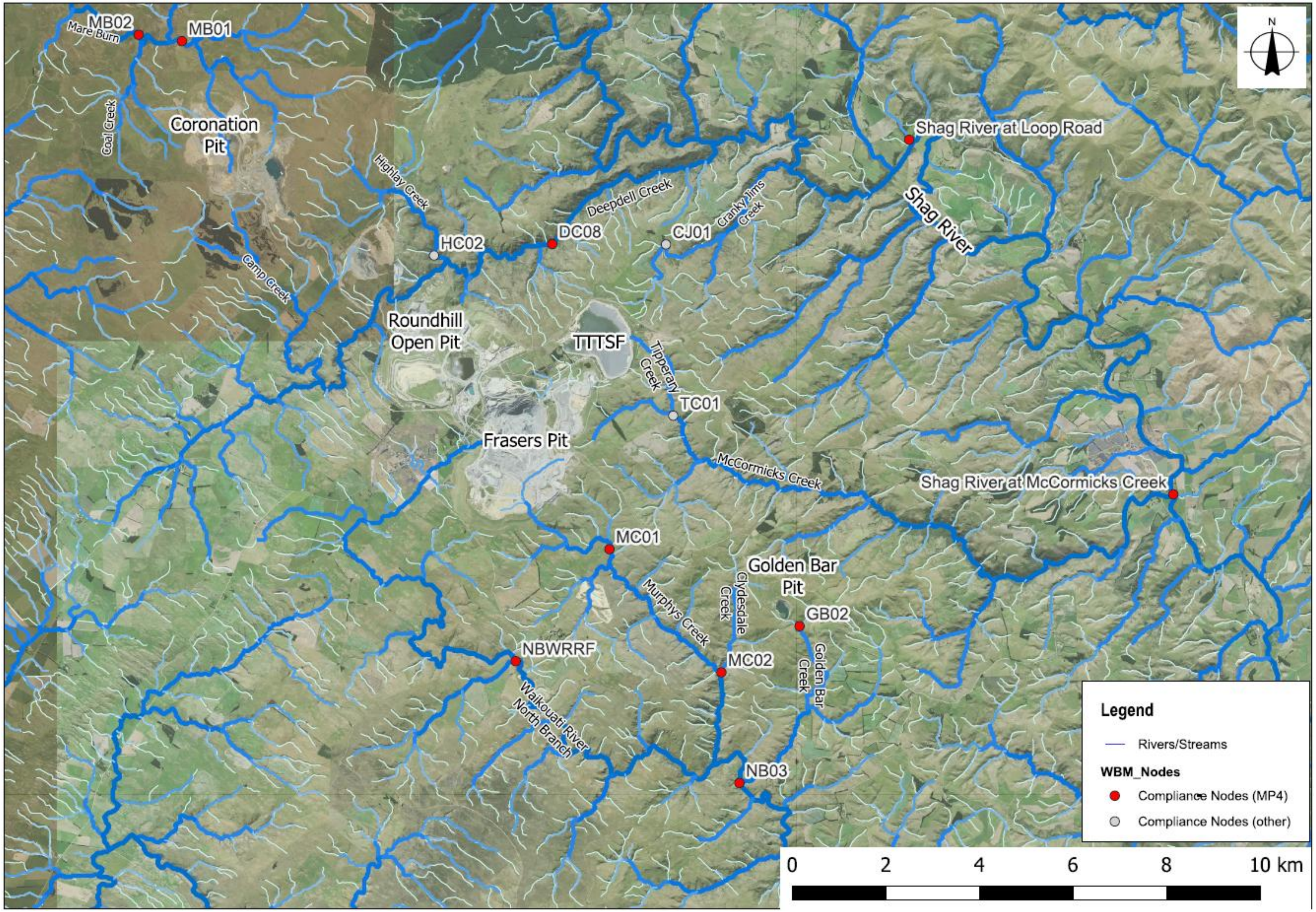


*Figure 6.10* *Site surface water compliance locations*

## 6.3.2 Receiving Surface Water Environment – Modelled Results

Selected WBM results are presented for the key surface water compliance locations as modelled exceedance probability curves. This enables a graphical representation of the stochastic modelled concentrations across the five modelled phases from operations through to long term. Applicable trigger values are provided for context based on definitions in Viridis (2026). The assessment against the proposed compliance criteria is made in Section 6.3.3.

Actual modelled concentrations for the full suite of compliance parameters are provided in detail in Appendix H. Results presented here are selected to provide an illustration of the change in concentrations through the modelled phases reflecting both the project elements and the proposed mitigation, and to illustrate what are considered the key contaminants of concern in terms of the receiving surface water environment.

### 6.3.2.1 Mare Burn MB01

Modelled results for flow, sulphate, copper and zinc are summarised in Figure 6.11, Figure 6.12, Figure 6.13 and Figure 6.14 respectively.

The results highlight a significant increase in flow rates through dry periods in Mining Phase B and into closure which is a reflection of water from the Coal Creek augmentation dam being pumped to upstream of MB01 during low flow periods. The dilutive effect of the augmentation water on the in-stream concentrations is evident compared to the Mining Phase A (no augmentation water) with considerably reduced modelled trigger concentration exceedances for sulphate, copper and zinc. Effective waste rock capping also contributes to reduced uncaptured seepage from the closure phase onwards (and hence reduces concentrations in receiving waters) as observed in the flow exceedance chart (Figure 6.11). This chart also depicts where the Coal Creek Dam capacity for flow augmentation has been reached in mining phase B, closure and overflow as indicated by the sharp reduction in flows at the 96$^{th}$% and 98$^{th}$% respectively. In these cases the contingent storage assigned for flushing flows (see Section 6.3.6) is not used and active management of the discharges is not applied beyond the fixed discharge rating curves (as described in Appendix F). In practice, active management with an eye on weather forecasts could achieve better outcomes for flows and concentrations.

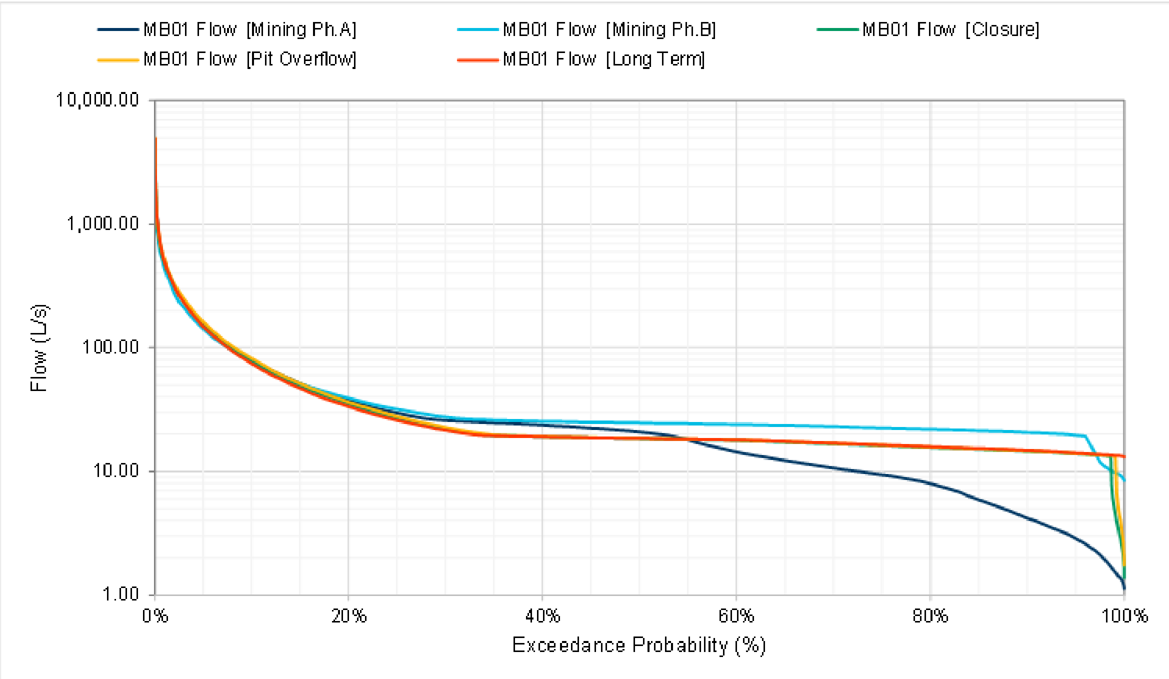


*Figure 6.11 MB01 – Flow*

Figure 6.12 shows the concentration exceedance probability curves for sulphate at MB01. On this chart the trigger value of 1,000 g/m³ is included for reference, based on the trigger value described in Viridis (2026). Higher concentrations are observed in mining phase A where mitigation measures have not been fully realised. In later phases, upward inflections in the concentration exceedance curves are observed at the lower percentiles and this is attributed to periods of reduced augmentation flow as discussed above.

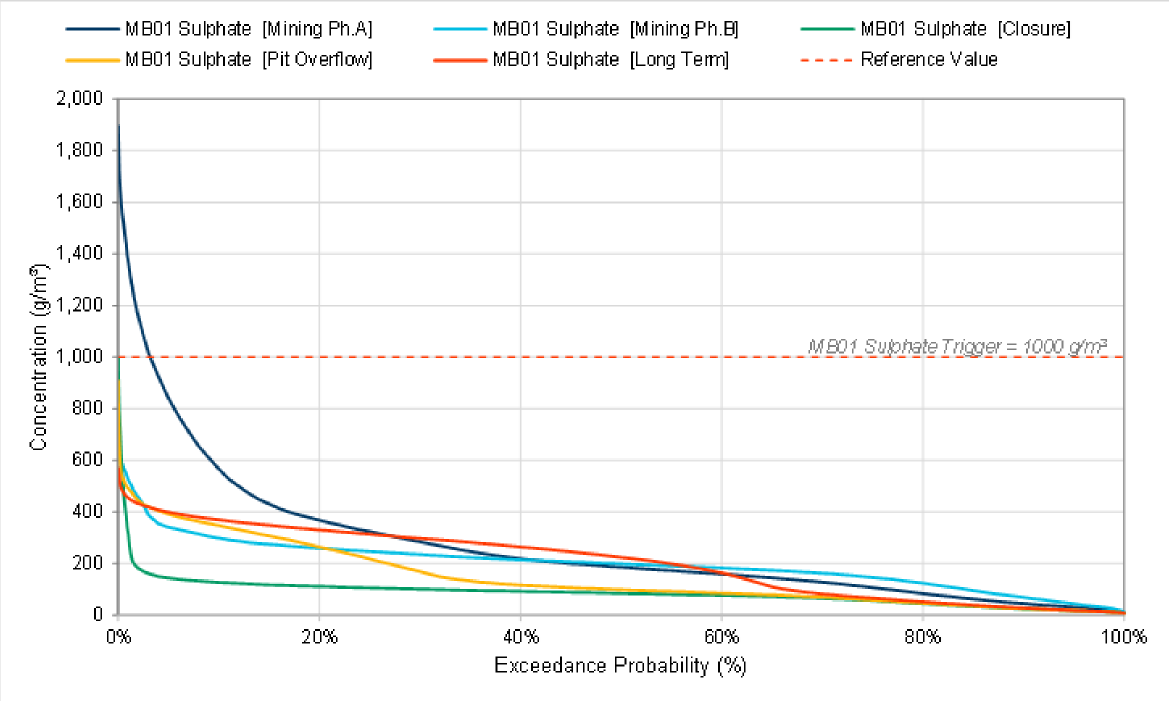


***Figure 6.12 MB01 – Sulphate***

Figure 6.13 and Figure 6.14 show the normalised concentration exceedance probability curve for copper and zinc at MB01 respectively. Where these normalised curves are presented, the chart is derived from data that represents the daily modelled concentration divided by a daily calculation of the trigger value as determined by the modifying criteria in Viridis (2026) (also presented in Appendix H). On these charts a normalised value of 1.0 represents a modelled concentration equivalent to the trigger value, while 2.0 would represent a concentration equivalent to twice the trigger value. During the mining phases copper concentrations are modelled as exceeding the trigger value approximately 40-45% of the time and this reduces once all mitigation measures are implemented. It is noted that copper is likely overrepresented in the model results and this is discussed further in Table 6.3. Zinc concentrations follow a similar pattern of behaviour to copper.

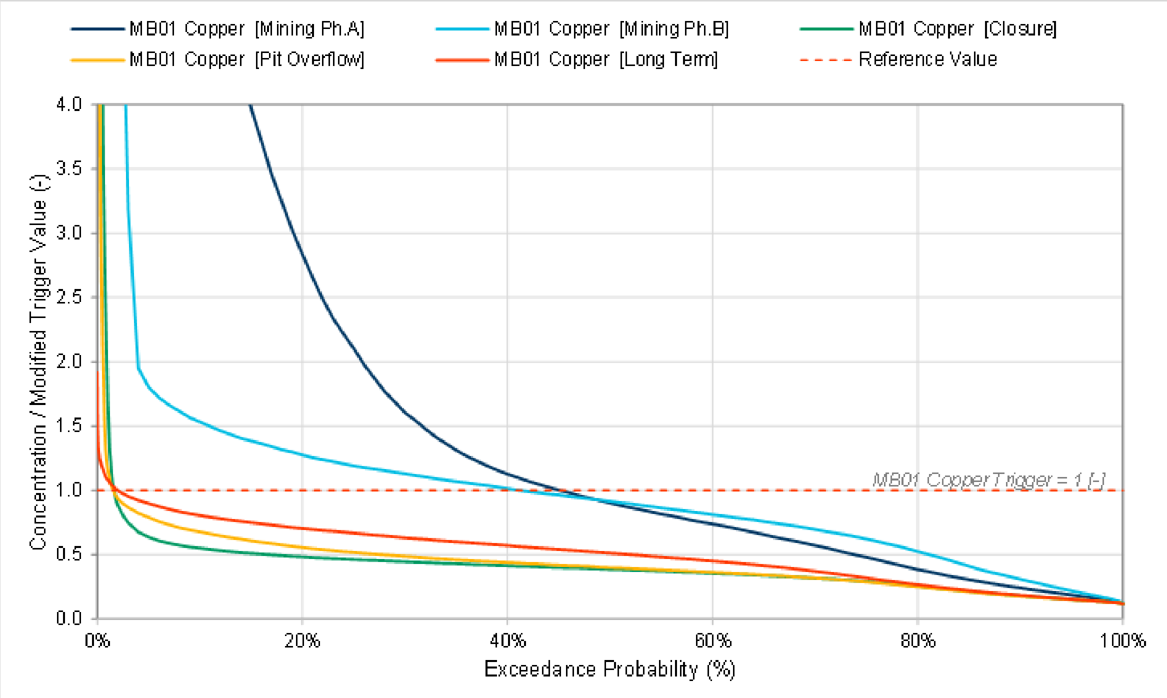


*Figure 6.13 MB01 – Copper - normalised to the chronic trigger value*

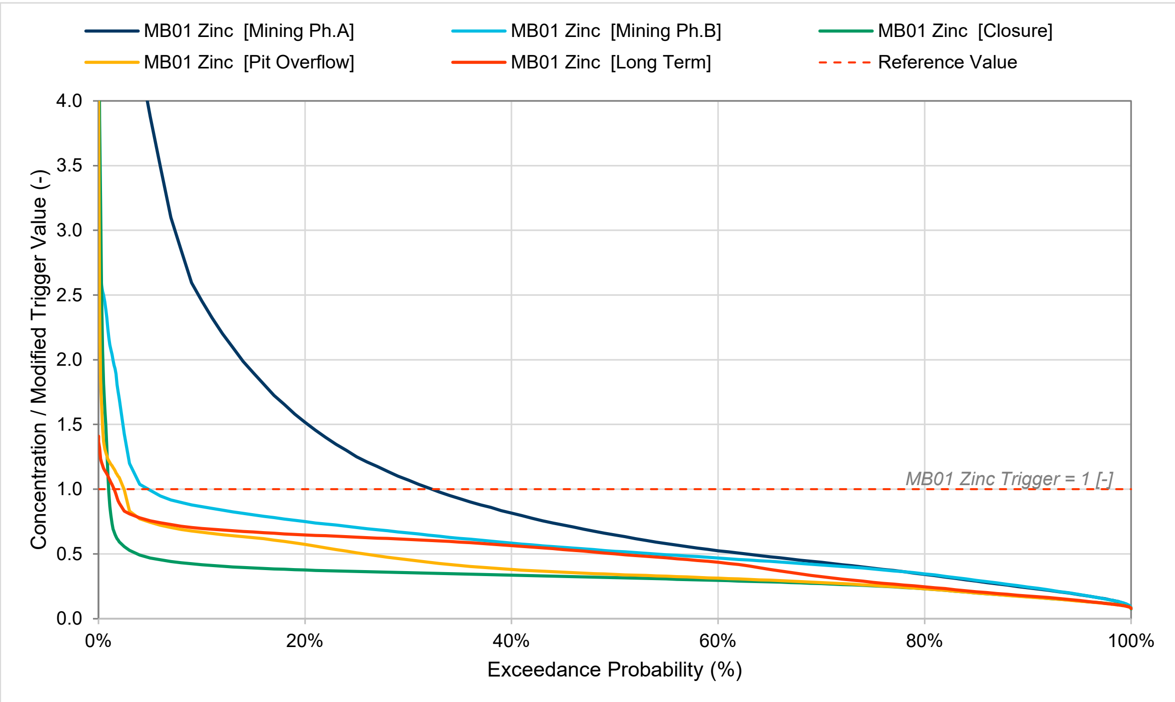


*Figure 6.14 MB01 – Zinc - normalised to the chronic trigger value*

### 6.3.2.2 Mare Burn MB02

A similar pattern to that modelled in MB01 can also been seen at MB02 with modelled results for flow and sulphate summarised in Figure 6.15 and Figure 6.16 respectively.

Concentrations of sulphate (and other contaminants of concern) are lower at MB02 compared to MB01 as additional dilution from the surrounding catchments occurs and the sources of contaminants of concern are generally sited further up catchment.

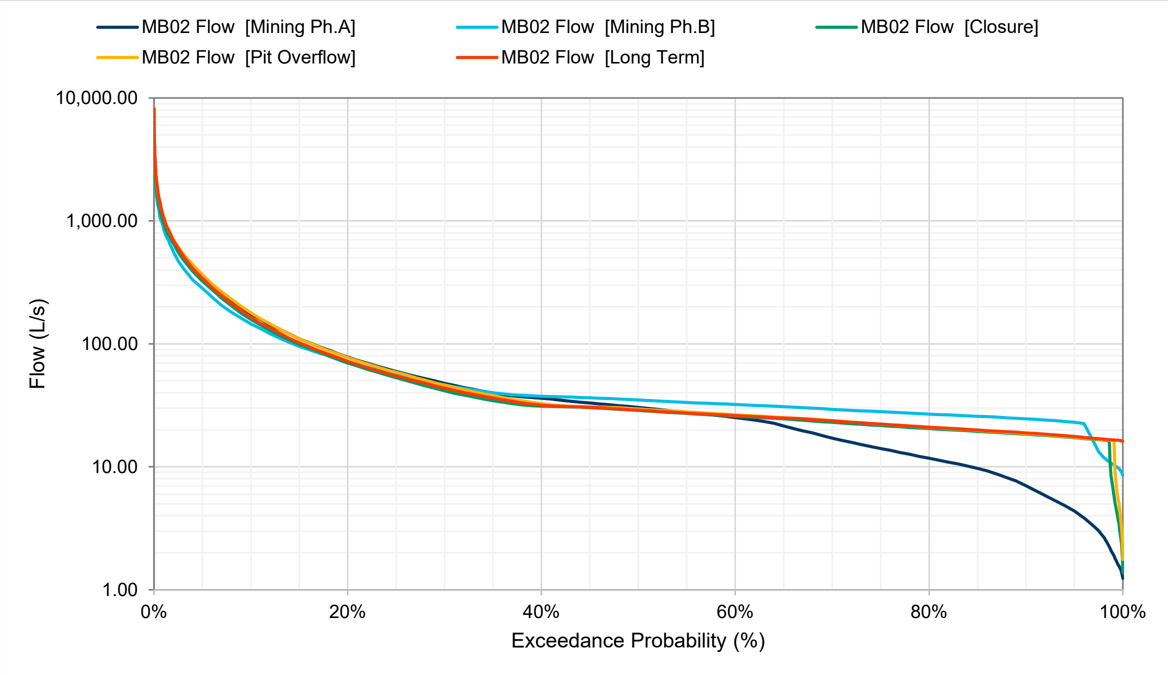


*Figure 6.15 MB02 - Flow regimes*

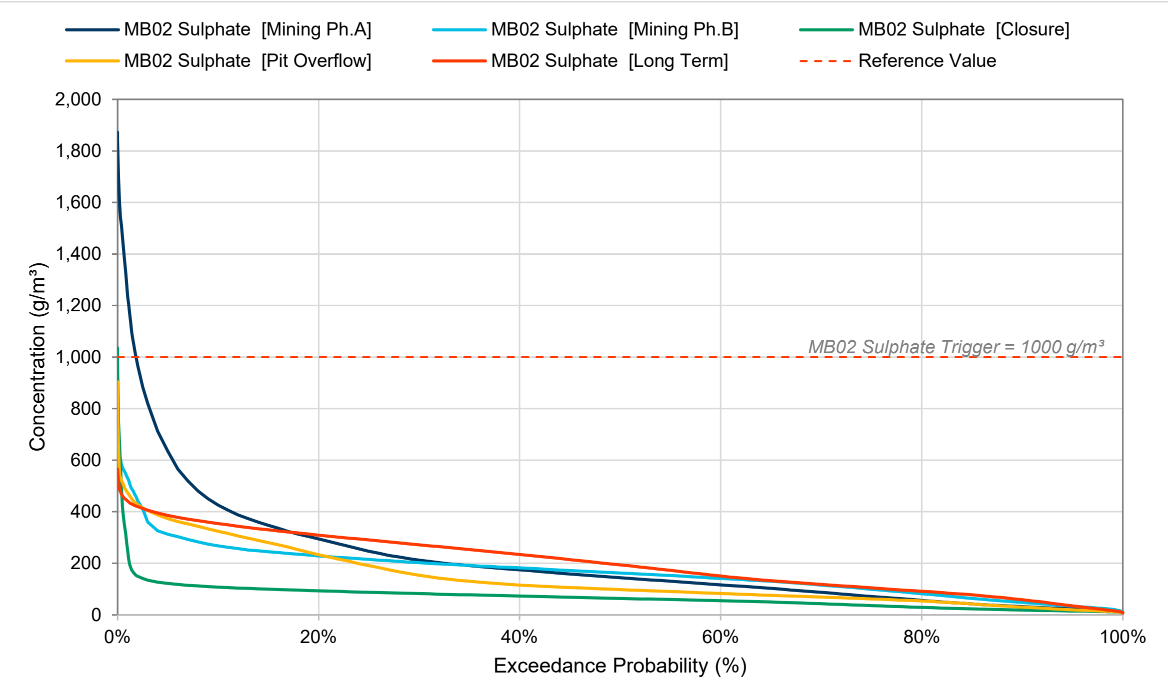


*Figure 6.16 MB02- Sulphate concentration*

### 6.3.2.3 Deepdell DC08

Modelled results for flow, sulphate, and arsenic are summarised in Figure 6.17, Figure 6.18, and Figure 6.19 respectively. The results highlight a significant increase in low flows in Mining Phase B and into closure which is a reflection of water from the Camp Creek augmentation dam provided during low flow periods. The dilutive effect of the augmentation water on the in-stream concentrations is evident compared to the Mining Phase A (no augmentation water) with significantly reduced low flow concentrations and reduced modelled trigger concentration exceedances for sulphate and arsenic. Waste rock capping also contributes to reduced uncaptured seepage (and hence elevated low flow concentrations) during closure.

Relative increases in sulphate and arsenic from Mining Phase B and closure to the Pit Overflow and Long-Term Phases are reflective of pit lake overflow from the Deepdell North, Coronation and Innes Mills Pit Lakes during these phases and increasing concentrations within the uncaptured seepage with time.

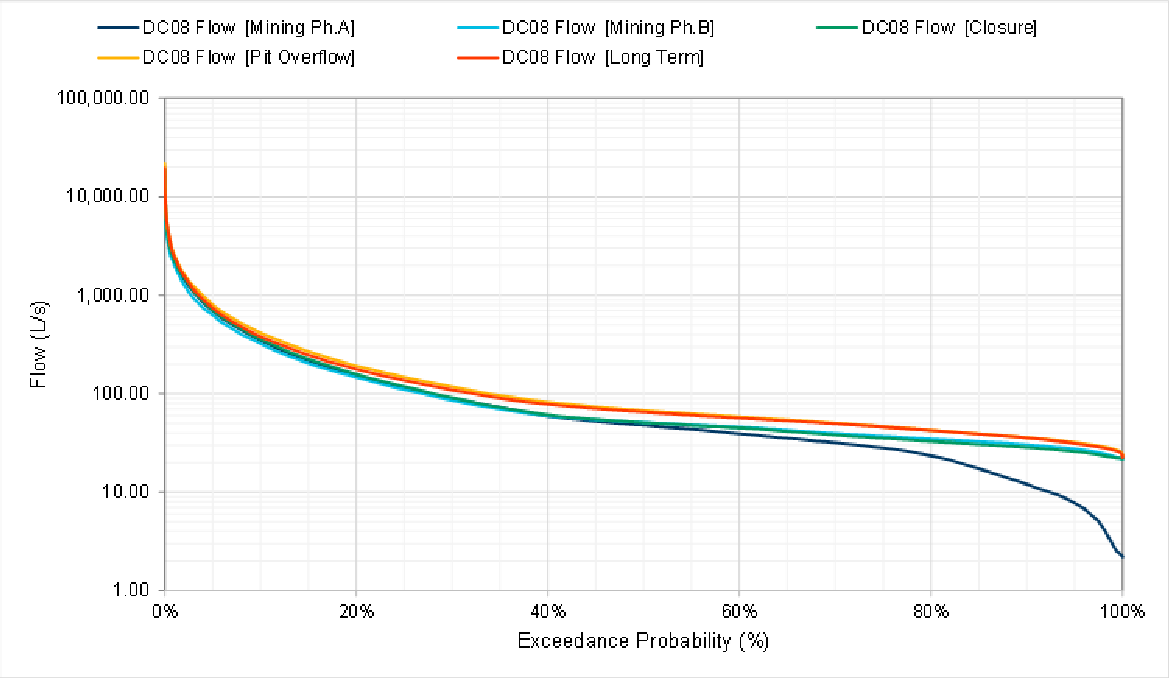


*Figure 6.17 DC08 - Flow*

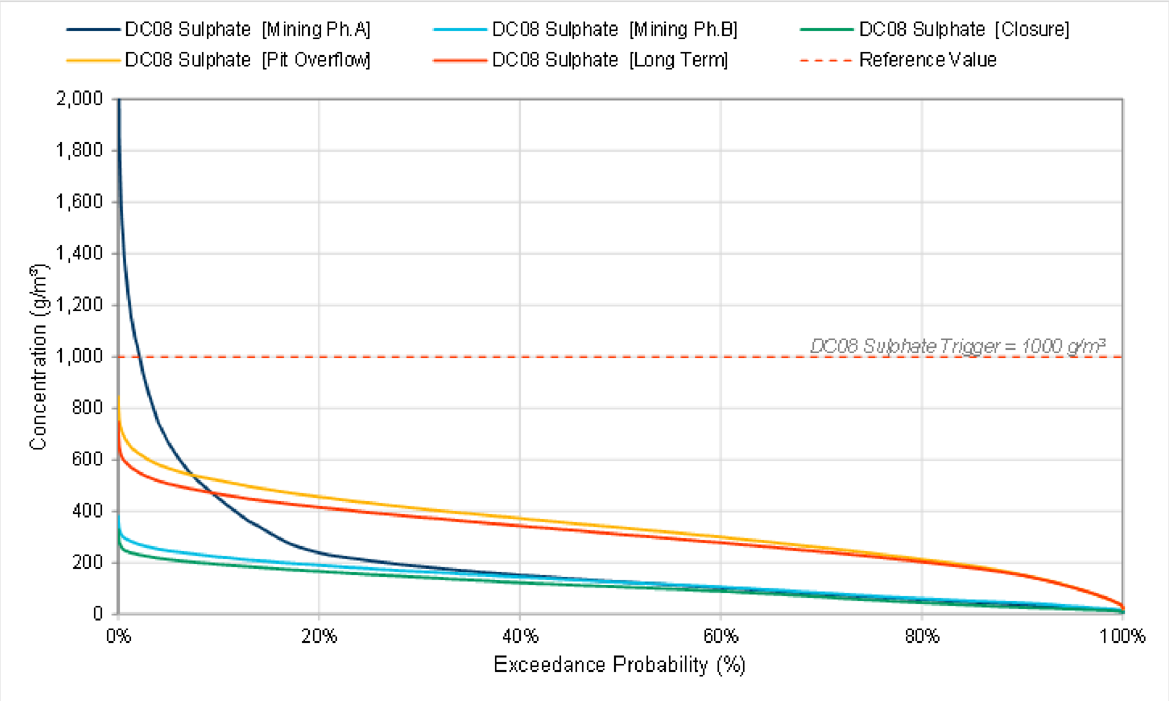

*Figure 6.18 DC08 - Sulphate*

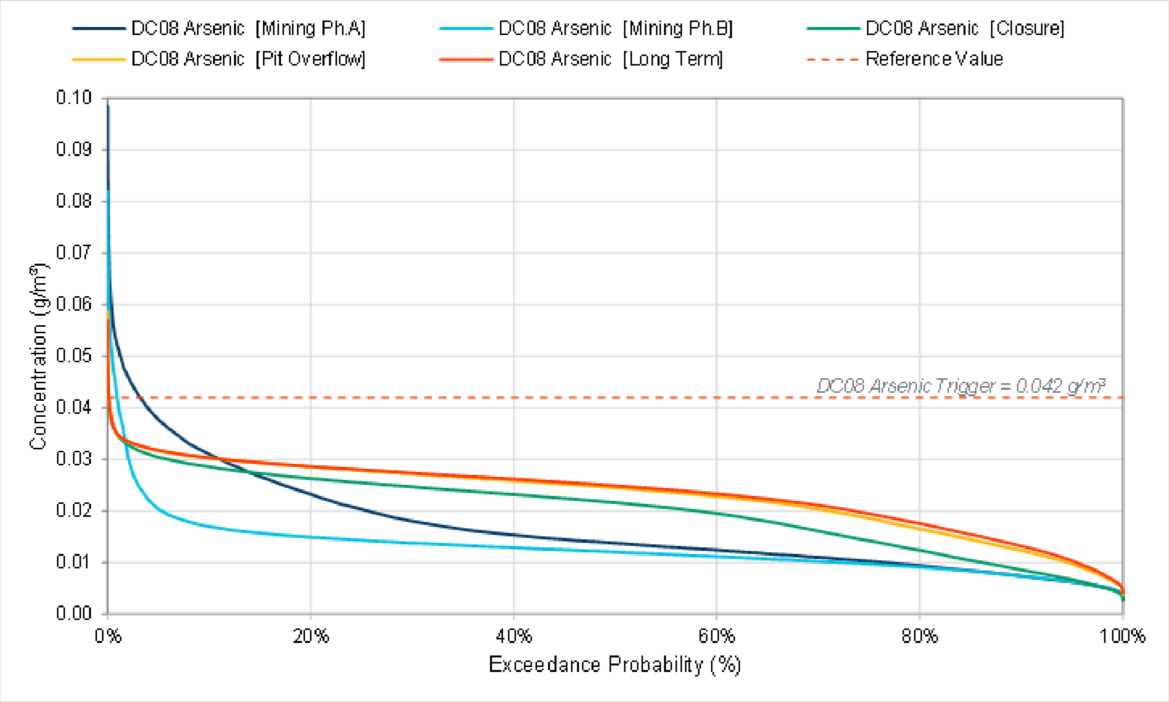


*Figure 6.19 DC08 - Arsenic*

#### 6.3.2.4 Shag River at McCormicks

Modelled results for flow and sulphate are summarised in Figure 6.20 and Figure 6.21 respectively.

The results highlight very little change to the predicted flow regimes through the various phases due to the large natural catchment flows relative to mine influenced flows from the Macraes Operation catchments. A small increase in the low flow regime is modelled which is the result of the augmentation water released through the Camp Creek augmentation dams.

Sulphate is modelled to increase in the pit overflow and long-term phases relative to the mining and closure phases. This is predominately reflective of pit lake overflow from the Deepdell North, Coronation, Golden Bar and Innes Mills Pit Lakes during these phases and increasing concentrations within the uncaptured seepage with time.

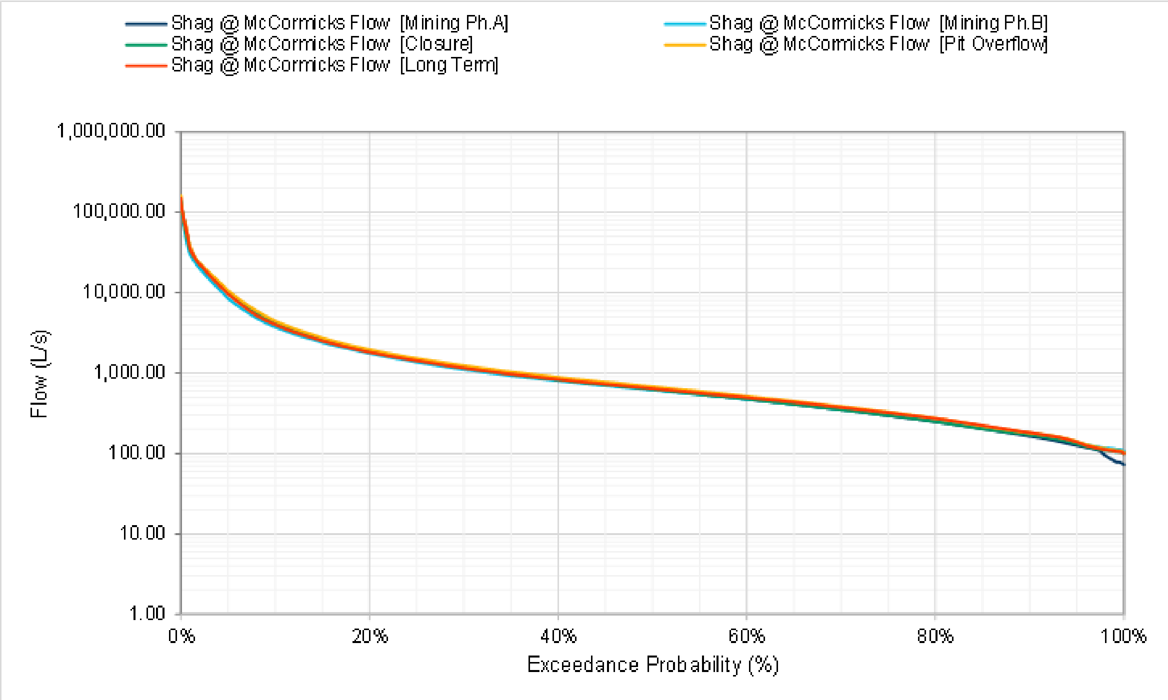


*Figure 6.20 Shag River @ McCormicks – Flow*

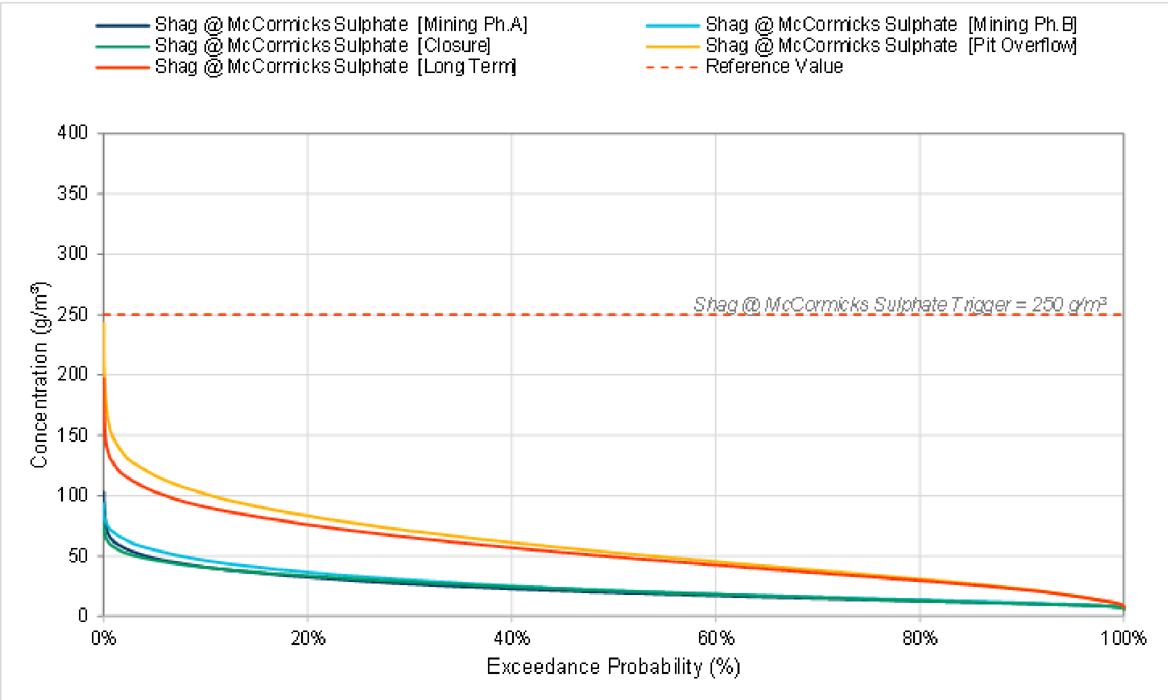


*Figure 6.21 Shag River @ McCormicks – Sulphate*

### 6.3.2.5 North Branch Waikouaiti NBRRF

Modelled results for flow, sulphate and zinc are summarised in Figure 6.22, Figure 6.23, and Figure 6.24 respectively.

The results highlight increased low flows during closure and in the long term. This is predominantly the result of the increased headwaters within the Waikouaiti River North branch once they are reinstated upon the closure and capping of FTSF.

Concentrations of sulphate and zinc are modelled to increase in Mining Phase B relative to Mining Phase A and then decrease again at closure. This is associated with increasing height within the Frasers WRSs during mining generating higher concentrations in seepage waters. Subsequently this results in a greater mass flux from uncaptured seepage reporting to the head waters of the Waikouaiti River North branch during this stage. Through part of mining phase A, the stage 1 WTP is also represented as discharging 4.25 L/s upstream of NBWRRF, which is higher than the expected discharge from the stage 2 WTP in mining phase B. This  provides a greater dilutive effect and is represented by higher concentrations in mining phase B relative to mining phase A. The modelled reduction of sulphate and zinc at closure is associated with the capping of WRSs and relative decrease in infiltration combined with the implementation of the seepage capture drains reducing uncaptured seepage and subsequent treatment and discharge of this water.

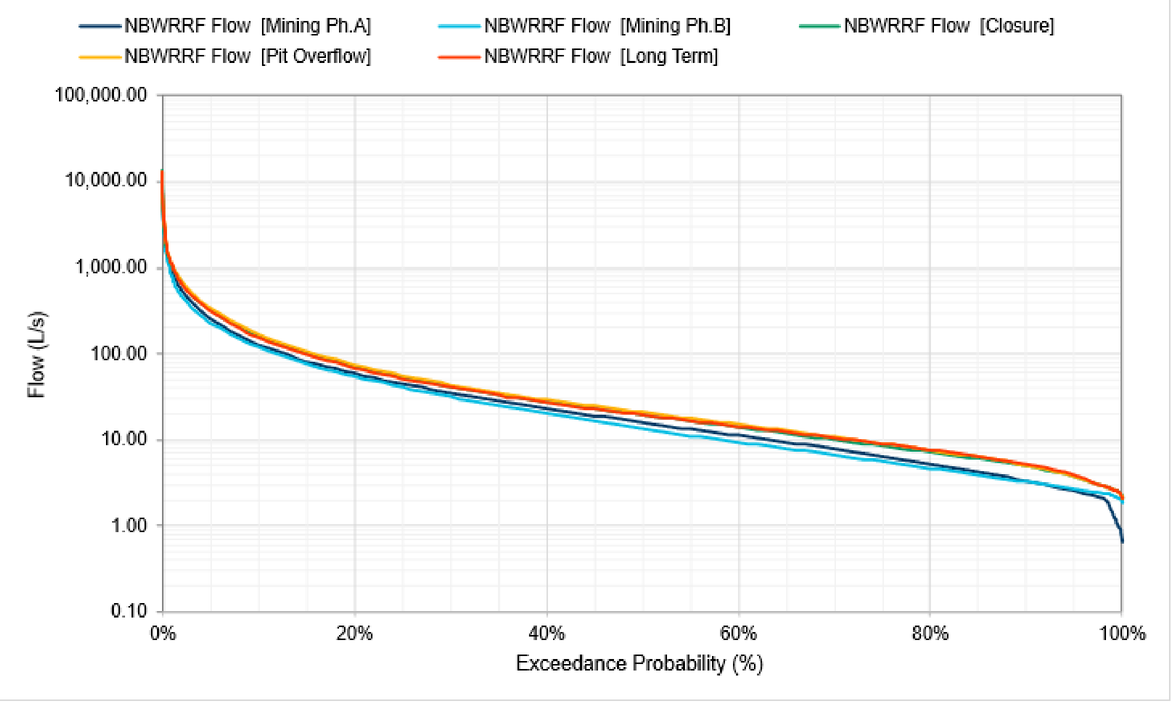


***Figure 6.22*** ***NBRRF - Flow***

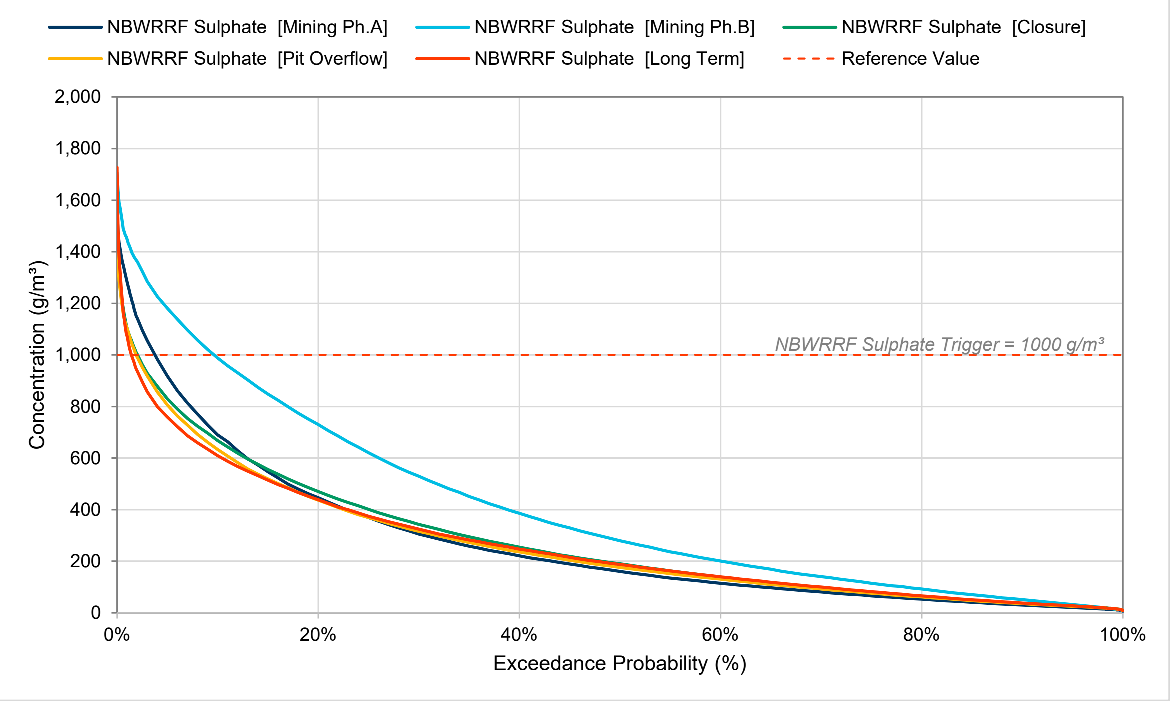


***Figure 6.23*** ***NBRRF- Sulphate***

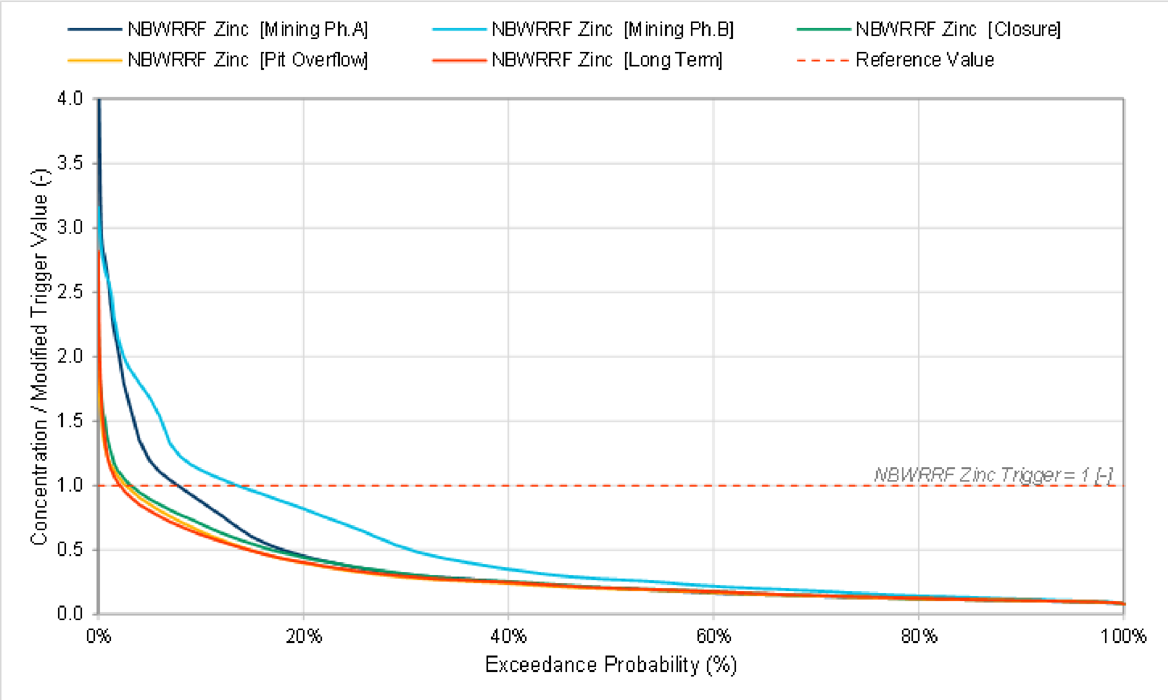


*Figure 6.24* ***NBRRF - Zinc - normalised to the chronic trigger value***

### 6.3.2.6 North Branch Waikouaiti NB03

Modelled results for flow and sulphate are summarised in Figure 6.25 and Figure 6.26 respectively.

The results highlight a decrease in flows across most flow regimes for Mining Phase B relative to current, closure and long-term results. This is the result of Golden Bar Pit having being dewatered during Mining Phase A and B and not discharging until recovery. The change in the flow regime is also affected by a reduction in seepage flow rates due to the proposed change in WRS capping methodology (represented as being effective from closure), and an increase in catchment size (and hence flows) from the re-connection of the headwaters of the Waikouaiti River North Branch. The stage 1 WTP discharge also increases flow through mining phase A.

Concentrations of sulphate are modelled to increase in Mining Phase B relative to Mining Phase A and then decrease again at closure (as also observed at compliance location NBRRF). This is associated with increasing height within the Frasers WRSs during mining resulting in a greater volume of uncaptured seepage reporting to the head waters of the Waikouaiti River North branch during this stage. The reduction at closure is associated with the capping of these WRSs and relative decrease in infiltration combined with the implementation of the seepage capture drains reducing uncaptured seepage and subsequent treatment and discharge of this water.

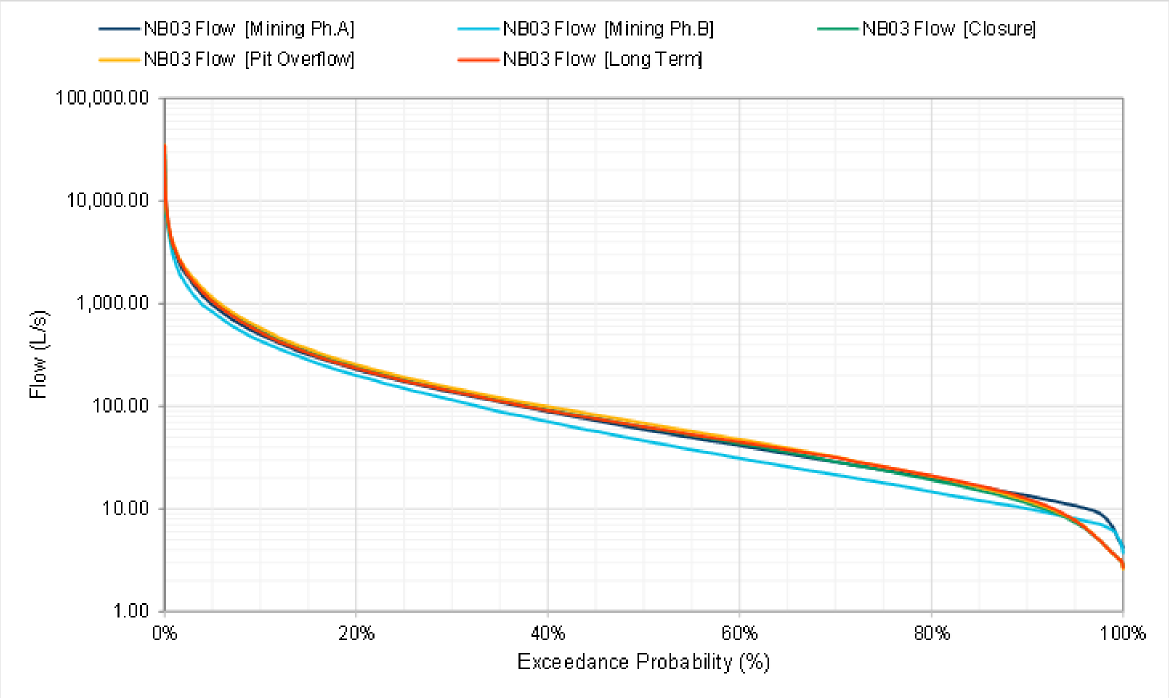


*Figure 6.25* *NB03 - Flow regimes*

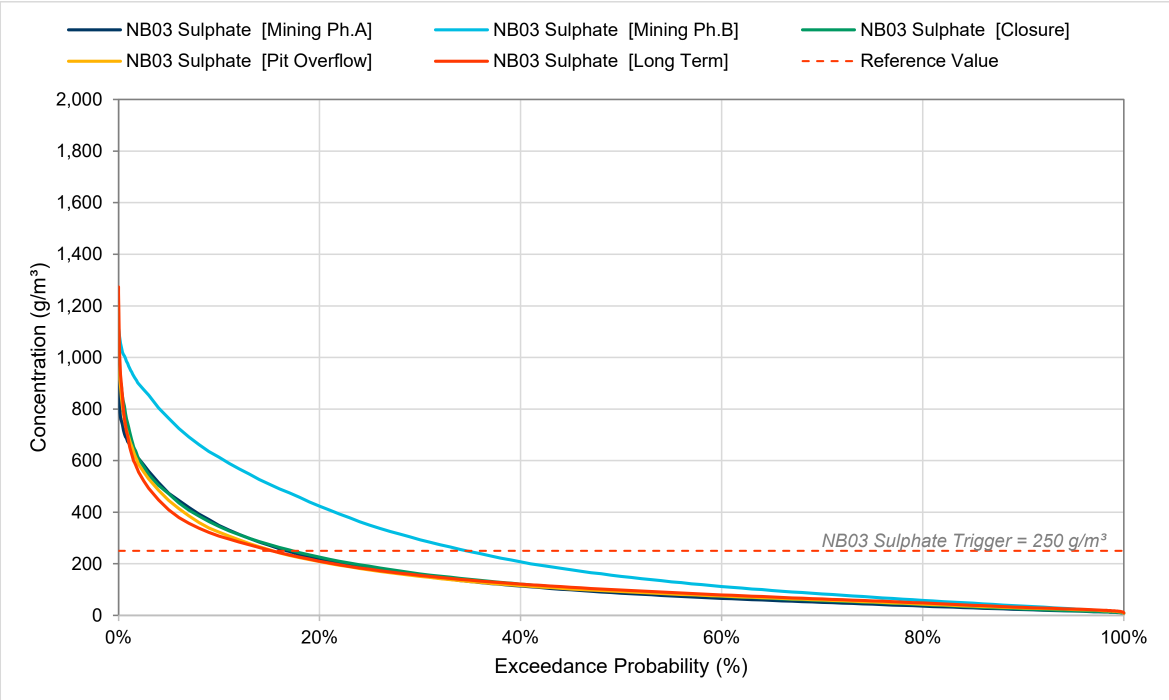


*Figure 6.26* *NBO3 - Sulphate*

#### 6.3.2.7 North Branch Waikouaiti MC02

Modelled results for flow and sulphate are summarised in Figure 6.27 and Figure 6.28 respectively.

The results highlight an increased flow rate during dry periods of Mining Phase B relative to Mining phase A, closure and long-term results. This is the result of the cessation of the Murphys Silt Pond pump back during Mining Phase A, resulting in increased flow reporting to the head of this tributary during Mining Phase B.

Concentrations of sulphate are modelled to increase in Mining Phase B relative to Mining Phase A and then decrease at closure (similar to that modelled at compliance locations NBRRF and NB03). This is associated with increased heights of the Frasers WRSs during mining resulting in an increased contaminant source flux, and hence, increased uncaptured seepage mass flux reporting to the head waters of Murphys Creek during this stage. It is also representative of the seepage water being captured at a proposed seepage capture bund at the toe of the WRS, rather than in the Murphys Creek silt pond as is current practice. This approach captures less of the total mass flux (also reducing the total flows captured for treatment). The reduction in low flow regimes at closure is associated with the capping of the WRSs and relative decrease in infiltration combined with the implementation of the seepage capture drains reducing uncaptured seepage and subsequent treatment and discharge of this water.

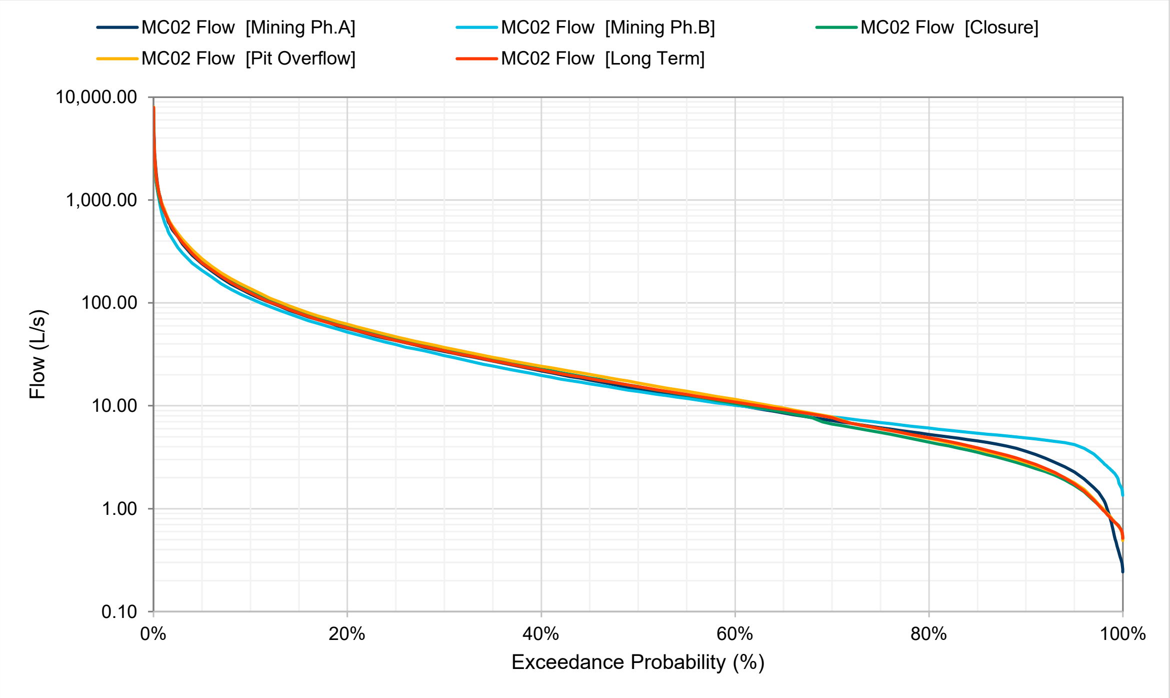


*Figure 6.27* *MC02 - Flow*

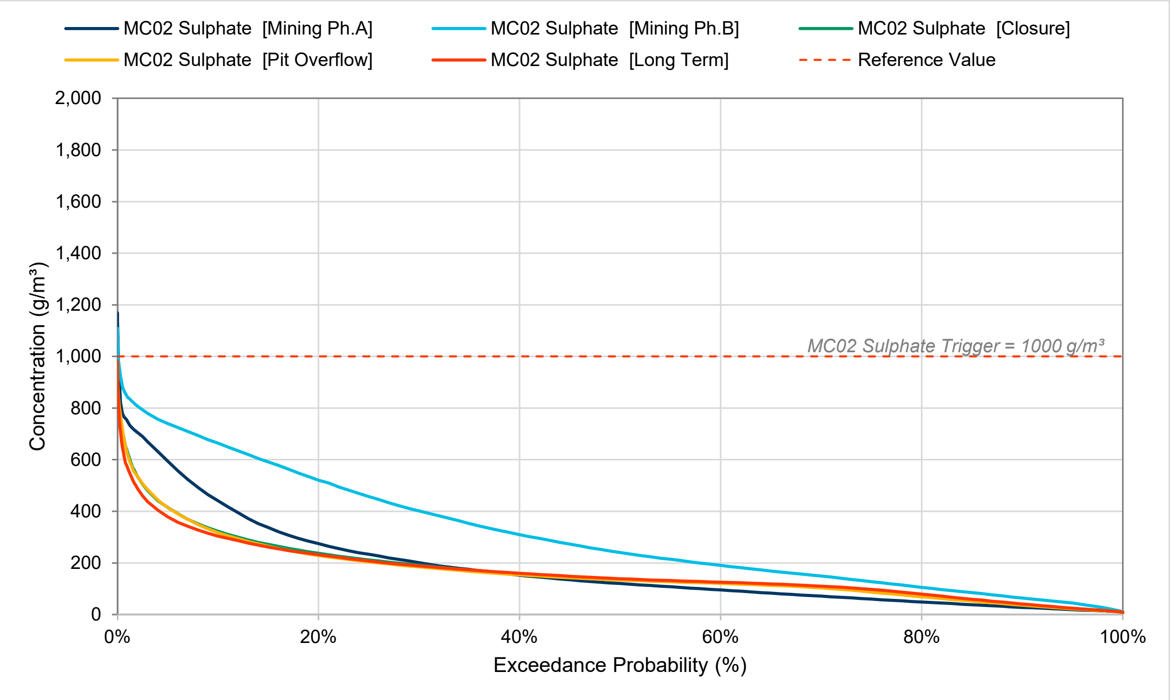


*Figure 6.28* *MC02 - Sulphate*

## 6.3.3 Receiving Surface Water Environment – Compliance

### 6.3.3.1 Application of Proposed Compliance Criteria

Details on how the proposed compliance criteria (Viridis, 2026) are applied to the evaluation of model data is outlined in Appendix H. As the model represents daily data rather than monthly samples as proposed for compliance monitoring, the proposed chronic compliance criteria is applied as a percentage basis to capture the portion of time that the proposed compliance criteria is not met. This calculation does not allow for any 'compliance status reset' criteria. Where acute criteria are proposed, the results are reported as the percentage of results exceeding the acute trigger value.

The results are evaluated against each of these compliance criteria, with the current criteria applied against modelled results for mining phase A, and the proposed ecological compliance criteria being applied to all other project phases. In addition, the proposed drinking water quality driven criteria is applied to NB03 and Shag River compliance sites for mining phase A through to the long-term phases.

### 6.3.3.2 Modelled Compliance against proposed criteria

A summary of the compliance statistics, comparing to both ecological and drinking water criteria, is provided in Table 6.2. This table represents the compliance status for each modelled parameter across the five mining phases (refer Section 6.3.1) at each site. For the overview, the table is colour coded as per the modelled non-compliance probability.

Non-compliances presented in Table 6.2 are defined by five probability descriptors. Frequent modelled non-compliances are defined as those occurring more than 50% of the time, this would consist of at least half of all samples exceeding the acute trigger value, or three or more samples within a 12 month window exceeding the chronic criteria every two years. Periodic modelled non-compliances are defined as those occurring 25%-50% of the time. This would consist of at least a quarter of all samples exceeding the acute trigger value (i.e. all summer months), or three or more samples within a 12 month window exceeding the chronic criteria every four years. Occasional modelled non-compliances are defined as those occurring 5%-25% of the time. This would consist of at least 1 in 20 samples exceeding the acute trigger value (i.e. a dry summer every five years), or three or more samples within a 12 month window exceeding the chronic criteria every four to 20 years. Rare modelled non-compliances are defined as those occurring less than 5% of the time. This would consist of less than 1 in 20 samples exceeding the acute trigger value (i.e. less than 18 days per year), or three or more monthly samples within a 12 month window exceeding the chronic criteria every 20 or more years.

The table includes symbolled classifications indicating where there is further consideration to be given to the modelled non-compliance probability. These classifications include:

- Potential for unaccounted physical and chemical attenuation processes to be reducing in-stream concentrations;
- The potential for trigger exceedances to be influenced by factors not linked to Macraes Operations; and
- The potential for mitigations to be applied that are not represented in the modelled results.

Where no additional symbol is added, the results are considered possible outcomes based on the current understanding of the site and modelled performance of the proposed mitigation measures.

Modelling applies a conservative mass transport assumption, and this provides a credible mass balance for components that remain dissolved under stable geochemical conditions at site, e.g. sulphate, calcium, magnesium and chloride. However, some components such as iron, copper and arsenic can attenuate during transport. These attenuation processes are not built into the model and therefore the model can overestimate concentrations in some situations. In addition, assumed seepage and runoff water quality from waste rock and pit walls are generally considered to rise to peak values then remain static whereas these are likely to decline with time. Comparison between the baseline data and modelled data (and appropriate model calibration) can provide a basis for with which to assess the suitability of the modelled outcomes. This basis and that of potentially mitigating considerations is outlined with the results.

The modelled compliance is addressed by compliance location, where modelled exceedance of the compliance criteria are discussed and outlined in Table 6.3.

Key considerations when viewing these modelled non-compliances are:

– Generally, the risk of modelled trigger exceedance and non-compliance reduce through mining phase B and into the post closure phases once the proposed mitigation measures are implemented and effective.
– The implementation and effectiveness of the mitigation measures as defined are not immediate and in some cases the effectiveness is not realised (within the modelling undertaken) until closure (i.e. The capping of some WRSs). This has an influence on pre-closure modelled compliance.
– Baseline data supports the likelihood of some biogeochemical processes occurring at specific locations that appear to directly influence a decrease in concentrations of some selected elements. The mass conservative WBM does not model these processes.
– Attenuation of contaminants of concern with the sub surface (via chemical and/or physical processes) is not considered within the WBM and its results.
– Treatment potential in pit lakes water is not fully represented in the assumed pit water quality adopted within the WBM.
– Active management has the potential to significantly reduce modelled trigger exceedances and non-compliances. This is especially true for the operation of the flow augmentation dams, and the pit lakes where the current assumed pit lake water quality is considered conservative and overflow can be controlled during lower flow periods.
– Modelled trigger exceedances can be a reflection of both the conservative nature of the some of the modelled inputs and the stochastic combination of ‘worst case’ conditions. The highest modelled concentrations and low-level modelled exceedances can be considered allow probability of being realised in some instances assuming that appropriate performance monitoring and action plans (TARPS) are implemented effectively on site.

*Table 6.2 Compliance Summary*

| Parameter | Deepdell Creek | | | | | Shag River | | | | | | | | | | Mare Burn | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DC08 | | | | | Loop Road | | | | | McCormicks Creek | | | | | MB01 | | | | | MB02 | | | | |
| | Mining Ph.A | Mining Ph.B | Closure | Pit OF | Long-Term | Mining Ph.A | Mining Ph.B | Closure | Pit OF | Long-Term | Mining Ph.A | Mining Ph.B | Closure | Pit OF | Long-Term | Mining Ph.A | Mining Ph.B | Closure | Pit OF | Long-Term | Mining Ph.A | Mining Ph.B | Closure | Pit OF | Long-Term |
| Sulphate | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nitrate-N | ▼ | | | | | | | | | | | | | | | | | | | | | | | | |
| Ammoniacal-N | | | | | | | | | | | | | | | | | | | | | ▽ | | | | |
| Arsenic | | | | | | ▼ | ▼ | ▼ | ▼ | ▼ | ▼ | ▼ | | ▼ | ▼ | | | | ▼ | ▼ | | | | ▼ | ▼ |
| Copper | | | | | | | | | | | | | | | | ▼ | ▼ | ▼ | ▼ | ▼ | ▼ | ▼ | ▼ | ▼ | |
| Iron | | | | | | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | | ▽ | ▽ | ▽ | | | ▽ | ▽ | | |
| Lead | | | | | | | | | | | | | | | | | | | | | | | | | |
| Zinc | | | | | | | | | | | | | | | | | | | | | | | | | |
| pH | | | | | | | | | | | | | | | | | | | | | | | | | |

| Parameter | Waikouaiti River North Branch | | | | | | | | | | | | | | | Murphys Creek | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NBWRRF | | | | | NB03 | | | | | GB02 | | | | | MC01 | | | | | MC02 | | | | |
| | Mining Ph.A | Mining Ph.B | Closure | Pit OF | Long-Term | Mining Ph.A | Mining Ph.B | Closure | Pit OF | Long-Term | Mining Ph.A | Mining Ph.B | Closure | Pit OF | Long-Term | Mining Ph.A | Mining Ph.B | Closure | Pit OF | Long-Term | Mining Ph.A | Mining Ph.B | Closure | Pit OF | Long-Term |
| Sulphate | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nitrate-N | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ammoniacal-N | | | | | | | | | | | | | | | | | | | | | | | | | |
| Arsenic | | | | | | | | | ■ | ■ | | | | ■ | ■ | | | | | | | | | | |
| Copper | | ▼ | | | | | | | | | | | | | | | ▼ | | | | | | | | |
| Iron | ▲ | ▲ | ▲ | ▲ | ▲ | ▽ | ▽ | ▽ | ▽ | ▽ | | | | | | | ▽ | ▽ | ▽ | ▽ | | ▽ | | | |
| Lead | | | | | | | | | | | | | | | | | | | | | | | | | |
| Zinc | | | | | | | | | | | | | | | | | | | | | | | | | |
| pH | | | | | | | | | | | | | | | | | | | | | | | | | |

| Modelled Probability | Descriptor |
|---|---|
| 0 | No modelled exceedance |
| ≤5% | Rare modelled risk of exceedance |
| 5%-25% | Occasional modelled risk of exceedance |
| 25%-50% | Periodic modelled risk of exceedance |
| ≥50% | Frequent modelled risk of exceedance |

| Symbol | Descriptor |
|---|---|
| ▼ | Model likely overstating risk due to conservative transport assumptions and/or conservative input values, and true value is expected to be lower |
| ▲ | Model likely understating risk, and true value is expected to be higher |
| ▽ | Control site considerations could offer mitigation based on historic data |
| ■ | Identified risk is plausible as modelled, with identified further mitigation measures available |

*Table 6.3 Discussion of projected compliance exceedances*

| Parameter, criteria (compliance exceedance range)[1] | Classification | Discussion |
|---|---|---|
| **Mare Burn 01 (MB01)** | | |
| Sulphate, chronic (0-3.2%) | – Mitigations identified | Non-compliances are projected in mining phase A. This is largely an existing risk carried by existing consented activities and will remain until the proposed mitigations are implemented including seepage capture drains and the Coal Creek Augmentation dam. |
| Arsenic, chronic (0-7%) | – Likely overstated,<br>– Mitigations identified | Arsenic non-compliances are predicted in the long term once levels in the CO and CN pits result in discharge via groundwater plumes. These non-compliances are likely overstated in the modelling due to:<br>1. Pit lake arsenic concentrations are assumed to be treated to 0.042 g/m³ and modelling by MWM (2026g) indicates that higher removal rates may be feasible.<br>2. At the Macraes Operation Arsenic in the slow-moving GW plume is shown to significantly attenuated through the rock mass by absorption (Golder 2011b).<br>3. As stream flows tend towards zero, the WBM assumes that the portion of inflow from the GW plume increases to the point of mine water inflows (plumes and seepages) being the whole source of inflow to the stream. In practice, we would expect the mine water flows to become a more dominant feature in the total flow makeup, but not 100% of the makeup. The modelling is conservative in this manner owing to a current lack of detailed low flow monitoring to verify less accurate representations. |
| Copper & Zinc (0-84%) | – Likely overstated, | Copper and zinc non-compliances are predicted through all mining phases, except mining phase A due to the higher current compliance limits. For both these parameters the concentrations are predicted to be higher across most flow regimes during this initial phase until the proposed mitigation measures are implemented.<br>Changes to zinc concentrations are expected to be minimal due to MP4 developments being a function of the additional WRS area only, while Copper concentrations do show corelation with WRS height (MWM 2026b) and the total generated load rises.<br>Current site data shows that attenuation rates are significant for copper, hence, the copper predictions are likely significantly overstated in the modelling results. |
| Iron (0-11%) | – Plausible non-compliance, | Iron concentrations are expected to progressively decrease from commencement of the Project and the compliance risk against the proposed criteria is a function of the proposed triggers lowering from current levels, reducing from 1.0 g/m³ to 0.28 g/m³. The implementation of the proposed mitigation measures including seepage capture, treatment and Camp Creek augmentation dams all serve to reduce iron concentrations from current observed levels.<br>There will be an ongoing risk of trigger exceedance in the Mare Burn and a significant contribution to this is the high iron loads observed at the control site (MB00) and likely other intermediate tributaries, which are not affected by mine water discharges and likely mitigate non-compliances. |
| **Mare Burn 02 (MB02)** | | |
| Sulphate (0-1.8%) | – Plausible non-compliance,<br>– Short term,<br>– Existing | As per MB01, this is an existing risk that will progressively reduce as mitigation measures are implemented. |
| Nitrate-N (0-7.5%) | – Plausible non-compliance,<br>– Short term,<br>– Existing | Existing Nitrate-N levels are elevated in the Mare Burn and an occasional risk of non-compliance against the existing compliance criteria is modelled in mining phase A. Modelling indicates that this risk will be appropriately managed by the proposed mitigation measures, significantly reducing total future Nitrate-N loads to the Mare Burn |

| Parameter, criteria (compliance exceedance range)[1] | Classification | Discussion |
|---|---|---|
| Ammoniacal-N<br>(0-15%) | – Likely overstated, | Modelling predicts a chance of non-compliances at MB02 under the existing criteria and this does not persist once the mitigation measures are implemented.<br>Based on comparison with existing measured data, which has only shown elevated concentrations in March 2020, the modelling is considered to be overly conservative at this location due to attenuation. |
| Copper & Zinc<br>(0-28%) | – Likely overstated, | See MB01 discussion<br>There is potential for further reduction in Copper and Zinc concentrations at this location due to reductions in the pit lake waters from the proposed treatment, and these reductions are not represented in the presented results. |
| Iron<br>(0-9.4%) | – Plausible non-compliance, | See MB01 discussion |
| **Deepdell Creek 08 (DC08)** | | |
| Sulphate<br>(0-2.1%) | – Plausible non-compliance,<br>– Short term,<br>– Existing | A rare probability of non-compliance is predicted at DC08 during mining phase A and commissioning of the Camp Creek Dam mitigates this risk is subsequent phases.<br>Ongoing operational control of mine water discharges in the Deepdell catchment is key to achieving this outcome, including:<br>– Control of water levels within the Round Hill sump to avoid uncontrolled discharge through the historic Golden Point Adit, and<br>– Return pumping of Māori Tommy and Northern Gully silt ponds such that overflows do not adversely affect water quality in Deepdell Creek |
| Nitrate-N<br>(0-6.8%) | – Likely overstated,<br>– Short term,<br>– Existing | A occasional probability of non-compliance is predicted at DC08 during mining phase A and commissioning of the Camp Creek Dam mitigates this risk. Additionally, current Nitrate-N concentrations at DC08 are low and the model is likely over estimating future concentrations. There is some level of attenuation of Nitrate-N through Deepdell Creek due to reducing concentrations observed in measured results, this is not represented in the WBM. |
| Ammoniacal-N | | There are currently no compliance criteria for Ammoniacal-N at DC08. Under current conditions, modelling indicates there would be low level compliance exceedances against criteria applied at other sites. The existing data and expected changes in the catchment over mining phase A do not support these elevated concentrations, indicating that the model is overly conservative in this case.<br>Once the proposed mining phase mitigations have been implemented in the Deepdell catchment, there is no further modelled compliance exceedances. |
| **Shag River at Loop Road** | | |
| Sulphate,<br>drinking water<br>(<1%) | – Plausible non-compliance, | A rare probability of non-compliance against the drinking water criteria is predicted at Loop Road following overflow of the IM pit lake. This model prediction is considered to be a plausible outcome under the current proposed mitigation measures. However, still unlikely to actually occur due to the low modelled probability. Moreover, there is scope to control the discharge from the lake in particularly dry periods if they do not naturally cease due to evaporative effects and/or pump water to the WTP which will likely have spare capacity in drier periods. |
| Arsenic,<br>ecological<br>(0-0.7%) | – Plausible non-compliance,<br>– Mitigations identified | A rare probability of non-compliance against drinking water criteria is predicted at Loop Road from mining phase A and commissioning of the Camp Creek Dam is expected to fully mitigate this risk. |
| Arsenic,<br>drinking water<br>(<1%) | – Plausible non-compliance,<br>– Mitigations identified | A rare non-compliance is predicted at Loop Road during mining and closure, and this risk is expected to be similar to current conditions. Modelled non-compliances increase to occasional once lakes overflow.<br>A low-level chance of compliance exceedance is also predicted once the IM pit lake reaches overflow. Pit lake arsenic concentrations are assumed to be |

| Parameter, criteria (compliance exceedance range)[1] | Classification | Discussion |
|---|---|---|
| | | treated to 0.042 g/m³ and modelling by MWM (2026g) demonstrate that this could improve, mitigating this risk. |
| Iron<br>(0-10%) | – Plausible non-compliance,<br>– Likely overstated | An occasional chance of non-compliance under the existing and proposed criteria is projected for Iron,. This risk aligns with measured data and is generally driven by background inputs. There is insufficient control site data in the Shag River catchment to be certain of the origins of dissolved Iron loading and it is control site data would likely decrease the non-compliances in practice.<br>Based on the modelling and mine generated loads, it is not expected that future concentrations will increase from existing due to the proposed Project. |
| **Shag River at McCormicks Creek** | | |
| Arsenic<br>ecological<br>(0-10%) | – Plausible non-compliance,<br>– Likely overstated | A rare non-compliance risk (1 in 1,000 modelled years) is projected for mining, then further occasional non-compliances following pit lake overflows commencing.<br>The later exceedances are associated with a conservative representation of pit lake overflows and seepage discharges from the TTTSF to the Tipperary Creek / McCormicks Creek catchment. This risk is likely overstated in the modelling. |
| Arsenic<br>drinking water<br>(0-7.5%) | – Plausible non-compliance,<br>– Likely overstated | As per the Arsenic ecological criteria. |
| Iron<br>ecological<br>(0-12%) | – Plausible non-compliance,<br>– Likely overstated | A low risk of compliance failure is projected in the pit overflow phase, associated with a conservative representation of seepage discharges from the TTTSF. This risk is likely overstated in the modelling. |
| Iron,<br>Drinking water<br>(0-19%) | – Plausible non-compliance,<br>– Likely overstated | As per the Iron ecological criteria. |
| **Murphys Creek 01 (MC01)** | | |
| Sulphate,<br>(<1%) | – Plausible non-compliance,<br>– Short term<br>– Existing | A low-level chance of compliance exceedance under existing criteria is projected at MC01 during mining phase A. This aligns with current measured observations and considers reducing loads being discharged as the seepage capture systems are installed. No exceedances are predicted beyond the initial mitigation measures of seepage capture and treatment being commissioned. |
| Copper,<br>(0-25%) | – Plausible non-compliance,<br>– Short term | A risk of exceeding the copper criteria during mining phase B is projected, this results from elevated uncaptured loads from Frasers West WRS seepage. This load is modelled to reduce following WRS capping and rehabilitation and no non-compliances are projected beyond closure.<br>There is expected to be a greater level of attenuation than represented in the modelling and the proposed interim management practices on Frasers West WRS surfacing is expected to reduce infiltration rates from current (and modelled inputs), reducing risk of non-compliance. |
| Iron,<br>(0-85%) | – Plausible non-compliance,<br>– Existing | frequent non-compliance under mining phase B is projected, with this being predominantly an existing effect that is not projected to worsen with the Project. Compliance failure is not modelled in mining phase A due to the higher acute compliance limit of 1 g/m³, which reduces to a chronic trigger of 0.28 g/m³. The chance of compliance exceedance then reduces from closure as capping has an effect on infiltration rates at Frasers West WRS.<br>There is expected to be a greater level of attenuation than represented in the modelling and the proposed interim management practices on Frasers West WRS surfacing is expected to reduce infiltration rates from current (and modelled inputs), reducing risk of non-compliance. |
| Zinc,<br>(0-72%( Ph.B)) | – Plausible non-compliance,<br>– Short term | As per Iron above. The project is not expected to worsen discharges of zinc to this catchment. Modelling shows the proposed compliance limit at this location results in frequent non-compliance until all proposed mitigation options are fully implemented. |

| Parameter, criteria (compliance exceedance range)[1] | Classification | Discussion |
|---|---|---|
| | – Existing | |
| **Murphys Creek 02 (MC02)** | | |
| Sulphate, (<1%) | – Plausible non-compliance,<br>– Short term<br>– Existing | A low-level chance of compliance exceedance under existing criteria is projected at MC02 during mining phase A. This aligns with current measured observations and considers reducing loads being discharged as the seepage capture systems are installed. No non-compliances are predicted beyond the initial mitigation measures of seepage capture and treatment being commissioned at Murphys Creek and Clydesdale silt ponds. |
| Copper, (0-4.1%) | – Plausible non-compliance,<br>– Short term | A rare non-compliance under existing criteria is projected at MC02 during mining phase B. This aligns with current measured observations and considers reducing loads being discharged as the seepage capture systems are installed. No non-compliances are predicted beyond the initial mitigation measures of seepage capture and treatment being commissioned. |
| Iron, (0-59%) | – Plausible non-compliance,<br>– Short term<br>– Existing | As per MB01, with additional contributions from Golden Bar WRS included. No risk of non-compliance modelled beyond closure. |
| Zinc, (0-18%) | – Plausible non-compliance,<br>– Short term<br>– Existing | As per MB01, with additional contribution from Golden Bar WRS included. No risk of non-compliance modelled beyond closure. |
| **Waikouaiti River North Branch at Ross Road Ford (NBWRRF)** | | |
| Sulphate, (1-18%) | – Plausible non-compliance, | Rare non-compliances against existing sulphate criteria are modelled through mining phase A and this is primarily attributed to the period of time before the seepage capture systems are implemented and the stage 1 WTP is operational discharging 4.2 L/s above NBWRRF.<br>Occasional non-compliances are predicted during mining phase B where the modelling represents a reduced WTP discharge rate (based on only the captured seepage water being treated and returned), and elevated WRS infiltration rates persist. There is scope to manage these exceedances by adjusting the WTP discharge rates to this catchment. The proposed interim WRS management practices that are not represented in the modelling may also reduce sulphate concentrations (refer to Appendix F).<br>Following closure, the proposed mitigation measures result in a low residual risk of compliance failure, reducing from 2.2%. |
| Nitrate-N, (-) | - Likely overstated | Modelling does not project any Nitrate-N compliance failures with WTP discharges including targeted Chloride adjustments to manage toxicity effects. The modelled Nitrate-N can be elevated within this catchment.<br>Measured data indicates that there is naturally high attenuation rates within the upper reaches of the Waikouaiti River North Branch, given high concentrations recorded near the mine and consistently low concentrations near NBWRRF. This is likely to continue. However, further understanding of the flows regimes and attenuation mechanisms would be required to rely on this mechanism long term. |
| Copper, (0-1.4%) | – Likely overstated | Rare non-compliance for copper is projected through mining phase B, associated with uncaptured seepage from Frasers West WRS and the elevated mining phase infiltration rates. Once all proposed mitigation measures are implemented there are no further modelled compliance exceedances. |
| Iron, (-) | – Likely understated | Modelling does not indicate any risk of failing compliance based on current Acute and proposed Chronic Iron concentrations, however, applying the proposed criteria to measured data indicates frequent compliance failure is likely (Viridis, 2026). In this case the modelled results are unconservative and there is a residual risk. There is no relevant control site to determine the source of Iron, however, comparison with the Mare Burn control point MB00 suggests that the source may not be mine related. This is described further in Appendix E. |

| Parameter, criteria (compliance exceedance range)[1] | Classification | Discussion |
| --- | --- | --- |
| Zinc, (3-37%) | – Plausible non-compliance, | Periodic non-compliance is projected for mining phase B, where the proposed compliance regime is implemented. With the proposed mitigation measures being implemented, the contaminant mass load will be reducing through this same period from existing levels. Compliance exceedance risk reduces to a low-risk post closure. These non-compliances are likely overstated in the modelling due to the current observed concentrations in the upper reaches of the Waikouaiti River North Branch, however, there is insufficient baseline data to reduce the modelled source terms at this stage. |
| **Golden Bar Creek 02 (GB02)** | | |
| Arsenic, (0-69%) | – Mitigations identified | Frequent non-compliance is projected at GB02 once the Golden Bar pit overflows resume. With the proposed in pit treatment mitigation applied, concentrations will be lower than current conditions. Pit lake arsenic concentrations are assumed to be treated to 0.042 g/m³ and modelling by MWM (2026x) demonstrates that this could improve, reducing this risk. The pit lake could be managed (via selective pumping) to prevent overflows during period of elevated risk of compliance exceedance. |
| **Waikouaiti River North Branch 03 (NB03)** | | |
| Sulphate, drinking water, (15-35%) | – Plausible non-compliance | Occasional non-compliances against the drinking water criteria for sulphate is projected through all project phases, with temporarily elevated risks through mining phase B to periodic non-compliance. The contributing sulphate flux is primarily due to uncaptured seepage from Frasers WRSs and Golden Bar WRS. |
| Arsenic, drinking water, (<1%) | – Mitigations identified | Rare non-compliance for arsenic at NB03 is projected once Golden Bar pit overflows. Refer to GB02 discussion for mitigations. |
| Iron, ecological & drinking water, (0-38%) | – Mitigations identified | Periodic non-compliance is projected at NB03 during mining. This risk is existing in current mining activities and the proposed mitigation measures are expected to reduce iron fluxes as they are implemented. The existing measurements at this site are also expected to be highly influenced by natural catchment inflows. |

[1]. Ecological compliance exceedance unless otherwise stated. Values provide the range of exceedances over all mine phases, see full breakdown in Appendix H.

### 6.3.4 Climate Change Sensitivity Assessment

A climate change sensitivity assessment was undertaken using the RCP8.5 scenario, incorporating projected changes to rainfall and evaporation. The detailed results and discussion for this is presented in Appendix H Climate change is likely to increase hydrological variability, resulting in more frequent and prolonged low-flow periods during summer. Under these conditions, mine water discharges comprise a greater proportion of receiving water flows, leading to modest increases in predicted contaminant concentrations and non-compliance risk at some compliance locations.

Overall, the assessment indicates increases in median, 95th percentile, and maximum constituent concentration statistics generally less than 10% across compliance sites. Where a non-zero risk of non-compliance exists under baseline conditions, climate change typically results in a corresponding increase in non-compliance probability. Notable exceptions include a reduction in arsenic non-compliance risk at GB02 and additional rare non-compliance events for copper at MB02 and zinc at MC01.

The modelling demonstrates that the proposed mine design and mitigation measures provide resilience to climate change impacts. Key controls include flow augmentation dams that maintain baseflows during dry periods, the WTP which provides operational flexibility and treatment capacity for mine-affected water, pit lake discharges that can cease during extended dry periods, and enhanced WRS capping that may further reduce infiltration and seepage generation under future rainfall regimes.

### 6.3.5 Water Treatment Plant

The proposed WTP operation as implemented in the WBM is outlined in Appendix F. Two stages of WTP development are represented in the WBM:

- Stage 1 – a plant treating up 5 L/s and discharging primarily to the Waikouaiti River North Branch, likely near Giffords Road.
- Stage 1 – a full-scale plant treating all captured seepage waters with distributed discharges across the Macraes Operation.

A summary of the mean inflow rates to the WTP estimated by the WBM are outlined in Table 6.4 with the following key transitions:

- Through stage 1, in Mining phase A, of the WTP inflow rates are modelled as 5 L/s, resulting in a discharge rate of 4.25 L/s based on 15% of influent waters retained as brine.
- Inflow then rises to a mean inflow of 18.2 L/s representing maximum possible captured WRS seepage in mining phase B.
- Immediately following completion of mining, it is assumed that the reductions in WRS seepage rates will not yet be recognised, with influent WRS remaining at 18.2 L/s. In addition, the TSF underdrains will also be treated through the plant at a projected rate of 26.9 L/s.
- Approximately 10 years post closure WRS seepage rates and TSF underdrain flows are expected to have reduced to mean inflows of 7 L/s and 15.9 L/s respectively.

During mining, mean annual inflow rates to the WTP are estimated to be 18.2 L/s and rise to 45.1 L/s at closure. By 2050 total inflow rates are estimated to reduce to a mean annual flow of 22.9 L/s. For application of these modelling outcomes, it is suggested that a variability of ±30% is applied to the annualised flow rates (to account for the likely variation in daily treatment requirements) and an additional +25% contingency (to account for uncertainty in seepage flow capture rates).

Table 6.5 summarises the mean influent concentrations for WRS seepage and TSF underdrains, with the annual contaminant mass loading rates. It is suggested that a variability of ±30% is applied to the annualised loading rates. Note that the dates defined are selected on the basis of being key inflection points on the contaminant and flow loading rates to the WTP.

*Table 6.4 Summary of WTP mean inflow rates by mining phase*

| Phase | Mining Stg.1 WTP (2030)[1] | Mining Stg.2 WTP (2032)[2] | Closure (~2040)[3] | Post Closure (~2050)[3] |
|---|---|---|---|---|
| WRS Seepage Combined (L/s) | 5 | 18.2 | 18.2 | 7 |
| TSF Underdrains Combined (L/s) | - | - | 26.9 | 15.9 |
| Total Mean Inflow (L/s) | 5 | 18.2 | 45.1 | 22.9 |

[1]. Stage 1 WTP at peak flow of 5 L/s assumed.
[2]. Stage 2 WTP with current WRS infiltration rates.
[3]. Stage 2 WTP with reduced WRS infiltration rates recognised.

*Table 6.5 Summary of WTP mean influent water concentrations and mass loading rates*

| Parameter | Influent Concentrations ($g/m^3$) | | Influent Mass Loads (kg/yr) | | | |
|---|---|---|---|---|---|---|
| | Combined WRS seepage | Combined TSF under drains | Mining (2030)[1] | Mining (2032)[2] | Closure (~2040)[3] | Post Closure (~2050)[3] |
| Ammoniacal-N | 0.139 | 7.5 | 21.9 | 79.6 | 6,440 | 3,790 |
| Arsenic | 0.00163 | 5.42 | 0.257 | 0.936 | 4,600 | 2,720 |
| Copper | 0.0109 | 0.0015 | 1.72 | 6.27 | 7.55 | 3.17 |
| Hardness (as $CaCo_3$ eq) | 2,870 | 2,430 | 453,000 | 1,650,000 | 3,710,000 | 1,850,000 |
| Iron | 0.06 | 20.7 | 9.45 | 34.4 | 17,600 | 10,400 |
| Lead | 0.00016 | 0.00105 | 0.0252 | 0.0916 | 0.984 | 0.563 |
| Nitrate-N | 9.62 | 0.66 | 1,520 | 5,520 | 6,080 | 2,450 |
| Sulphate | 2,320 | 2,980 | 366,000 | 1,330,000 | 3,850,000 | 2,000,000 |
| Zinc | 0.0852 | 0.00249 | 13.4 | 48.9 | 51 | 20.1 |
| DOC | 0.0995 | - | 15.7 | 57.1 | 57.1 | 22 |
| Chloride | 9.9 | 25.5 | 1,560 | 5,680 | 27,300 | 15,000 |
| pH (pH units) | 7.4 | 7.2 | - | - | - | - |

[1]. Stage 1 WTP at peak flow of 5 L/s assumed.
[2]. Stage 2 WTP with current WRS infiltration rates.
[3]. Stage 2 WTP with reduced WRS infiltration rates recognised.

Modelled WTP discharge concentrations are presented in Appendix H. There is scope to dispose some of the treated water across the Macraes Operation to developing pit lakes or through irrigation. However, given the quality of the water expected to be achieved from the plant, this is generally considered to be counterproductive to achieving the desired receiving environment water quality outcomes as the WTP discharges create a positive water quality mitigation affect.

### 6.3.6 Freshwater Dams

Low flow periods are when there is the greatest risk of exceedance of the current and/or proposed receiving surface water quality compliance targets. These periods are when there is elevated risk of groundwater drawdown induced flow reductions and/or elevated contaminants of concern (via uncaptured seepage). The consented, but yet to be constructed, Camp Creek and Coal Creek freshwater augmentation dams are modelled to be constructed and commissioned during mining phase A . They provide augmentation flows in Deepdell Creek and Mare Burn catchments respectively during periods of low flow reducing the risk of surface water quality compliance target exceedance and provide capacity for releasing “fresher” flows for Periphyton flushing if required. Their proposed operation is detailed in Appendix F.

To allow for flushing flow prevision a lower storage capacity of 80,000 $m^3$ is represented in the Camp Creek Dam and 45,000 $m^3$ is provided in the Coal Creek Dam.

The WBM provides an estimation of water storage availability in each impoundment which has been used to optimise attenuation flow rates applied to the respective receiving environments. The stochastic model representation of water storage in both the Camp Creek and Coal Creek freshwater augmentation dams is provided in Figure 6.29 and Figure 6.30 respectively. The results show that generally, there is sufficient storage available after filling such that the risk of there being no augmentation water available (dam volumes dropping below the live storage volume) is low. This risk is more elevated during the filling phase, particularly if the filling phase coincides with a prolonged low flow period.

It is concluded that the freshwater dams enable the practical implementation of the augmentation flow regime as outlined in Appendix F with a minor risk during an extended low flow period.

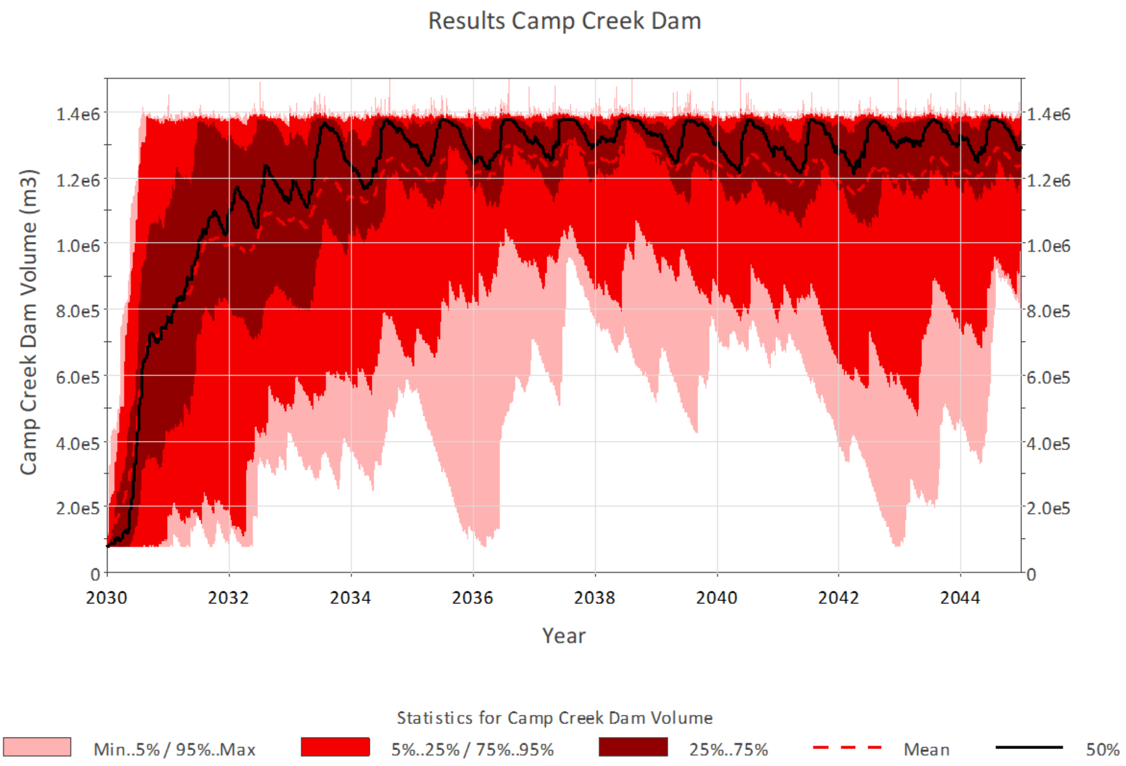


*Figure 6.29 Camp Creek dam - Probabilistic filling rate*

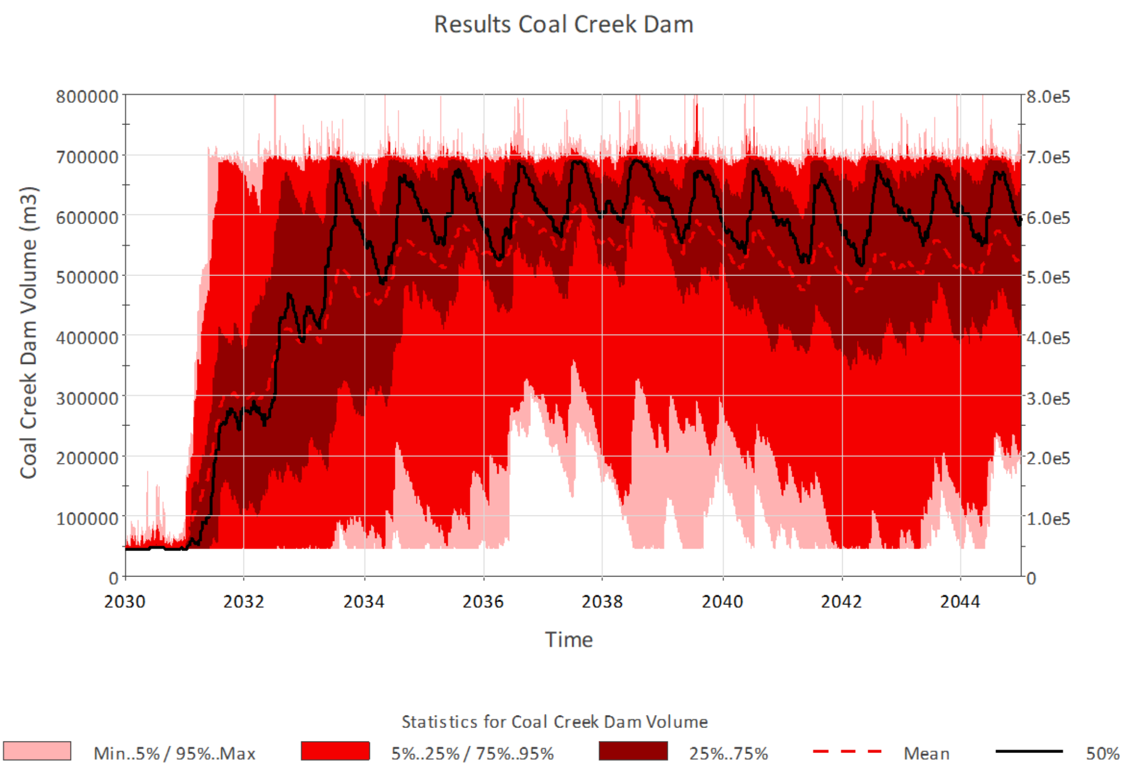


*Figure 6.30 Coal Creek dam - Probabilistic filling rate*

## 6.4 Surface Water Summary

An sitewide Goldsim Water Balance Model (WBM) has been updated to estimate future impacts on the receiving water quality as a result of mining and rehabilitation activities. The WBM includes catchment boundaries and landforms to reflect both the current and future developments under MP4; such as pit lake groundwater inflows and outflows; seepage estimates from the groundwater modelling undertaken; pit lake and seepage water quality estimates; and recalibration of the WBM utilising updated flow and water quality monitoring data.

Proposed mitigation measures have been incorporated into the WBM as per a defined implementation timeline with the monitoring of surface water and groundwater to be implemented during the early phases of the project, and detailed design and construction of physical water management features to take place including:

- Construction of seepage capture drains and toe bunds,
- Implementation of a water treatment plant,
- Construction of the Camp Creek and Coal Creek augmentation dams,
- Improvements to current and future WRS construction methodology and management practices to minimise infiltration rates,
- Ongoing monitoring and water treatment of pit lakes through ferric chloride dosing for managing arsenic and dissolved metals concentrations, and
- Implementation of a flushing regime (where indicated by periphyton monitoring programs).

The modelled pit lakes (formed in Golden Bar Pit, Coronation Pit, Coronation North Pit and the Innes Mills Pit) are predicted to overflow following the cessation of dewatering activities after a median modelled timeframe of 58, 23, 64 and 67 years respectively and overflow water (based on defined water quality) directly impacts compliance monitoring locations during the modelled closure period. Overflow water quality is significantly improved by Ferric Chloride dosing of the pit lakes in the closure phase (MWM 2026g).

The WBM predicts that generally, long term concentration of contaminants of concern are lower during low flow periods compared to current conditions and this is a reflection of interception and capture of seepage, the operation of the augmentation dams (discharging to Mare Burn and Deepdell Creek) as well as capping of the WRSs. The active WTP is estimated to treat an average of approximately 45 L/s of captured seepage waters on closure, waters that would otherwise contribute to the contaminant load within the receiving surface water environment. This volume is modelled to decrease by nearly half to 23 L/s within 10 years on closure as seepage rates as TSF underdrain rates reduce. Discharges from the WTP to receiving waters create a positive water quality mitigation measure in the receiving environment due to the relatively good quality discharge compared receiving water quality in low flow periods. Some increases in concentrations are predicted as a result of pit lake overflow in the post closure period.

Modelling indicates that when the proposed mitigation measures are combined with the Camp and Coal Creek augmentation dams, the proposed surface water quality compliance limits will be met in most of the time. The implementation of the mitigation measures during mining Phase A and becoming operational in phase B and beyond is clear in the result of modelling.

There are some exceptions with modelled results indicating concentrations that exceed the proposed water quality limits for some contaminants of concern during both the mining and closure phases. During mining, uncaptured seepage plays contributes to modelled copper exceedances within the Mare Burn at compliance location MB01 and modelled zinc exceedances within the Waikouaiti North Branch at compliance locations MC01 and NBWRRF. This is a result of current high infiltration rates to the Frasers, Trimbells and Coronation North WRSs. These infiltration rates (and resultant uncaptured seepage volumes) are significantly reduced with appropriate capping (proposed at closure) and the installation of the capture drains (proposed during the mining phase)

To address the higher WRS infiltration rates during the operational phase of the project, the site is committed to introducing interim WRS management practices. These involve any sections of WRS's that will be or can be made dormant for 12 months or more into an active water shedding (reduced permeability) state. These outcomes are not quantified in the modelling, so are expected to represent an improvement to the presented results.

In addition, modelled copper and Nitrate-N concentrations are overrepresented at compliance locations MB01 and NBWRRF respectively compared to the current baseline data. This suggests that there are potentially biogeochemical processes occurring upstream of these locations that are directly influencing the downstream concentrations of these elements. Modelled concentrations and non-compliances (where applicable) are therefore not supported by the current in-stream dataset for Copper and Nitrate-N at these respective locations and are likely a result of the mass conservative nature of the WBM.

During the closure phase, potential non-compliances are reduced compared to mining phase non-compliance projections, reflecting the capping and rehabilitation of the WRSs at closure and the reduction in the uncaptured seepage volume (and mass) reporting to the receiving surface water environment. Remaining modelled non-compliance projections are largely associated with the pit lake overflows. It is considered that active management and treatment of pit lake water quality and representation of revised treatment outcomes in the WBM has the potential to significantly reduce these modelled exceedances before these pit lakes are discharged to the environment. There are also potential long-term management solutions allowing control of the lake discharges as a contingency measure if deemed necessary for receiving water quality outcomes.

# 7. Conclusions

Groundwater modelling indicates that groundwater inflows to, and seepage from, the existing and proposed pits, waste rock stacks, tailings storage facilities and pit lakes are expected to occur predominantly through the weathered and fractured schist. Groundwater flow and drawdown effects associated with current and proposed mining activities are predicted to remain largely localised around the existing and proposed pit extensions and underground workings. On this basis, there are no modelled drawdown effects on non-OGL groundwater bores.

Modelling results indicate that dewatering for the proposed pit and underground workings extensions will reduce groundwater discharge to some local streams and creeks; however, these reductions are expected to represent a relatively small proportion of the total groundwater contribution to stream flows for the majority of the creeks. However, for Deepdell Creek (to DC08) and its tributary ephemeral streams, the predicted reduction in groundwater discharge is calculated to be 1.5 L/s (a 3.4% decrease compared to the existing conditions modelled groundwater discharges).

Sulphate is the primary contaminant indicator for transport modelling because it is expected to occur at elevated concentrations, is already present in some receiving waters as a result of historic mining activities, and has limited attenuation potential within the groundwater system. The contaminant transport modelling results have therefore been used to provide conservative estimates of groundwater-derived contaminant fluxes for input to the surface water quality assessment.

Estimated sulphate fluxes include approximately 68 kg/day from the Coronation area and 291 kg/day from the Central Area to Deepdell Creek, approximately 412 kg/day from the Coronation area to the Mare Burn, and approximately 149 kg/day from the Golden Bar area and 418 kg/day from the Central Area to the Waikouaiti River North Branch. The majority of the modelled contaminant mass is sourced from waste rock stack seepage, with additional contributions from pit lakes and other mine-related sources.

Current consented groundwater takes, bores and proposed bores were reviewed against the maximum predicted extent of the modelled sulphate plume. This review indicates that these groundwater receptors are not expected to be intersected by the predicted plume extent, and adverse water quality effects on groundwater users are therefore unlikely.

Overall, groundwater modelling results indicate that groundwater-related water quality effects from the proposed mining activities are expected to be manageable with the proposed mitigation measures. Seepage capture drains, water treatment,  waste rock stack capping, pit lake monitoring and treatment are important controls for reducing groundwater-derived contaminant loads to receiving surface waters during operations and closure. The groundwater-derived contaminant fluxes have been incorporated into the receiving surface water quality assessment and provide a conservative basis for assessing long-term cumulative surface water effects.

Water quality is currently deteriorating on site and is predicted to continue to deteriorate under status quo management options. To meet the proposed compliance limits, it is shown that a number of mitigation measures are required. The WBM results represent a number of proposed mitigation measures which are assumed applied on a progressive basis both during the mining and closure phases of the proposed project. As these mitigations are implemented through early phases of MP4 there is a risk that water quality deteriorates from current levels before the benefits of the mitigations are realised. Generally, this deterioration in water quality in the short term is not a function of MP4. The mitigation measures are:

– Construction of seepage capture drains and toe bunds,
– Implementation of a water treatment plant,
– Construction of the Camp Creek and Coal Creek augmentation dams,
– Improvements to current and future WRS construction methodology and management practices to minimise infiltration rates,
– Ongoing monitoring and water treatment of pit lakes through ferric chloride dosing for managing arsenic and dissolved metals concentrations, and
– Implementation of a flushing regime (where indicated by periphyton monitoring programs).

In general, the modelling indicates that upon closure, the proposed surface water quality compliance limits will largely be met. This indicates the implementation of the mitigation measures during the operational phase of the mine and into closure. The exceptions to this are some modelled increases in concentrations and/or exceedances noted for some contaminants of concern during both the mining and closure phases. These are outlined as follows:

*Mining Phase Non-Compliances*

During the mining phase, it is noted that high exceedances of Copper (in the Mare Burn at MB01) and Zinc (in the MC01 at NBWRRF) – 72% and 37% respectively are modelled. Uncaptured seepage plays a significant role within the modelled exceedances as presented. Due to the modelled higher infiltration rates applied to the Frasers WRS, Trimbells WRS and the Coronation North WRS, the volume of uncaptured seepage during the mining phase (rehabilitation and lower net infiltration is not modelled until closure) is significantly higher during mining than at closure. This results in a significantly higher load of contaminants of concern discharging untreated to the respective receiving surface water environments until appropriate capping is put in place. It is expected that these elevated infiltration rates (and hence higher uncaptured) loads could be reduced by the implementation of appropriate active management on the surfaces of these uncapped WRSs until final closure and rehabilitation is achieved.

In addition, it is important to note that the modelled water quality (for both Copper at MB01 and Nitrate-N at NBWRRF) representing current conditions does not compare well with recent measured water quality at compliance locations within these catchments. This suggests that there are biogeochemical processes occurring within these catchments that are directly influencing the downstream concentrations of both Copper and Nitrate-N in these catchments. The mechanisms for this reduction in mass (and hence concentration) are not currently well understood, however it is likely these ‘attenuation’ mechanisms will continue to influence the downstream concentrations of these contaminants of concern in the future. The modelled concentrations and exceedances of the compliance limits (where applicable) are therefore not supported by the current in-stream dataset for Copper and Nitrate-N at these respective locations and are likely a result of the mass conservative nature of the WBM.

*Closure Phase Non-Compliances*

Modelled closure phase non-compliances are generally significantly reduced compared to modelled mining phase non-compliances in magnitude and frequency. This reflects the successful capping and rehabilitation of the WRSs at closure and the reduction in the uncaptured seepage volume (and mass) reporting to the receiving surface water environment. Increases in modelled non-compliance probabilities (compared to the mining phase) are modelled where pit lake overflows have a significant influence on the receiving surface water environment. This is particularly noted at compliance monitoring location GB02 for Arsenic (modelled exceedance of up to 69%) and Sulphate at compliance monitoring location NB03 (modelled non-compliances of up to 38%). It should be noted that overall Arsenic concentrations at GB02 are predicted to improve compared to current conditions and the modelled exceedance is a result of the recommended more stringent compliance limits. Active management of pit lake water quality has the potential to significantly reduce these modelled exceedances before these pit lakes are discharged to the environment with the current assumed pit lake water considered a conservative estimate of resultant pit lake water quality once pit lake treatment has been undertaken.

Further to this, it is important to consider that model is deliberately structured so that uncertainty is combined in a manner that highlights the key areas of risk rather than mask them. Modelled trigger exceedances are at times a reflection of both the conservative nature of the some of the modelled inputs and the stochastic combination of ‘worst case’ conditions. It should be noted that the highest modelled concentrations and low-level modelled exceedances can be considered a  low likelihood of being realised  These exceedances therefore have, and should continue to, inform risk-informed decisions and outcomes (including management actions to address areas of higher risk). The reported outcomes should inform application of management strategies that will have improvements beyond what is modelled in this work (such as the interim waste rock stack management). Recommendations as outlined in the next section will go some way to address the uncertainty (within the modelling undertaken) and help to refine mitigation measures and reduce uncertainty and risk in to the future.

*Climate Change Non-Compliances*

Climate change is likely to increase hydrological variability, resulting in more frequent and prolonged low-flow periods during summer. Under these conditions, mine water discharges comprise a greater proportion of receiving water flows, leading to modest increases in predicted contaminant concentrations and non-compliance risk at some compliance locations. Overall, the assessment indicates increases in median, 95th percentile, and maximum constituent concentration statistics generally less than 10% across compliance sites. Where a non-zero risk of non-compliance exists under baseline conditions, climate change typically results in an increase in non-compliance probability.

# 8. Recommendations

This section outlines the key recommendations that will provide ongoing verification of this work and assist in meeting the outcomes presented in this report.

The groundwater and surface water assessment presented includes modelling undertaken by GHD and a range of inputs from other parties. Recommendations made here cover the direct outcomes of the GHD assessments, and recommendations that could affect key inputs from other parties where it affects the outcomes of this report.

**Surface water assessment**

1. Site hydrology and climate inputs are primarily determined by flow monitoring in Deepdell Creek and Climate monitoring at Macraes and Golden point weather stations. It is expected that there is significant variability in the climatic conditions given the spatial and topological distribution of the site. To improve certainty on model calibrations and environmental assessments going forward it is recommended that electronic weather stations including evaporation measurements be maintained near Coronation North, Golden Point and Frasers South areas. These locations are at approximately 5km intervals with 300 m of elevation difference between them.

   ***Monitoring and model validation***

2. The modelling results presented incorporate a range of mitigation measures that are well understood, including, a two-stage water treatment process, seepage capture systems, flow augmentations and WRS cover systems. Performance monitoring and benchmarking against the assumptions outlined in this report will be required to validate the model outcomes.

   ***Attenuation***

3. The WBM implements a conservative mass balance approach to modelling. Through comparison with existing data it is noted that there is significant attenuation of some contaminants in the receiving waters as supported by the reduction in concentrations between mine water discharges, control sites and compliance monitoring sites. It is recommended that additional studies are undertaken to categorise and represent this behaviour in the surface water modelling. This is expected to reduce uncertainty introduced through conservatism and provide improved confidence in the predictive capabilities of the model.

**Mitigation measures**

   ***Water Treatment and Discharge***

4. Active water treatment is proposed to meet the water quality objectives of this Project, and it will require significant ongoing inputs. It is recommended that source contaminant reduction and passive treatment options continue to be investigated with the aim of reducing the ongoing reliance on active water treatment systems.
5. It is recommended that management options for WTP brine are further investigated for the purpose of increasing the fraction of treated water that can be returned, increasing stream flows, and reducing disposal volumes of brine during mining and post closure.
6. Water treatment implementation currently assumes that all influent streams are combined prior to treatment and returned to the respective catchments based on the fractional influent flow rates. This is likely a sub-optimal arrangement for long-term environmental outcomes. It is expected that there will be room for improving this approach as the WTP is implemented, and further source water and receiving water flow and concentration monitoring has been undertaken. It is recommended that further evaluation of the proposed WTP discharge arrangements is undertaken and discharge arrangements are amended with a target of achieving overall improvements to environmental outcomes. It is suggested that a SQEP/s be involved in preparing a management plan that determines a preferred outcome for the WTP discharges based on environmental outcomes and the long-term practicalities associated with operating the system. It is anticipated that once the seepage capture systems and WTP have been commissioned there will be valuable data available for supporting this assessment. This is particularly relevant for the following areas:
   - Seepage from Coronation WRS is represented as returning to the Coronation Silt Pond, upstream of the proposed Camp Creek Dam. An alternative discharge could be to Deepdell Creek at or above DC04 to reduce permanent pumping needs to Coronation, Discharge rating curves from Camp Creek would be

adjusted to match the re-distribution of water. From a stream flow perspective, this would result in a reduction in baseflow upstream of the Camp Creek Dam.

- Seepage water from WRSs in the Mare Burn catchment is modelling as returning to the point of capture, resulting in constant discharge to streams that were likely ephemeral pre-mining. It may be preferable for the long-term discharges to be to one or two discrete locations in Trimbells Gully, Māori Hen silt pond, or the Coal Creek freshwater dam.
- Seepage water captured from Frasers East and Frasers West WRSs is represented as being discharged to the point of capture. In practice this is unlikely to be the best arrangement for Frasers East WRS due to the risk of flow losses as water is conveyed across the Frasers Backfill, via the re-connected Waikouaiti River North Branch head waters. A concentrated discharge near the monitoring site NBWRGR near the historic Gay Tan's House may be preferable. The portion of water taken from Frasers West WRS at Murphys Creek should be considered separate from this, as it will for a significant contribution to the base flow in Murphys Creek.
- Seepage water captured from Clydesdale silt pond is represented as discharging back at this location. Long-term, this requires a two-way pipeline to be maintained if a centralised WTP is implemented. The return pipeline could be removed and no effect on modelling outcomes presented if the discharge of this treated water was to Murphys Creek (below Murphys Creek silt pond). However, it would result in a small reduction in baseflow in Clydesdale Creek from the silt pond to the confluence with Murphys Creek at MC02 (approximately 2 km).

It is recommended that this is captured in a WTP discharge management plan prepared prior to the full scale WTP being commissioned.

7. It is recommended that in-pit water treatment for arsenic removal be trialled and monitored to (i) improve the understanding of the expected efficiency of the treatment, and (ii) improve understanding of future treatment frequencies and appropriate delivery mechanisms for these treatments, thus, determine the reliability at which the target in-pit water quality objectives can be met.

***Pit Lake Discharge and Management***

8. It is recommended that provision be made for active management of pit lake discharges through discharge control and treatment if required to meet receiving environment water quality objectives in the long-term.

***WRS Construction Methodology***

9. A key input to the surface water modelling is the assumed infiltration rates for the WRSs which have been developed off limited measured data.
   a. It is recommended that a detailed WRS construction and capping/rehabilitation methodology is developed and implemented to promote water shedding and evapotranspiration capabilities.
   b. It is recommended that localised adjustments be made to existing WRSs to reduce surface ponding and areas promoting infiltration.
   c. It is recommended that site wide monitoring of seepage flow rates be undertaken as outlined in the monitoring plan.

***Seepage capture systems***

10. The seepage capture systems form an integral component of the water management strategy proposed for the Macraes Operation as a result of MP4. They offer the first significant reduction in mass load contributing to the receiving waters. An improved understanding of the flow rates captured by these systems is essential for sizing water treatment and transmission infrastructure. Early construction of these seepage collection systems should be prioritised as they will affect the development of the full scale WTP and capturing baseline measurements to assess improvements in cover systems against.

***WBM Updates***

11. It is recommended that an update to the WBM and the findings of this study be completed prior to the commissioning and detailed design of the full scale WTP (by the end of 2030) that incorporates the following:
    - Additional monitoring data collected
    - Performance monitoring of seepage capture drains

- Calibration of a seepage flow model with antecedent rainfall data and river flow
- Performance of pilot and stage 1 WTPs
- Flow monitoring undertaken in The Mare Burn, Deepdell and Waikouaiti River
- Any realised gains on WRS capping methodology and management
- Report on the outcomes expected as the site progresses to the proposed compliance criteria.

**Groundwater and Surface Water Monitoring**

A separate surface water and groundwater monitoring plan (GHD 2026b) has been developed that outlines detailed monitoring requirements for the site. The following aspects of this plan are required to be implemented to support the modelling and mitigations proposed in this report.

12. Groundwater detection bores shall be constructed for the ongoing monitoring of potential plume migration and to monitor groundwater levels . Recommended locations for these are provided in GHD (2026b).
    a. Continuous groundwater level, EC and temperature monitoring using loggers, data recording intervals ≤1hr.
    b. Groundwater quality sampling quarterly

    Surface water flow and water quality monitoring at or near MB02, DC08 and NB03. As it is likely impractical to install monitoring equipment at these exact locations, it is recommended that a site investigation culminating in a documented feasibility assessment is carried out to determine suitable sites. Provision for long-term access, reliability of measurements, and damage prevention should be considered in sighting the monitoring points in preference to aligning to the current WQ measurement site.
13. Monitoring should include the following metrics:
    a. Real time flow rate with remote monitoring, data recording intervals ≤1hr.
    b. Real time water quality with remote monitoring, data recording intervals ≤1hr. It is recommended that water quality monitoring include a minimum of electrical conductivity (EC), pH, temperature and turbidity. Real time sampling equipment is also available that can capture the full array of compliance parameters and it is recommended that these be investigated for application for the following reasons; (i) EC currently maintains a strong relationship with sulphate concentrations and can be used as an indicator of mine water discharges, this relationship may not hold once WTP discharges commence, and (ii) a track record of the technology applied on site may allow for less labour intensive sampling programs later in mining or closure. It is not recommended that this sampling replaces physical monthly sampling for compliance.
14. Mine water flow and water quality monitoring
    a. It is recommended that real time flow rate, EC, pH and temperature monitoring be installed at mine water seepage and discharge locations as per Table 5.1 of GHD (2026b), data recording intervals ≤1hr.
    b. Once installed, it is recommended that flow and EC monitoring commences on the seepage capture locations, with data recording intervals ≤1hr. In addition, a complete suite of monthly water quality sampling be undertaken.
    c. Where silt ponds are typically pumped to the mine water management system, it is recommended that flow monitoring be installed on the overflow of the pond (likely in the form of a constructed flow monitoring flume, or flow control weir and level sensor), and discharge pipework is installed and used. Data recording intervals ≤10min.
15. Dewatering flow monitoring
    a. It is recommended that dewatering flow rates are recorded for all pit dewatering (data recording intervals ≤10min) and that this includes records of any abstraction for use via water carts (date and volume).
    b. It is recommended that any controlled and/or intentional discharges to pits be monitored, with flow rate recorded at intervals ≤10min. Where this is to a developing pit lake, it is recommended that water quality measurements be taken of the influent water based on the pit lake sampling suite. The purpose of this is to understand any pit lake discharges that have not been part of the modelling and may affect the long-term water quality of that water body.
16. Pit lake development and overflow

   a. It is recommended that pit lake development rates, once dewatering ceases, are monitored by taking water level readings at monthly intervals..
   b. Where the pit lakes are nearing the long-term overflow level it is recommended that a discharge weir be constructed at the outlet and level monitoring be installed such that outgoing flow rates may be recorded. If monitoring and assessments indicate that pit lake water quality will exceed the predictions applied in this assessment (as per MWM 2026) additional mitigation measures (such as treatment and/or water level management) will need to be implemented.
17. It is recommended that all the monitoring undertaken be subject to stringent quality assurance processes. .
18. It is also recommended that all mine water discharges to receiving waters (i.e. any of the waterways and/or their tributaries flow through or away from site) are recorded into a single electronic database. This should include records of start and end of the discharge, measured or approximated flow rates and cause of the discharge. This recommendation is not intended to be applied to uncontrolled passive discharges (i.e. uncontrolled silt pond discharges or seepage discharges), though would apply where silt ponds are typically being pumped to the mine water management system and are manually released to receiving waters as per recommendation 14c.

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# Appendices

# Appendix A

## Groundwater Technical Modelling Details and Results – Golder Bar Mining Area

# Appendix B

## Groundwater Technical Modelling Details and Results – Coronation Mining Area

# Appendix C

## Groundwater Technical Modelling Details and Results – Central Mining Area

# Appendix D

## Groundwater Seepage Modelling

# Appendix E

## Water Balance Model Description

# Appendix F

## Mitigation Methods

# Appendix G

## Pit Lakes Filling Water Balance

# Appendix H

## Surface Water – Detailed Results

# Appendix I

## Catchment Maps

This Appendix contains surface water overview maps:

**Overview – Water Balance Model Nodes**

1. Whole Project

**Central Site – Surface Types**

2. Current
3. MP4 Mining
4. Closure

**Central Site – Surface Water Receiving Nodes**

5. Current
6. Closure

**Central Site – WRS Seepage Water Receiving Nodes**

7. Current
8. Closure

**Central Site – Waste Rock Stack Names**

9. Current
10. Closure

**Coronation and Golden Bar – Surface Types**

11. Current
12. MP4 Mining
13. Closure

**Coronation and Golden Bar – Surface Water Receiving Nodes**

14. Current
15. Closure

**Coronation and Golden Bar – Seepage Water Receiving Nodes**

16. Current
17. Closure

**Coronation and Golden Bar – Waste Rock Stack Names**

18. Current
19. Closure

# Appendix J

## Groundwater Data

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→ The Power of Commitment