WGA

OceanaGold (New Zealand) Ltd

Macraes Phase IV Project, Water Treatment Plant Brine Disposal

TECHNICAL REPORT

WGA260144

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27 August 2026

EXECUTIVE SUMMARY

OceanaGold (New Zealand) Limited (OGNZL) is progressing the Macraes Phase Four Project (MP4) to extend the operating life of the Macraes Operation. The proposed freshwater-compliance regime is expected to require active treatment of some mine-impacted waters. Reverse Osmosis (RO) has been identified as the base-case treatment technology. However, this process would generate a concentrated brine waste stream requiring long-term management. Wallbridge Gilbert Aztec (WGA), supported by three-dimensional groundwater modelling undertaken by GHD Ltd (GHD), has assessed the technical viability and environmental implications of storing this brine in the closed Frasers Underground Mine (FRUG).

The proposed full-scale RO water treatment plant is projected to produce brine at approximately 15% of influent flow. Annual brine production is estimated at about 86,100 m^3 during Mining Stage B, rising to approximately 213,300 m^3 during closure and reducing to approximately 108,300 m^3 during long-term post-closure. Additional treatment stages could reduce these volumes, but no such reduction has been assumed. Therefore, this storage requirement likely represents a worst-case scenario.

FRUG comprises hydraulically connected workings extending to approximately 910 m below ground level and has an estimated residual void volume of 5.67 Mm^3. A conservative capacity calculation, excluding seepage to the surrounding schist and Frasers Tailings Storage Facility (TSF), indicates a minimum storage period of approximately 43 years from the start of Mining Stage B, although brine storage in FRUG may not begin before the close of Mining Stage B.

Density-dependent groundwater modelling simulated brine injection to FRUG for 400 years. The denser brine is expected to occupy the deeper workings first and migrate slowly into the surrounding low-permeability Otago Schist and, over time, into tailings within Frasers TSF. The modelled water balance for FRUG indicates the underground workings can accept the projected long-term brine flows throughout the simulation period without overflow, provided mine water levels are monitored and managed. After 400 years, the modelled brine plume, defined at a minimum concentration of 1% brine, extends approximately 2 km north and east of FRUG but remains at depth. At that time, the simulated plume is approximately 65 m below Deepdell Creek and more than 260 m below Tipperary Creek and does not daylight in creeks or tributary gullies.

Modelled sulfate contributions to surface flows at the diffuse outer margins of the brine plume (<1% brine) are approximately 1.9 kg/day to gullies and 5.3 kg/day to major streams. These calculated loads are principally dispersion-driven within the numerical model and are considered to be overestimates, given the anisotropic nature of the schist host rock. These loads would represent less than 2% of modelled post-mitigation sulfate loads from other sources in the Deepdell Creek and Tipperary Creek catchments and would not be detectable at relevant water quality compliance monitoring points.

The principal operational risk is excessive pressure or rising mine water levels displacing mine water or brine toward Frasers TSF or the surface, particularly during the higher brine-production rates expected during closure. This risk can be managed by injecting brine into the deeper workings, continuously monitoring injection flows and mine water levels, monitoring electrical conductivity where practicable, and abstracting mine water as required to maintain levels below defined triggers. Detailed design will be required for the injection system, trigger levels, abstraction arrangements and monitoring programme.

Overall conclusion: FRUG is considered a technically viable location for long-term storage of RO brine generated by the proposed water treatment plant. The proposed storage is projected to have a negligible effect on surface-water quality and compliance. The site-specific risks arising from the storage of brine in FRUG can, if necessary, be addressed through defined monitoring and operational management measures. The proposed storage of brine in FRUG is not expected to materially affect environmental management or compliance with the proposed MP4 water-quality consent conditions.

Revision History

REV	DATE	ISSUE	ORIGINATOR	CHECKER	APPROVER
A	19/08/2026	OGNZL	BS	WD	BS
B	21/08/2026	OGNZL	BS	WD	BS
0	27/08/2026	OGNZL	BS	WD	BS

CONTENTS

Figures

Tables

Appendices

1 INTRODUCTION

1.1 Background

OceanaGold (New Zealand) Limited (OGNZL) currently undertakes open pit and underground gold mining operations at the Macraes Operation, 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) seeks to extend the life of mining at the Macraes Operation.

A review of the freshwater quality compliance criteria appliable at the Macraes Operation (Viridis 2026) has recommended changes to existing water quality compliance criteria applicable to the site. The recommendations from the Viridis report include changes to the compliance framework, additional compliance parameters and ecologically driven changes to trigger concentrations for several parameters. These changes have been incorporated by OGNZL in recommending a new compliance regime that would apply to MP4.

One of the consequences of the recommended new compliance regime is the need to incorporate active treatment of mining impacted water derived from several sources on site to meet compliance obligations. Process Flow Limited (Process Flow) was engaged by OGNZL to provide an assessment on applicable active water treatment technologies to treat waters impacted by the Macraes Operation.

A preliminary recommendation from Process Flow (2026) was the use of RO technology as the base case mine water treatment system for MP4. The report also identified a need for further treatment or disposal of the waste stream from the RO plant, which consists of a brine.

Wallbridge Gilbert Aztec was retained by OGNZL to evaluate the potential for storage of the brine wastewater from the RO treatment plant in the closed Frasers Underground Mine (FRUG) at the Macraes Operation. GHD Limited (GHD) was retained to undertake 3D groundwater modelling of the potential for transport of brine outward from FRUG and identify potential surface receiving waters. This report documents the analyses undertaken by Wallbridge Gilbert Aztec and GHD, and the results of these investigations. This report also presents international examples where high-density brine or similar water has been stored in closed underground mines (Appendix A). A site-specific risk review focused on the storage of brine in FRUG is provided in Appendix B.

It is important to note that OGNZL and Process Flow are currently also investigating an alternate mine water treatment option using an Ettringite precipitation process. WGA understands this Ettringite process would not generate a brine waste stream. OGNZL may decide in the future to follow an alternative treatment option, whether it be an Ettringite precipitation process or some other process that offers waste management advantages. The content and conclusions documented in this report do not restrict OGNZL from making alternative arrangements for mine water treatment and waste management.

1.2 Water Treatment Plant Brine Wastes

An initial trial plant is to be installed by OGNZL to test and optimise the treatment process using mine water collected from site. Brine production as a waste stream from the trial plant is expected to be approximately 15% of the feed water (Process Flow 2026). This flow rate equates to brine totalling approximately 65 m^3/day requiring management (Table 1). It is proposed that this brine be returned to the Macraes Operation mine water management system rather than being stored or otherwise disposed of.

Following completion of the RO trial and optimisation investigation, OGNZL proposes to install a larger WTP using RO technology. This capacity is expected to be sufficient to treat collected mine water through the remaining period of MP4 operations and the subsequent closure and post-closure period. The peak projected influent rate of approximately 45.1 L/s equates to a peak annual brine production rate of 213,300 m^3, based on an expected brine production at 15% of the feed water flow (Process Flow 2026). Following mine closure the water treatment requirement at the WTP is expected to decline to an influent rate of approximately 22.9 L/s.

Following mine closure and capping of each waste rock stack (WRS), the net percolation rate to each WRS is expected to decline from the current rates to a long-term average rate of approximately 5% of annual rainfall (GHD 2026a). However, no further projected decline in net percolation rate or improvement in WRS leachate water quality has been incorporated in the water balance modelling (GHD 2026a). Therefore, for mine water modelling purposes, the post-closure water treatment and brine management requirements are considered to continue indefinitely (Table 1).

It is important to note that options are available for brine concentration processes that could be installed on site to improve recovery (Process Flow 2026). Therefore, the 15% brine production rate incorporated in the calculations presented in Table 1 can be reduced through the implementation of additional treatment stages. As these additional stages have not yet been investigated in detail by Process Flow, no potential reduction in the 15% brine production rate has been taken into account in this brine disposal report. Therefore, the storage requirement described above likely overstates the eventual requirement for brine disposal.

When considering the design for the WTP, GHD (2026a) has suggested that a variability of ±30% be 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). With regards the assessment documented in this report:

1. Short term variability in flow rates has no long-term effect on brine volumes requiring management annually or the long-term behaviour of the contaminant plume. However, short term variations in brine disposal rates may lead to variations in water levels and pressures within FRUG. These variations are addressed through the monitoring and management processes documented in Section 4.1.
2. An increase in brine flows arising from uncertainty in seepage flow capture rates would result in the more rapid filling of the available storage in FRUG. Should captured flows exceed the expected flows, this could be addressed through additional management measures as set out in the Water Quality Management Plan for the site. As indicated above, short term variations in brine disposal rates may lead to variations in water levels and pressures within FRUG. These variations are addressed through the monitoring and management processes documented in Section 4.1.

Table 1: Brine Volumes Requiring Management Annually

PARAMETER	UNITS	TREATMENT STAGE A	TREATMENT STAGE B	CLOSURE PERIOD	POST-CLOSURE
WRS seepage combined	L/s	5.0	18.2 (1)	18.2 (1)	7 (2)
TSF drains combined	L/s	-	-	26.9	15.9
Total WTP influent	L/s	5.0	18.2	45.1	22.9
Brine percentage of influent	%	15	15	15	15
Brine flow requiring disposal as daily average	m^3/day	65	236	584	297
Brine flow requiring disposal annually (3)	m^3/year	23,700	86,100	213,300	108,300

Note:

(1) Seepage captured based on current WRS net percolation rates.

(2) Seepage captured following capping of WRS areas and corresponding reduction in net percolation.

(3) Values rounded to nearest 100 m^3.

The RO plant brine is projected to have a dissolved solids concentration of 34,300 g/m^3. Assuming this is mainly magnesium sulphate, the brine density would be approximately 1,032 g/L at 25˚C (G. Smith, Process Flow, pers comm). This density is slightly greater than the average density of sea water at shallow depths.

2 FRASERS UNDERGROUND MINE

2.1 Introduction

In 2005, resource consents were approved, authorising the construction and operation of FRUG, which commenced operations in 2006 (WSP, 2023). The FRUG targeted the down-dip continuation of the Hangingwall Shear mined in Frasers Pit. The orebody is relatively shallow dipping (15 – 20°) toward the east.

The mining method used was retreat longhole stoping, which entailed 15 m wide open stopes with 6 m wide yielding pillars between parallel stopes. A mine panel consisted of several parallel mine stopes. Mine panels are separated by 20 m to 60 m wide regional pillars. The mine panels are generally restricted to about 120 m width and 160 m length. Stope heights varied between the access drive height of 5 m up to 25 m (WSP 2023), although the average stope extraction heights were generally 11 m to 12 m.

Operational experience at FRUG indicated fractured rock mass permeability generally decreased with increasing depth of coverage, most likely due to decreasing intensity of weathering and increasing overburden pressures resulting in smaller fracture apertures (WGA, 2020). Localised changes in density of structural features in rock mass did not result in measurable long-term changes in groundwater inflow. However, groundwater associated with faults intersecting workings did on occasion result in transient inflow increases (WSP 2023). The major east-west trending Macraes Fault intersects the northern end of Frasers Pit and forms the northern boundary of FRUG development (WSP 2023). Approaches of the workings to this fault did not result in clear ongoing increases in seepage flows into the mine.

Overall, groundwater inflows to FRUG were low, estimated to reach a maximum of about 1,100 m^3/day (13 L/s) under normal operating conditions. This equates to a groundwater inflow of approximately 6.1 m^3/day/ha (0.07 L/s/ha), indicative of a very low to low permeability rock mass. Groundwater inflows did not increase significantly with increasing footprint area.

There has been no record of exploration boreholes generating significant ongoing inflows. Localised chimney collapse zones did not reach the surface above FRUG (R Redden, OGNZL, pers comm). Review of the inflow data for FRUG indicated chimney collapse zones, when they did occur, did not contribute substantially to the overall mine water flows (WGA, 2020).

2.2 Mine Layout and Void Space

The underground extractive workings extend from a depth of approximately 210 m to 910 m bgl (approximately 350 mRL down to -355 mRL) and cover an area of 180 ha (Figure 1). FRUG was developed for a distance of over two kilometres down-dip from the uppermost mine stopes (WGA 2020). The FRUG underground workings predominantly underlie Frasers East Waste Rock Stack (WRS) and part of Top Tipperary Tailings Storage Facility (TSF) (Figure 1). Some of the shallowest of the mine stopes also underlie the eastern high wall of Frasers Pit.

The Frasers TSF is currently under construction in Frasers Pit. The final projected tailings elevation in Frasers Tailings Storage Facility (TSF) under MP4 is projected to range from approximately 508.5 mRL up to 517.5 mRL, grading downward from the southeast to the northwest (J. Zou. EGL, pers comm. 14 August 2026). This elevation is subject to a small uncertainty, depending on the final average bulk density of the stored tailings.

The FRUG workings are exposed to tailings stored in Frasers TSF at an elevation of between 270 m and 275 m RL (Table 2). At a higher elevation, the main FRUG access portal is exposed to Frasers TSF at 352 mRL. Although seals behind these exposures were installed during the operational period and at closure of FRUG, none of the seals are expected to be fully hydraulically effective. Seepage of tailings pore water, both through intact schist and past the FRUG seals, is expected to contribute to mine water accumulating in FRUG.

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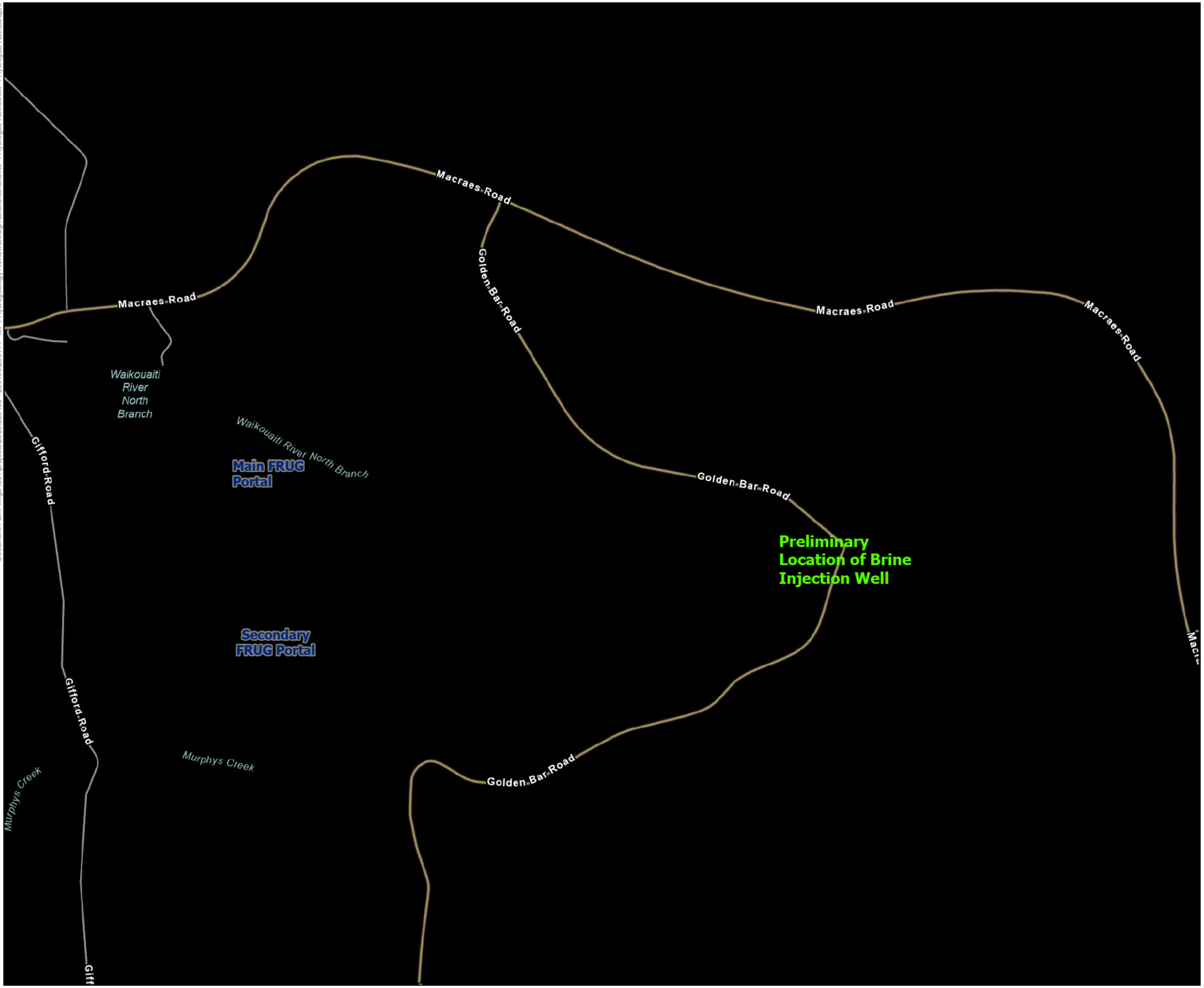

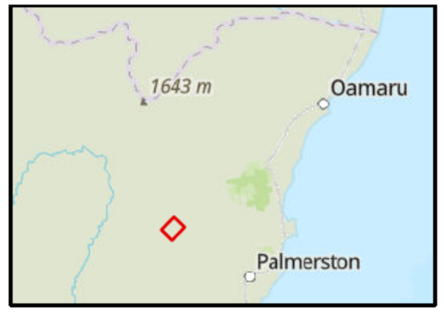

LEGEND

- Preliminary Location of Brine Injection Well
- FRUG Verical Access Shafts
- Mine Access Portals
- Streams
- FTSF 480mRL Stage2
- TTTSF 570 5RL
- FRUG AB Stopes
- FRUG AB Development Lateral

0 150 300 450 600 m

Scale 1:14,000 @ A3

Coordinate System: unnamed

Figure 1

MP4 Hydrogeology Review

FRUG Layout

Table 2: FRUG Exposure to Frasers Pit

ELEVATION POINT (1)	ELEVATION (mRL)	DESCRIPTION AND NOTES
FRUG Mine Portal	352	On northern hall road for Frasers Pit. Sealed.
FRUG Secondary Portal	270 (2)	Closed portal located behind southeastern high wall of Frasers Pit. Had been sealed prior to pit wall failure and burial of the portal. Seal not designed to prevent seepage flows.
FRUG Trial Stopes Drive	275 (3)	Closed drive located behind northern high wall of Frasers Pit. Sealed prior to pit wall failure and burial of a drive exposed in the pit wall. Seal not designed to prevent seepage flows.
Frasers TSF Spillway	508.5 (4)	Design spillway intake invert between the rehabilitated Frasers TSF and the North Branch of the Waikouaiti River (NBWR).

Notes:

(1) Source: Golder (2015).

(2) Estimated. Effectively dependent on degree of rock disturbance behind pit face.

(3) Access drive to stopes has an upward gradient toward the main FRUG access drive. Overflow elevation is at intersection with main FRUG access drive.

(4) Source: J Zou, EGL, pers comm, 26 June 2026.

The projected rise in tailings level (Figure 2) indicates the main FRUG portal is already buried by tailings. The current level of mine water in FRUG is not known, but it is likely that seepage losses from Frasers TSF have contributed to the accumulating water in the underground workings. Assuming that the tailings pore water has a similar quality to the tailings water discharging from Top Tipperary TSF, the hardness and sulfate concentrations are likely to be in the order of 2,600 g/m^3 $CaCO_3$ equivalent and 3,100 g/m^3, respectively (GHD 2026a). These concentrations are substantially lower than the 34,300 g/m^3 dissolved solids concentration projected for the RO brine. It is expected that the tailings water mixed with the inflowing groundwater from the schist will have a density similar to that of the regional groundwater.

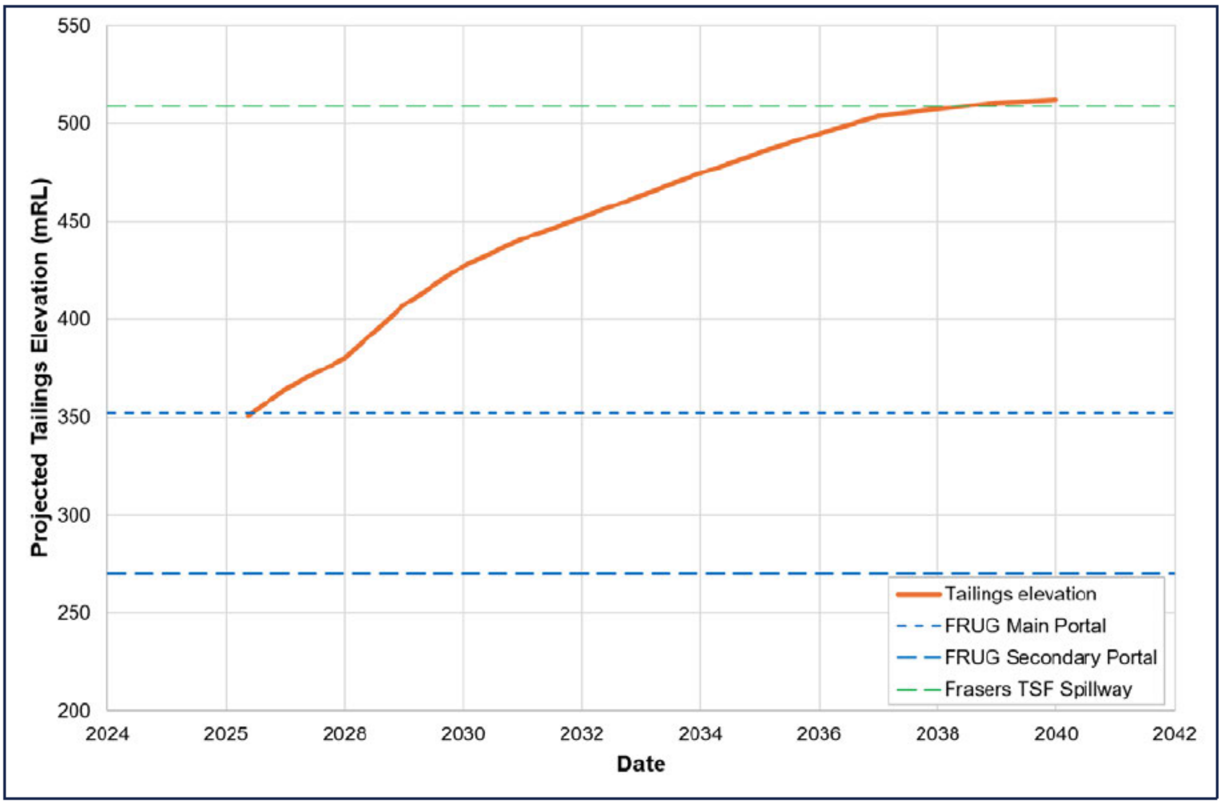

Figure 2: Frasers TSF Projected Tailings Filling Trend

The water storage capacity of FRUG is calculated to be approximately 5.67 Mm^3 (Table 3). This capacity is based on the known mass of rock extracted during the operational period of the mine, taking into account an approximation of ground settlement at surface above the FRUG workings.

Table 3: Water Storage Capacity in FRUG

FRUG COMPONENT (1)	VALUE	UNITS
FRUG extracted mass	15,300,000	t
Rock specific gravity	2.65	t/m^3
FRUG void volume	5,770,000	m^3
Approximate ground settlement area above FRUG workings	50	ha
Approximately average ground settlement at surface	0.2	m
Volume loss in FRUG through ground settlement	100,000 (3)	m^3
Final FRUG void volume	**5,670,000 (2)**	**m^3**

Notes:

(1) Source: Rod Redden, OGNZL, pers comm, 16 July 2026.

(2) Volume rounded to three significant figures.

(3) Accuracy of approximation is considered to be low. However, the outcome is small compared to the overall FRUG extraction volume. This level of accuracy does not significantly impact the outcomes of the void and brine storage calculations.

3 FRUG GROUNDWATER MODELLING

3.1 Conceptual Model

Conceptually, FRUG consists of an open volume of underground workings which dip at 15 to 20° downward toward the east from the eastern edge of Frasers TSF. The underground workings are hydraulically connected with the TSF and, although they are partially collapsed, they are hydraulically connected throughout their extent. Eventually, the water level in the upper workings will reflect the post-closure water level in the capped tailings mass.

The overall void space in the remnant open FRUG workings and in the collapsed stopes is approximately 5.67 Mm^3. The roof rock above the workings is more permeable than the intact schist to a height of some 100 m, due to stope collapse. The floor rock permeability is likely to reflect that of intact schist.

The model run starts with the underground workings being empty prior to the introduction of brine to FRUG. This is not the case in reality, as mining and dewatering operations ceased several years ago and the water level is assumed to have been recovering since that time. The current water level in FRUG is unknown, so the starting condition has been assumed. This assumption only affects the calculated groundwater inflow rates during the first few years of the model, which are not critical to the long-term projections for brine storage in FRUG.

As brine is introduced to the deeper FRUG workings, it will gradually displace the existing mine water. The brine will tend to stay below the existing mine water due to its higher density. This means, the hydraulic pressure toward the lower end of the workings will be greater than the pressure at the top end of the workings. The offset water will either:

1. Discharge as seepage via intact or disturbed schist, or via seepage past the FRUG portal seals, disturbed schist or exposed workings to Frasers TSF.
2. If the water level in the vertical access shafts rises to approach the ground level in Frasers TSF, the pressure will be managed at below the TSF ground level by pumping, with the discharged water either being returned to the site mine water management system or being treated and discharged.

The objective of managing the water level in FRUG is to minimise any risk of brine water seeping into the stored tailings in Frasers TSF and being forced upward to surface by the pressures developed in the underground workings. Migration of brine upward through the tailings into the TSF cap could eventually lead to increased contaminant loads to the NBWR or Innes Mills Pit Lake. In each case, this could result in increased contaminant loads potentially reporting to the NBWR or Deepdell Creek catchments. Such a situation would only arise through an inadvertent failure in the FRUG water level monitoring system, which would be corrected once identified. If necessary, brine flows escaping upward through the tailings mass could be captured and directed to the active water treatment plant while water levels in FRUG are returned to normal operating levels.

OGNZL has advised that underground operations under Frasers Pit, and behind the Frasers Pit eastern wall, have resulted in significant disturbance of the remaining in-situ schist rock mass. Although the in-situ schist surrounding Frasers TSF is modelled as having the same characteristics as schist at similar depths elsewhere in the model, it is expected that direct hydraulic connection between FRUG and Frasers TSF has already occurred. The implications are considered later in this report.

Groundwater pressures above the underground mine are mainly controlled by rainfall infiltration into the Frasers East WRS. It is expected that the infiltrating water will accumulate on top of the in-situ soils and rock at the base of the WRS, and then flow laterally toward Frasers TSF. This infiltrating water will ensure a downward hydraulic gradient is retained through the rock overlying FRUG. The eastern, deeper, end of FRUG is overlain by part of Top Tipperary TSF. Again, the groundwater in the tailings mass will ensure a downward hydraulic gradient is retained to the underlying FRUG.

3.2 Numerical Model

A variant of the central numerical groundwater model has been developed by GHD to simulate the long-term effects of brine storage in FRUG. The layout of the model and the input parameters applied to enable the simulation of density-driven brine seepage away from FRUG has been documented in Appendix C of the water balance modelling report (GHD 2026b).

The numerical model structure assumes there is no direct hydraulic connection between the FRUG workings and Frasers TSF, either through open drives or via disturbed schist. However, as documented in Section 3.1, direct hydraulic connections are very likely to exist. These connections via disturbed schist are mainly below the existing tailings level in Frasers TSF. As documented later in this report, the presence of direct hydraulic connections between Frasers TSF and FRUG does not change the outcome of this report significantly.

The simulation represented brine injection through a new well screened at approximately -260 m RL, near the deepest point of the FRUG workings. The injected brine had a higher density than the surrounding groundwater and existing FRUG mine water. The brine was injected at a rate of 3.45 L/s for the full period of the model run (400 years). The brine density was set at 1,032 kg/m^3, contrasting with the density of 1,000 kg/m^3 applied to the surrounding groundwater (GHD 2026b).

The injected brine was assigned a relative concentration of 1, representing 100% brine and 0% freshwater or other mine water. By default, the concentration of all other waters is the model was set at 0. The outer limit of the simulated brine plume was defined as 0.01, equivalent to 1% brine mixed with 99% freshwater or other mine water (GHD 2026b).

For density driven flow modelling it was assumed that the dissolved solids in the brine consist of 100% $MgSO_4$. That assumption implies that 100% brine equates to 34.3 kg/m^3 $MgSO_4$ or 27.7 kg/m^3 sulfate. For the purposes of interpreting the groundwater modelling results, this assumption is being retained. However, it does lead to conservatively large results in terms of calculated sulfate loads as any carbonate contribution to the total dissolved solids is ignored.

3.3 Numerical Model Results

3.3.1 Simulated Flows

The modelled flows into and out of FRUG incorporate an assumption that the underground workings are empty at the start of the model run. Therefore, the first 10 years of simulated flows are highly influenced by a combination of rapid groundwater inflows and brine injection to the workings (Figure 3). These flows are not relevant to the long-term hydraulic interaction between the mine workings and the surrounding rock mass. The key water balance relates to the period following the complete inundation of the FRUG workings.

The modelled flows presented in Figure 3 exclude direct hydraulic interaction between FRUG and Frasers TSF. The hydraulic effectiveness of the seals installed in the workings is poorly understood. Therefore, the flows between the two mine structures are subject to a high level of uncertainty. However, this uncertainty predominantly affects the water balance through the FRUG filling period and does not significantly influence long-term off-site groundwater movement.

Following inundation of FRUG, the modelled water balance is generally:

- Outflows at 320 to 330 m^3/day
- Inflows, excluding brine injection, at 30 to 50 m^3/day
- Net flows, outflowing at 280 to 290 m^3/day

These flows are to an extent driven by the density difference between the injected brine and the fresher surrounding groundwater.

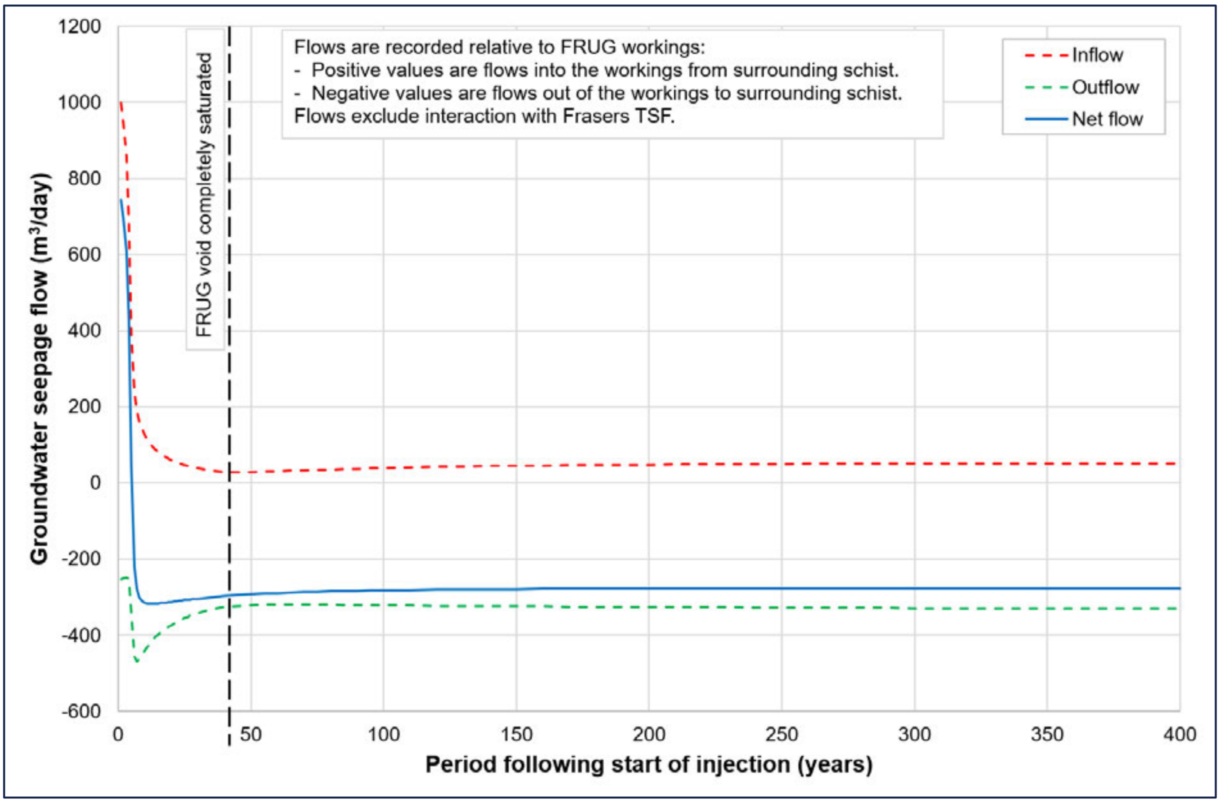

Figure 3: Simulated FRUG Interaction Flows with Surrounding Schist (D Avanidou, GDH, pers comm)

3.3.2 Simulated Mass Loads

For the purposes of this assessment, the brine plume has been defined as the area containing relative brine concentrations between 1% (equivalent to 99% freshwater) and 100% (pure brine). In a groundwater model of this scale and duration, dispersion effects generate brine concentrations beyond the main plume at levels far below what may be detected in the real world by any available technique. This is the reason for defining the plume boundary at 1% of the brine concentration.

The modelled lateral extent of the plume 400 years after the start of brine storage in FRUG (Figure 4) indicates the brine migrated approximately 2 km to the north and east of the FRUG footprint. The average modelled plume expansion rate toward the north and east was approximately 5 m/year, although the rate of expansion would slow substantially through the modelled period. The modelled plume migrated to a lesser distance in other directions from FRUG.

Model results indicate that the plume is not predicted to daylight at any creek or any tributary gully through the simulated period. Instead, it is expected to remain at depth, approximately 65 m below the bed of Deepdell Creek (Figure 5) and more than 260 m below the streambed of Tipperary Creek (Figure 6 and Figure 7).

The apparent brine plume connection between the shallow end of the FRUG workings and the surface shown in Figure 5 and Figure 7 is an artifact of the model design rather than an outcome expected in the real world. The tailings mass in Frasers TSF is simulated in the model as a single layer. Therefore, a brine entering the base of the tailings mass under density-driven flow shows up as an increase in concentration through the full thickness of the tailings mass. As documented in Section 3.1, the high-density brine is expected to remain deep in the tailings mass provided the mine water level management in FRUG is operating as required under the Mine Water Quality Management Plan.

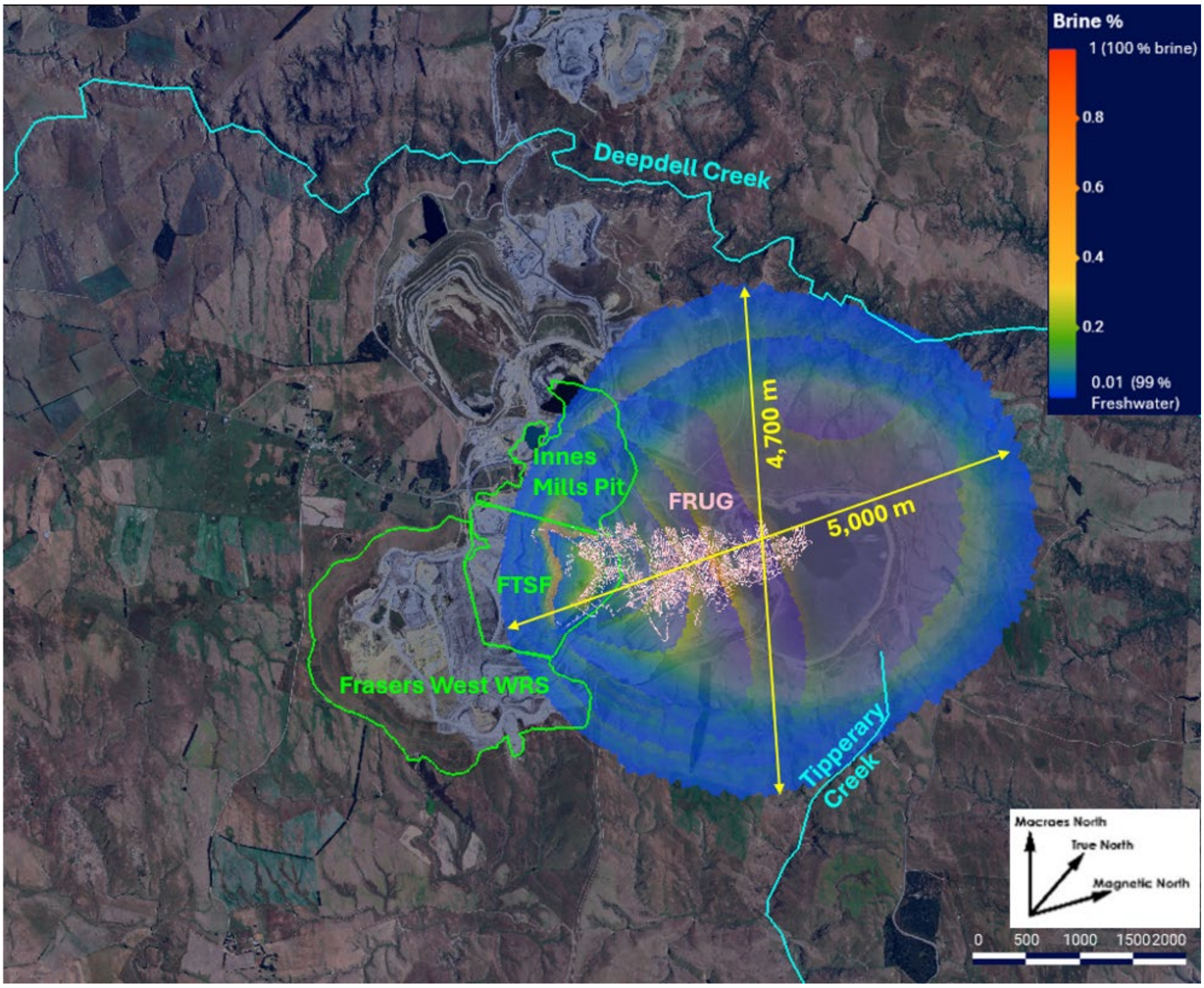

Figure 4: Plan View Map of Projected Brine Plume Lateral Extent After 400 Years (GHD 2026b)

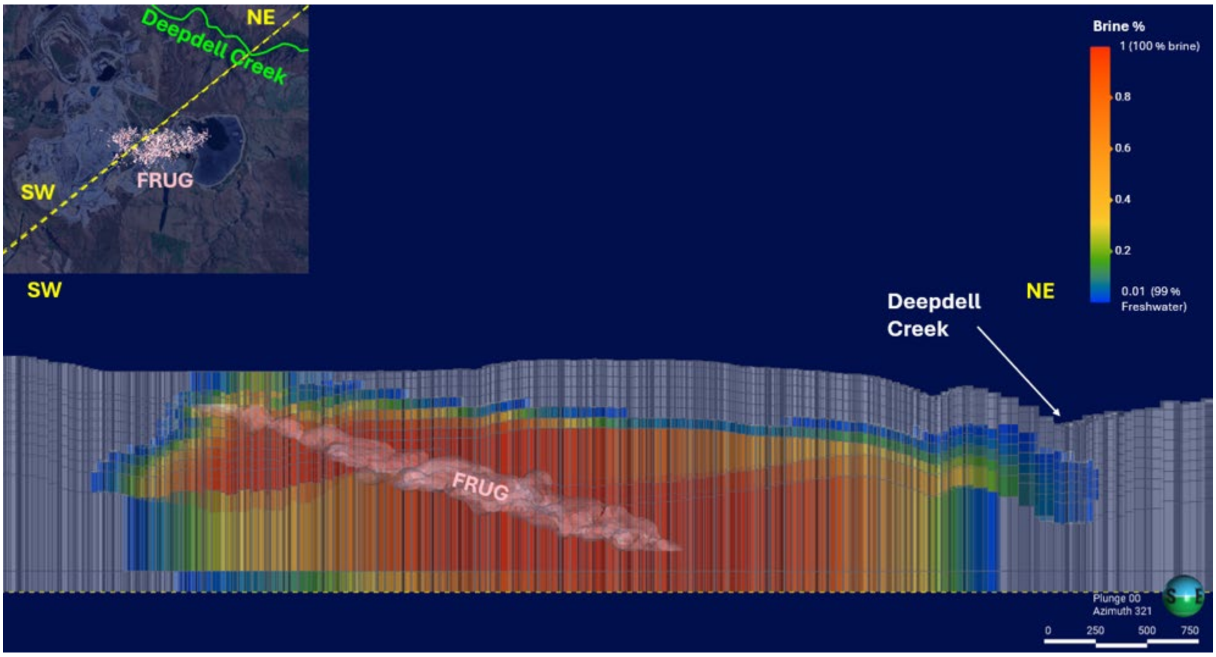

Figure 5: Cross Section Showing Projected Plume Extent Between FRUG and Deepdell Creek (GHD 2026b)

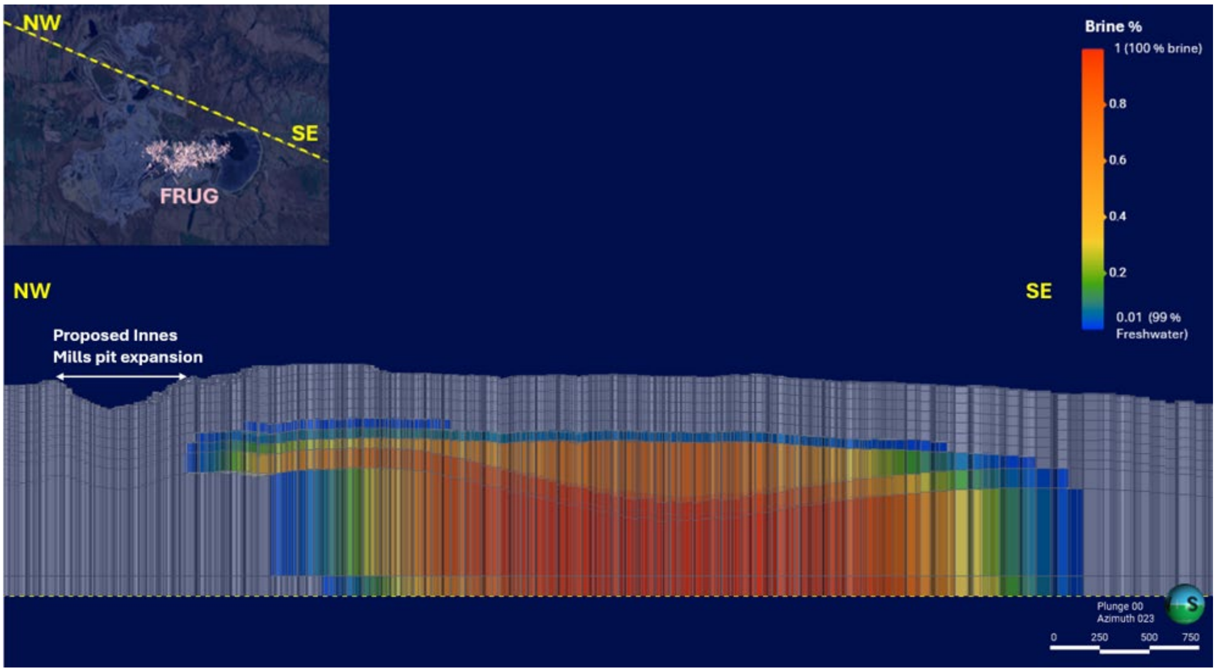

Figure 6: Cross Section Showing Projected Plume Extent Near the Proposed Innes Mills Pit (GHD 2026b)

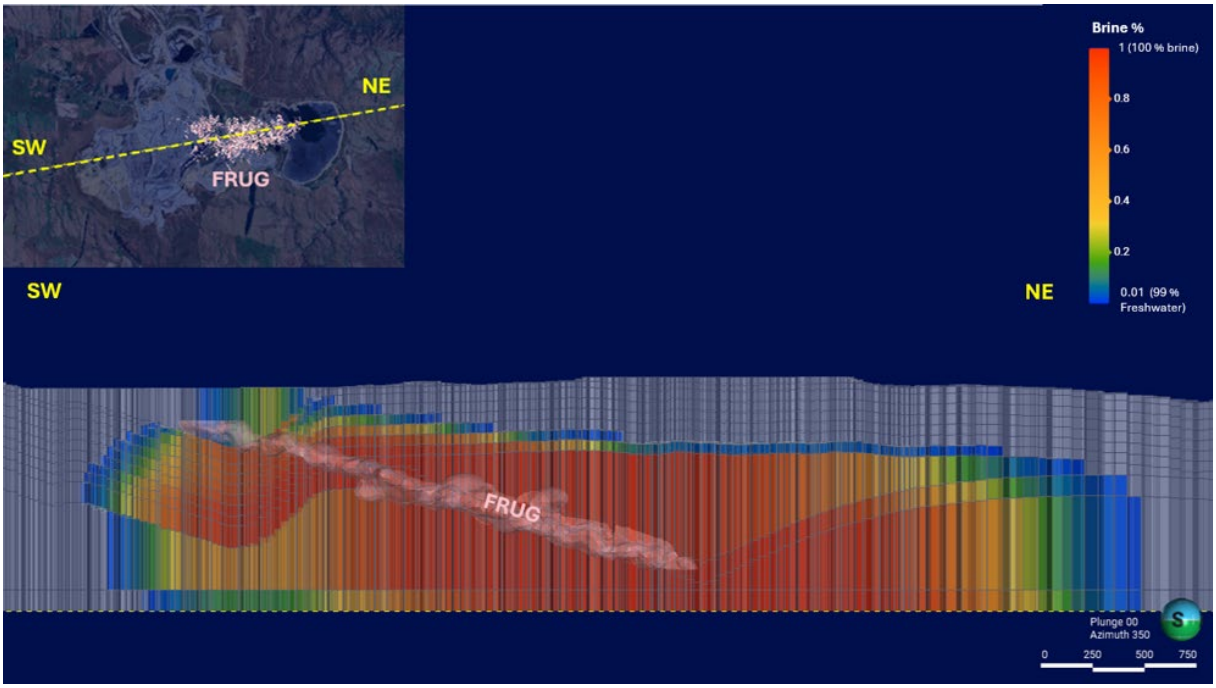

Figure 7: Cross Section Showing Projected Plume Extent Along FRUG (GHD 2026b)

The mass loads from the groundwater model output (Figure 8) indicate small discharges of brine water to nearby gullies and streams. The plume map (Figure 4) and the cross sections (Figure 5, Figure 6, Figure 7) indicate visually that the brine plume does not discharge to these surface water features. It is interpreted that these small discharges are a result of simulated dispersion of contaminants over long timeframes and transport distances, as has been noted above. These mass loads identified in Figure 8 are highly diffuse, small and may not eventuate even over very long timeframes. Therefore, the model has not been interrogated to determine the specific receiving catchments.

The mass loads from the model output (Figure 8) relate to a contaminant scale from 0 to 1, with 1 being equivalent to 27.7 kg/m^3 sulfate. Converting the output mass loads for the final time step of the model to sulfate loads:

- Discharges to gullies: Model load: 0.067 Sulfate equivalent: 1.9 kg/day

- Discharges to major streams: Model load: 0.19 Sulfate equivalent: 5.3 kg/day

For comparison purposes, modelled sulfate mass loads to receiving waters around the Macraes Operation after 400 years (GHD 2026a), excluding brine contributions, are approximately:

- Deepdell Creek upstream from DC08: 290 kg/day
- Tipperary Creek 220 kg/day

The calculated sulfate loads to stream and gullies are principally driven by the mass dispersion factor applied in the modelling, as opposed to advective transport (D Avanidou, GDH, pers comm). Bearing in mind the highly anisotropic nature of the foliated schist host rock, it is expected that these calculated sulfate mass loads are conservatively large.

Assuming these combined modelled long-term contributions of brine from FRUG to potential receiving streams and gullies are distributed evenly between the Deepdell Creek and Tipperary Creek catchments, these mass loads would represent less than 2% of the modelled sulfate loads to these catchments from other sources. These contributions from brine stored in FRUG would not be detectable through sampling at the compliance monitoring points on Deepdell Creek (DC08) or Tipperary Creek (TC01). Therefore, the proposed storage of brine in FRUG is projected to have a negligible effect on water quality at the Compliance monitoring sites for the Macraes Operation.

```
  MASS BUDGET FOR ENTIRE MODEL AT END OF TIME STEP      60 IN STRESS PERIOD      74
  ------------------------------------------------------------------------------------

     CUMULATIVE MASS        M/L^3 * L^3       RATES FOR THIS TIME STEP      M/L^3 * L^3/T
     ------------------                  ------------------------

           IN:                                      IN:
           ---                                      ---
        MASS STORAGE =         16.7134           MASS STORAGE =      1.2278E-06
    CNST H MASS FLUX =          0.0000       CNST H MASS FLUX =          0.0000
      WELL MASS FLUX =   43519678.0396         WELL MASS FLUX =        298.0800
       GHB MASS FLUX =      9.3326E-05          GHB MASS FLUX =      4.5866E-09
       DRN MASS FLUX =      2.3620E-10          DRN MASS FLUX =      3.1089E-14
       RIV MASS FLUX =      7.8561E-11          RIV MASS FLUX =      1.1468E-20
       RCH MASS FLUX =          0.0000          RCH MASS FLUX =          0.0000

            TOTAL IN =   43519694.7531               TOTAL IN =        298.0800

          OUT:                                     OUT:
          ----                                     ----
        MASS STORAGE =   43120126.4240           MASS STORAGE =        287.2561
    CNST H MASS FLUX =          0.0000       CNST H MASS FLUX =          0.0000
      WELL MASS FLUX =          0.0000         WELL MASS FLUX =          0.0000
       GHB MASS FLUX =     396027.6829          GHB MASS FLUX =         10.5609
       DRN MASS FLUX =       1110.5833          DRN MASS FLUX =      6.7408E-02
       RIV MASS FLUX =       2430.0585          RIV MASS FLUX =          0.1955
       RCH MASS FLUX =          0.0000          RCH MASS FLUX =          0.0000

           TOTAL OUT =   43519694.7486              TOTAL OUT =        298.0800

            IN - OUT =      4.4559E-03               IN - OUT =      4.4263E-07

 PERCENT DISCREPANCY =           0.00     PERCENT DISCREPANCY =          0.00
```

Figure 8: Mass Balance Results from the FRUG Groundwater Model (GHD 2026b)

The model mass load to the general head boundary (GHB) of 10.56 (modelled relative mass / m^3), as presented in Figure 8, equates to a sulfate load of approximately 293 kg/day. The receiving GHB in the model is Frasers TSF (D Avanidou, GDH, pers comm), with the expectation that the mass load will principally discharge at depth to the stored tailings. The modelled sulfate load to Frasers TSF does not start to manifest immediately following the start of brine storage. Instead, the FRUG voids are filled first and brine seeps out into the surrounding schist, delaying the migration of brine into the Frasers TSF tailings mass (Figure 9). It is noted that the mass load calculated from the model outputs presented in Figure 8 is higher than the peak mass load presented in Figure 9. Although the reason for this discrepancy has not yet been identified, the uncertainty does not affect the overall outcomes presented in this report.

Provided the water pressure in FRUG does not greatly exceed the decant pond or capped surface in Frasers TSF, it is expected that the dense brine will migrate downward within the tailings rather than upward. The 'pooling' of brine in the base of the tailings mass has no environmental implications for water quality in surface waters around the site. Any increase in this mass load due to direct hydraulic connections between FRUG and Frasers TSF has equally no environmental implications for water quality in surface waters around the site for the same reason. However, such connections would increase the effective brine acceptance capacity of FRUG, compared to the currently modelled acceptance capacity (Section 4).

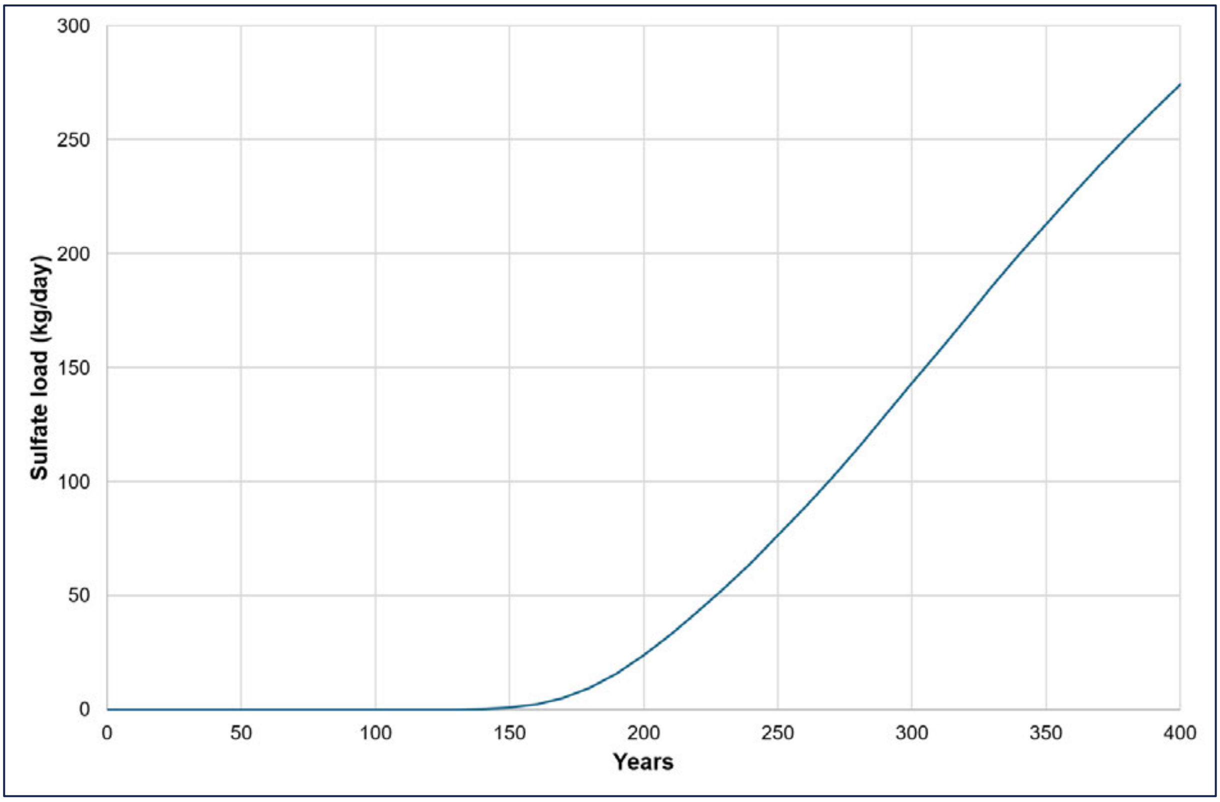

Figure 9: Modelled Sulfate Mass Load Reporting to Frasers TSF Over Time (D Avanidou, GDH, pers comm)

4 FRUG BRINE ACCEPTANCE CAPACITY

An initial calculation was undertaken to evaluate the potential capacity of the FRUG workings to store brine, excluding the seepage of brine into the surrounding schist rock mass. In effect, the calculation assumes the brine progressively replaces the mine water and any remnant air within the underground workings. It is assumed that the displaced mine water is pumped away once a water level within the upper FRUG workings reaches the main portal elevation of 352 mRL (Table 2), which is effectively the top of the workings. On this basis, the calculation estimates how long FRUG would be able to accept brine injection, without taking into account seepage losses into the surrounding schist. This calculation also assumes the brine from the WTP is returned to the Macraes mine water system during Mining Stage A, after which it is stored in FRUG. Operationally, brine from the WTP may be returned to the mine water system through until the end of Mining Stage B. However, this later start in brine storage operations in FRUG would have a negligible impact on the storage calculations documented below.

The outcome of the above analysis indicates FRUG storage has the capacity to accept brine from the WTP for approximately 43 years following the start of Mining Stage B. As this calculation does not take into account brine seepage into the surrounding schist or tailings stored in Frasers TSF, it should be considered as the minimum period through which brine storage in FRUG is viable.

Table 4: Brine Storage Period in FRUG Excluding Seepage into Schist

PARAMETER	UNITS	MINING STAGE A	MINING STAGE B	CLOSURE PERIOD	POST-CLOSURE
WRS seepage combined	L/s	5.0	18.2	18.2	7
TSF drains combined	L/s	-	-	26.9	15.9
Total WTP influent	L/s	5.0	18.2	45.1	22.9
Brine percentage of influent	%	15	15	15	15
Brine flow to FRUG	m^3/day	0 (2)	236	584	298
	m^3/year (1)	0 (2)	86,100	213,300	108,300
Discharge period to FRUG	years	0	4	10	29 (3)
Total volumes (1)	m^3	165,600	344,100	2,135,200	3,194,300
Volume to FRUG	m^3	0	5,673,600 (4)		
Total years storage	years	0	43		

Note:

(1) Values rounded to nearest 100 m^3 for presentation in table.

(2) Brine produced during Mining Stage A is returned to the MWM system; not stored in FRUG.

(3) This disposal period has been calculated iteratively to indicate the post-closure time period through which brine may be stored in the closed FRUG workings without overflow. It assumes that a corresponding volume of existing mine water will be extracted from FRUG workings each year of brine storage in these workings.

(4) This value equates to the FRUG void volume presented in Table 3.

The groundwater modelling results indicate the long-term FRUG water balance, including the injection of approximately 298 m^3/day of brine from the WTP, is slightly positive at approximately 20 m^3/day (Figure 10). This means, overall water inflows to FRUG over the long term will slightly exceed outflows to the surrounding schist. The difference relates to long-term seepage from FRUG to Frasers TSF.

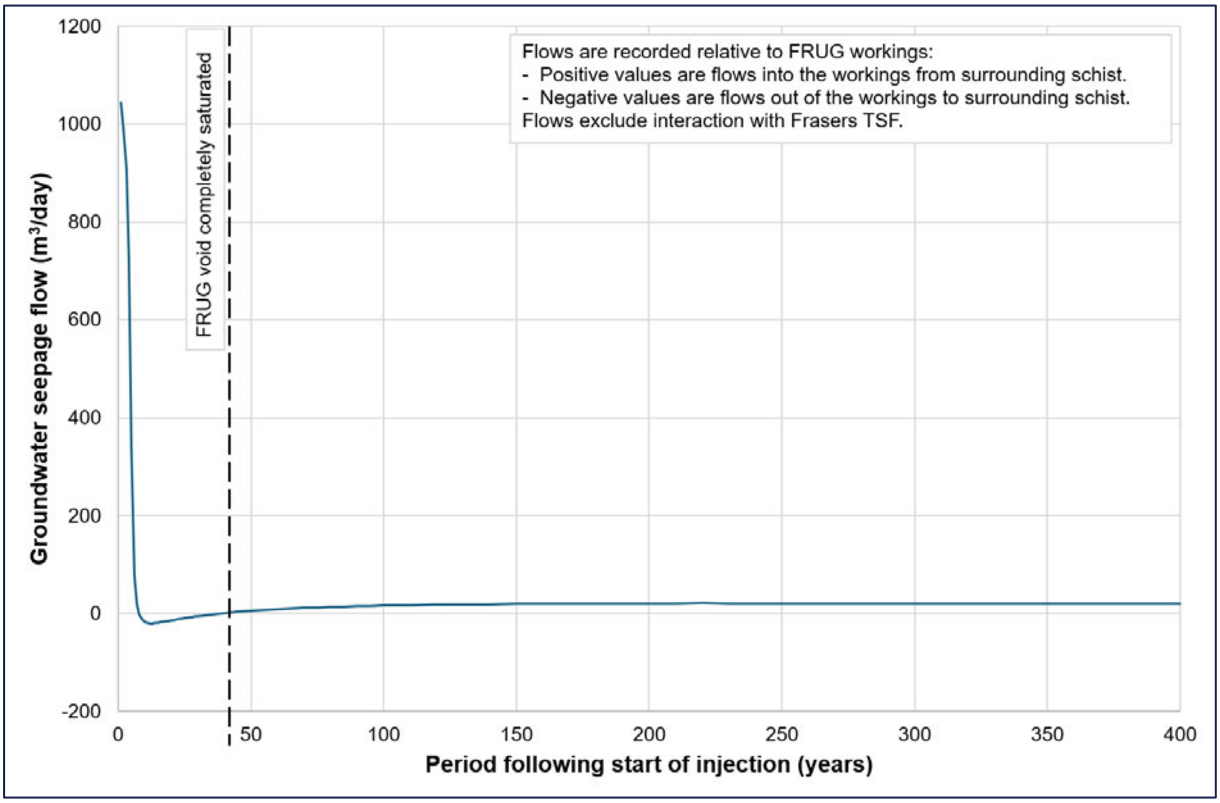

Figure 10: Simulated Net FRUG Water Balance

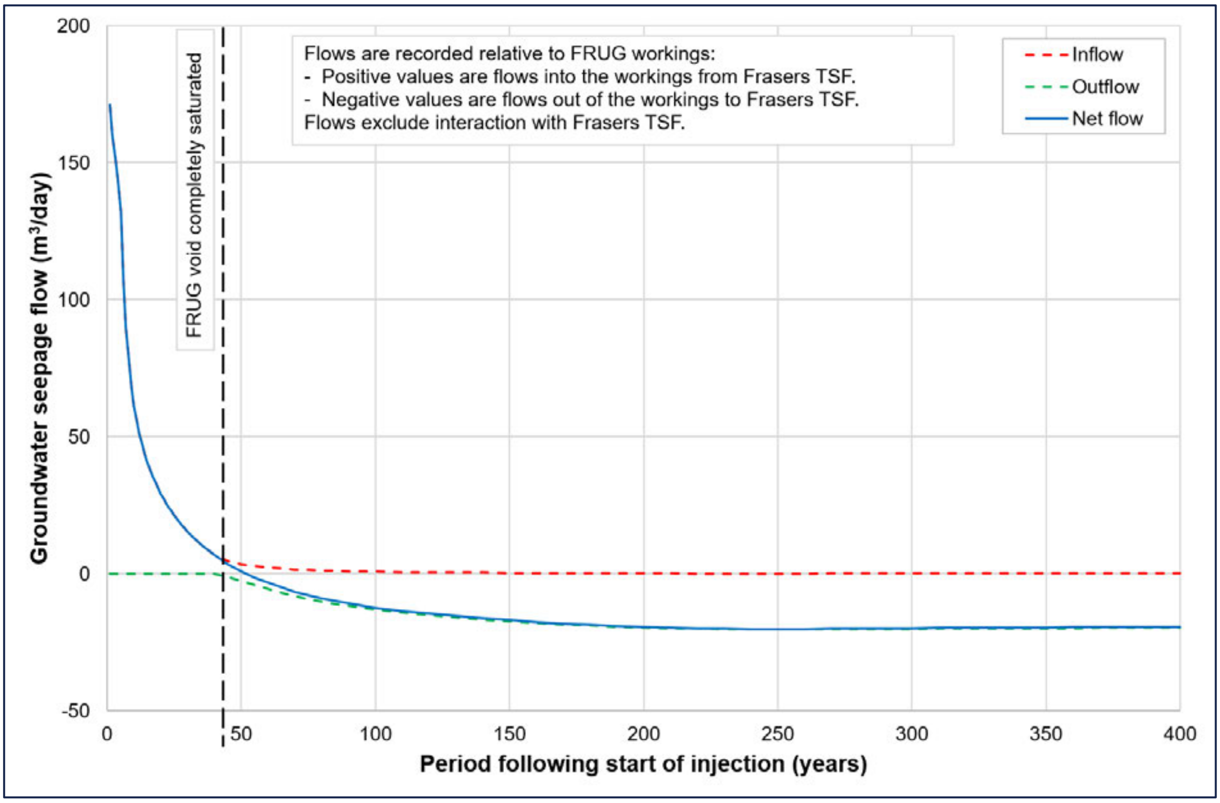

Figure 11: Simulated FRUG Interaction Flows with Frasers TSF

Overall, FRUG has the capacity to accept the projected brine flows throughout the 400 years of the groundwater model run time without overflow (Refer to Section 4.1.2). Brine escaping the underground workings into the surrounding schist host rock and the stored tailings in Frasers TSF is not expected to detectably discharge to surface within the 400 year run time of the FRUG groundwater model.

4.1 Operational Factors

4.1.1 Brine Injection Point

As the RO brine is denser than the existing mine water in FRUG, the injected brine will tend to flow downward toward the deeper sections of the underground workings (Refer to Appendix A). Operationally, the preferred location to introduce brine to FRUG would therefore be the deeper sections of the underground workings. The objective is to minimise the mixing of the introduced brine with the existing fresher mine water, thereby ensuring the brine remains in the deepest workings.

Much of the surface overlying FRUG is occupied by Frasers East WRS and Top Tipperary TSF. These structures introduce difficulties in the installation of an injection well targeting the deeper workings of FRUG. Therefore, a preliminary location for the injection well has been identified in the area between Frasers East WRS and Top Tipperary TSF. The location of the injection well is subject to change, following detailed review of the layout and roof rock characteristics of the underground workings in this area. The primary objective is to enable the introduction of brine to the underground workings in an area that has high connectivity with the wider FRUG.

4.1.2 Mine Water Abstraction

The projected long-term post-closure rate of brine discharge into FRUG is approximately 298 m^3/day. However, during the MP4 closure period, brine discharge rates from the WTP are expected to average approximately 584 m^3/day. This rate is approximately twice the projected post-closure average.

The greater rate of brine injection to FRUG during the MP4 closure period (if not managed) could potentially result in:

- Brine being forced out under pressure into the Frasers TSF tailings mass, and thence to the capped TSF surface or to Innes Mills Pit via the planned drainage systems to be installed in Frasers Pit.
- Mine water levels rising within the FRUG access shafts until the overflow level is reached, although this is a less likely outcome.

As documented in Section 4.2, OGNZL is proposing to undertake continuous monitoring of the mine water level in one of the FRUG vertical shafts throughout the period of active brine storage in the underground workings. The water level monitoring system should support the operational mine water abstraction from FRUG to maintain a water level initially below a trigger level linked to the decant water level in Frasers TSF surface elevation. Over the longer term, the trigger level is to be linked to the capped level of Frasers TSF. The trigger level in both situations is expected to be above the designated surface in Frasers TSF, as there is no environmental benefit arising from maintaining the water level in FRUG below these designated surfaces.

4.2 Monitoring

OGNZL is proposing to undertake the following continuous monitoring with regards brine storage in FRUG:

- Monitor brine injection flows on the delivery line between the WTP and the injection well.
- Monitor mine water levels in one of the FRUG vertical access shafts throughout the period of brine injection to the underground workings. The objective of the water level monitoring is to provide data to support the management of mine water abstraction rates as described in Section 4.1.1.
- Monitor the electrical conductivity of the water at the base of the eastern access shaft, if possible. This monitoring is to enable OGNZL to detect injected brine when the interface between the brine and the original mine water reaches the elevation of the monitoring sensor.

The above monitoring is proposed principally to support operational management of the brine storage process, rather than for environmental compliance purposes.

5 CONCLUSIONS

The full-scale RO WTP planned for the Macraes Operation is projected to produce a brine concentrate at approximately 15% of influent flow. Annual brine volumes are expected to increase from about 86,100 m^3 during Mining Stage B to a peak of approximately 213,300 m^3 during closure, before reducing to approximately 108,300 m^3 in the long-term post-closure period. Additional treatment stages could reduce these quantities, but no such reduction has been assumed in this assessment.

FRUG comprises hydraulically connected underground workings extending to approximately 910 m bgl, and has an estimated residual void volume of approximately 5.67 Mm^3. Groundwater inflows during mining were low, consistent with the very low to low permeability of the surrounding Otago Schist. A conservative storage calculation that excludes seepage into the surrounding schist and Frasers TSF indicates that the available void space could accept projected brine production for approximately 43 years from the start of Mining Stage B. This represents a minimum storage period because it assumes that brine progressively replaces mine water and remaining air-filled void space without accounting for ongoing seepage outflows.

The density-dependent groundwater model (GHD 2026b) simulated injection of approximately 3.45 L/s of brine to FRUG for 400 years. After FRUG becomes inundated, modelled interaction with the surrounding schist comprises outflows of approximately 320 to 330 m^3/day and non-brine inflows of approximately 30 to 50 m^3/day. The denser brine is expected to fill the deeper workings first and to migrate slowly into the surrounding schist. As the brine level rises within the FRUG workings, seepage is expected to occur into the tailings stored in Frasers TSF. The model indicates that FRUG can accept the projected long-term brine flows throughout the 400-year simulation without overflow, provided mine water levels are monitored and managed if necessary.

After 400 years, the modelled plume, defined by a minimum concentration of 1% brine, extends approximately 2 km north and east of FRUG but remains at depth. It is predicted to remain approximately 65 m below Deepdell Creek and more than 260 m below Tipperary Creek, without daylighting in creeks or tributary gullies. Modelled diffuse sulfate contributions attributable to possible dispersive transport on the margins of the plume FRUG brine are approximately 1.9 kg/day to gullies and 5.3 kg/day to major streams. These modelled mass loads are driven principally by dispersion rather than advective transport and are expected to represent a conservative over-estimate of sulfate discharges from FRUG to these catchments. These mass loads would represent less than 2% of the modelled sulfate loads to either Deepdell Creek or Tipperary Creek from other sources and would not be detectable at the relevant compliance monitoring points. The proposed storage is therefore projected to have a negligible effect on surface-water quality and compliance at the Macraes Operation.

The principal operational risk from brine storage in FRUG relates to excessive water pressure or rising mine water levels displacing existing mine water or brine toward Frasers TSF or the surface, particularly during the higher brine-production rates expected in the closure period. This risk can be managed by injecting brine into the deeper underground workings and abstracting equivalent volumes of mine water if required to maintain the FRUG water level below designated trigger level. Although seepage of brine from FRUG into the stored tailings is expected over the long term, its higher density should promote downward migration within the tailings rather than movement toward the surface.

Continuous operational monitoring should include measurement of brine injection flows, mine water levels in a FRUG vertical shaft and, where practicable, electrical conductivity near the base of the eastern access shaft to detect arrival of brine at that point.

The site-specific risk review found that risks to groundwater resources, surface water, soils and structural stability are either negligible or can be addressed through the defined monitoring and management measures. Overall, none of the identified risks is expected to materially affect environmental management or compliance with the proposed MP4 water-quality consent conditions.

Overall, FRUG is considered a technically viable location for long-term storage of RO brine generated by the proposed WTP. Detailed design of the injection system, trigger levels, abstraction arrangements and monitoring programme is required prior to implementation.

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APPENDIX A
BRINE STORAGE UNDERGROUND

Background

When water with a density equivalent to that of seawater is introduced to a freshwater aquifer, either naturally in coastal areas or anthropogenically, the migration of the saline water or bine is driven by the density differential. In coastal areas, the intrusion of seawater into aquifers has been identified and evaluated mathematically for a long time (Ghyben 1888, Herzberg 1901)

Examples of Brine Storage in Underground Mines

Brine storage underground is an option that is normally considered and implemented in inland area away from the coastline, as marine discharge of brine tends to present fewer environmental, consenting and operational risks.

Ranger 3 Deeps Underground Mine (Australia): Energy Resources of Australia has integrated a water management strategy for mine closure that included injecting highly concentrated brine from its reverse osmosis treatment facility directly into the deep underground mine workings and associated backfilled pits (ERA 2022). By the end of February 2021, a total of 92,000 m^3 of brine had been stored in backfilled open pits (Supervising Scientist 2021). The latest closure plan for Ranger Mine incorporates the planned storage of a total of 1.9 to 2.1 Mm^3 of brine in fill within Pit 3 backfill at the site (ERA 2025).

Springen Mine, Werra District (Germany): The stowage of waste process brine comprising a waste brine conditioning plant, a pipeline transport infrastructure for the stowage brine and a stowage sequence for the Springen Mine has been investigated and is proceeding to implementation (Pinkse et al 2019). Brine totalling 1.5 Mm^3/year is to be stored from 2022 onward in closed potash mines.

Eagle Mine, Michigan (USA): Eagle mine is an underground nickel and copper mine on Michigan’s Upper Peninsula. After mining at the site ceased in the late 1970s, the open pit filled with groundwater and surface water. Tailings seepage water and RO brine from an on-site WTP is managed at the site through storage in the pit lake. A density-stratified structure has developed in the pit lake, which is also used for tailings storage (Obermeyer et al 2025).

APPENDIX B
RISK REVIEW

Introduction

Disposal of concentrated reject brine from RO plants into closed or abandoned underground mines is increasingly used as a mine water management strategy. This occurs extensively when treating highly saline mine water or acid mine drainage to comply with environmental regulations. However, storing concentrated RO brine in underground mine voids can create hydrogeological and geochemical challenges.

A high-level review of international sites where brine or otherwise highly saline water is stored in underground mine voids has identified a set of general environmental risks from use of this practice. Documented environmental risks from this review are summarised below, together with notes on the applicability or management of these risks as they apply to Frasers Underground.

Aquifer Contamination Impacting Groundwater Resources

The storage of RO brine in underground mine reservoirs can lead to high hydrostatic pressures being applied to the surrounding rock strata. Over time, these pressures force the concentrated salts and any chemical additives from the RO process out of the mine void into the surrounding rocks. Should these lithologies include a unit that functions as an aquifer, the quality of groundwater in the aquifer and the future use of the aquifer as a water resource can be impacted.

1. **Rapid aquifer penetration.** The underground mine used for brine storage is directly linked to a productive freshwater aquifer. The brine rapidly penetrates the aquifer, driven by hydraulic pressure differences between the mine workings and the wider aquifer. The quality of the aquifer water becomes progressively degraded by the introduced brine. The movement of groundwater within the aquifer transports the brine away from the immediate area of the mine. Eventually, the aquifer water becomes locally unusable as a water resource.

   The in-situ schist surrounding FRUG, although occasionally described as an aquifer for reporting purposes, has a low permeability (GHD 2026a). It is not an aquifer in the sense that it is not used for water supply purposes. Bores drilled into the Otago schist are generally poorly producing or are effectively 'dry'. Natural groundwater recharge to the schist rockmass is low at approximately 32 mm/year. <u>Overall, the risk of rapid brine penetration to any great extent into the schist rock mass surrounding the underground workings is negligible</u>.

2. **Long-term slow penetration.** Brine seeps through the floor and walls of the mine workings into an adjacent freshwater aquifer, driven by either hydraulic pressure gradients or water density differentials. The aquifer water quality becomes progressively degraded. Degradation initially occurs in the area where the brine is introduced to the aquifer. The quality of the aquifer water becomes progressively degraded by the introduced brine. The movement of groundwater within the aquifer transports the brine away from the immediate area of the mine. Eventually, the aquifer water becomes locally unusable as a water resource.

   The in-situ schist surrounding FRUG, although occasionally described as an aquifer for reporting purposes, has a low permeability (GHD 2026a). Even the heavily fractured zone of the Macraes Fault or the low angle shears of the Hyde Macraes Shear Zone would not normally be considered aquifers due to moderately low permeability. The only existing user of groundwater in the Macraes area is the Stanleys Hotel, which uses a bore for a potable water supply. Frasers Pit and the proposed Frasers tailings storage facility (TSF) are located between the hotel bore and FRUG. The bore is located approximately three kilometres to the west of the FRUG mine panels at their closest approach. <u>Overall, the risk of slow brine penetration into the schist rock mass and thereby impacting the use of groundwater for potable supply is negligible</u>.

Surface Water and Soils Contamination

3. **Buoyancy and displacement.** Dense, concentrated brine settling into the lowest workings of an underground mine can force existing lower-density mine water upward through fractures, unsealed boreholes, collapsed stopes and historic shafts. This upward flow can result in mine water contaminating surficial soils or discharging to surface. Surface discharges then have the potential to enter surface waterbodies, thereby impacting water quality in those waterbodies.

This risk is a valid concern at FRUG. Unless management measures are put in place, actively storing brine in FRUG would result in mine water levels rising. The initial discharges from the mine would likely be past seals installed in the mine access portals and thence into the tailings stored in Frasers TSF. Should this occur, existing pore water in the tailings mass would be displaced and discharge to surface, affecting the water quality in the NBWR. If the seals and stored tailings restrict seepage losses from FRUG, the water levels would rise until they eventually discharge to surface above the mine. This discharge would likely happen via one of the vertical shafts or potentially through the settled rock mass above one or more of the mine panels.

The above risk is addressed through the implementation of monitoring and management measures. The monitoring entails ongoing monitoring of FRUG mine water levels in one of the two vertical access shafts throughout the period that brine storage is actively taking place. The management entails pumping out and treating mine water at equivalent volumes to the amounts of brine stored in FRUG, to ensure mine water levels do not rise substantially.

4. **Replacement.** The ongoing introduction of dense brine into underground workings progressively fills those workings, eventually replacing the existing mine water and air-filled void spaces in the underground mine. Once this happens, the continuing storage of brine in the underground mine leads to a corresponding discharge of brine to the surface. This surface discharge then has the potential to enter surface waterbodies, thereby impacting water quality in those waterbodies.

   This risk is similar to Risk 4, the same impacts although potentially to a greater scale as the brine is much more concentrated than the existing FRUG mine water. The risk is addressed in much the same way, through the implementation of monitoring and management measures. In addition, the measures described for Risk 3, monitoring would include the installation of an electrical conductivity sensor in the base of one of the vertical access shafts. The shafts are both located toward the top end of FRUG workings. This electrical conductivity sensor would detect when the brine reaches that elevation inside the FRUG workings, enabling site operators to implement other brine management measures if necessary.

Mobilisation of Metals and Secondary Geochemical Reactions

The brine from the Macraes RO plant is not expected to be acidic or chemically active. However, in addition to concentrated salts and metals, brine from the plant may contain residual water-treatment chemicals like antiscalants, biocide residues, and cleaning agents. The brine will also be oxygen rich rather than geochemically reducing.

5. **Mine wall rock reactions.** The use of a pre-treatment stage in the water treatment plant should result in relatively low concentrations of most dissolved metals in the brine, compared to the influent mine water. The brine from the Macraes RO plant is likely to be geochemically oxidising and capable of reacting with the exposed walls and collapsed roof rock the FRUG workings. These reactions may result in raised dissolved metals concentrations compared to those in the injected brine. It is not clear whether the dissolved metals concentrations would be above the concentrations in the existing FRUG mine water.

   The potential dissolution of metals from FRUG wall and roof rock is not considered to represent a significant additional risk. Dissolved contaminants in the brine, whether injected with the brine or derived from mine rock reactions, can be managed through applying the same monitoring and management measures as described for Risk 4.

Induced Structural Instability

6. **Roof rock collapse.** Injecting large volumes of fluid into closed underground mine networks can lead to increased pore pressures in the surrounding rock mass. Such increases have been known to lead to reduced stability of mine pillars and roof rock, leading to mine roof collapse. This collapse can increase the risk of hydraulic pathways developing between the underground mine and the overlying surface.

Optimisation of the FRUG mine panels for ore extraction included incorporating mine stope roof collapse and yielding mine pillars to the overall mine design. Most of the mine panels are expected to have partially or fully collapsed already. Additional collapse of roof rock above the mine panels would simply add to the extent of the existing goaf (collapsed roof rock) zones in the mine. The bulking factor that applies to collapsed roof rock in FRUG physically limits the height to which roof collapse can occur.

The average roof collapse height is approximately 110 m above the stope roof, based on collapse height being approximately 10 times average stope height (WGA 2020). The FRUG mine stopes are substantially deeper than 110 m below the ground surface, with the exception of stopes developed below Frasers Pit. It is expected that a degree of disruption of the rock mass between the Frasers Pit shell and the underlying stopes has already happened and resulted in hydraulic connection between these two mine features. Therefore, no significant changes to the current hydraulic behaviour of the mine as a whole are expected as a result of any additional roof caving that may arise from brine storage in FRUG.

The proposed monitoring and mitigation measures applied to Risk 3 would also partially address any risk of additional roof rock collapse. In effect, the water levels and pressures within the upper sections of the mine would not change significantly from those expected if the current closure plan for FRUG was left unchanged. Therefore, no significant change in the structural stability risk profile is expected.

Stored Brine Loss to Other Mine Workings

7. **Leakage Into Frasers TSF.** The existing FRUG workings had three hydraulic exposures to Frasers Pit, as summarised in Table 2 of the report. All three exposures have been sealed, although the seals do not preclude a risk of hydraulic leakage. Furthermore, as noted against Risk 9 above, it is expected that a degree of disruption of the rock mass between the Frasers Pit shell and the underlying stopes has already happened and resulted in hydraulic connection between these two mine features. The risk arises from the potential for concentrated brine to enter the tailings stored in Frasers TSF and thence be transported upwards to the surface within Frasers TSF.

   It is assumed the tailings pore water in Frasers TSF is similar in quality to the drainage water from Top Tipperary TSF. On that basis, the brine will be substantially denser than the tailings pore water in Frasers TSF. As is commonly observed in coastal aquifers, sea water intrusion to the aquifer is driven by density driven flow. The denser sea water enters the aquifer under a layer of fresh water and these waters generally tend to stay separate although the interface between them is a gradual one.

   It is expected that brine entering the tailings in Frasers TSF will behave much like seawater intruding to a coastal aquifer. The dense brine will tend to migrate downward within the tailings and collect within the base of the infilled pit. The exception to this expected behaviour would occur if there is a clear upward hydraulic gradient within the tailings bringing the brine to surface. Such a gradient may arise during the tailings consolidation period, when gradual tailings settlement causes the pore water to discharge to drainage systems installed in the tailings or to surface. However, the hydraulic pressures arising from tailings consolidation would also tend to reduce brine seepage flows from FRUG into Frasers TSF. Additionally, the planned management of water levels in FRUG through the brine storage period would also mitigate against brine entering the Frasers TSF when the tailings consolidation process is underway.

   Overall, there is a known risk and expectation that brine will eventually migrate from FRUG into the tailing stored in Frasers TSF. However, the environmental risks arising from this seepage are considered to be negligible, provided the proposed water level management in the FRUG workings is implemented.

Summary

The risks identified in this appendix are either:

1. Negligible when considered on a site-specific basis; or
2. Amenable to clearly defined monitoring and management measures.

None of the risks identified represent potential issues that may significantly impact on the environmental management and compliance with the proposed water quality consent conditions for MP4 at the Macraes Operation.

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