Appendix H

Surface Water Modelling Detailed Results

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The Power of Commitment

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H-1 Introduction

This appendix outlines the results of the surface water modelling for the Macraes Phase 4 Fast Track Approvals project. An overview of the project description is provided in Section 2 of the "Macraes Phase 4 FTA – Surface and Groundwater Assessment" of which this Technical Memorandum is included as an Appendix. Limitations and assumptions detailed in Section 1 of the "Surface and Groundwater Assessment" are applicable to this memorandum.

Within this Appendix the following topics are covered:

– **Section H-2. Assessment Framework** – describing how outputs from the WBM are presented and assessed against the proposed compliance criteria.
– **Section H-3. Receiving Water Quality Results** – describing:
  - Summary of predicted water quality statistics,
  - Compliance against the proposed ecological protection compliance criteria,
  - Compliance against the proposed drinking water compliance criteria,
  - Climate change sensitivity assessment, and
  - Summary of flow statistics in receiving waters.
– **Section H-4. Flow Augmentation Dams** – describing operation of the flow augmentation dams
– **Section H-5. Water Treatment Plant Operation** – describing operation of the water treatment plant (WTP)

H-1.1 Purpose of this Appendix

The purpose of this appendix is to present the surface water quality modelling results and evaluate the results against the proposed compliance criteria for the Project. It provides a summary of the results at the proposed compliance locations.

H-1.2 Scope and Limitations

This document is an Appendix to GHD Report – Macraes Phase 4 FTA, Surface and Groundwater Assessment. Scope and Limitations apply as outlined in that document.

H-2 Assessment Framework

Details on how the proposed compliance criteria (Viridis, 2026) are applied to the evaluation of model data is outlined in the application notes on Section H-2.4. As the model represents daily data rather than monthly samples as proposed to be undertaken, the proposed chronic compliance criteria is applied as a percentage basis to capture the portion of time that proposed compliance criteria is not met (Note that the significant figures on the percentage conversion is selected to capture the number of whole days in periods with and without leap years). 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.

H-2.1 Reporting Horizons

The WBM runs a Monte-Carlo simulation, producing multiple model iterations with a daily timestep for a duration of 200 years. To allow this information to be presented without unnecessary complexity, results are presented based on five key time horizons, and a long-term climate change sensitivity representation as outline in Table H-2.1. These time horizons (project phases) look to capture key milestones in the mine water management and site hydrology. The presented model statistics in the following sections are derived from the ensemble of simulations and years modelling within the given time horizon.

Table H-2.1 Description of key reporting horizons

Project Phase	Assessment Start Date	Assessment End Date	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. Compliance assessment though this phase is based on existing compliance criteria (Table H-2.3).
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. Compliance assessment is based on the proposed compliance criteria (Table H-2.4).
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.
Pit Overflow	1/01/2100	31/12/2109	Defined to be where all pit lakes area overflowing to the receiving water courses and 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

H-2.2 Modelled Nodes

The water balance model represents flow and water quality outcomes at more than 50 model nodes across the site to enable a range of mining features and water interactions to be represented. The furthest downstream nodes within the system represent the compliance locations within the receiving environment and the extents of the modelled system. Results are presented at these water quality compliance locations to enable assessment of effects from the proposed project and mitigations. The compliance locations included within this project assessment as described in Table H-2.2 and shown in Figure H-2.1.

Table H-2.2 Summary of compliance locations assessed

Ref. Name	Full Name	Description
Mare Burn Catchment		
MB01	Mare Burn 01	Located on the Mare Burn downstream of Māori Hen Creek confluence, receiving flow from Coronation North and Trimbells WRSs
MB02	Mare Burn 02	Located on the Mare Burn downstream of the Coal Creek confluence and all other mining activities, receiving flow from MB01, Coronation North WRS and future overflow of the Coronation North pit lake
Deepdell Creek Catchment		
DC08	Deepdell Creek 08	Located on the Deepdell Creek below all workings in the Deepdell catchment.
Shag River		
Shag at LR	Shag River at Loop Road	Located on the Shag River receiving flow from Deepdell Creek via DC08 and Cranky Jims Creek
Shag at McC	Shag River at McCormicks Road	Located on the Shag River below the confluence of McCormicks Creek and all other mining activities in this catchment, receiving flow from Shag at LR and Tipperary Creek via McCormicks Creek.
Murphys Creek Catchment		
MC01	Murphys Creek 01	Located on Murphys Creek, receiving flow from Frasers West WRS via Murphys Creek Silt Pond
MC02	Murphys Creek 02	Located on Murphys Creek downstream of the Clydesdale Creek confluence, receiving flow from MC01 and Golden Bar WRS
Waikouaiti River North Branch		
NBWRRF	North Branch Waikouaiti River at Ross Road Ford	Located on the Waikouaiti River North Branch, receiving flow from the Frasers West WRS and future flow from Frasers West WRS, Top Tipperary TSF cap, Frasers TSF cap and Frasers South BF.
GB02	Golden Bar 02	Located on Golden Bar Creek, downstream of the Golden Bar pit lake outlet.
NB03	Waikouaiti River North Branch 03	Located on the Waikouaiti River North Branch downstream of the confluence with Golden Bar Creek and all other mine workings.

Some existing compliance locations are not included in this assessment due to the proposed Project not having direct influence on these locations, including; Cranky Jims Creek (CJ01), Highlay Creek (HC01) and Tipperary Creek (TC01)

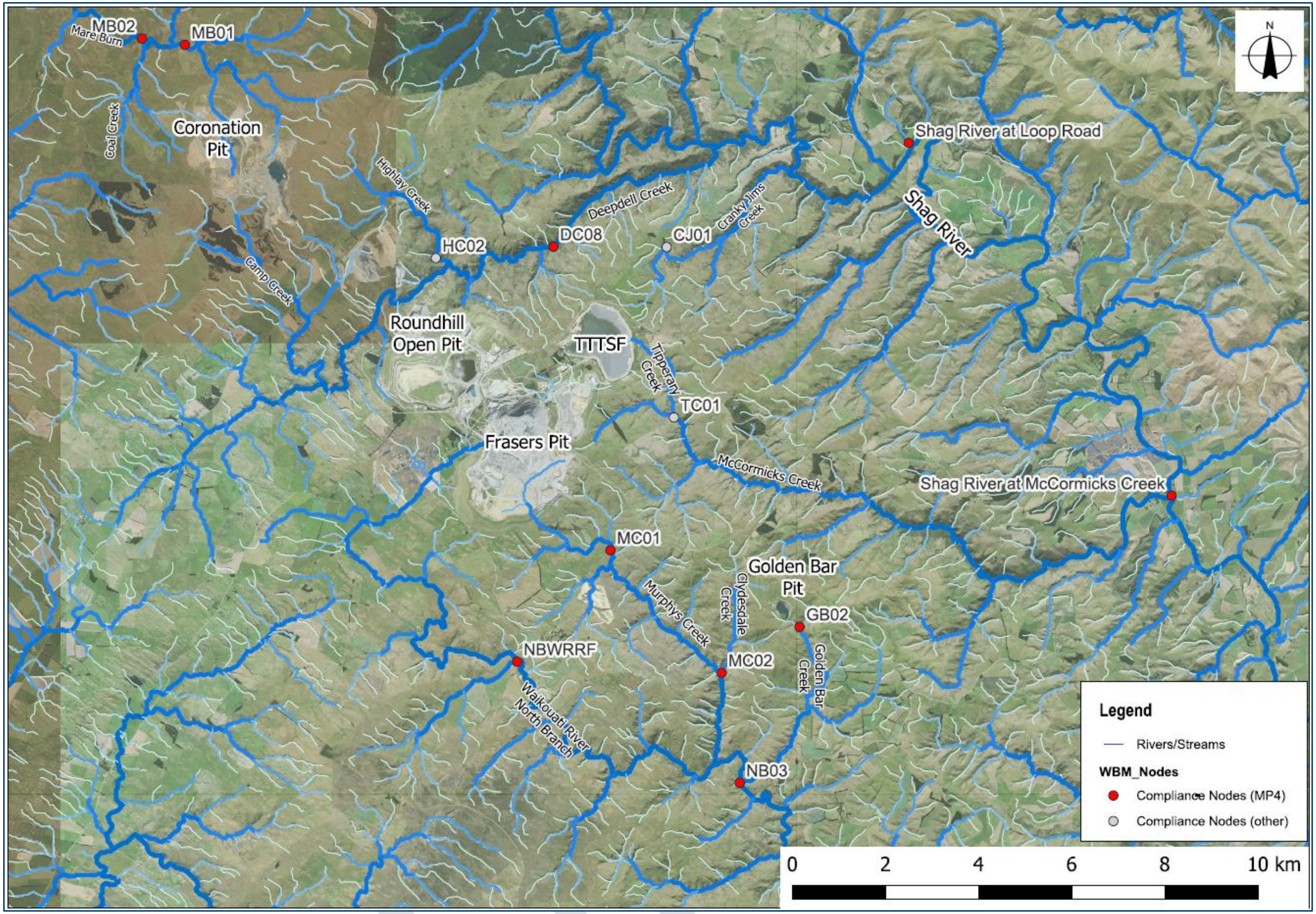

Figure H-2.1 Site overview with compliance locations

H-2.3 Compliance Criteria

The presented results in Section H-3 are evaluated against a number of existing and proposed water quality compliance criteria. These include:

- Existing compliance criteria summarised in Table H-2.3 with site applicability shown for each parameter,
- Proposed ecological protection driven criteria summarised in Table H-2.4 and detailed in Viridis (2026) applicable to all assessed compliance site, and
- Proposed drinking water quality driven criteria summarised in Table H-2.5 and detailed in Viridis (2026) applicable to NB03 and Shag River compliance sites.

The criteria in each of the tables are based on a monthly sample being taking from each site for testing (i.e. 12 annual samples). Where toxicity modifiers are included for the compliance parameters, these are applied based values determined from that tested sample.

A complete set of the proposed compliance criteria (Viridis 2026) is outlined in Table H-2.4 and Table H-2.5 for completeness, with the parameters not included in the modelled results being greyed out and basis for inclusion and/or exclusion being described in the right-hand column.

The results are evaluated against each of these compliance criteria, with the existing criteria applied against modelled results for mining phase A, and the ecological 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 B through to long term.

Table H-2.3 Existing water quality compliance limits at Macraes Operation (Source - adapted from Table 2, Viridis 2026)

Parameter	Limit	DC08	GB02	MB01	MB02	MC01	MC02	NBWRRF	NB03	Shag at LR	Shag at MC
pH (unitless)	7 - 8.5	●								●	●
	6.5 - 9.5				●						
	6.0 - 9.5	●	●	●		●	●	●	●		
Visibility (TSS / turbidity)	30-50% Δ				●						
Sulphate	1,000	●		●		●		●			
	250								●	●	●
Ammoniacal Nitrogen (g N/m^3)	0.24 [2]				●						
Nitrate Nitrogen (g N/m^3)	2.4 [2]	●			●					●	
	3.5 [3]	●								●	
Arsenic	0.15	●	●	●	●	●	●	●			
	0.01								●	●	●
Copper	0.018 [1]	●	●	●	●	●	●	●	●	●	●
Iron	1	●	●	●	●	●	●	●			
	0.2								●	●	●
Lead	0.0059 [1]	●	●	●	●	●	●	●	●	●	●
Zinc	0.23 [1]	●	●	●	●	●	●	●	●	●	●
Cyanide	0.1	●		●	●	●		●	●		●

Units are in g/m^3 unless stated otherwise; All metals are tested in the dissolved fraction unless stated;
1. HMTV = hardness modified trigger value; Adjusted here for a standard Macraes Operation hardness of 220 g/m^3 as $CaCO_3$.
2. Applied as an annual 95th% limit.
3. Applied as an annual median limit.

Table H-2.4 Proposed ecological trigger values, toxicity modifiers and compliance criteria (Source – modified from Table 3, Viridis 2026)

Parameter	Type	Toxicity modifiers	Proposed trigger value	Non-compliance criteria	WBM application
pH (unitless)	Chronic	-	6.5-9.0	More than two exceedances within any rolling 12-month period	
Turbidity (NTU)	Chronic	-	5	More than two exceedances within any rolling 12-month period	Not Modelled – Turbidity is typically driven by peak flows and operational erosion and sediment control practices and is not suitably represented in the WBM.
Sulphate	Chronic	Hardness	500 (when <100 g/m^3 hardness) 1,000 (when ≥100 g/m^3 hardness)	More than two exceedances within any rolling 12-month period	Included in modelling and compliance results
Ammoniacal nitrogen (g N/m^3)	Chronic	pH, temperature	Refer to lookup Tables in Viridis (2026) for TV adjustment Equivalent to 0.52 when the pH is 7.8 and T is 20 °C.	More than two exceedances within any rolling 12-month period	Included in modelling and compliance results based on NH_{4+}
Nitrate nitrogen (g N/m^3)	Chronic	Hardness, chloride	1.1 (when <30 g/m^3 hardness) 2.6 (when 30-150 g/m^3 hardness or >150 g/m^3 with Cl <30 g/m^3) 29 (when >150 hardness with Cl ≥30 g/m^3)	More than two exceedances within any rolling 12-month period	Included in modelling and compliance results based on NO_{3-}.
SIN (g N/m^3)[1] Ecological response indicator	Eutrophication	-	0.075 Ecological response trigger to be refined through the consenting process	Rolling annual median exceeds the applicable nutrient trigger value; and Ecological response compliance criteria to be refined through the consenting process	Not explicitly modelled and presented, can be approximated by sum of NO_{3-} and NH_{4+}
Arsenic	Chronic	-	0.013 (0.042 at DC08)	More than two exceedances within any rolling 12-month period	Included in modelling and compliance results based on total dissolved As.
Boron	Chronic	-	0.94	More than two exceedances within any rolling 12-month period	Not included in modelling due to insufficient baseline data.
Copper	Chronic	DOC	$TV = 0.00047 \times \left(\frac{DOC}{0.5}\right)^{0.977}$ Equivalent to 0.004 when DOC is 4.5 g/m^3	More than two exceedances within any rolling 12-month period	Included in modelling and compliance results based on total dissolved Cu.
	Acute	Hardness, pH, DOC	$TV = \frac{exp\,(-6.6\, +\, 0.78\,pH\, +\, 0.58\, \times\, ln(hard.)\, +\, 0.70\, \times\, ln(DOC)}{1{,}000}$ Equivalent to 0.039 when DOC is 4.5 g/m^3, pH is 7.8, and hardness is 220 g/m^3	Single exceedance	
Iron	Chronic	-	0.28	More than two exceedances within any rolling 12-month period	Included in modelling and compliance results. Inputs based on total and dissolved Fe measurements

Parameter	Type	Toxicity modifiers	Proposed trigger value	Non-compliance criteria	WBM application
Lead	Chronic	Hardness	$TV = 0.0034 \times \left(\frac{Hardness}{30}\right)^{1.27}$ Equivalent to 0.045 when hardness is 220 g/m^3	More than two exceedances within any rolling 12-month period	Included in modelling and compliance results based on total dissolved Pb.
Nickel	Chronic	Hardness, pH, DOC	Refer to lookup Table A2 in Appendix A for TV adjustment Equivalent to 0.008 when DOC is 4.5 g/m^3, pH is 7.8, and hardness is 220 g/m^3	More than two exceedances within any rolling 12-month period	Not included in modelling due to insufficient baseline data.
Zinc	Chronic	Hardness, pH, DOC	Refer to lookup Tables in Viridis (2026) for TV adjustment Equivalent to 0.016 when DOC is 4.5 g/m^3, pH is 7.8, and hardness is 220 g/m^3	More than two exceedances within any rolling 12-month period	Included in modelling and compliance results.
	Acute	Hardness, pH, DOC	$TV = \frac{\exp(2.5 - 0.12\, pH + 0.6 \times \ln(hardness) + 0.13 \times \ln(DOC))}{1{,}000}$ Equivalent to 0.15 when DOC is 4.5, pH is 7.8 and hardness is 220 g/m^3	Single exceedance	
Cyanide	Chronic	pH, temperature	$TV = 0.007 \times (1 + 10\hat{}(pH - (9.721 - 0.0194 \times T)))$ Equivalent to 0.0072 when the pH is 7.8 and T is 20 °C.	More than two exceedances within any rolling 12-month period	This parameter is not included in modelling as it breaks down when exposed to microbial activity and sunlight. High attenuation in receiving waters makes it unsuitable for inclusion in a conservate mass balance model. Further, baseline data is heavily influenced by lower detection limits and would result in a significant overestimate of the risk.

Notes: All units g/m^3 unless stated; metals analysed in dissolved fraction unless stated; TV = trigger value; DGV = default guideline value; DOC = dissolved organic carbon;
¹. SIN = soluble inorganic nitrogen, which is the sum of ammoniacal nitrogen, nitrate nitrogen and nitrite nitrogen;

Table H-2.5 Proposed drinking water values applicable to NB03 and Shag River sites (Source – modified from Table 4, Viridis 2026)

Parameter	Value[1]	Compliance criteria	WBM application
Arsenic	0.01	MAV	Included in modelling and compliance results based on total dissolved As.
Boron	2.4	MAV	Not included in modelling due to insufficient baseline data.
Copper	2	MAV	Included in modelling and compliance results based on total dissolved Cu.
Iron	0.2	IG	Included in modelling and compliance results. Inputs based on total and dissolved Fe measurements
Lead	0.01	MAV	Included in modelling and compliance results based on total dissolved Pb.
Nickel	0.08	MAV	Not included in modelling due to insufficient baseline data.
Nitrate-Nitrogen	11.3	MAV	Included in modelling and compliance results based on total NO3-.
pH (unitless)	7-8.5	AV	Included in modelling and compliance results.
Sulphate	250	AV	Included in modelling and compliance results based on total dissolved SO_4^{2-}.

Metals are in the dissolved fraction; **1.** units are in g/m^3 unless otherwise stated.
MAV: Maximum acceptable value as defined in New Zealand Government (2022)
AV: Aesthetic value as defined in the Taumata Arowai (2022)
IG: Irrigation guideline as defined in, ANZECC (2000) irrigation guideline (long-term)

H-2.4 Application of Compliance Criteria to Modelled Results

There is a fundamental difference in the sampled data and the modelled data that needs to be considered when applying compliance criteria to model outcomes. This relates to the sampling frequency where measured data has/will have 12 samples annually at monthly intervals, whereas the modelled data presents 365 samples annually at daily intervals.

Acute Criteria

Exceedances against acute criteria are reported based on the percentage of days exceeding the trigger [compliance] limit. The percentage exceedance therefore represents the probability of failing to meet compliance on any one day.

Chronic Criteria

Exceedances against chronic criteria are reported based on the assumption that two samples can exceed the trigger value from 12 sample taken monthly. This is represented as 16.6% of samples (or 60 days per year) exceeding the trigger. On this basis where the trigger value is exceeded on 61 days from the prior 365 days, that day is considered to be non-compliant (and all subsequent days until the number of days exceeding the trigger value is 60 or less). The probability of failing to meet compliance is subsequently represented as the number of non-compliant days divided by the total number of days within the reporting period.

Given the model samples at a much high frequency (daily rather than monthly), the method of evaluating the results against the chronic criteria creates a conservative estimate of compliance failure. This is due to the rounding effect as the sampling frequency is reduced. A statistically similar representation would allow for 2.5 of 12 monthly samples (20.8%) exceed the trigger value before causing non-compliance. This interpretation is not applied.

Within the above calculations, wherever a compliance trigger value includes a toxicity modifier, the revised trigger value is determined daily, and the modelled concentration is evaluated against this.

What do the non-compliance statistics represent?

To provide context to the presented results consider the following:

– Compliance failure of 1% against an acute limit, would mean that on any given day there is a 1 in 100 chance of the acute trigger being exceeded. Typically, this would represent and exceedances occurring on a single month every eight years, or an extended dry summer period every 25 years under normal conditions.
– Compliance failure of 10% against a chronic limit, would mean that 1 in 10 randomly selected hydrological years is likely to have ≥61 days above the trigger, with the remaining 9 years having ≤60 days above the trigger. Typically, this result would be representative of a climate sequence where rainfall is at the lower end of predicted ranges, and infiltration rates and/or seepage concentrations are at the higher end of predicted ranges. By extension, a 1% chance of compliance failure can be represented by just more than 2 months above the trigger value over one summer in 100 modelled years. In the modelling this would typically represent a combination of a dry year with infiltration and seepage concentrations at the higher end of the modelled range. It may occur in some 200-year modelled sequences and not in others.

H-2.5 Model Statistics

For each of the compliance sites the following statistics are summarised by project phase:

– Surface water quality statistics at compliance nodes (Tables):
  - Median concentration,
  - 95th Percentile concentration, and
  - Maximum predicted concentrations.
– Surface water quality at compliance nodes (Charts):
  - Concentration – exceedance charts show the water quality distribution.
  - Normalised concentration - exceedance charts show the modelled water quality normalised by the compliance trigger value calculated on that day, providing an indication of frequency and magnitude of trigger exceedance for modified compliance parameters.
– Compliance against the proposed ecological protection compliance criteria (Tables):
  - Probability of non-compliance against proposed criteria.
– Compliance against the proposed drinking water compliance criteria (Tables):
  - Probability of non-compliance against proposed criteria.
– Summary of flow statistics in receiving waters (Tables):
  - Median flow,
  - 90th percentile low flow (Q90) – flow exceeded 90% of the time, and
  - 95th percentile low flow (Q95) - flow exceeded 95% of the time.
– Flow exceedance at compliance nodes (Charts):
  - Flow exceedance curves demonstrating the distribution of flows for a particular phase. Note charts are on a log scale to focus on lower flow regime data, aligning with the models focus and application.

H-3 Receiving Water Quality Results

This section summarises the water quality and water quality compliance projections from the water balance and contaminant mass transport modelling. The results are presented based on the modelling nodes, phases of operation and compliance criteria outline in Section H-2.

An overview of the compliance statistics for all sites is provided in Section H-3.7 along with analysis of the modelled compliance exceedances. The detailed results are then presented in Sections H-3.1 to H-3.4. A summary of the flow rates is outlined in Section H-3.6.

Charts are presented with a reference trigger value, representing the trigger values described in Viridis (2026). Where normalised curves are presented, the chart is derived from data that represents the daily modelled concentration divided by a daily calculation of the modified trigger value. 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. The intercept of the concentration exceedance curves with the reference lines do not represent 'non-compliance' against the chronic criteria as the distribution of these results with time affects the outcomes.

H-3.1 Mare Burn Catchment

The Mare Burn catchment includes two existing (and proposed) compliance monitoring locations as shown in Figure H-2.1. Water Quality and flow regimes at MB01 and MB02 compliance points both respond in a similar manner to the modelling process.

MB01 receives most of the mine water discharges from the Coronation North and Trimbells Gully WRSs constructed in the Māori Hen Creek and Trimbells Gully catchments. There is also long-term plume development from Coronation Pit and Coronation North Pit reporting to MB01.

MB02 receives additional mine water discharges from the western parts of the Coronation North WRS and Coronation North Backfill, with long-term groundwater plumes discharging to MB02 via Coal Creek.

It is proposed to construct the consented Coal Creek Augmentation Dam upstream of MB02, with discharges from this dam to both Coal Creek and Māori Hen Creek upstream of MB01.

In Figure H-3.1 to Figure H-3.5 for MB01 and Figure H-3.6 to Figure H-3.10 for MB02, the following key transitions can be observed:

– During mining phase B there are periods of low flow observed where the stream is likely to nearly dry out with input primarily from seepage sources. Seepage capture drains being constructed through this period remove some of seepage contributions to receiving waters (refer mining phase A flows in Figure H-3.2).
– Low flow regimes are elevated above 10 L/s through mining phase B due to Coal Creek Dam augmentation flows being realised at MB01, and treated seepage water being returned to the receiving waters. There is a small taper in flows above the 95th percentile low flows resulting from Coal Creek Dam not supplying sufficient residual flow during commissioning through dry periods (refer mining phase B flows in Figure H-3.2).
– There are reductions in flows above the 98th percentile representing the risk of Coal Creek Dam live storage running low and not meeting the augmentation demand. Noting that no reactive management of these discharges are represented in the modelling, which would serve to reduce the chance of this occurring. Once Coronation North Pit reaches overflow, the additional discharges from the lake contributing to Coal Creek Dam result in no further incidents of reaching the defined dead storage level (refer to closure phase flows in Figure H-3.2).
– Mining phase A concentrations are typically higher across most flow regimes as the seepage capture, treatment and augmentation flows are not fully implemented. This is largely representative of current conditions (Figure H-3.1, Figure H-3.3 and Figure H-3.4).

- Mining phase B sees contaminant source loads continuing to increase, with the addition of mitigation measures resulting in an overall load and concentration reduction.
- The lowest contaminant concentrations are observed post closure, once all mitigation measures are considered to be working to full effectiveness and groundwater plumes from pit lake discharges have not yet been observed.
- Through pit overflow and long-term phases, there are increases relative to the closure phase for most key contaminants as pit lake discharges commence and reach steady long-term behaviour.

H-3.1.1 MB01

Table H-3.1 MB01 – Modelled water quality statistics

Phase	Metric	Measured (2020-2026)	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	Long Term (Climate Change)
Sulphate	Median	220	190	200	85	99	220	270
	95th %	857	840	340	140	390	400	430
	Maximum	1120	1890	830	1000	910	570	900
Nitrate-N	Median	2.3	0.79	0.71	0.25	0.25	0.3	0.3
	95th %	7	4.1	1.1	0.41	0.4	0.4	0.5
	Maximum	17	9.2	2.7	2.7	2.3	0.7	2.7
Ammoniacal-N	Median	0.005	0.13	0.22	0.062	0.057	0.054	0.055
	95th %	0.017	0.53	0.3	0.12	0.1	0.092	0.099
	Maximum	0.75	0.82	0.72	0.77	0.6	0.21	0.58
Arsenic	Median	0.0005	0.0019	0.0051	0.0023	0.0026	0.0073	0.0086
	95th %	0.0015	0.0088	0.0082	0.0032	0.012	0.013	0.014
	Maximum	0.0050	0.02	0.021	0.012	0.019	0.019	0.021
Copper	Median	0.0007	0.0032	0.003	0.0018	0.0018	0.0021	0.0022
	95th %	0.0012	0.015	0.0052	0.0027	0.0027	0.003	0.0031
	Maximum	0.0025	0.04	0.013	0.021	0.014	0.0051	0.016
Iron	Median	0.08	0.19	0.24	0.19	0.18	0.16	0.16
	95th %	0.21	0.38	0.29	0.22	0.22	0.21	0.21
	Maximum	0.37	0.53	0.49	0.45	0.36	0.27	0.37
Lead	Median	0.00005	0.000038	0.000039	0.000035	0.000033	0.000034	0.000035
	95th %	0.00005	0.000065	0.000047	0.00004	0.00004	0.000039	0.000041
	Maximum	0.00050	0.00011	0.000091	0.000081	0.000097	0.000093	0.000075
Zinc	Median	0.003	0.011	0.0093	0.0052	0.0058	0.0099	0.011
	95th %	0.023	0.062	0.016	0.0084	0.016	0.016	0.018
	Maximum	0.039	0.16	0.042	0.07	0.049	0.023	0.052
pH	Median	8	7.5	7.5	7.6	7.6	7.6	7.6
	95th %	8.4	7.7	7.7	7.7	7.7	7.7	7.7
	Maximum	8.5	7.8	7.8	7.9	7.9	7.9	7.9

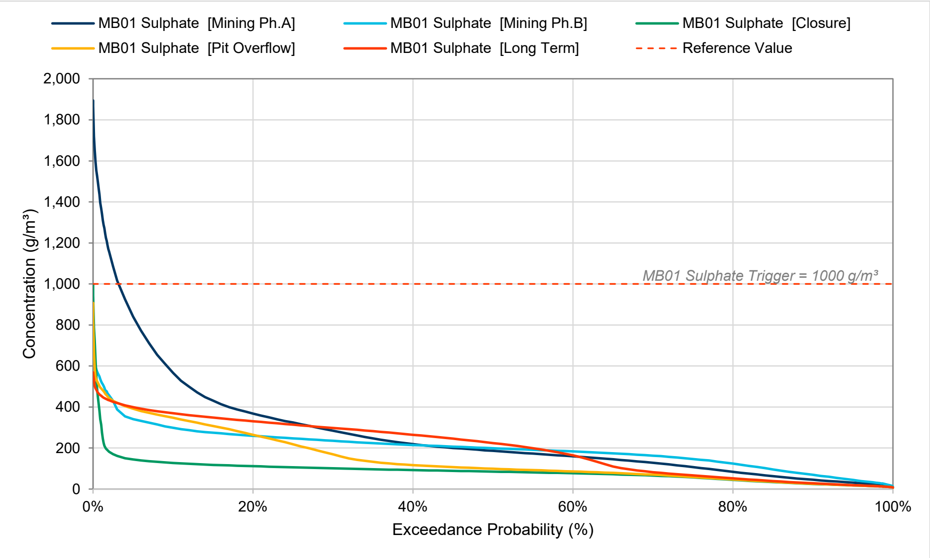

Figure H-3.1 MB01 - Sulphate

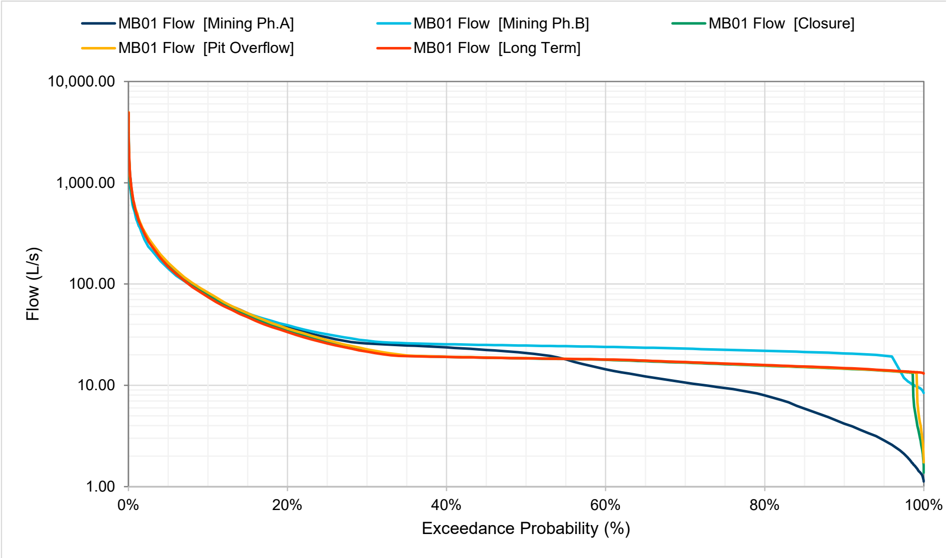

Figure H-3.2 MB01 – Flows

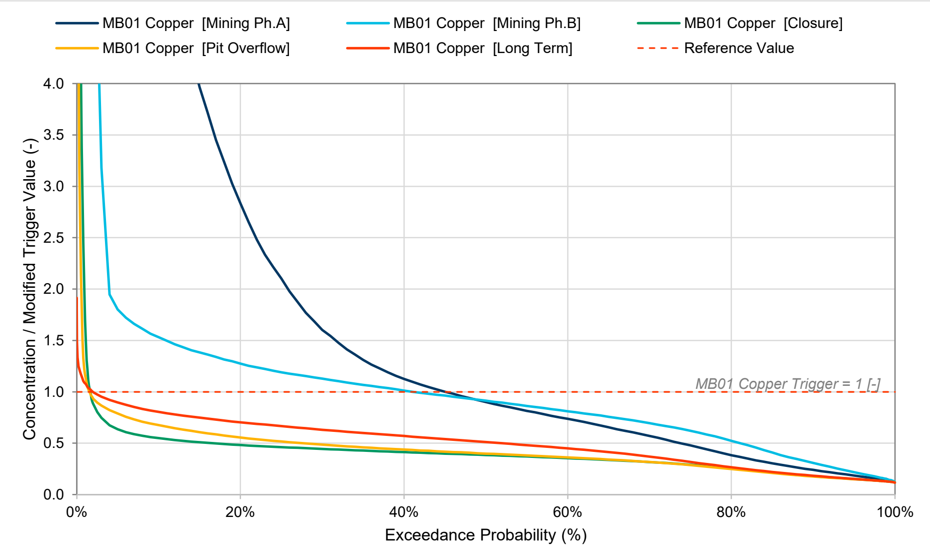

Figure H-3.3 MB01 - Copper

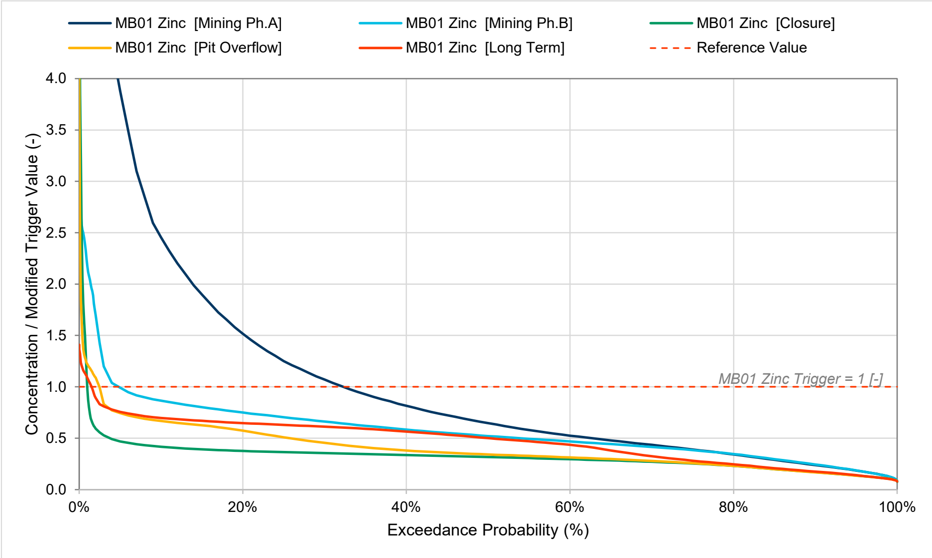

Figure H-3.4 MB01 - Zinc

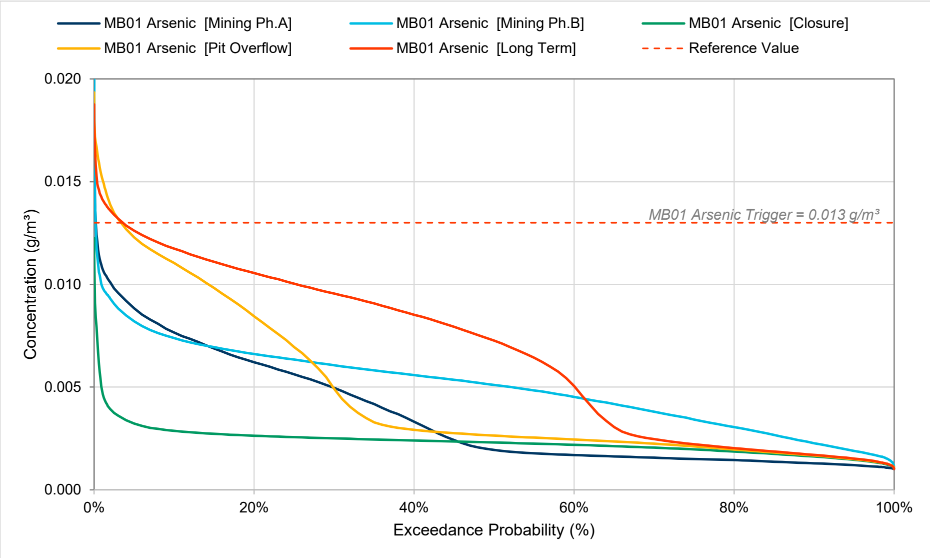

Figure H-3.5 MB01 - Arsenic

Table H-3.2 MB01 – Modelled exceedances of proposed compliance criteria[1]

Parameter	Type[2]	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	LongTerm (C.C.)
Sulphate	Chronic	3.2%	-	-	-	-	-
Nitrate-N	Chronic		-	-	-	-	-
Ammoniacal-N	Chronic		-	-	-	-	-
Arsenic	Chronic	-	-	-	6.2%	7.4%	20%
Copper	Acute	3.4%	0.44%	0.052%	0.0082%	-	0.027%
	Chronic		84%	2.6%	3.2%	2.9%	7.1%
Iron	Chronic	-	11%	0.40%	0.86%	-	-
Lead	Chronic	-	-	-	-	-	-
Zinc	Acute	-	-	-	-	-	-
	Chronic		7.6%	2.5%	5.9%	2.4%	7.3%
pH	Chronic		-	-	-	-	-

[1]. All exceedances represent the percentage of time that the compliance criteria is not met. Greyed cells represent no applicable compliance criteria. No value [-] shows that all modelled sequences comply with the compliance criteria.
[2]. Does not apply to Mining Phase A results, which are captured by existing consent criteria.

H-3.1.2 MB02

Table H-3.3 MB02 – Modelled water quality statistics

Phase	Metric	Measured (2020-2026)	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	Long Term (Climate Change)
Sulphate	Median	138	140	160	64	98	190	240
	95th %	498	630	310	120	370	390	420
	Maximum	700	1870	850	1040	900	570	940
Nitrate-N	Median	1	0.63	0.58	0.2	0.19	0.2	0.2
	95th %	3	3.1	1	0.35	0.34	0.3	0.4
	Maximum	13	9.2	2.8	2.8	2.3	0.5	2.7
Ammoniacal-N	Median	0.005	0.084	0.16	0.045	0.04	0.039	0.041
	95th %	0.022	0.46	0.26	0.088	0.079	0.071	0.075
	Maximum	1.3	0.81	0.71	0.76	0.59	0.15	0.57
Arsenic	Median	0.0017	0.0029	0.0044	0.002	0.0029	0.0067	0.008
	95th %	0.0041	0.0082	0.0077	0.0028	0.012	0.012	0.014
	Maximum	0.0096	0.02	0.02	0.012	0.019	0.019	0.021
Copper	Median	0.0007	0.0023	0.0024	0.0014	0.0014	0.0017	0.0018
	95th %	0.0012	0.011	0.0043	0.0022	0.0023	0.0026	0.0027
	Maximum	0.0025	0.036	0.013	0.021	0.014	0.0039	0.015
Iron	Median	0.17	0.18	0.22	0.19	0.17	0.16	0.16
	95th %	0.34	0.34	0.27	0.21	0.21	0.19	0.19
	Maximum	0.79	0.53	0.48	0.45	0.36	0.24	0.36
Lead	Median	0.00005	0.000039	0.000038	0.000034	0.000032	0.000033	0.000034
	95th %	0.00005	0.000059	0.000047	0.000038	0.000038	0.000037	0.000039
	Maximum	0.00050	0.00011	0.000091	0.000068	0.000076	0.00007	0.000069
Zinc	Median	0.001	0.0074	0.0071	0.0038	0.0049	0.0082	0.0096
	95th %	0.012	0.043	0.014	0.0067	0.015	0.015	0.016
	Maximum	0.021	0.15	0.041	0.069	0.047	0.022	0.051
pH	Median	7.9	7.6	7.5	7.7	7.7	7.6	7.6
	95th %	8.2	7.7	7.7	7.7	7.7	7.7	7.7
	Maximum	8.4	7.8	7.8	7.8	7.8	7.8	7.8

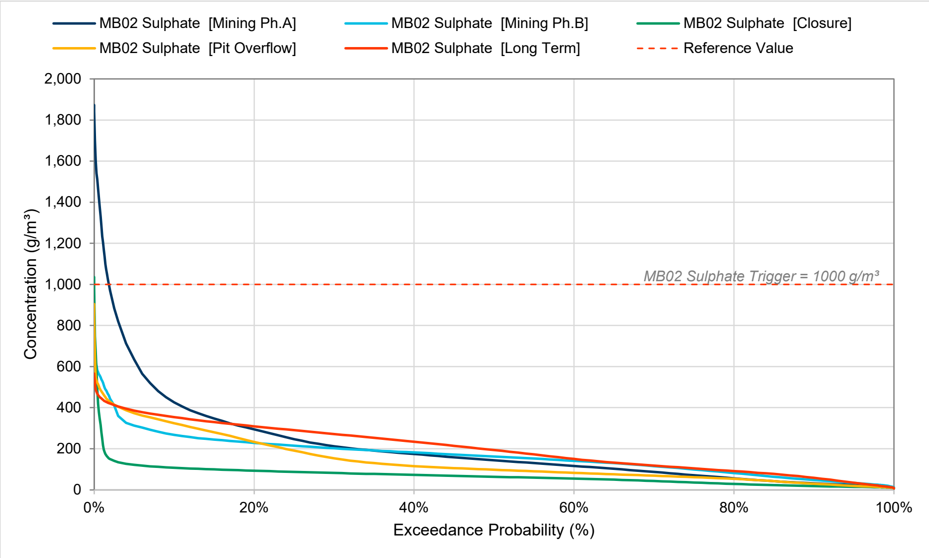

Figure H-3.6 MB02 - Sulphate

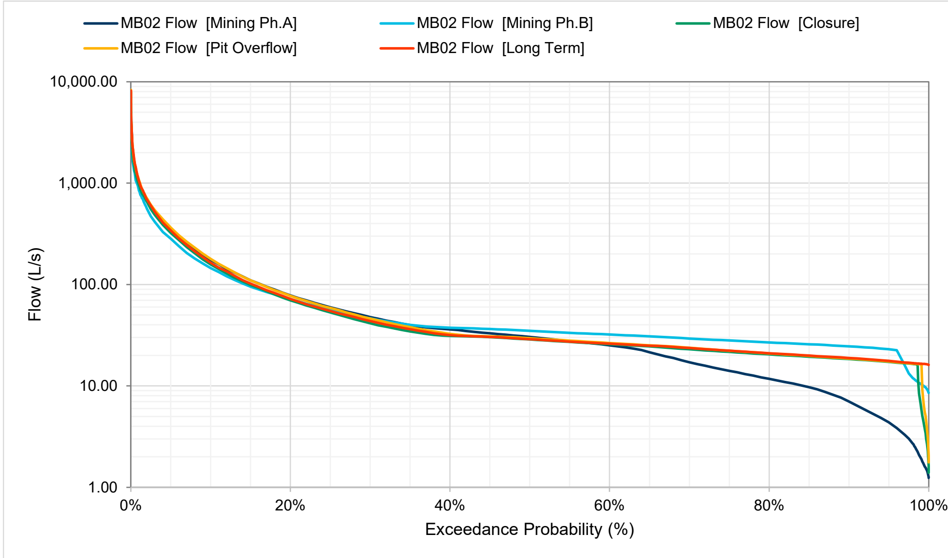

Figure H-3.7 MB02 – Flows

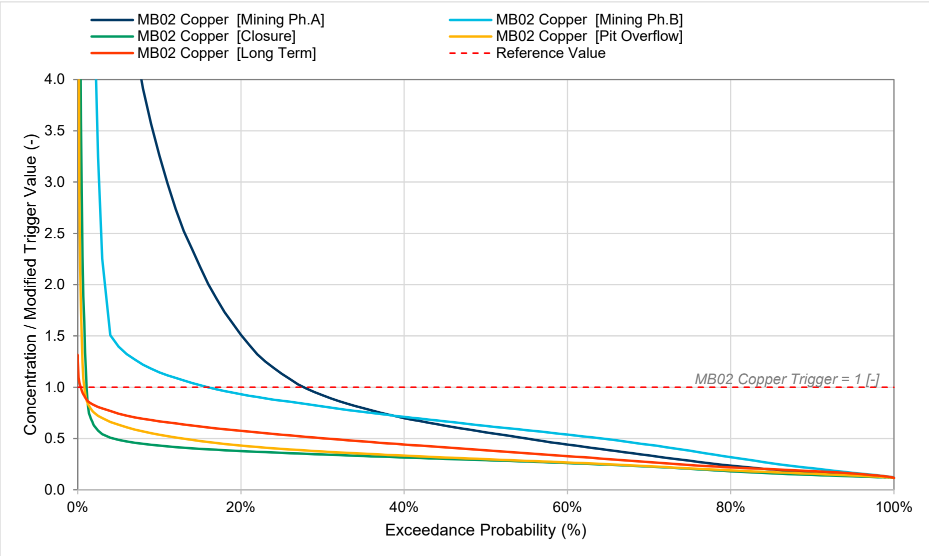

Figure H-3.8 MB02 - Copper

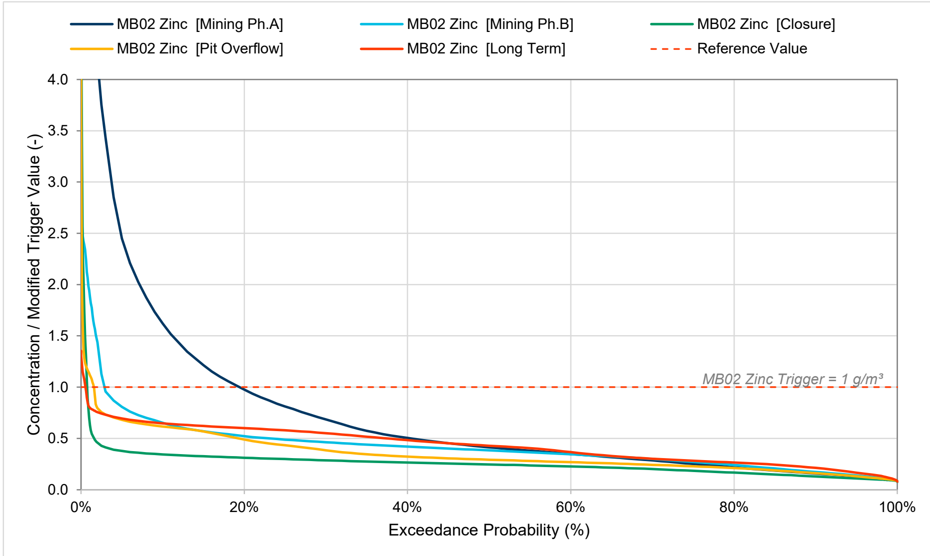

Figure H-3.9 MB02 - Nitrate-N

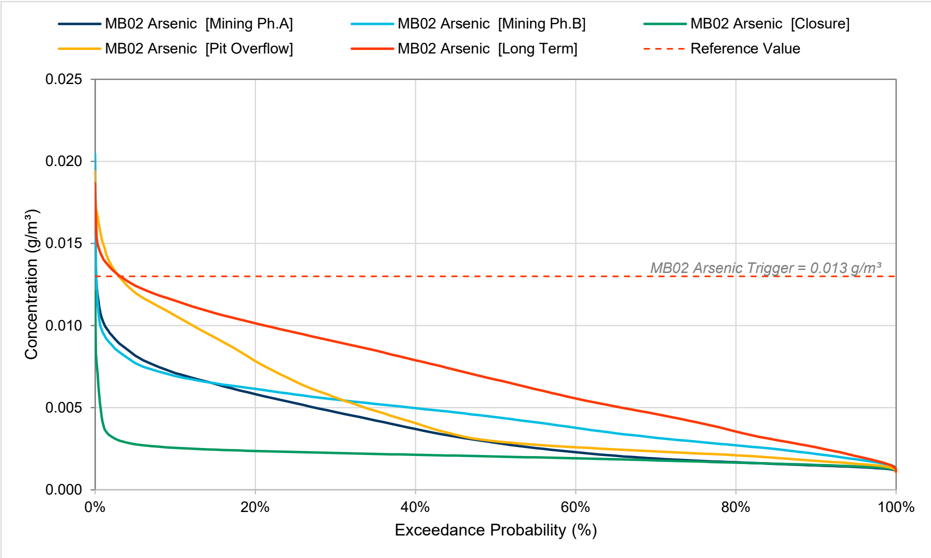

Figure H-3.10 MB02 - Copper

Table H-3.4 MB02 – Modelled exceedances of proposed compliance criteria[1]

Parameter	Type[2]	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	LongTerm (C.C.)
Sulphate	Chronic	1.8%	-	-	-	-	-
Nitrate-N	Chronic	7.5%	-	-	-	-	-
Ammoniacal-N	Chronic	15%	-	-	-	-	-
Arsenic	Chronic	-	-	-	6.0%	6.7%	19%
Copper	Acute	1.5%	0.20%	0.041%	0.0027%	-	0.027%
	Chronic		28%	2.6%	2.2%	-	1.6%
Iron	Chronic	-	9.4%	0.13%	-	-	-
Lead	Chronic	-	-	-	-	-	-
Zinc	Acute	-	-	-	-	-	-
	Chronic		6.8%	2.1%	2.9%	0.90%	4.1%
pH	Chronic		-	-	-	-	-

[1]. All exceedances represent the percentage of time that the compliance criteria is not met. Greyed cells represent no applicable compliance criteria. No value [-] shows that all modelled sequences comply with the compliance criteria.
[2]. Does not apply to Mining Phase A results, which are captured by existing consent criteria.

H-3.2 Deepdell Creek and Shag River Catchments

Deepdell Creek has a compliance monitoring location downstream of all mine workings affecting the catchment as shown in Figure H-2.1. DC08 receives mine water discharges from the central site originating from mining features generally north of the catchment divide along Macraes Road, the southern aspects of Coronation workings and Deepdell workings. This catchment also includes influences from historic mining activities and natural mineralisation. There are two further compliance locations on the Shag River downstream from DC08, being (1) the Shag River at Loop Road which incorporates mine water discharge effects from TTTSF via Cranky Jims Creek, and (2) the Shag River at McCormicks Creek which incorporates mine water discharge effects from TTTSF via Tipperary and McCormicks Creeks. From the perspective of the MP4 project effects, water quality and flow regimes at these three sites respond in a similar manner and are described here.

It is proposed to construct the consented Camp Creek Augmentation Dam upstream of DC08 during mining phase A along with seepage capture systems at Coronation WRS, Māori Tommy Silt Pond and Northern Gully Silt Pond and within the Golden Point Pit.

In Figure H-3.11 to Figure H-3.14 for DC08, Figure H-3.15 to Figure H-3.16 for Shag River at Loop Road and Figure H-3.17 to Figure H-3.18 for Shag River at McCormicks Creek, the following key flow and water quality transitions can be observed:

– Low flow periods are frequent and significant during current conditions and persisting into mining with near dry conditions being observed in Deepdell Creek during extended dry summer periods (refer mining phase A Figure H-3.12).
– The proposed Camp Creek Dam being commissioned early in mining phase B raises low flow conditions to a minimum of 20 L/s (Figure H-3.12). Within the Shag River this corresponds to a raise in the lowest flow conditions by approximately 20%, hence has relatively small influence on Shag River contaminant concentrations (refer Figure H-3.16).
– On closure, there is a reduction in mean seepage rates from the WRSs and an addition of treated water discharging to Deepdell Creek, resulting in a similar overall flow regime to mining phase B.
– Once the Innes Mills, Coronation and Deepdell North pits reach overflow, there is a progressive increase in flows within Deepdell Creek and the Shag River. These pit lakes typically have elevated sulphate, arsenic, copper and zinc concentrations which result in an increase in the receiving water concentrations.

H-3.2.1 DC08

Table H-3.5 DC08 – Modelled water quality statistics

Phase	Metric	Measured (2020-2026)	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	Long Term (Climate Change)
Sulphate	Median	180	130	120	110	340	310	320
	95th %	568	670	250	210	570	510	530
	Maximum	1310	2480	380	330	840	750	730
Nitrate-N	Median	0.01	0.52	0.51	0.47	0.43	0.4	0.5
	95th %	0.49	2.8	0.99	0.93	0.81	0.8	0.9
	Maximum	2	10	1.8	1.4	1.2	1.2	1.3
Ammoniacal-N	Median	0.005	0.028	0.041	0.025	0.03	0.025	0.03
	95th %	0.016	0.16	0.23	0.12	0.096	0.08	0.087
	Maximum	0.4	0.59	0.55	0.19	0.44	0.33	0.32
Arsenic	Median	0.013	0.014	0.012	0.022	0.024	0.025	0.026
	95th %	0.034	0.038	0.02	0.03	0.032	0.032	0.032
	Maximum	0.04	0.098	0.082	0.049	0.059	0.057	0.064
Copper	Median	0.0007	0.00065	0.00063	0.00063	0.0007	0.00079	0.00078
	95th %	0.0014	0.00088	0.00072	0.00069	0.0008	0.001	0.001
	Maximum	0.0025	0.0016	0.0012	0.00079	0.00094	0.0013	0.0014
Iron	Median	0.04	0.17	0.18	0.17	0.15	0.15	0.15
	95th %	0.18	0.22	0.25	0.21	0.18	0.18	0.18
	Maximum	0.27	0.43	0.42	0.24	0.32	0.27	0.24
Lead	Median	0.00005	0.000046	0.000044	0.000041	0.000041	0.000043	0.000046
	95th %	0.00010	0.00013	0.000068	0.000054	0.000063	0.000064	0.00007
	Maximum	0.00050	0.00038	0.00029	0.00011	0.00018	0.00017	0.00018
Zinc	Median	0.0005	0.0043	0.0042	0.0028	0.0046	0.0049	0.0049
	95th %	0.0018	0.019	0.0083	0.0052	0.0075	0.0079	0.0082
	Maximum	0.0050	0.065	0.014	0.013	0.012	0.013	0.013
pH	Median	8.2	7.7	7.7	7.7	7.7	7.7	7.7
	95th %	8.6	7.7	7.7	7.7	7.7	7.7	7.7
	Maximum	8.9	7.9	7.8	7.8	7.8	7.8	7.8

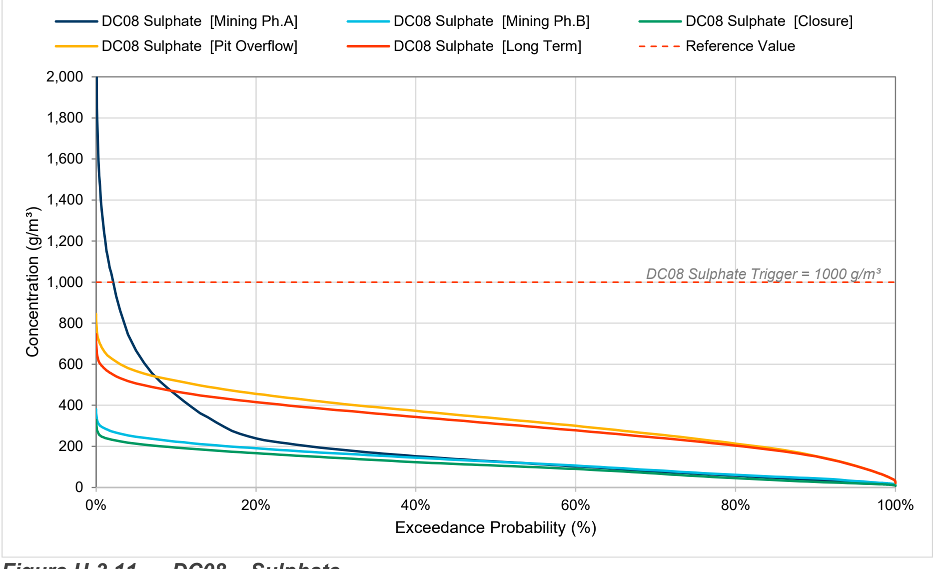

Figure H-3.11 DC08 – Sulphate

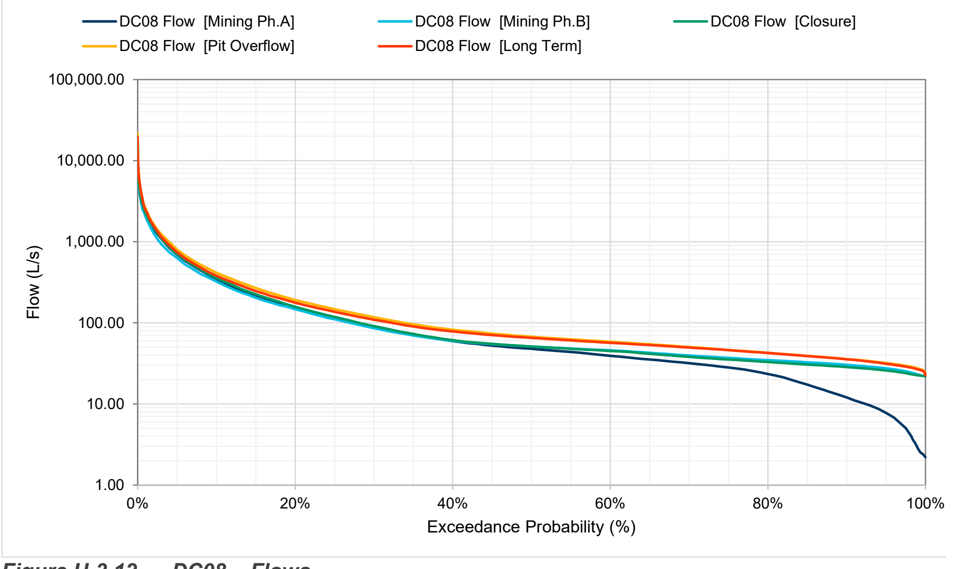

Figure H-3.12 DC08 – Flows

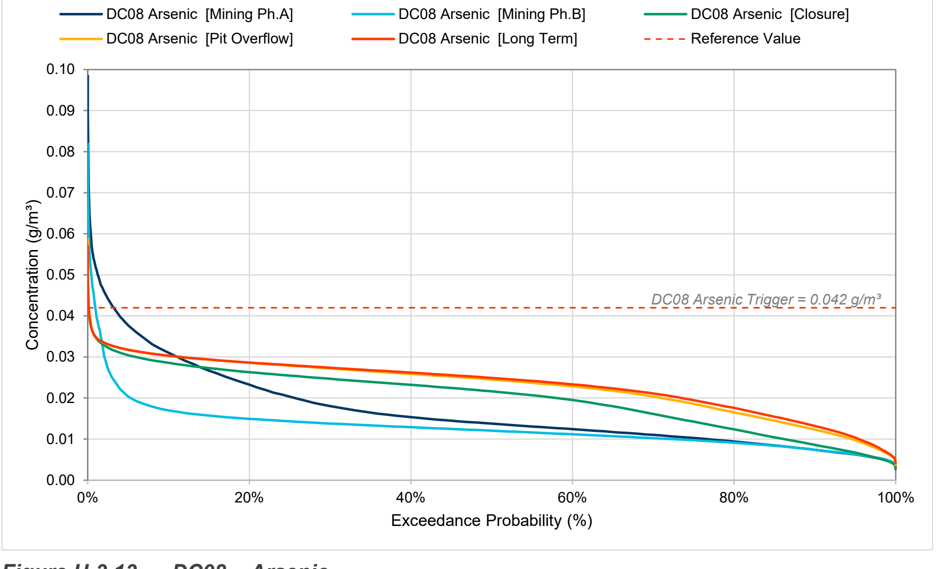

Figure H-3.13 DC08 – Arsenic

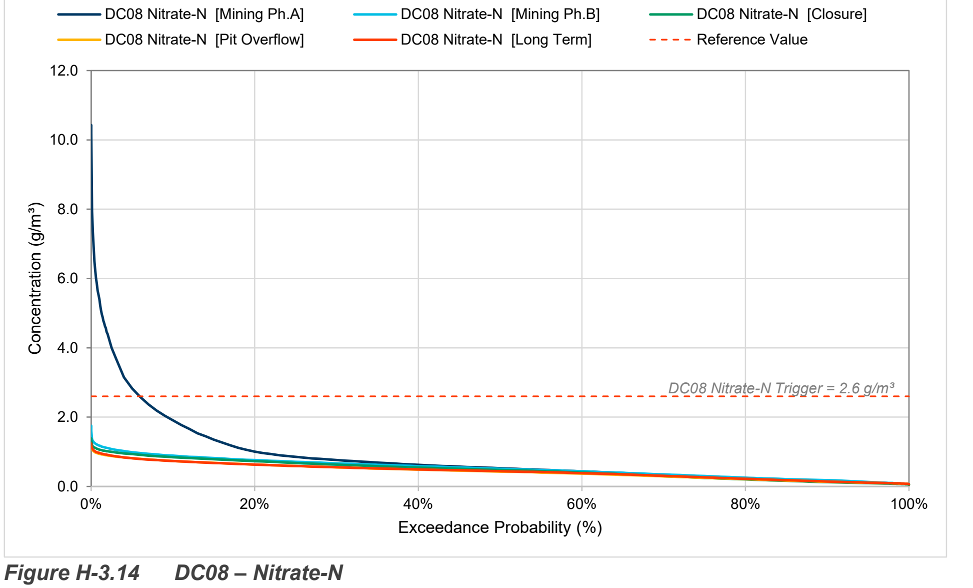

Figure H-3.14 DC08 – Nitrate-N

Table H-3.6 DC08 – Modelled exceedances of proposed compliance criteria¹

Parameter	Type²	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	LongTerm (C.C.)
Sulphate	Chronic	2.1%	-	-	-	-	
Nitrate-N	Chronic	6.8%	-	-	-	-	
Ammoniacal-N	Chronic		-	-	-	-	
Arsenic	Chronic	-	-	-	-	-	
Copper	Acute	-	-	-	-	-	
	Chronic		-	-	-	-	
Iron	Chronic	-	-	-	-	-	
Lead	Chronic	-	-	-	-	-	
Zinc	Acute	-	-	-	-	-	
	Chronic		-	-	-	-	
pH	Chronic		-	-	-	-	

¹. All exceedances represent the percentage of time that the compliance criteria is not met. Greyed cells represent no applicable compliance criteria. No value [-] shows that all modelled sequences comply with the compliance criteria.
². Does not apply to Mining Phase A results, which are captured by existing consent criteria.

H-3.2.2 Shag at Loop Road

Table H-3.7 Shag at LR – Modelled water quality statistics

Phase	Metric	Measured (2020-2026)	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	Long Term (Climate Change)
Sulphate	Median	26	23	24	21	65	61	69
	95th %	53	66	75	60	160	140	150
	Maximum	95	160	140	110	300	280	280
Nitrate-N	Median	0.02	0.11	0.12	0.11	0.11	0.1	0.1
	95th %	0.46	0.29	0.31	0.27	0.27	0.3	0.3
	Maximum	1	0.63	0.55	0.45	0.45	0.4	0.5
Ammoniacal-N	Median	0.005	0.01	0.013	0.011	0.012	0.011	0.012
	95th %	0.011	0.037	0.055	0.036	0.029	0.025	0.027
	Maximum	0.021	0.1	0.097	0.073	0.21	0.16	0.15
Arsenic	Median	0.002	0.0031	0.0032	0.0042	0.0053	0.0054	0.006
	95th %	0.0031	0.0058	0.0055	0.0084	0.01	0.01	0.011
	Maximum	0.005	0.019	0.018	0.012	0.024	0.017	0.02
Copper	Median	0.0005	0.00061	0.0006	0.00061	0.00062	0.00064	0.00064
	95th %	0.0014	0.00074	0.00073	0.00073	0.00074	0.00076	0.00076
	Maximum	0.0025	0.00081	0.0008	0.00077	0.00079	0.0009	0.00094
Iron	Median	0.01	0.17	0.17	0.17	0.17	0.17	0.17
	95th %	0.091	0.21	0.21	0.21	0.2	0.2	0.2
	Maximum	0.19	0.22	0.23	0.22	0.22	0.22	0.22
Lead	Median	0.00005	0.000033	0.000033	0.000032	0.000033	0.000033	0.000034
	95th %	0.00013	0.000043	0.000043	0.000039	0.00004	0.00004	0.000042
	Maximum	0.00050	0.000095	0.000087	0.000049	0.00012	0.000088	0.000099
Zinc	Median	0.0005	0.0014	0.0015	0.0013	0.0016	0.0017	0.0018
	95th %	0.0024	0.0027	0.003	0.0021	0.0027	0.0028	0.0029
	Maximum	0.0054	0.0051	0.0052	0.0037	0.0048	0.005	0.0052
pH	Median	8	7.7	7.7	7.7	7.7	7.7	7.7
	95th %	8.2	7.8	7.8	7.8	7.8	7.8	7.8
	Maximum	8.4	7.8	7.8	7.8	7.8	7.8	7.8

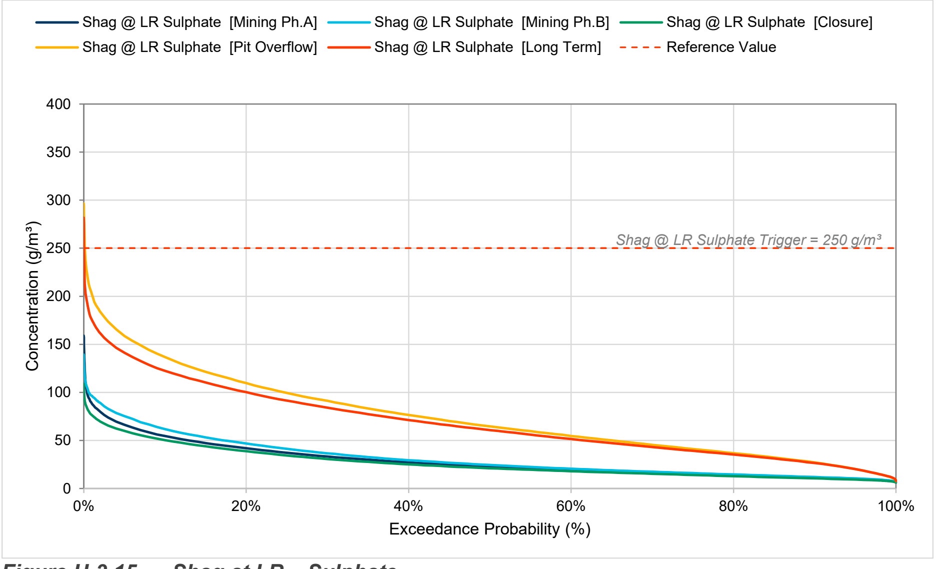

Figure H-3.15 Shag at LR – Sulphate

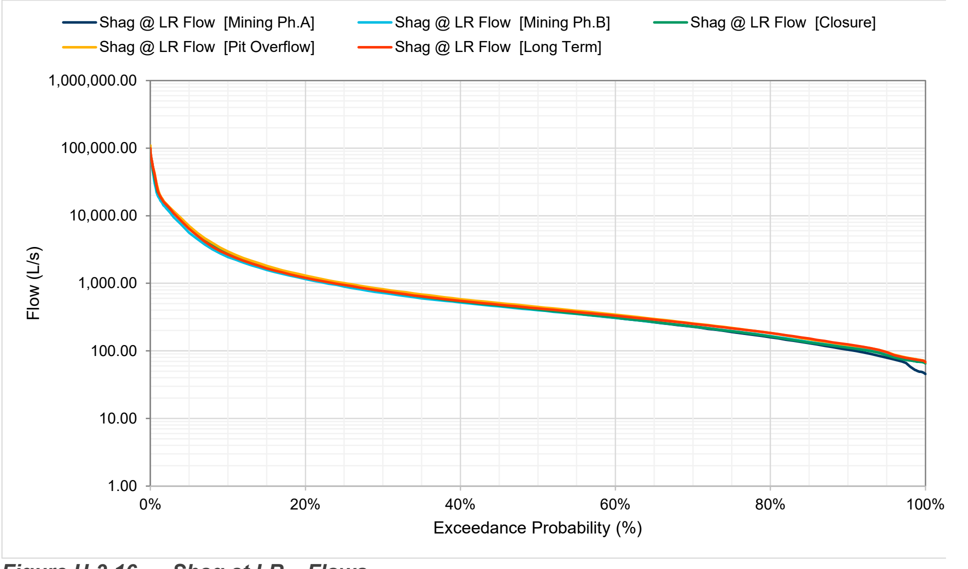

Figure H-3.16 Shag at LR – Flows

Table H-3.8 Shag at LR – Modelled exceedances of proposed compliance criteria¹

Parameter	Type²	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	LongTerm (C.C.)
Sulphate	Chronic	-	-	-	-	-	-
Nitrate-N	Chronic	-	-	-	-	-	-
Ammoniacal-N	Chronic		-	-	-	-	-
Arsenic	Chronic	0.68%	-	-	-	-	-
Copper	Acute	-	-	-	-	-	-
	Chronic		-	-	-	-	-
Iron	Chronic	10%	-	-	-	-	-
Lead	Chronic	-	-	-	-	-	-
Zinc	Acute	-	-	-	-	-	-
	Chronic		-	-	-	-	-
pH	Chronic		-	-	-	-	-

¹. All exceedances represent the percentage of time that the compliance criteria is not met. Greyed cells represent no applicable compliance criteria. No value [-] shows that all modelled sequences comply with the compliance criteria.
². Does not apply to Mining Phase A results, which are captured by existing consent criteria.

Table H-3.9 Shag at LR – Modelled exceedance of drinking water guidelines¹

Parameter	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	LongTerm (C.C.)	Type
Sulphate	-	-	-	0.12%	0.011%	0.036%	AV
Nitrate-N	-	-	-	-	-	-	MAV
Arsenic	0.68%	0.86%	0.85%	5.9%	5.1%	7.9%	MAV
Copper	-	-	-	-	-	-	MAV
Iron	10%	14%	11%	4.9%	5%	4.6%	IG
Lead	-	-	-	-	-	-	MAV

¹. All exceedances represent the percentage of time that the compliance criteria is not met. Greyed cells represent no applicable compliance criteria. No value [-] shows that all modelled sequences comply with the compliance criteria.

H-3.2.3 Shag at McCormicks

Table H-3.10 Shag at MC – Modelled water quality statistics

Phase	Metric	Measured (2020-2026)	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	Long Term (Climate Change)
Sulphate	Median	23	20	21	21	53	49	55
	95th %	42	48	55	47	120	100	110
	Maximum	82	100	93	77	240	200	190
Nitrate-N	Median	0.06	0.092	0.096	0.089	0.093	0.1	0.1
	95th %	0.66	0.2	0.22	0.2	0.2	0.2	0.2
	Maximum	1.2	0.41	0.36	0.32	0.33	0.3	0.4
Ammoniacal-N	Median	0.005	0.011	0.029	0.022	0.022	0.017	0.02
	95th %	0.02	0.084	0.1	0.075	0.068	0.045	0.051
	Maximum	0.059	0.17	0.16	0.14	0.31	0.089	0.11
Arsenic	Median	0.002	0.0029	0.0031	0.0037	0.0047	0.0046	0.005
	95th %	0.0025	0.005	0.0051	0.0068	0.02	0.0083	0.0086
	Maximum	0.08	0.014	0.013	0.0097	0.22	0.043	0.037
Copper	Median	0.0006	0.0006	0.00059	0.00059	0.00061	0.00062	0.00062
	95th %	0.0015	0.0007	0.00069	0.00069	0.0007	0.00072	0.00072
	Maximum	0.0025	0.00078	0.00076	0.00076	0.00076	0.00085	0.00082
Iron	Median	0.05	0.18	0.18	0.18	0.18	0.17	0.17
	95th %	0.11	0.21	0.22	0.21	0.24	0.2	0.2
	Maximum	0.49	0.26	0.25	0.25	1.1	0.34	0.3
Lead	Median	0.00005	0.000032	0.000032	0.000032	0.000032	0.000032	0.000033
	95th %	0.00012	0.000039	0.000039	0.000037	0.000038	0.000038	0.000039
	Maximum	0.00050	0.000076	0.000064	0.000042	0.000078	0.000062	0.000077
Zinc	Median	0.0005	0.0013	0.0013	0.0012	0.0014	0.0015	0.0015
	95th %	0.0021	0.002	0.0022	0.0017	0.0021	0.0022	0.0023
	Maximum	0.0094	0.0033	0.0035	0.0026	0.0036	0.0039	0.0037
pH	Median	8	7.7	7.7	7.7	7.7	7.7	7.7
	95th %	8.2	7.8	7.8	7.8	7.8	7.8	7.8
	Maximum	8.3	7.8	7.8	7.8	7.8	7.8	7.8

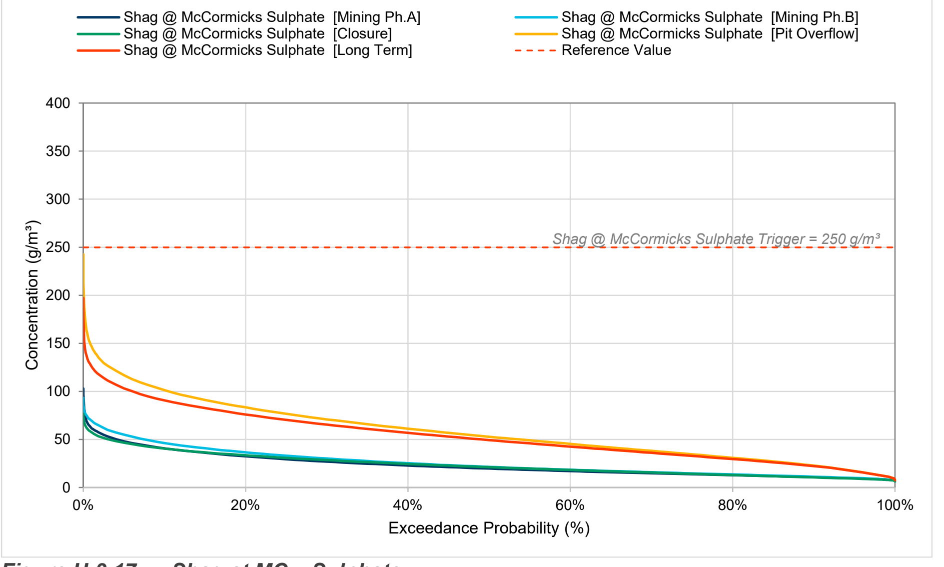

Figure H-3.17 Shag at MC – Sulphate

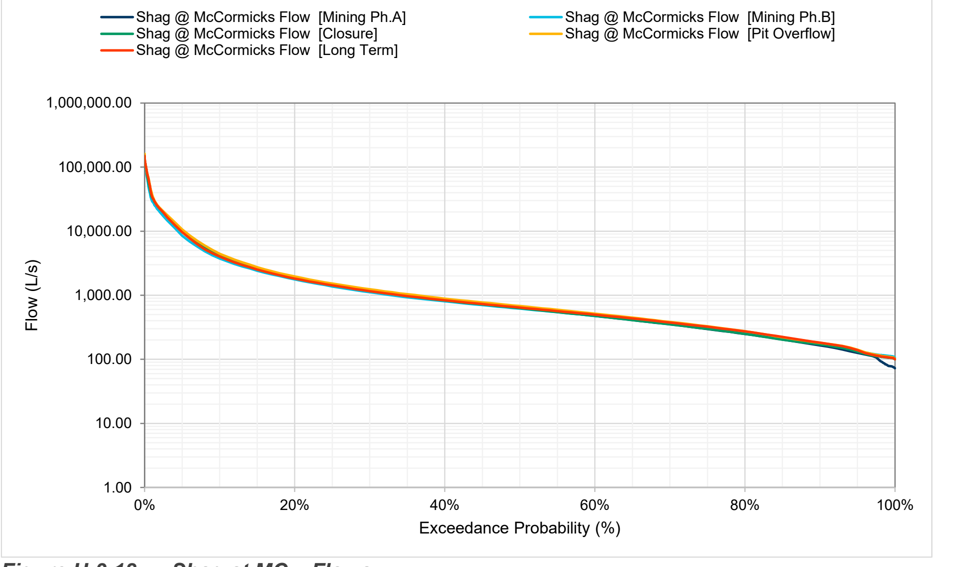

Figure H-3.18 Shag at MC – Flows

Table H-3.11 Shag at MC – Modelled exceedances of proposed compliance criteria[1]

Parameter	Type[2]	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	LongTerm (C.C.)
Sulphate	Chronic	-	-	-	-	-	-
Nitrate-N	Chronic		-	-	-	-	-
Ammoniacal-N	Chronic		-	-	-	-	-
Arsenic	Chronic	0.096%	-	-	9.8%	1.4%	2.4%
Copper	Acute	-	-	-	-	-	-
	Chronic		-	-	-	-	-
Iron	Chronic	12%	-	-	9.1%	-	-
Lead	Chronic	-	-	-	-	-	-
Zinc	Acute	-	-	-	-	-	-
	Chronic		-	-	-	-	-
pH	Chronic		-	-	-	-	-

[1]. All exceedances represent the percentage of time that the compliance criteria is not met. Greyed cells represent no applicable compliance criteria. No value [-] shows that all modelled sequences comply with the compliance criteria.
[2]. Does not apply to Mining Phase A results, which are captured by existing consent criteria.

Table H-3.12 Shag at MC – Modelled exceedance of drinking water guidelines[1]

Parameter	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	LongTerm (C.C.)	Type
Sulphate	-	-	-	-	-	-	AV
Nitrate-N	-	-	-	-	-	-	MAV
Arsenic	0.096%	0.12%	-	7.5%	2%	2.2%	MAV
Copper	-	-	-	-	-	-	MAV
Iron	12%	19%	14%	13%	5%	5.5%	IG
Lead	-	-	-	-	-	-	MAV

[1]. All exceedances represent the percentage of time that the compliance criteria is not met. Greyed cells represent no applicable compliance criteria. No value [-] shows that all modelled sequences comply with the compliance criteria.

H-3.3 Murphys Creek Catchments

Murphys Creek catchment includes two existing (and proposed) compliance monitoring locations as shown in Figure H-2.1. Water Quality and flow regimes at MC01 and MC02 compliance points both respond in a similar manner to the model process..

MC01 receives mine water discharges from Frasers West WRS constructed in the Murphys Creek Valley intersecting Frasers Pit workings.

MC02 is downstream of MC01 and receives additional mine water discharges from Golden Bar WRS via Clydesdale Creek.

It is proposed to construct seepage capture toe bunds within the Frasers West WRS at Murphys Creek and Golden bar WRS during mining phase A. This toe bund will take the place of the existing pumped return and controlled discharge approach being implemented at Murphys Creek Silt Pond. This seepage capture structure is included in the model for Mining Phase B.

In Figure H-3.19 to Figure H-3.22 for MC01 and Figure H-3.23 to Figure H-3.27 for MC02, the following key flow and water quality transitions can be observed:

– Through mining phase A the model assumes that all seepage and surface runoff is captured in Murphys Creek Silt Pond and returned to Frasers Pit. Following commissioning of the WTP, discharges from the WTP contribute to raising flows though dry periods in mining phase B (Figure H-3.20).
– As the seepage capture bund is constructed the modelling approach applies a 75% capture efficiency, with the remaining flow and mass fluxes reporting to the silt pond which will discharge naturally. This represents GW plumes reporting to Murphys Creek. A corresponding increase in contaminant concentrations is observed for this period.
– Following closure, once all proposed mitigations are implemented, there is a reduction in low flow conditions owing to a reduction in WRS percolation and hence seepage discharge. Peak discharges rates through wet periods are likely to increase due to the improved water shedding of the WRSs.
– Concentrations are typically the highest during mining phase B due to the elevated infiltration rates on the operational WRSs and reduce in the long term as uncaptured seepage becomes a smaller fraction of the receiving environment flows.

H-3.3.1 MC01

Table H-3.13 MC01 – Modelled water quality statistics

Phase	Metric	Measured (2020-2026)	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	Long Term (Climate Change)
Sulphate	Median	138	280	470	250	250	250	260
	95th %	1100	810	910	360	340	340	400
	Maximum	2500	1370	1150	1060	1020	1060	1180
Nitrate-N	Median	0.04	1.5	2.3	1.1	1.1	1.1	1.2
	95th %	4.36	4.2	4.5	1.7	1.6	1.6	1.9
	Maximum	7	7.1	5.9	4.5	4.3	4.5	5.2
Ammoniacal-N	Median	0.005	0.033	0.24	0.11	0.11	0.1	0.1
	95th %	0.042	0.44	0.49	0.18	0.17	0.16	0.17
	Maximum	0.058	0.55	0.55	0.57	0.53	0.47	0.52
Arsenic	Median	0.001	0.0023	0.005	0.0032	0.0031	0.0031	0.0031
	95th %	0.01	0.0081	0.0087	0.0042	0.0041	0.0039	0.0041
	Maximum	0.01	0.0098	0.0098	0.01	0.0095	0.0085	0.0094
Copper	Median	0.0005	0.00065	0.00065	0.00063	0.00063	0.00063	0.00064
	95th %	0.005	0.00082	0.00072	0.00075	0.00075	0.00075	0.00076
	Maximum	0.005	0.0011	0.00089	0.001	0.00088	0.00094	0.00096
Iron	Median	0.11	0.18	0.25	0.21	0.2	0.2	0.2
	95th %	0.26	0.32	0.34	0.25	0.25	0.24	0.25
	Maximum	0.32	0.38	0.38	0.4	0.38	0.35	0.37
Lead	Median	0.00005	0.000049	0.000058	0.000046	0.000046	0.000046	0.000048
	95th %	0.00100	0.000081	0.000083	0.000064	0.000062	0.000062	0.000068
	Maximum	0.00100	0.00012	0.0001	0.0001	0.000086	0.0001	0.0001
Zinc	Median	0.0005	0.006	0.0088	0.0047	0.0046	0.0046	0.0048
	95th %	0.0100	0.016	0.017	0.0072	0.0067	0.0066	0.0077
	Maximum	0.032	0.027	0.022	0.017	0.016	0.016	0.018
pH	Median	7.9	7.7	7.6	7.7	7.7	7.7	7.7
	95th %	8.3	7.8	7.7	7.8	7.8	7.8	7.8
	Maximum	8.5	8	7.9	7.9	7.9	7.9	7.9

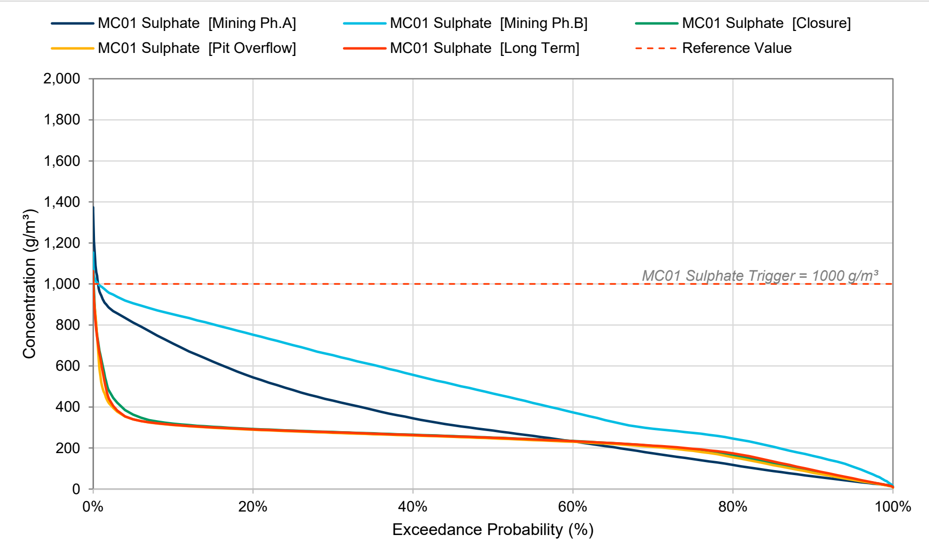

Figure H-3.19 MC01 – Sulphate

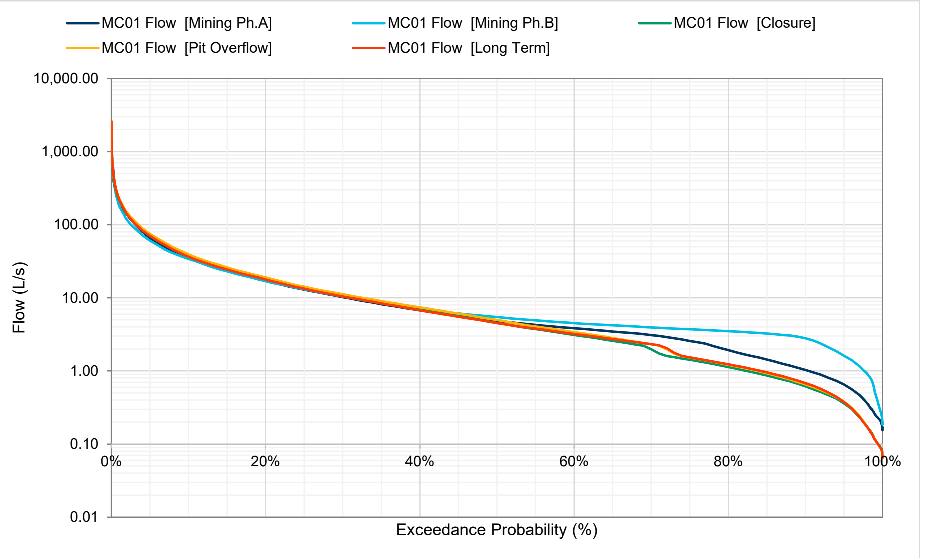

Figure H-3.20 MC01 – Flows

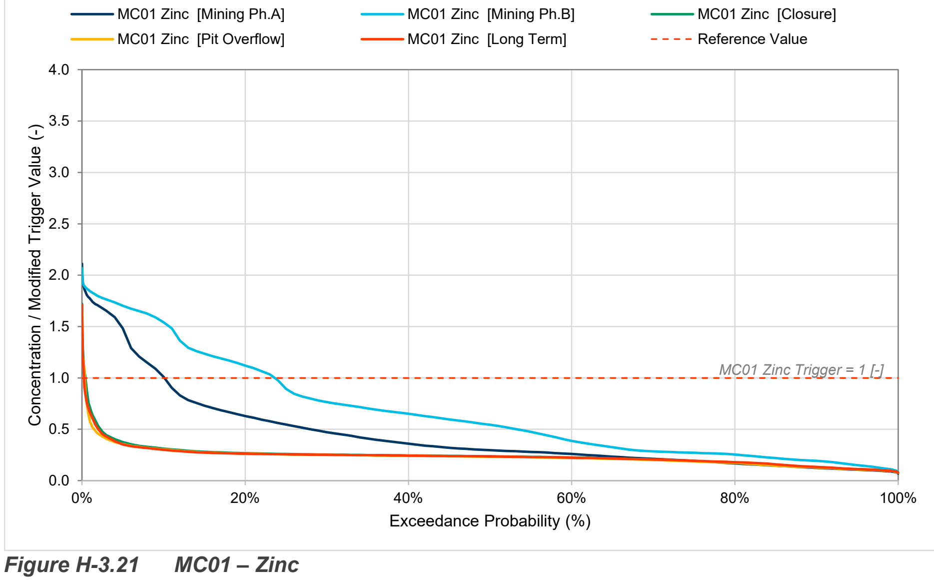

Figure H-3.21 MC01 – Zinc

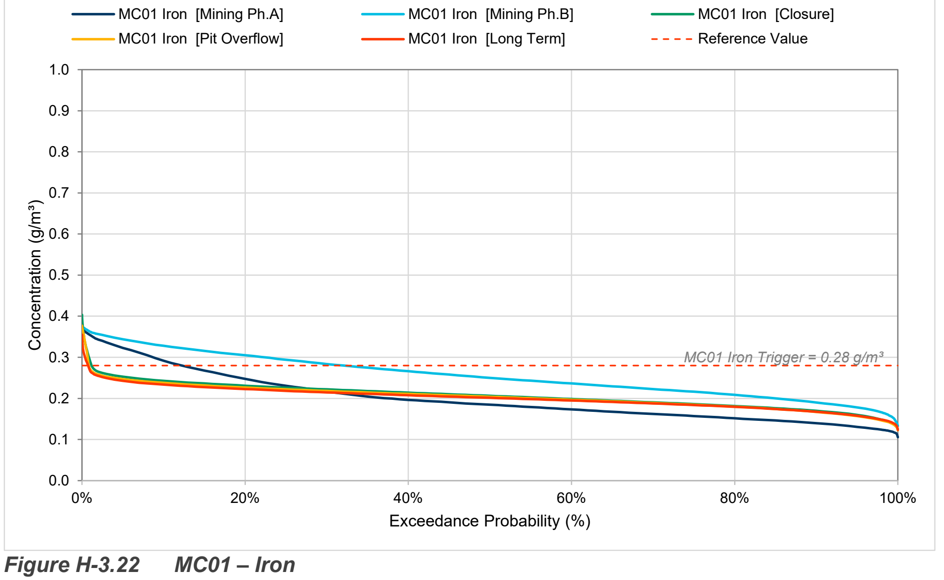

Figure H-3.22 MC01 – Iron

Table H-3.14 MC01 – Modelled exceedances of proposed compliance criteria[1]

Parameter	Type[2]	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	LongTerm (C.C.)
Sulphate	Chronic	0.6%	-	-	-	-	-
Nitrate-N	Chronic		-	-	-	-	-
Ammoniacal-N	Chronic		-	-	-	-	-
Arsenic	Chronic	-	-	-	-	-	-
Copper	Acute	-	-	-	-	-	-
	Chronic		25%	-	-	-	-
Iron	Chronic	-	85%	2.8%	1.9%	1.7%	5.8%
Lead	Chronic	-	-	-	-	-	-
Zinc	Acute	-	-	-	-	-	-
	Chronic		72%	-	-	-	1.1%
pH	Chronic		-	-	-	-	-

[1]. All exceedances represent the percentage of time that the compliance criteria is not met. Greyed cells represent no applicable compliance criteria. No value [-] shows that all modelled sequences comply with the compliance criteria.
[2]. Does not apply to Mining Phase A results, which are captured by existing consent criteria.

H-3.3.2 MC02

Table H-3.15 MC02 – Modelled water quality statistics

Phase	Metric	Measured (2020-2026)	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	Long Term (Climate Change)
Sulphate	Median	210	120	240	140	130	140	140
	95th %	1146	590	740	420	410	380	380
	Maximum	1320	1170	1110	980	980	980	980
Nitrate-N	Median	0.33	0.59	1.1	0.53	0.52	0.5	0.5
	95th %	1.1	2.9	3.5	1.5	1.4	1.3	1.3
	Maximum	1.2	5.7	4.6	3.7	3.4	3.7	3.7
Ammoniacal-N	Median	0.005	0.018	0.15	0.064	0.061	0.058	0.058
	95th %	0.011	0.39	0.47	0.12	0.11	0.097	0.097
	Maximum	0.050	0.56	0.56	0.45	0.4	0.35	0.35
Arsenic	Median	0.001	0.0018	0.0035	0.0023	0.0023	0.0022	0.0022
	95th %	0.0027	0.0071	0.0083	0.0033	0.0032	0.003	0.003
	Maximum	0.005	0.0099	0.0098	0.0083	0.0075	0.0065	0.0065
Copper	Median	0.0006	0.00061	0.0006	0.00062	0.00062	0.00062	0.00062
	95th %	0.0015	0.00072	0.00069	0.00071	0.00071	0.00072	0.00072
	Maximum	0.0350	0.00093	0.00076	0.00083	0.00077	0.00082	0.00082
Iron	Median	0.09	0.18	0.22	0.19	0.19	0.19	0.19
	95th %	0.22	0.31	0.34	0.22	0.22	0.21	0.21
	Maximum	0.28	0.4	0.39	0.34	0.33	0.28	0.28
Lead	Median	0.00005	0.000038	0.000042	0.000037	0.000037	0.000037	0.000037
	95th %	0.00025	0.000063	0.000069	0.000051	0.00005	0.000049	0.000049
	Maximum	0.00160	0.000095	0.000077	0.000083	0.000076	0.000078	0.000078
Zinc	Median	0.0005	0.0032	0.0052	0.0032	0.003	0.0032	0.0032
	95th %	0.0042	0.012	0.015	0.0087	0.0085	0.0078	0.0078
	Maximum	0.0210	0.025	0.023	0.017	0.019	0.019	0.019
pH	Median	7.8	7.7	7.6	7.6	7.6	7.6	7.6
	95th %	8.4	7.8	7.7	7.7	7.7	7.7	7.7
	Maximum	8.6	8	7.8	7.9	7.9	7.9	7.9

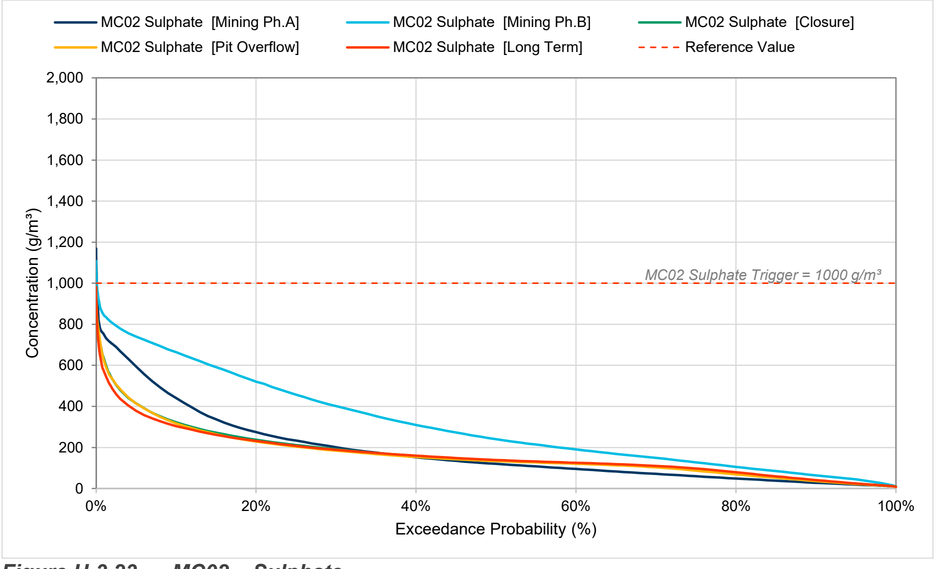

Figure H-3.23 MC02 – Sulphate

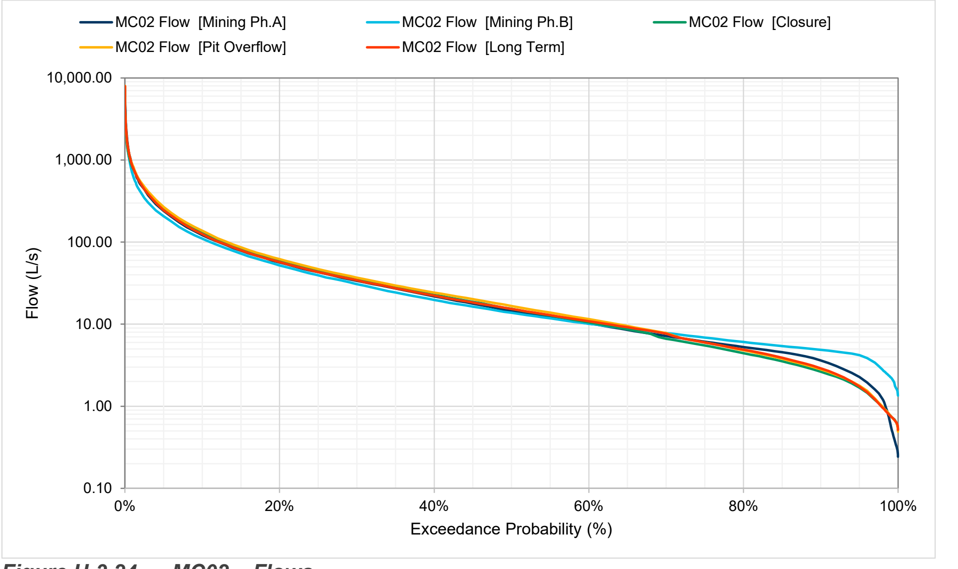

Figure H-3.24 MC02 – Flows

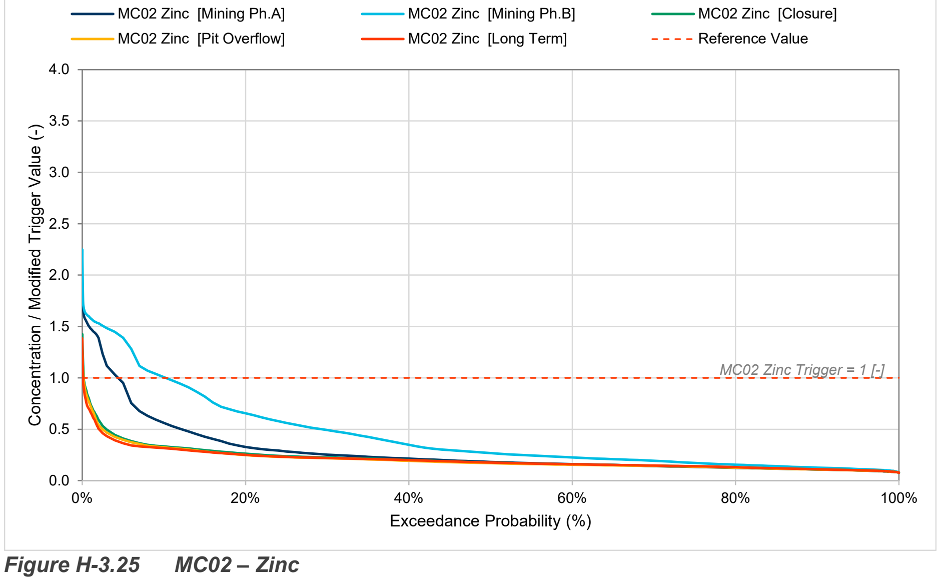

Figure H-3.25 MC02 – Zinc

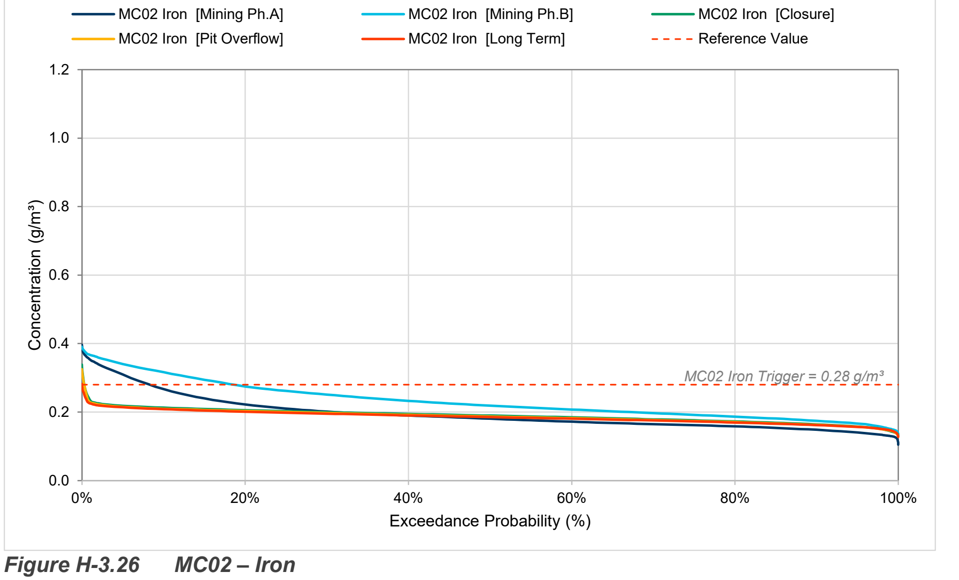

Figure H-3.26 MC02 – Iron

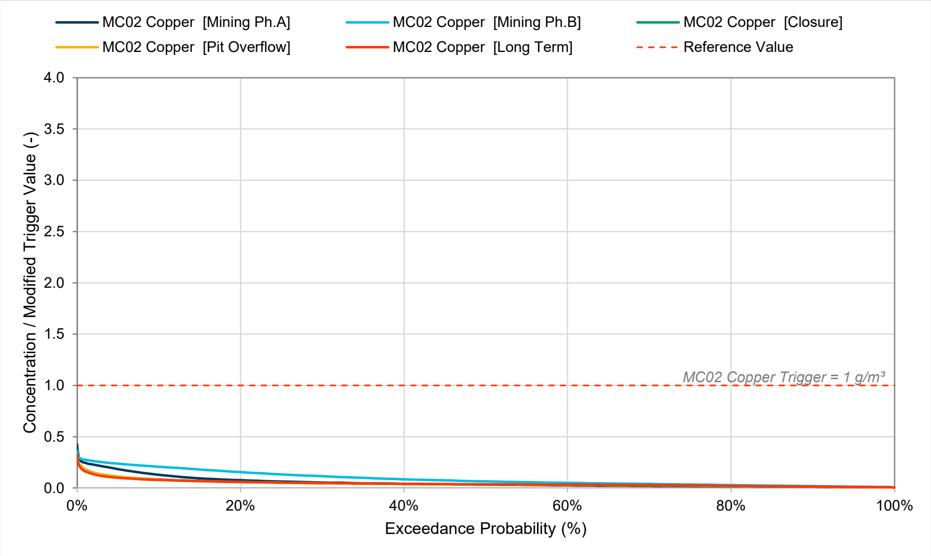

Figure H-3.27 MC02 – Copper

Table H-3.16 MC02 – Modelled exceedances of proposed compliance criteria[1]

Parameter	Type[2]	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	LongTerm (C.C.)
Sulphate	Chronic	0.087%	-	-	-	-	-
Nitrate-N	Chronic		-	-	-	-	-
Ammoniacal-N	Chronic		-	-	-	-	-
Arsenic	Chronic	-	-	-	-	-	-
Copper	Acute	-	-	-	-	-	-
	Chronic		4.1%	-	-	-	-
Iron	Chronic	-	59%	-	-	-	-
Lead	Chronic	-	-	-	-	-	-
Zinc	Acute	-	-	-	-	-	-
	Chronic		18%	-	-	-	-
pH	Chronic	-	-	-	-	-	-

[1]. All exceedances represent the percentage of time that the compliance criteria is not met. Greyed cells represent no applicable compliance criteria. No value [-] shows that all modelled sequences comply with the compliance criteria.
[2]. Does not apply to Mining Phase A results, which are captured by existing consent criteria.

H-3.4 Waikouaiti River North Branch Catchment

The Waikouaiti River North Branch has a compliance monitoring location at the Ross Road Ford (NBWRRF) and a further compliance monitoring location at NB03 downstream of all mine workings affecting the catchment as shown in Figure H-2.1. NB03 is just downstream of the Golden Bar Creek confluence and corresponding GB02 compliance monitoring location.

NBWRRF receives mine water discharges from Frasers West WRS during mining and once the headwaters have been reconnected across the Frasers Backfill, will also receive flows from Frasers East WRS, FTSF capping and TTTSF capping.

GB02 receives overflow from Golden Bar Pit and natural catchment areas. Discharges from Golden Bar Pit will cease once dewatering of the pit commences to enable mining of GB2 and GB3 pit stages. Overflows will re-commence once the lake reaches the fill level.

In Figure H-3.28 to Figure H-3.31 for NBWRRF, Figure H-3.32 to Figure H-3.35 for GB02 and Figure H-3.36 to Figure H-3.38 for NB03, the following key flow and water quality transitions can be observed:

- Lower dry weather flows are observed in mining phase A compared to subsequent phases, with a small rise in low flow conditions due to seepage capture and treated water discharges at Frasers West and Golden Bar WRSs (Figure H-3.29 and Figure H-3.37).
- There is a rise in contaminant concentrations through mining phase B as a result of rising contaminant source concentrations, a small increase of WRS area at Golden Bar and an assumption that the current high infiltration rates persist.
- In the post closure phase, where all mitigation measures are effectively implemented, the total uncaptured seepage mass load reduces and there is an increase in flows associated with the reconnected headwaters in all but the lowest 5% of flow conditions.

H-3.4.1 NBWRRF

Table H-3.17 NBWRRF – Modelled water quality statistics

Phase	Metric	Measured (2020-2026)	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	Long Term (Climate Change)
Sulphate	Median	119	160	280	190	180	190	210
	95th %	494	920	1180	830	810	760	840
	Maximum	880	1570	1710	1610	1560	1730	1800
Nitrate-N	Median	0.002	0.8	1.3	0.76	0.7	0.8	0.9
	95th %	0.11	4.7	5.5	3.3	3.2	3.0	3.3
	Maximum	0.53	8.2	8.2	6.5	6.4	6.8	7.3
Ammoniacal-N	Median	0.005	0.023	0.076	0.048	0.043	0.043	0.047
	95th %	0.022	0.25	0.32	0.18	0.17	0.15	0.16
	Maximum	0.23	0.42	0.44	0.38	0.31	0.33	0.33
Arsenic	Median	0.002	0.0019	0.0029	0.0031	0.003	0.003	0.0034
	95th %	0.0065	0.0056	0.007	0.0075	0.0072	0.007	0.0077
	Maximum	0.2	0.0084	0.013	0.014	0.013	0.014	0.014
Copper	Median	0.0003	0.00066	0.00069	0.00066	0.00065	0.00065	0.00066
	95th %	0.0011	0.00084	0.0009	0.00078	0.00078	0.00078	0.0008
	Maximum	0.0025	0.0011	0.0011	0.00096	0.00096	0.001	0.001
Iron	Median	0.21	0.17	0.19	0.18	0.18	0.18	0.18
	95th %	0.53	0.25	0.27	0.22	0.21	0.21	0.21
	Maximum	1	0.31	0.33	0.28	0.26	0.27	0.26
Lead	Median	0.00005	0.000043	0.000051	0.000048	0.000047	0.000048	0.000052
	95th %	0.00007	0.000092	0.00011	0.000093	0.000091	0.000089	0.000095
	Maximum	0.0005	0.00014	0.00014	0.00013	0.00013	0.00014	0.00014
Zinc	Median	0.0005	0.0037	0.0056	0.0039	0.0036	0.0038	0.0042
	95th %	0.0031	0.018	0.021	0.014	0.014	0.013	0.014
	Maximum	0.005	0.03	0.031	0.027	0.026	0.028	0.03
pH	Median	8	7.7	7.7	7.7	7.7	7.7	7.7
	95th %	8.0	7.9	7.8	7.8	7.8	7.8	7.8
	Maximum	8.3	8.5	8	8	8	8	8

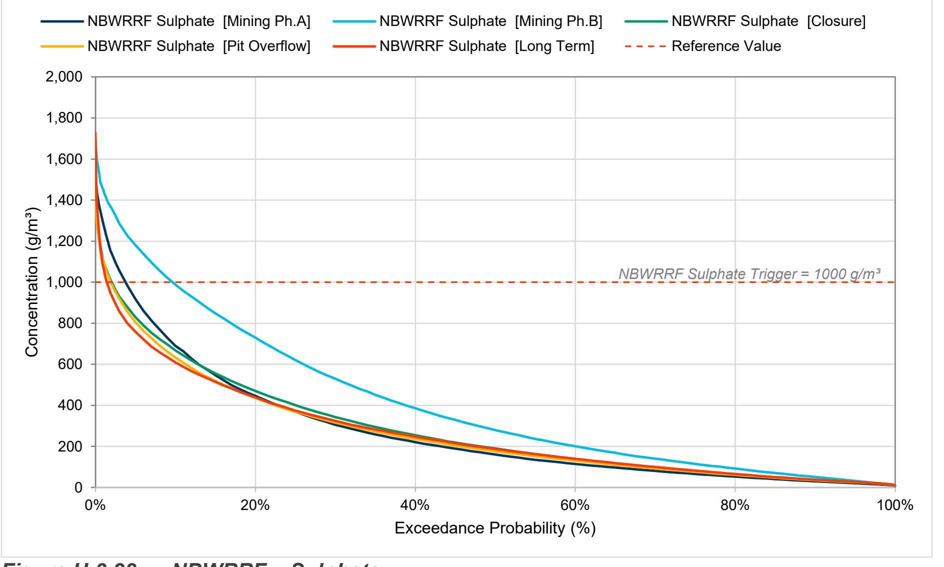

Figure H-3.28 NBWRRF – Sulphate

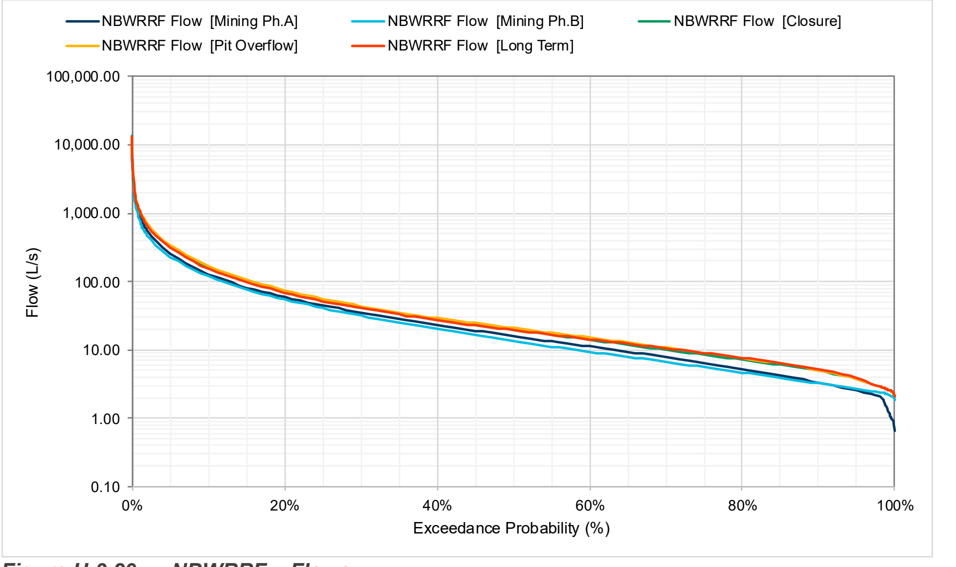

Figure H-3.29 NBWRRF – Flows

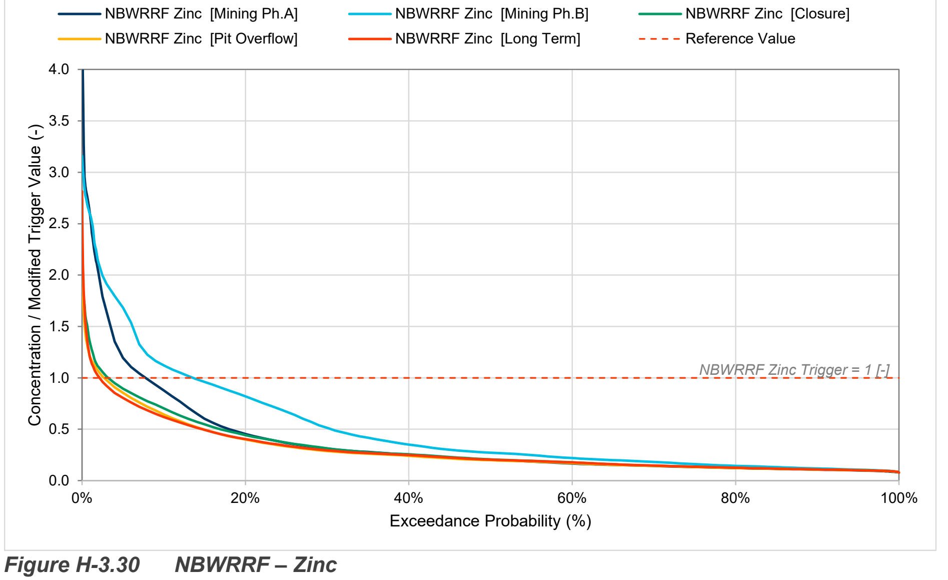

Figure H-3.30 NBWRRF – Zinc

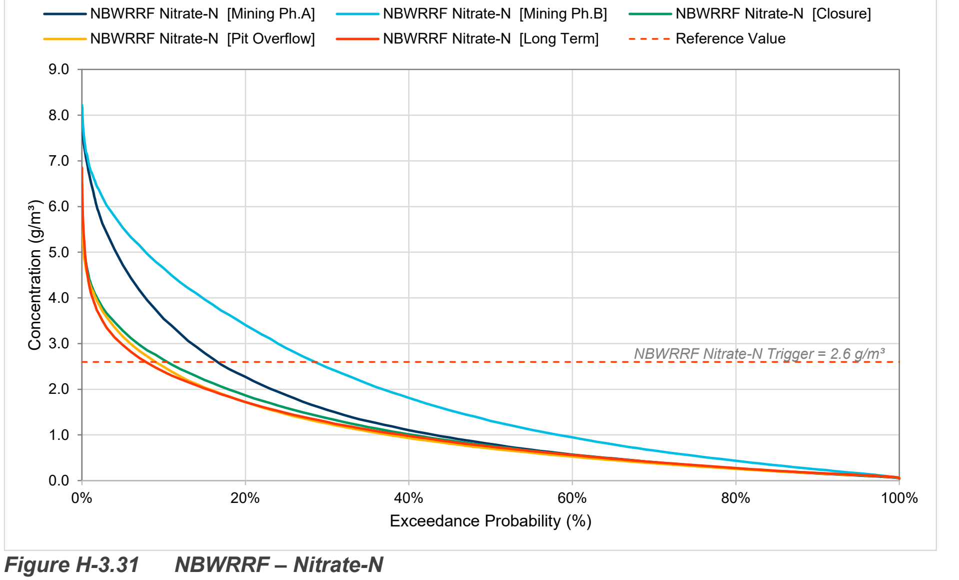

Figure H-3.31 NBWRRF – Nitrate-N

Table H-3.18 NBWRRF – Modelled exceedances of proposed compliance criteria[1]

Parameter	Type[2]	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	LongTerm (C.C.)
Sulphate	Chronic	3.8%	18%	2.2%	1.2%	0.97%	3.5%
Nitrate-N	Chronic		-	-	-	-	-
Ammoniacal-N	Chronic		-	-	-	-	-
Arsenic	Chronic	-	-	-	-	-	-
Copper	Acute	-	-	-	-	-	-
	Chronic		1.4%	-	-	-	-
Iron	Chronic	-	-	-	-	-	-
Lead	Chronic	-	-	-	-	-	-
Zinc	Acute	-	-	-	-	-	-
	Chronic		37%	3.9%	3.2%	3.0%	4.2%
pH	Chronic		-	-	-	-	-

[1]. All exceedances represent the percentage of time that the compliance criteria is not met. Greyed cells represent no applicable compliance criteria. No value [-] shows that all modelled sequences comply with the compliance criteria.
[2]. Does not apply to Mining Phase A results, which are captured by existing consent criteria.

H-3.4.2 GB02

Table H-3.19 GB02 – Modelled water quality statistics

Phase	Metric	Measured (2020-2026)	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	Long Term (Climate Change)
Sulphate	Median	110	11	9.9	8.2	10	11	10
	95th %	233	200	34	10	440	460	460
	Maximum	250	230	75	15	570	600	600
Nitrate-N	Median	0.02	0.048	0.056	0.05	0.047	0.0	0.0
	95th %	0.53	0.08	0.096	0.061	0.06	0.1	0.1
	Maximum	0.63	0.19	0.17	0.065	0.065	0.1	0.1
Ammoniacal-N	Median	0.005	0.0078	0.0093	0.008	0.0074	0.0073	0.0074
	95th %	0.005	0.015	0.019	0.0098	0.0096	0.0097	0.0097
	Maximum	0.005	0.042	0.036	0.01	0.01	0.01	0.01
Arsenic	Median	0.026	0.0016	0.0015	0.0014	0.0018	0.0018	0.0017
	95th %	0.053	0.035	0.0018	0.0018	0.032	0.032	0.032
	Maximum	0.064	0.041	0.0024	0.003	0.041	0.041	0.041
Copper	Median	0.00025	0.00055	0.00061	0.0006	0.00065	0.00065	0.00064
	95th %	0.0006	0.00072	0.00073	0.00074	0.00096	0.00097	0.00096
	Maximum	0.0006	0.00078	0.0008	0.00081	0.0011	0.0011	0.0011
Iron	Median	0.07	0.15	0.17	0.17	0.16	0.15	0.16
	95th %	0.179	0.21	0.21	0.21	0.21	0.21	0.21
	Maximum	0.23	0.22	0.22	0.22	0.22	0.23	0.22
Lead	Median	0.00005	0.000032	0.000031	0.000031	0.000035	0.000036	0.000035
	95th %	0.00005	0.000051	0.000038	0.000039	0.00013	0.00013	0.00013
	Maximum	0.00005	0.000054	0.000051	0.000062	0.00016	0.00016	0.00016
Zinc	Median	0.0005	0.00093	0.001	0.001	0.0012	0.0012	0.0011
	95th %	0.0011	0.0012	0.0013	0.0012	0.0091	0.0096	0.0095
	Maximum	0.0021	0.0015	0.0015	0.0014	0.012	0.012	0.012
pH	Median	8.1	7.7	7.7	7.7	7.7	7.7	7.7
	95th %	8.3	8.1	7.8	7.8	7.8	7.8	7.8
	Maximum	8.4	8.2	7.9	7.9	7.9	7.9	7.9

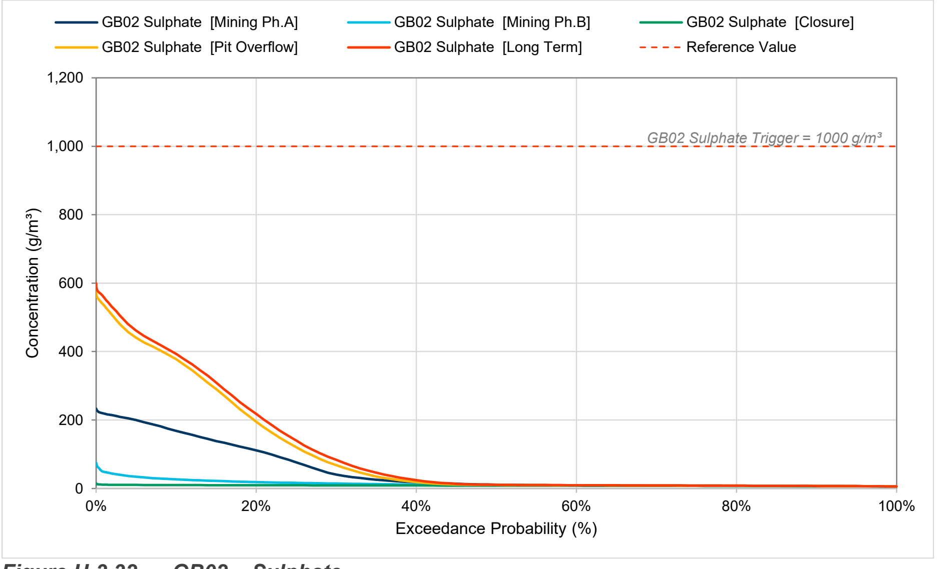

Figure H-3.32 GB02 – Sulphate

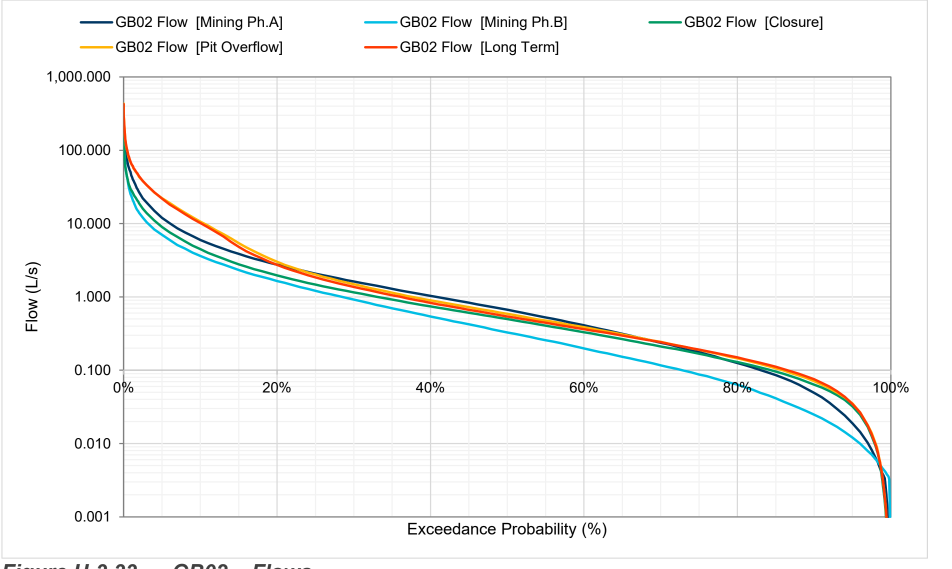

Figure H-3.33 GB02 – Flows

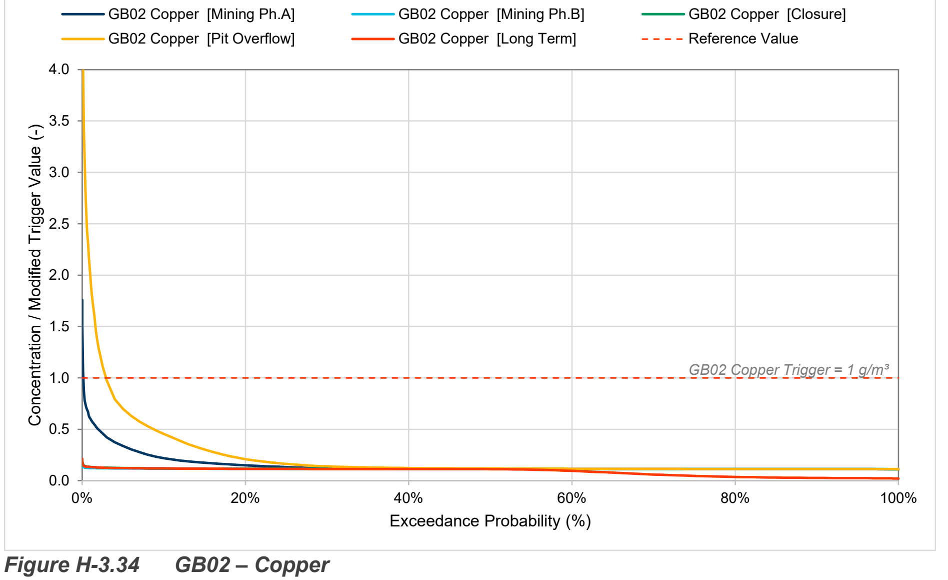

Figure H-3.34 GB02 – Copper

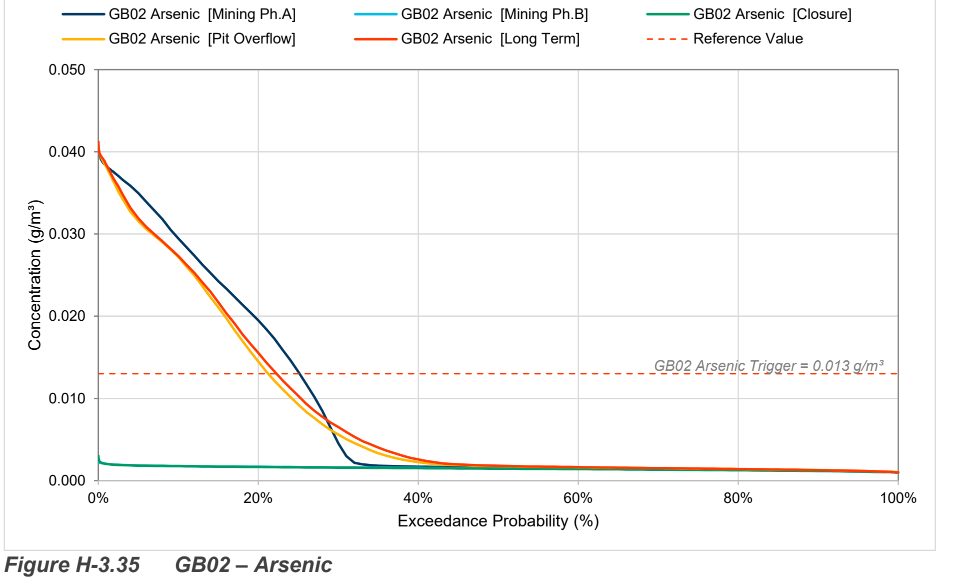

Figure H-3.35 GB02 – Arsenic

Table H-3.20 GB02 – Modelled exceedances of proposed compliance criteria[1]

Parameter	Type[2]	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	LongTerm (C.C.)
Sulphate	Chronic		-	-	-	-	
Nitrate-N	Chronic		-	-	-	-	
Ammoniacal-N	Chronic		-	-	-	-	
Arsenic	Chronic	-	-	-	69%	69%	51%
Copper	Acute	-	-	-	-	-	
	Chronic		-	-	-	-	
Iron	Chronic	-	-	-	-	-	
Lead	Chronic	-	-	-	-	-	
Zinc	Acute	-	-	-	-	-	
	Chronic		-	-	-	-	
pH	Chronic		-	-	-	-	

[1]. All exceedances represent the percentage of time that the compliance criteria is not met. Greyed cells represent no applicable compliance criteria. No value [-] shows that all modelled sequences comply with the compliance criteria.
[2]. Does not apply to Mining Phase A results, which are captured by existing consent criteria.

H-3.4.3 NB03

Table H-3.21 NB03 – Modelled water quality statistics

Phase	Metric	Measured (2020-2026)	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	Long Term (Climate Change)
Sulphate	Median	74	70	150	94	92	98	110
	95th %	195	480	780	470	450	410	490
	Maximum	340	1220	1170	1190	1210	1270	1350
Nitrate-N	Median	0.005	0.34	0.74	0.39	0.36	0.4	0.4
	95th %	0.24	2.5	3.8	1.9	1.7	1.6	1.9
	Maximum	0.78	6.4	5.6	4.7	4.8	4.9	5.4
Ammoniacal-N	Median	0.005	0.017	0.066	0.033	0.031	0.03	0.032
	95th %	0.013	0.22	0.34	0.11	0.1	0.088	0.11
	Maximum	0.038	0.5	0.49	0.3	0.28	0.27	0.3
Arsenic	Median	0.0026	0.0019	0.0025	0.0022	0.0023	0.0023	0.0025
	95th %	0.0071	0.005	0.0067	0.0048	0.0048	0.0047	0.0052
	Maximum	0.012	0.0091	0.0089	0.0096	0.011	0.014	0.012
Copper	Median	0.0003	0.00061	0.00063	0.00063	0.00062	0.00063	0.00063
	95th %	0.0012	0.0007	0.00072	0.00071	0.0007	0.0007	0.00072
	Maximum	0.0025	0.00086	0.00083	0.00084	0.00085	0.00088	0.00088
Iron	Median	0.09	0.17	0.19	0.18	0.18	0.18	0.18
	95th %	0.21	0.24	0.29	0.2	0.2	0.19	0.2
	Maximum	0.3	0.36	0.35	0.27	0.26	0.23	0.25
Lead	Median	0.00005	0.000035	0.00004	0.000038	0.000038	0.000038	0.00004
	95th %	0.00005	0.00006	0.000076	0.000064	0.000063	0.000061	0.000067
	Maximum	0.0005	0.0001	0.00011	0.00011	0.00011	0.00012	0.00011
Zinc	Median	0.0005	0.0021	0.0035	0.0024	0.0023	0.0025	0.0027
	95th %	0.0019	0.0098	0.015	0.0086	0.0082	0.0075	0.0088
	Maximum	0.01	0.024	0.023	0.02	0.021	0.022	0.023
pH	Median	8	7.7	7.7	7.7	7.7	7.7	7.7
	95th %	8.4	7.8	7.7	7.7	7.7	7.7	7.7
	Maximum	9.3	8.4	7.8	7.9	7.9	7.9	7.9

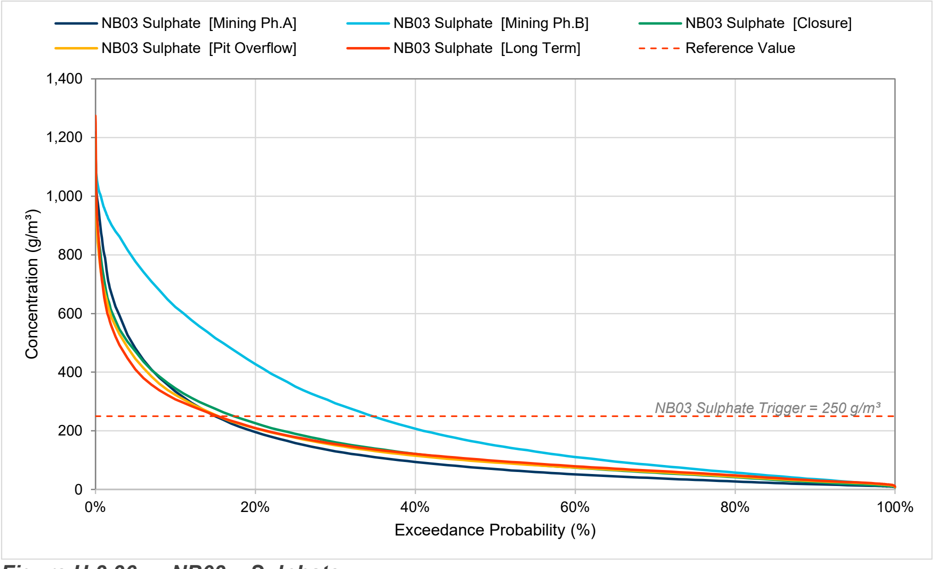

Figure H-3.36 NB03 – Sulphate

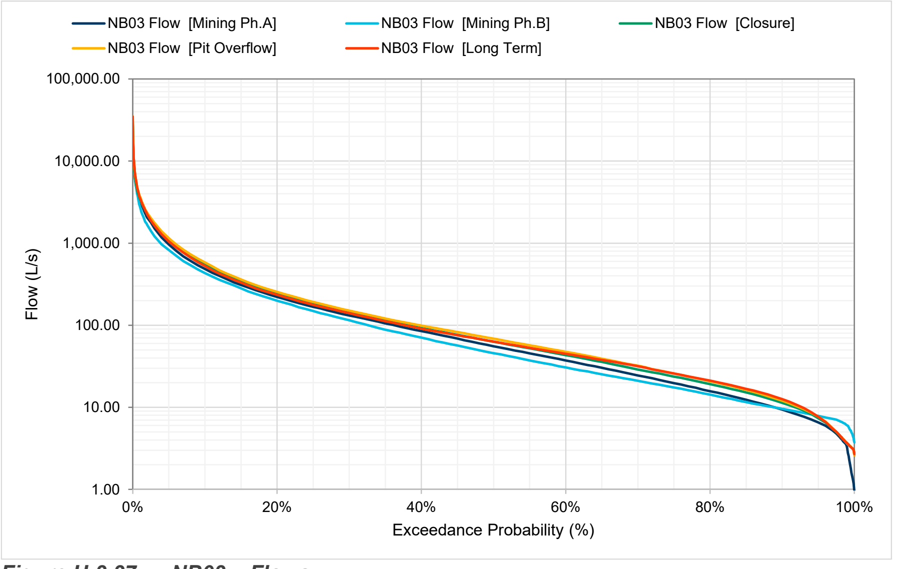

Figure H-3.37 NB03 – Flows

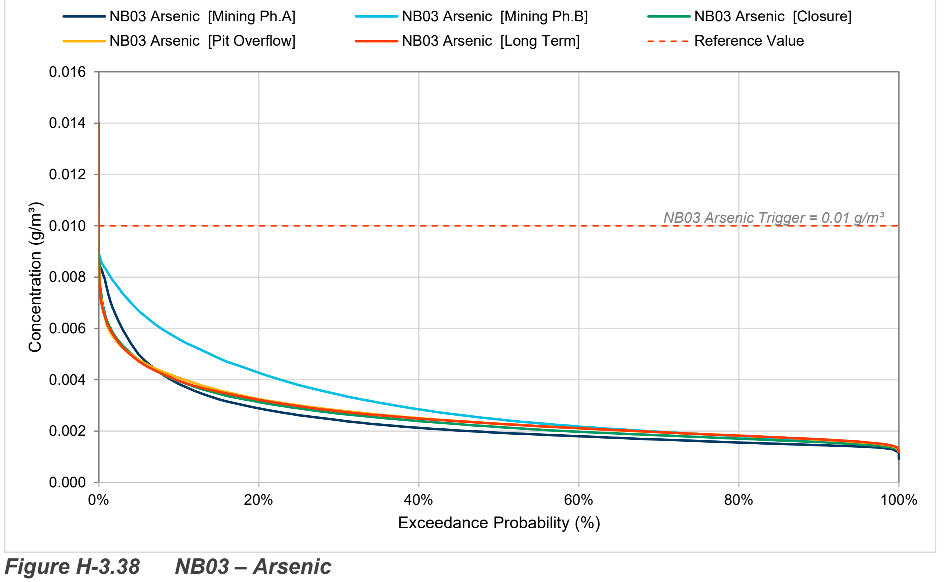

Figure H-3.38 NB03 – Arsenic

Table H-3.22 NB03 – Modelled exceedances of proposed compliance criteria[1]

Parameter	Type[2]	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	LongTerm (C.C.)
Sulphate	Chronic	15%	-	-	-	-	-
Nitrate-N	Chronic		-	-	-	-	-
Ammoniacal-N	Chronic		-	-	-	-	-
Arsenic	Chronic	-	-	-	-	-	-
Copper	Acute	-	-	-	-	-	-
	Chronic		-	-	-	-	-
Iron	Chronic	16%	7.8%	-	-	-	-
Lead	Chronic	-	-	-	-	-	-
Zinc	Acute	-	-	-	-	-	-
	Chronic		3.8%	-	-	-	-
pH	Chronic		-	-	-	-	-

[1]. All exceedances represent the percentage of time that the compliance criteria is not met. Greyed cells represent no applicable compliance criteria. No value [-] shows that all modelled sequences comply with the compliance criteria.
[2]. Does not apply to Mining Phase A results, which are captured by existing consent criteria.

Table H-3.23 NB03 – Modelled exceedance of drinking water guidelines[1]

Parameter	Mining Ph.A	Mining Ph.B	Closure	Pit Overflow	Long Term	LongTerm (C.C.)	Type
Sulphate	15%	35%	17%	15%	15%	20%	AV
Nitrate-N	-	-	-	-	-	-	MAV
Arsenic	-	-	-	0.0027%	0.0027%	0.0027%	MAV
Copper	-	-	-	-	-	-	MAV
Iron	16%	38%	6%	4.3%	2%	3.1%	IG
Lead	-	-	-	-	-	-	MAV
pH	-	-	-	-	-	-	AV

[1]. All exceedances represent the percentage of time that the compliance criteria is not met. Greyed cells represent no applicable compliance criteria. No value [-] shows that all modelled sequences comply with the compliance criteria.

H-3.5 Climate Change Sensitivity Test

The sensitivity of the modelling and compliance assessment to climate change considers the RCP8.5 scenario through adjusting rainfall and evaporation rates as described in Appendix E. The effects of climate change result in greater variability in rainfall and evaporation rates, resulting in extended dry (low flow) periods. These periods occur through summer months where reduced rainfall and increased evaporation have a reducing effect on stream flow rates. The result is that mine water discharges make up a greater portion of the receiving environment flows during these extended dry periods.

To summarise the effect of climate change, the modelling outcomes show:

– An increase in modelled median, 95^{th}% and maximum concentrations of between 0 to 10% at the compliance sites,
– Where parameters are modelled to have a non-zero risk of non-compliance in the long-term, there is typically an increase in non-compliance probability.
  - GB02 is an exception to this where arsenic non-compliance risk reduces due to increased evaporation rates affecting discharges from the Golden Bar pit lake during low flow periods.
  - Copper at MB02 and Zinc at MC01 which show rare non-compliances under the climate change scenario and no non-compliances under standard conditions.

The proposed mitigation measures and mine design offer a level of resilience to the effects of climate change, these include:

– **Flow augmentation dams** – These dams enable baseflows to be maintained in the Mare Burn and Deepdell Creek during dry periods, when natural flows could otherwise cease.
– **WTP** – The WTP enables mine-affected water to be captured and treated before discharge to receiving waters, providing greater confidence in the management of downstream water quality. This capability is particularly important because the hydrological response of the WRSs to changes in rainfall patterns remains uncertain. Following wet periods and associated increases in groundwater recharge, the WTP provides an operational control for managing potential differences between the recession rates of WRS seepage and receiving water flows.
– **Pit lakes** – Pit lakes generally have low filling rates and may cease to discharge during extended dry periods. Where pit-lake water contains elevated constituent concentrations relative to receiving waters, the absence or reduction of discharge during dry periods limits the potential effect on downstream water quality.
– **WRS capping** – Changing the approach to WRS capping will increase the water shedding characteristics of WRSs. The resulting influence on WRS hydrology under climate-change conditions is not explicitly represented in the WBM. However, where climate change results in increased total rainfall driven by more intense rainfall events, improved capping may provide a proportionally greater reduction in infiltration and associated seepage generation.

H-3.6 Flow Statistics

As the mine develops and progresses through mine closure and long-term phases, changes in the flow regimes will occur in the downstream water ways. The key influences on the flow regimes from the Macraes Operation include:

– Changes in runoff areas due to the development and management of WRSs,
– Changes in WRS infiltration rates and subsequent seepage rates,
– The construction of seepage capture systems reducing untreated mine affected water discharges to receiving waterways,
– The construction of flow augmentation dams reducing, or removing, periods of low flow with receiving waterways,
– Treated water discharges distributed to catchments across the Macraes Operation,
– The recovery of or adjustment to groundwater tables, and
– The establishment of pit lakes and subsequent discharges to receiving waterways,

These influences are represented in the flow regimes modelled with the WBM. Table H-3.24 Shows the key flow statistics for the compliance locations including; Median flow, 90th percentile low flow (Q90), and 95th percentile low flow (Q95) across the modelled phases. The key outcomes of the modelling include:

Mare Burn Catchment

– There is an initial reduction to the low flow statistics (Q90 and Q95) in the Mare Burn as mine water seepage is captured (reducing untreated water discharging to the environment). This occurs between the construction of the seepage capture systems in 2029 and commissioning of the Coal Creek flow augmentation dam in 2031 (within mining phase A).
– With the construction of the flow augmentation dam there is an overall increase in the median flow statistics calculated for mining phase A.
– All presented flow statistics increase through mining phase B as flow augmentation is more reliably available (i.e. the dam has been filled to capacity) and discharges from the WTP commence. This increase is most notable on the low flow statistics.
– There is a reduction in the flow statistics from closure due to reduced infiltration rates (tending towards natural catchment infiltration rates), hence, reduced seepage and returned treated seepage discharges. The reduction in infiltration rates will also increase wet weather flow rates as WRS shed more water during rainfall events. The low flow statistics from closure remain higher than current (existing conditions) predictions and median flows are similar to the current phase.
– Flows in the Trimbells Gully to the confluence with Māori Hen Creek will be reduced as seepage capture is implemented from 2029 and restored from 2032 when full scale WTP is implemented and treated seepage is returned to the catchment (less the 15% of treated flow lost to brine).

Deepdell and Shag River Catchment

– Camp Creek (above Camp Creek Dam) will observe a small decrease in low flows due to seepage water from Coronation WRS being captured from 2029.
– Low flow statistics increase from mining phase A due to the commissioning of the Camp Creek Dam from 2030. This is seen as a small rise in low flow statistics through the end of mining phase A and an increase from mining phase B of approximately 20 L/s.
– From closure, the modelled reduction in WRS seepage rates is balanced by increased WTP discharges due to the treatment TSF seepage water that is no-longer reused within the MWMS.
– All flow statistics increase from the pit lake overflow phase as Coronation Pit, Deepdell North Pit and Innes Mills Pit begin to discharge to Deepdell Creek. Groundwater recovery associated with GPUG also results in a small modelled flow increase.

Waikouaiti River North Branch Catchment

– Golden Bar Creek flow statistics decrease as dewatering of the current pit lake commences and remains the same until pit lake overflow occurs. Once overflow occurs, the higher flow statistics above the ~20th% increase, indicating an intermittent discharge from the lake (refer Figure H-3.33).

- The Waikouaiti River North Branch will reduce from current flows through mining phase A due to seepage capture systems being implemented. Flow statistics then increase as the connection across the Frasers Embankment is established and treated water is discharged near NBWRGR. There will also be a temporary increase in flows through mining phase A as the Stage 1 WTP discharges at a rate of 4.2 L/s. This effect is not fully captured in the flow statistics as the calculation period exceeds the operational period of the Stage 1 WTP and it is offset by seepage capture systems being implemented.
- Murphys Creek observes a temporary increase in flows through mining phase B as the WTP is discharging a portion of the captured seepage water to the Creek. As seepage rates decrease from closure, the returned treated water rate also does, resulting in flow statistics similar to the current phase. The median flows increase from current across all phases due to the permanent return pumping of the Murphys Creek silt pond ceasing (based on assumption that there have been no discharges from the silt pond in recent years).

Table H-3.24 Flow statistics

Metric	Phase	MB01	MB02	DC08	Shag at LR	Shag at McC.	MC01	MC02	NBWRRF	GB02	NB03
Median Flow (L/s)	Current[1]	18	29	41	390	600	3.3	15	17	1.4	60
	Mining Ph.A	21	30	48	410	630	4.9	15	16	0.70	56
	Mining Ph.B	25	35	51	400	620	5.5	14	14	0.30	46
	Closure	18	29	51	410	630	4.5	15	20	0.50	63
	Pit Lake Overflow	19	30	67	430	650	5.0	17	21	0.59	69
	Long Term	18	29	65	420	640	4.5	15	19	0.54	63
Q90 (L/s)	Current[1]	11	13	9	88	140	0.62	3.2	4.9	0.13	12
	Mining Ph.A	4.2	7.0	12	100	160	1.0	3.6	3.3	0.049	9.4
	Mining Ph.B	21	25	30	110	180	2.8	4.9	3.2	0.025	9.6
	Closure	15	18	29	110	170	0.62	2.6	4.9	0.064	11
	Pit Lake Overflow	15	19	36	120	180	0.66	2.8	5.1	0.071	12
	Long Term	15	19	36	120	180	0.68	2.9	5.2	0.075	13
Q95 (L/s)	Current[1]	11	12	6.5	64	100	0.41	2.3	3.8	0.051	8.0
	Mining Ph.A	2.9	4.4	7.7	79	130	0.65	2.3	2.6	0.019	6.6
	Mining Ph.B	20	23	28	88	140	1.6	4.2	2.7	0.012	7.9
	Closure	14	17	26	86	130	0.36	1.7	3.7	0.032	7.4
	Pit Lake Overflow	14	17	32	96	140	0.38	1.8	3.8	0.035	7.7
	Long Term	14	18	31	96	140	0.38	1.7	3.8	0.035	7.7

[1]. 'Current' represents the modelled flow statistics under existing conditions prior to MP4 changes to the mine plan being implemented.

H-3.7 Water Quality Overview Statistics

A summary of the compliance statistics, compared to ecological and drinking water criteria, is given in Table H-3.27. This table represents the compliance status for each modelled parameter across the five mining phases (see. Section H-2.1) at each site. For the overview, the table is colour coded as per the exceedance probabilities outlined in Table H-3.25. Modelling is represents a mass balance for components that remain dissolved under geochemical conditions at site (e.g. sulphate, calcium, magnesium and chloride). However, some components (e.g. iron, copper and arsenic) are likely to attenuate during transport. These attenuation processes are not built into the model and therefore can provide a conservative representation for some components and the model calibration can provide a basis for these. Table H-3.26 provides a key of mitigating considerations relevant to interpreting the results.

Table H-3.25 Overview statistics key – compliance failure modelled risks

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

Table H-3.26 Overview statistics key – mitigating features

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 H-3.27 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 non-compliances are discussed in Table H-3.28, outlining where these are likely risks or have other mitigating considerations. These can be typically summarised with the following key words for quick reference:

– **Plausible non-compliance**,
– **Plausible non-compliance**, with **short term** effects being addressed by proposed mitigation measures,
– **Plausible non-compliance,** with **existing** effects being addressed by proposed mitigation measures,
– **Mitigations identified** that are not represented in modelling,
– **Likely overstated** or **understated** risk due to conservative contaminant transport modelling and/or data gaps in source monitoring.

Table H-3.28 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, – 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: 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. 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). 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. 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. 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. 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

Parameter, criteria (compliance exceedance range)[1]	Classification	Discussion
		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, – Short term, – 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, – Short term, – 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
Ammoniacal-N (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. 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 (0-28%)	– Likely overstated,	See MB01 discussion 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 (0-9.4%)	– Plausible non-compliance,	See MB01 discussion
Deepdell Creek 08 (DC08)		
Sulphate (0-2.1%)	– Plausible non-compliance, – Short term, – 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. Ongoing operational control of mine water discharges in the Deepdell catchment is key to achieving this outcome, including: – Control of water levels within the Round Hill sump to avoid uncontrolled discharge through the historic Golden Point Adit, and – Return pumping of Māori Tommy and Northern Gully silt ponds such that overflows do not adversely affect water quality in Deepdell Creek
Nitrate-N (0-6.8%)	– Likely overstated, – Short term, – 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. 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		

Parameter, criteria (compliance exceedance range)[1]	Classification	Discussion
Sulphate, drinking water (<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, ecological (0-0.7%)	– Plausible non-compliance, – 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, drinking water (<1%)	– Plausible non-compliance, – 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. 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 treated to 0.042 g/m³ and modelling by MWM (2026g) demonstrate that this could improve, mitigating this risk.
Iron (0-10%)	– Plausible non-compliance, – 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. 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 ecological (0-10%)	– Plausible non-compliance, – 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. 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 drinking water (0-7.5%)	– Plausible non-compliance, – Likely overstated	As per the Arsenic ecological criteria.
Iron ecological (0-12%)	– Plausible non-compliance, – 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, Drinking water (0-19%)	– Plausible non-compliance, – Likely overstated	As per the Iron ecological criteria.
Murphys Creek 01 (MC01)		
Sulphate, (<1%)	– Plausible non-compliance, – Short term – 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, (0-25%)	– Plausible non-compliance,	A risk of exceeding the copper criteria during mining phase B is projected, this results from elevated uncaptured loads from Frasers

Parameter, criteria (compliance exceedance range)[1]	Classification	Discussion
	– Short term	West WRS seepage. This load is modelled to reduce following WRS capping and rehabilitation and no non-compliances are projected beyond closure. 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, (0-85%)	– Plausible non-compliance, – 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/m^3, which reduces to a chronic trigger of 0.28 g/m^3. The chance of compliance exceedance then reduces from closure as capping has an effect on infiltration rates at Frasers West WRS. 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, (0-72% (Ph.B))	– Plausible non-compliance, – Short term – Existing	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.
Murphys Creek 02 (MC02)		
Sulphate, (<1%)	– Plausible non-compliance, – Short term – 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, – 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, – Short term – 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, – Short term – 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. 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.

Parameter, criteria (compliance exceedance range)[1]	Classification	Discussion
		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. 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.
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

H-4 Flow Augmentation Dams

It is proposed that the currently consented flow augmentation dams be constructed to service the Deepdell and Mare Burn catchments. Modelling has scheduled Camp Creek dam, within the Deepdell catchment to be constructed at the beginning of 2030. Coal Creek dam, within the Mare Burn catchment will follow in 2031. The proposed operating approach for both dams is outlined in Appendix F.

Both dams have been configured in the model to provide functional flow augmentation from commissioning. If dam storage is depleted and the proposed augmentation flows cannot be maintained, releases are assumed to reduce to run-of-river discharges. Modelled storage fluctuations for each dam are discussed in the following sections.

H-4.1 Camp Creek Dam

Figure H-4.1 shows the statistical distribution of modelled Camp Creek Dam storage volumes following commissioning, based on 50 model iterations. The results indicate an increased likelihood of the dam not sustaining the full augmentation flow demand through the first three years after commissioning. This is indicated in the figure where the 5th% and 25th% volume statistics reach the lower storage capacity through years 2030-2033. During this period, increased operational intervention in discharge management is likely to be required to improve filling rates and support dam performance through potential dry periods. A lower storage capacity of 80,000 m³ is represented to provide provision for flushing flows that are not explicitly modelled in the WBM.

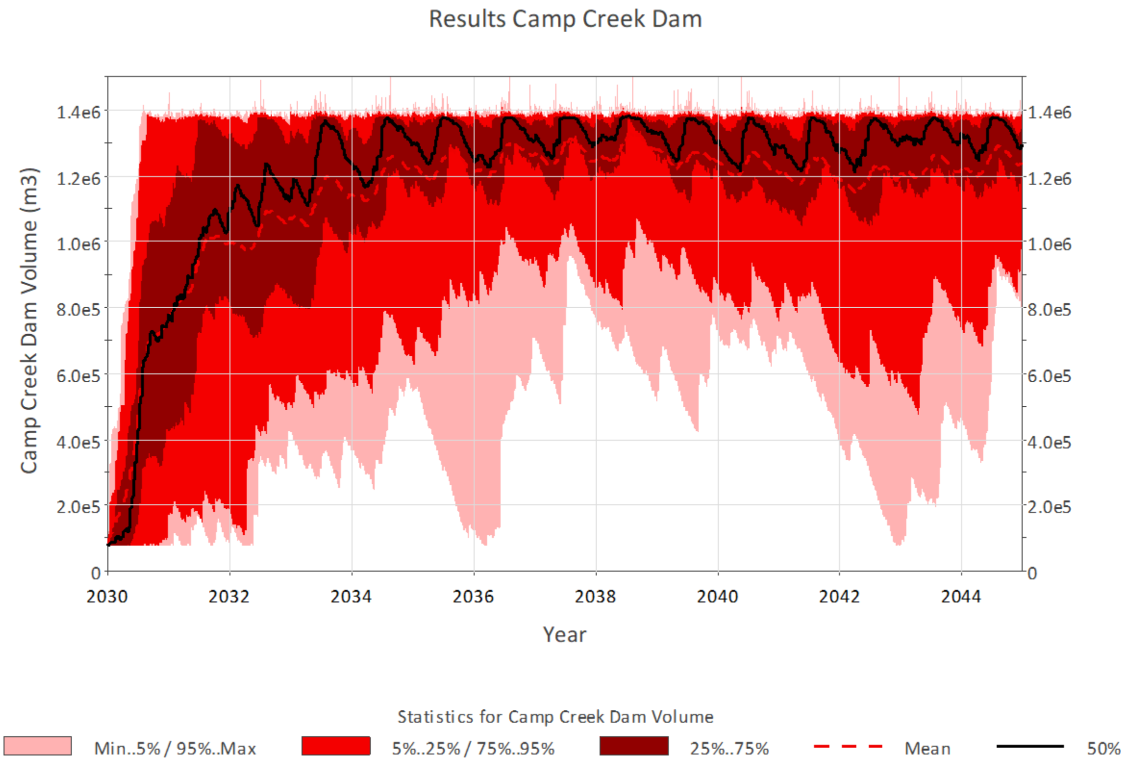

Figure H-4.1 Camp Creek Dam – Commissioning volumes

Figure H-4.2 shows the statistical distribution of available storage volume across each mining phase. Across all phases, the dam is expected to surcharge approximately 20% of the time, resulting in natural overflow via the dam spillway. As this represents a statistical summary of approximately 100 hydrological sequences, there remains potential for multiple consecutive years to occur without spillway overflow.

The storage exceedance results indicate that Camp Creek Dam may dry out following commissioning; however, under the proposed discharge regime, it is not expected to fully deplete through later mining phases.

Figure H-4.3 shows the monthly storage projections for Camp Creek Dam. Storage is expected to reach its lowest levels during April and May, before recovering through the winter months and declining again from August to September.

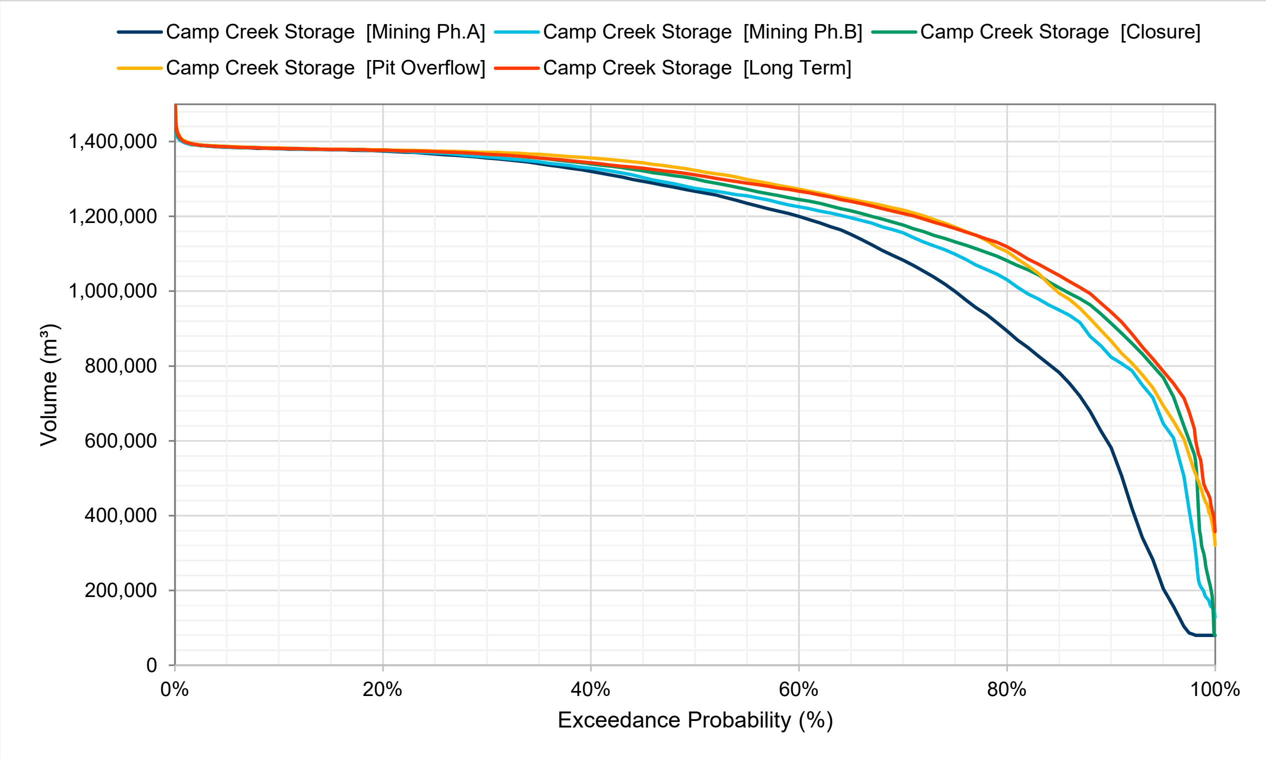

Figure H-4.2 Camp Creek Dam – Annual volumes

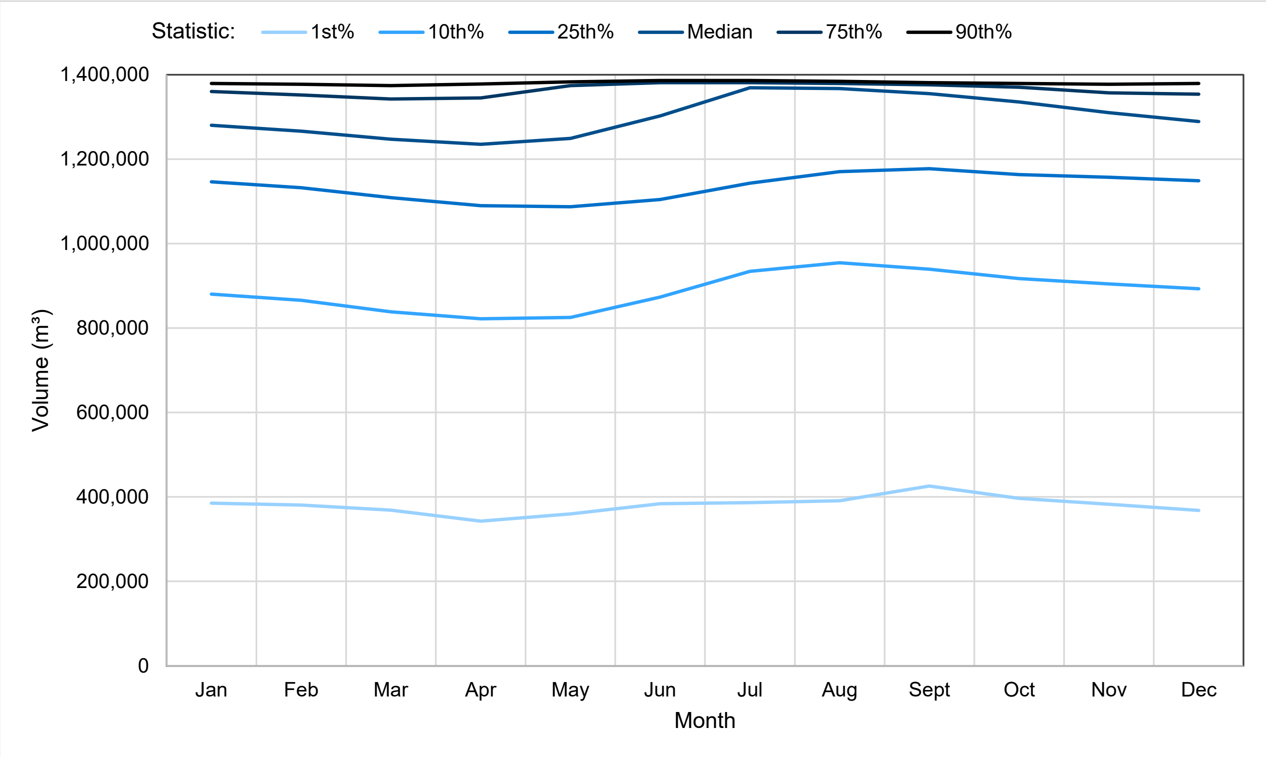

Figure H-4.3 Camp Creek Dam – Monthly storage distribution

H-4.2 Coal Creek Dam

Coal Creek Dam is projected to behave similarly to Camp Creek Dam under the proposed discharge regime (refer to Appendix F). However, due to its smaller contributing catchment relative to dam storage capacity, Coal Creek Dam is expected to take longer to reach its nominal full supply level. Based on the median model result, this is projected to occur approximately five years after commissioning. A lower storage capacity of 45,000 m³ is represented to provide provision for flushing flows that are not explicitly modelled in the WBM.

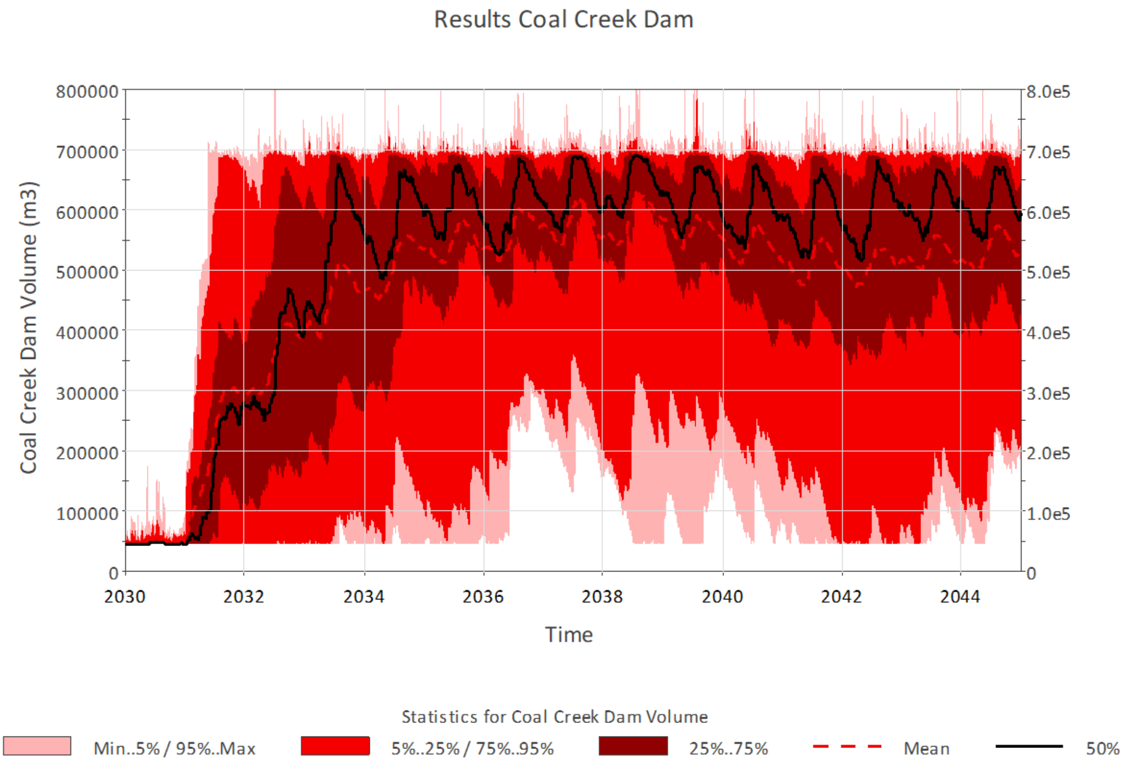

Figure H-4.4 Coal Creek Dam – Commissioning volumes

Figure H-4.5 shows that Coal Creek Dam is modelled to be full and naturally overflowing approximately 10% of the time across all mining phases. The risk of the dam drying out reduces over time as the dam becomes established and as overflows from Coronation North Pit begin contributing to dam inflows. Once Coronation North Pit begins overflowing (refer to the long-term curve in Figure H-4.4), Coal Creek Dam is not projected to be fully depleted.

Modelling shows that the proposed operational management regime could be optimised with respect to decreasing the probability of reaching the lower storage capacity during extended dry periods. This could improve downstream water quality outcomes by reducing the occurrence of less frequent but higher-concentration events in the receiving environment.

Figure H-4.6 shows the monthly storage projections for Coal Creek Dam. Storage is expected to reach its lowest levels in April, before recovering through the winter months and declining again from August to September.

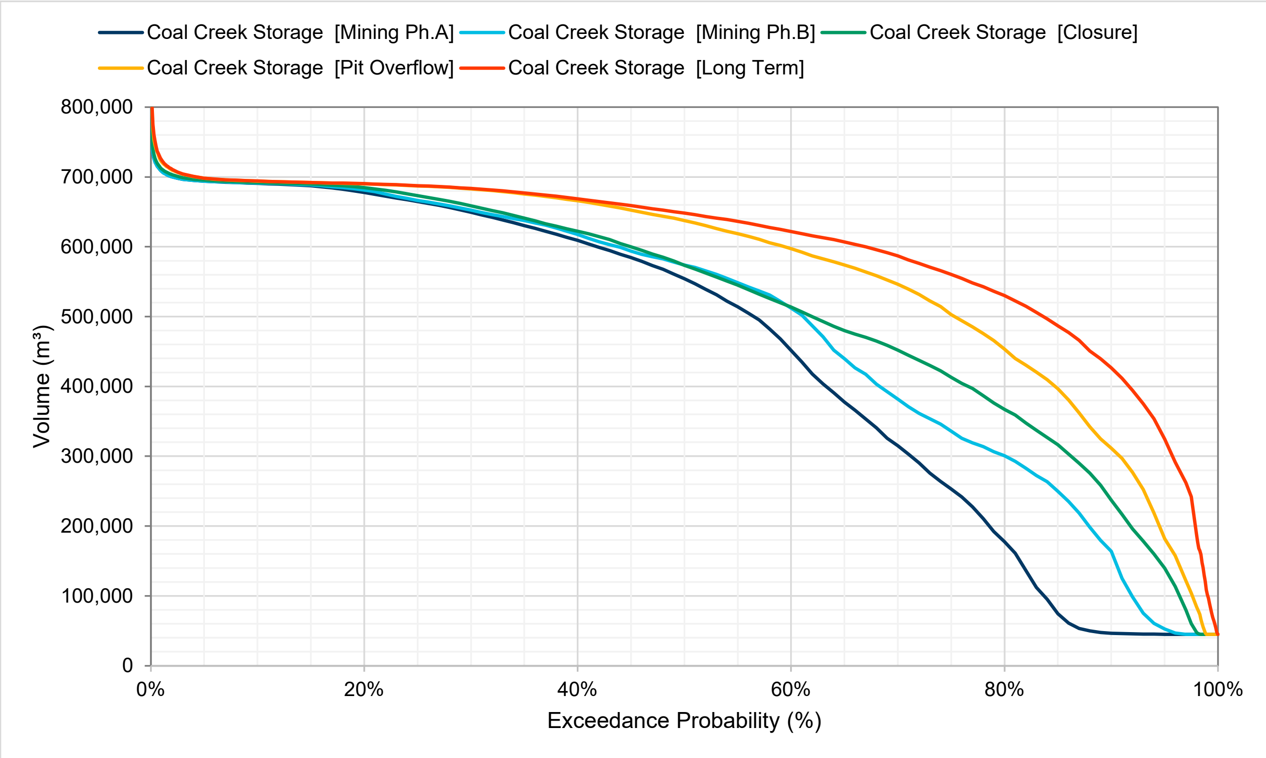

Figure H-4.5 Coal Creek Dam – Annual volumes

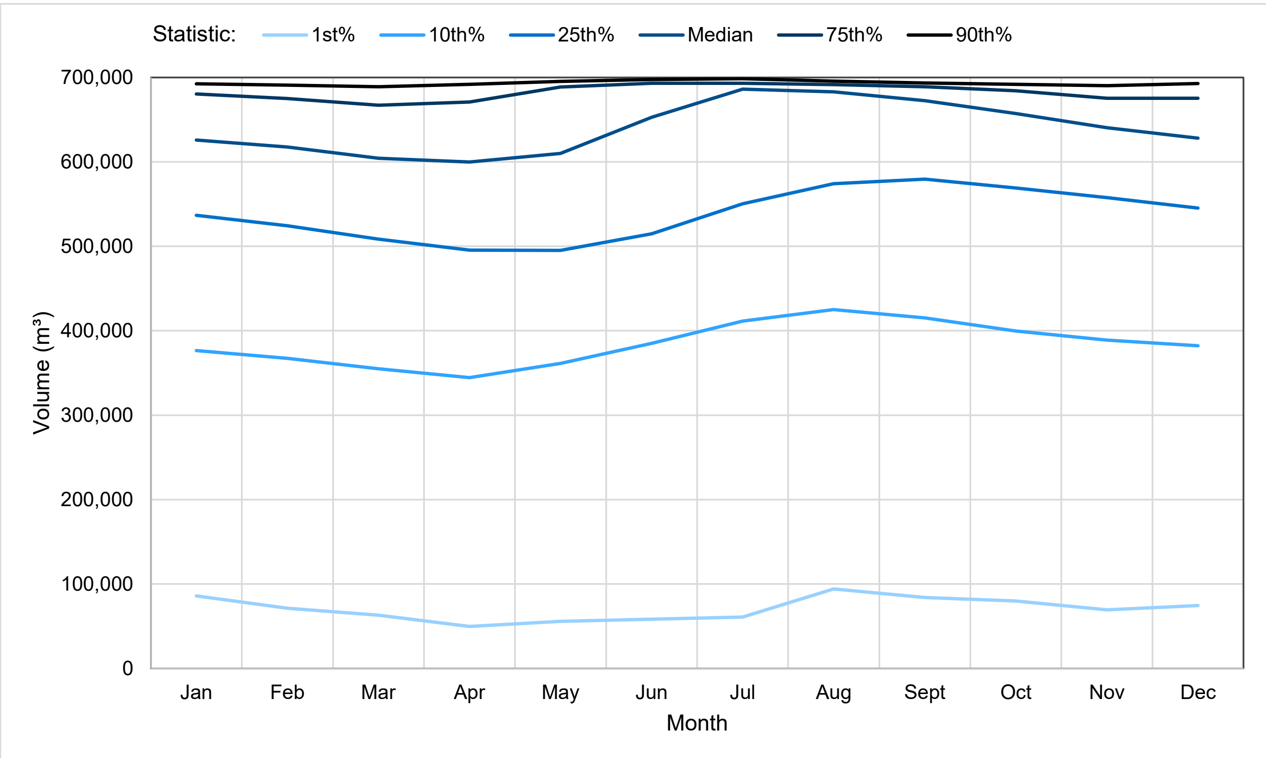

Figure H-4.6 Coal Creek Dam – Monthly storage distribution

H-5 Water Treatment Plant Operation

The proposed WTP operation as implemented in the WBM is outlined in Appendix F. The water balance and water quality modelling assumes the two-stage treatment process comprising lime dosing and settling as a pre-treatment step, followed by reverse osmosis (RO) treatment. While RO treatment has been adopted for modelling purposes based on current process studies, alternative or complementary treatment technologies may be implemented provided they achieve acceptable target water quality objectives.

The modelling represents the following WTP operations:

– **Stage 1** – A WTP managing an average inflow of 5 L/s treating WRS seepage water from November 2029 to January 2032. Modelling represents influent water quality as a combination of all captured WRS seepage waters.

– **Stage 2** – A full scale WTP treating all captured waters prior to discharge within the mine phases:

  - **Mining** – Treating all captured WRS seepage water and returning treated water to receiving catchments.
  - **Closure** - Treating all captured WRS seepage water and captured TSF underdrain water. The treated water is proportionally discharged back to the catchment of source.

A summary of the mean inflow rates to the WTP estimated by the WBM are outlined in Table H-5.1 with the following key transitions:

a. Through stage 1 of the WTP inflow rates is modelled as 5 L/s, resulting in a discharge rate of 4.25 L/s based on 15% of influent waters contributing to the brine.

b. Inflow then rises to a mean inflow of 18.2 L/s representing the totality of capture WRS seepage in mining phase B.

c. 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.

d. Approximately 10 years post closure WRS seepage rates and TSF underdrain flows are modelled to have reduced to mean inflows of 7 L/s and 15.9 L/s respectively. The reduction in WRS seepage rates results from improved water shedding and lower infiltration assumptions, while the reduction in TSF underdrain flows is a result of tailings consolidation and porewater drain down.

During mining, mean annual inflow rates to the WTP are calculated to be 18.2 L/s and rise to 45.1 L/s at closure. By 2050 total inflow rates are calculated 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 and an additional +25% contingency on flow rates representing uncertainty in seepage flow capture rates.

Table H-5.2 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 and contingency of +25%.

Table H-5.1 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	5	18.2	18.2	7
TSF Underdrains Combined	-	-	26.9	15.9
Total Mean Inflow	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 H-5.2 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	4600	2720
Copper	0.0109	0.0015	1.72	6.27	7.55	3.17
Hardness	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	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.

The resulting mean treated water concentrations at the WTP is outlined in Table H-5.3. These concentrations (and modelled variations) are represented in the WBM for the waters discharging to the receiving environment. This table does not represent any potential post treatment adjustments applied to pH, hardness and Chloride levels. The given WTP treatment rates (Refer Appendix F) mean water quality discharges are below the ecotoxicity trigger values (Viridis, 2026) for all parameters except ammoniacal-nitrogen.

Table H-5.3 Summary of WTP mean discharge water concentrations

Parameter	Discharge Water Quality (g/m^3)			
	Mining (2030)¹	Mining (2032)²	Closure (~2040)³	Post Closure (~2050)³
Ammoniacal-N	0.021	0.15	0.63	0.74
Arsenic	0.000005	0.0021	0.01	0.012
Copper	0.00039	0.00041	0.00025	0.00022
Hardness	17	19	18	18
Iron	0.0022	0.09	0.43	0.5
Lead	0.0000051	0.0000093	0.000022	0.000025
Nitrate-N	0.85	0.88	0.51	0.43
Sulphate	14	17	20	20
Zinc	0.00017	0.00017	0.000094	0.000077
DOC	0.0034	0.0035	0.0019	0.0015
Chloride¹	0.19	0.26	0.39	0.42
pH	7.4	7.3	7.3	7.3

¹. Post treatment adjustments to treat for Nitrate-N toxicity affects not included.

H-5.1 Discussion of WTP Results

- Modelling of influent WRS seepage water quality assumes that all waters are mixed prior to the WTP. This is expected to vary in practice as it will be more practical to separate a smaller number of influent sources to the WTP.
- Where influent waters will result in a treated outflow that varies significantly from that modelled here, it is suggested that the effect of the discharge on receiving waters is re-evaluated.
- Previous gauging of seepage flows suggests that a regular fluctuation of ±30% could be expected. It is likely that the seepage flow rates will reduce following dry periods, however, there is currently insufficient measured data to quantify the magnitude and lag effect across all WRSs. As the proposed seepage capture drains are constructed and flow monitoring is carried out there will be an improved understanding of the required design capacity for the WTP.
- A two-stage lime dosing and RO treatment process has been represented in the WBM. While RO treatment has been adopted for modelling purposes based on current process studies, alternative or complementary treatment technologies may be commissioned provided they achieve equivalent target water quality objectives.