

ATTACHMENT 3

Includes: Appendix I to Appendix O

APPENDIX I SOURCE TERM DEFINITION REPORT

Source Term Definition Report

Bendigo-Ophir Gold Project

5 August 2025

J-NZ0475-001-R-Rev2



MATAKANUI 
GOLD LIMITED

Source Term Definition Report

Bendigo-Ophir Gold Project

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EXECUTIVE SUMMARY

Mine Waste Management Limited (MWM) has developed this report to define the source terms for the water and load balance model (WLBM) for the Bendigo-Ophir Gold Project (BOGP) for Matakanui Gold Limited (MGL) to provide a summary of inputs that will be used during the modelling process. The model is discussed in MWM (2025c).

Objectives of this Study

The objectives of this report are to:

- Define the sources of data used for developing the water quality source terms.
- Define the rationale applied in deriving the source terms.
- Propose what performance monitoring is required to ensure potential effects are understood in advance.

Findings

The materials associated with the BOGP will generate neutral metalliferous drainage and may have elevated potential constituents of concern (PCOC) such as arsenic (As), sulfate, (SO₄), and trace metals. Nitrogenous compounds are also likely to be elevated. Collectively this is identified as mine impacted waters (MIW).

Water quality source terms were developed from a variety of sources including analogue data sources, baseline studies at the BOGP, and laboratory derived data from environmental geochemistry testing. This report provides an explanation of how the source terms for modelling were developed for the WLBM.

Management

Water management during the Operational Phase of the BOGP will involve discharge of only episodic runoff from haul roads and ELF surfaces. All other MIW (e.g., landform seepage) will be collected, used, and stored on site. In the Active Closure / Post Closure Phase, MIW will be treated and discharged to the receiving environment. Two models have been developed, that are reported elsewhere (MWM, 2025c) to reflect these phases:

- Operational Phase - Excel based models and calculations focussing on average annual water balance and runoff event discharge of MIW.
- Active Closure / Post Closure Phase - GoldSim based models and calculations, focussing on the evolution of instream water quality over time as a result of discharge of treated MIW.

Detailed stage models for years 1-13 of the BOGP will be developed using GoldSim¹ prior to mining commencing (i.e., during the project pre-startup phase). This will provide an operational tool for MGL to effectively manage water during operations.

¹ <https://www.goldsim.com>

General Background

MGL is proposing to establish the BOGP, which comprises gold mining operations, processing operations, ancillary facilities and environmental mitigation measures on Bendigo and Ardgour Stations in the Dunstan Mountains of Central Otago. The project site is located approximately 20 km north of Cromwell and will have a maximum disturbance footprint of 550 hectares.

The total Mineral Resource Estimate for the BOGP using a 0.5 g/t cut-off for open pit and 1.5 g/t for underground is 34.3 Mt at 2.1 g/t for 2.34 M oz (MGL, 2025). The Bendigo-Ophir resources occur in four deposits: Come in Time (CIT), Rise and Shine (RAS), Srex (SRX), Srex East (SRE). The majority of identified mineral resources are located within the RAS deposit. Three primary geological units are recognised at site:

- RSSZ – Rise and Shine Shear Zone
- TZ3 – Lower Greenschist facies Textural Zone 3 rocks of the Otago Schist
- TZ4 – Upper Greenschist facies Textural Zone 4 rocks of the Otago Schist

The resources will be mined by open pit methods at each deposit within the project site, with underground mining methods also proposed to be utilised at RAS to access the deeper gold deposits. The majority of the mining activities, ancillary facilities and associated infrastructure will be located in the Shepherds Valley with non-operational infrastructure located on the adjoining Ardgour Terrace. The BOGP also involves the taking of groundwater from the Bendigo Aquifer for use in mining-related activities and the realignment of Thomson Gorge Road via Ardgour Station.

There are numerous historic mine workings throughout the project area, which can impact baseline water quality. The archaeological survey completed by Lawrence et al. (2019) indicated 59 historic mine archaeological sites were identified within a 16 km² survey area. The majority of mine workings were pre-1900 mining activities and included the following key historic workings (Lawrence et al., 2019):

- Stamping batteries and processing areas.
- Underground mine adits.
- Mullock piles and tailings mounds.
- Sluicing areas.

These historical workings have affected the water quality in the area. For instance, arsenic is elevated in the Rise and Shine Creek, which is below these historic workings (MWM, 2025a).

Project Description

The proposed BOGP will include the following components:

- Open pits targeting the RAS, SRX, SRE, and CIT deposits.
- An underground mine targeting the RAS deposit.
- Three ex-pit engineered landforms (ELFs) – Shepherds ELF, SRX ELF, and West ELF (WELF).

- Two in-pit landforms (backfill) – CIT and SRE².
- Plant and processing area, where carbon-in-leach (CIL) extraction technologies will be used as part of the ore recovery process.
- A tailings storage facility (TSF) and TSF Embankment.
- Other ancillary support services / structures (e.g., roads, water management infrastructure, water treatment plants, etc).

Baseline Studies

The proposed BOGP water quality compliance limits (Ryder, 2025) are used as a screening tool to determine whether baseline water quality data are elevated. The assessment (MWM, 2025a) indicated that:

- Shepherds Creek is elevated in copper (Cu).
- Bendigo Creek is elevated in arsenic (As), cobalt (Co), Cu, and iron (Fe).
- Groundwater is elevated in As, Cu, Fe, zinc (Zn), and on occasion strontium (Sr) within the project area. Thallium (Tl) was elevated on one occasion (although this appears anomalous).

Geoenvironmental Hazards

All BOGP materials are classified as non-acid forming (NAF), with circum-neutral pH drainage expected from mine domains that contain the materials. However, neutral metalliferous drainage is likely to occur with elevated levels of arsenic (As), sulfate (SO₄), trace metal, and nitrogenous compounds.

The most significant AMD source hazard for waste rock relates to the TZ4 and RSSZ materials, some of which will be waste rock, and some will be processed (to extract gold) producing tailings.

Data for waste rock indicates that the TZ4 and RSSZ lithologies contain ~95.3% of arsenic and 21.9% of sulfur yet represents only 9.3% of the waste rock that will be disturbed. Hence, appropriate management of TZ4 and RSSZ materials to reduce sulfide mineral oxidation is a critical step to minimise deleterious effects, i.e., manage 9.3% of the waste rock well to mitigate 95.3% of the arsenic risk in the engineered landforms (ELFs) that will contain the waste rock.

The following potential constituents of concern (PCOC) are identified and are considered in this report:

- TZ3 materials are enriched As and cobalt (Co). Antimony (Sb) is possibly elevated.
- RZ4 and RSSZ materials are enriched in As, sulfur (S). Sb is possibly elevated.
- Geochemical testing indicates that BOGP materials could generate MIW that could be elevated in aluminium (Al), As, Co, copper (Cu), chromium (Cr), iron (Fe), and zinc (Zn).
- Process water quality data suggests that Al, As, Co, Cu, Cr, Fe, molybdenum (Mo), nickel (Ni), lead (Pb), Sb, strontium (Sr), Zn, cyanide (CN), and ammoniacal nitrogen (Amm-N) may be elevated. It is noted these data are limited.

² Note: SRE Pit is backfilled by the SRX ELF.

- Based on analogue data and general geoenvironmental hazards:
 - o Nitrogenous compounds (nitrate and ammoniacal nitrogen) are expected due to the use on ammonium-nitrate based explosives and cyanide.
 - o Sulfate is considered a PCOC based on sulfate being elevated at the Macraes Gold Mine, which is considered a suitable analogue site due to its similar sulfur content.

Water and Load Balance Model

A WLBm that contains water flow and quality data is required for the BOGP to understand potential deleterious effects on the receiving environment associated with these MIW (noting the management of TSS is covered by the sediment and erosion management plan: EGL (2025a)). The WLBm has been developed using the GoldSim modelling platform³. Key water quality inputs (source terms) need to be defined for the WLBm and this includes the following key model components:

- Baseline streams within the BOGP area
- Groundwater
- Engineered Landform (ELF) seepage
- Pit voids
- Ore stockpile
- Tailings storage facility (TSF)
- Hardstand areas, ELF surfaces, and roads (e.g., mine impacted surfaces)
- Underground workings
- Rehabilitated surfaces

Derivation of Source Terms

Source terms were developed from a variety of sources including analogue data sources, baseline studies at the BOGP, and laboratory derived data from environmental geochemistry testing. This report provides an explanation of how the source terms for modelling were developed for the WLBm.

Source terms need to be validated through performance monitoring that should be ongoing through the operational and closure phases of the project.

³ <https://www.goldsim.com>

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1 INTRODUCTION

Mine Waste Management Limited (MWM) has developed this report to define the source terms for the water and load balance model (WLBM) for the Bendigo-Ophir Gold Project (BOGP) for Matakanui Gold Limited (MGL) to provide a summary of inputs that will be used during the modelling process. The WLBM is discussed in MWM (2025c).

1.1 Background

MGL is proposing to establish the BOGP, which comprises a new gold mine, ancillary facilities and environmental mitigation measures on Bendigo and Ardgour Stations in the Dunstan Mountains of Central Otago. The project site is located approximately 20 km north of Cromwell and will have a maximum disturbance footprint of 550 hectares.

As part of the assessment of environmental effects, the BOGP requires the development of a WLBM that will simulate flow and key water quality parameters associated with mine impacted waters (MIW) to support water management and treatment planning/design and forecast water quality at downstream compliance monitoring sites.

A key component of developing a WLBM is the development of appropriate source terms to define the water quality of each model domain. Some of these source terms will share commonality between model components, others will be unique to the model domain. Clarity on how these terms are derived is important to support the modelling process.

1.2 Project Description

MGL is proposing to establish the BOGP, which comprises gold mining operations, processing operations, ancillary facilities and environmental mitigation measures on Bendigo and Ardgour Stations in the Dunstan Mountains of Central Otago. The project site is located approximately 20 km north of Cromwell and will have a maximum disturbance footprint of 550 hectares.

The total Mineral Resource Estimate for the BOGP using a 0.5 g/t cut-off for open pit and 1.5 g/t for underground is 34.3 Mt at 2.1 g/t for 2.34 M oz (MGL, 2025). The Bendigo-Ophir resources occur in four deposits: Come in Time (CIT), Rise and Shine (RAS), Srex (SRX), Srex East (SRE). The majority of identified mineral resources are located within the RAS deposit. Three primary geological units are recognised at site:

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- TZ4 – Upper Greenschist facies Textural Zone 4 rocks of the Otago Schist

The resources will be mined by open pit methods at each deposit within the project site, with underground mining methods also proposed to be utilised at RAS to access the deeper gold deposits. The majority of the mining activities, ancillary facilities and associated infrastructure will be located in the Shepherds Valley – which includes a conventional carbon-in-leach (CIL) gold processing plant and water treatment plant, a tailing storage facility, three engineered landforms, internal haul roads, topsoil stockpiles, water pipelines, underground utilities and electrical supply - with non-operational infrastructure located on the adjoining Ardgour Terrace. The BOGP also involves the taking of

groundwater from the Bendigo Aquifer for use in mining-related activities and the realignment of Thomson Gorge Road via Ardgour Station.

There are numerous historic mine workings throughout the project area, which can impact baseline water quality. The archaeological survey completed by Lawrence et al. (2019) indicated 59 historic mine archaeological sites were identified within a 16 km² survey area. The majority of mine workings were pre-1900 mining activities and included the following key historic workings (Lawrence et al., 2019):

- Stamping batteries and processing areas.
- Underground mine adits.
- Mullock piles and tailings mounds.
- Sluicing areas.

These historical workings have affected the water quality in the area. For instance, arsenic (As) is elevated in the Rise and Shine Creek, a tributary of Bendigo Creek, which is below these historic workings (MWM, 2025a).

The proposed BOGP will include the following components:

- Open pits targeting the RAS, SRX, SRE, and CIT deposits.
- An underground mine targeting the RAS deposit.
- Three ex-pit engineered landforms (ELFs) – Shepherds ELF, SRX ELF, and West ELF (WELF).
- Two in-pit landforms (backfill) – CIT and SRE⁴.
- Plant and processing area, where CIL extraction technologies will be used as part of the ore recovery process.
- A tailings storage facility (TSF) and TSF Embankment.
- Other ancillary support services / structures (e.g., roads, water management infrastructure, water treatment plants, etc).

⁴ Note: SRE Pit is backfilled by the SRX ELF.

1.3 Mine Plan

The proposed mine plan is shown in Table 1 as a schedule of activities.

Table 1. BOGP Mine Plan

MONTH	YEAR	MINING PHASE	DESCRIPTION OF PHASE
Pre-startup			Detailed design phase
0 to 6	0 to 0.5	Startup	Pioneering / RAS Pre-Strip, Initial Jean Creek Silt Pond, earthworks at process plant.
6 to 24	0.5 to 2	Project Development	Construction of process plant, TSF, Shepherds Creek Silt Pond, North Diversion Channel, Commissioning, mining RAS pre-strip (Pre-strip ends month 19).
Operations			
25 to 54	3 to 4.5	RAS pit mining on its own	Operations (Pit ore production in month 20. UG Development begins month 54)
54 to 72	4.5 to 5	RAS pit with UG development	Operations (UG Ore production begins month 70 -)
72 to 132	6 to 11	RAS pit plus RAS UG	Operations (UG Ore production months 70 to 150)
		RAS Pit plus RAS UG plus CIT Pit	Operations (CIT Pit mined months 102 to 114)
		RAS Pit plus RAS UG, plus CIT backfilled, plus Srex	Operations (Srex Pit mined months 145 onwards)
120 - 160	10 to 13.3	RAS UG continues on its own with CIT and Srex open pit feeds	Operations (all mining halted month 160)
Closure			
160 - 372	11 to 31	Active Closure	All mining halted. Active closure of pits, TSF, and wider site, plus setup of active water treatment plant (option).
372 -	31 onwards	Post-Closure	Passive treatment and maintenance

TSF = Tailings Storage Facility; UG = Underground

1.4 Objectives

The purpose of this report is to define and present the relevant data that have been used to derive the key source terms to be used in the WLBM for the BOGP. The objectives of this report are to:

- Define the sources of data used for developing the water quality source terms.
- Define the rationale applied in deriving the source terms.
- Propose what performance monitoring is required to ensure potential effects are understood in advance.

1.5 Source Term Components

Models that assess the effects on water quality generally require flow rates and water quality estimates. Source terms are created to represent the water quality of each component of the model. Source terms are derived from empirical site data and analogue data, which may be from the compilation of data (mean, 95th percentile, etc) or from geochemical relationships (e.g., sulfate versus potential constituents of concern (PCOC)). Source terms that require definition for BOGP include:

- The composition of rainfall water, for understanding its interaction with project materials.
- Baseline surface water quality.
- Groundwater inflow quality (e.g., to the RAS Pit void).
- ELF seepage.
- Process water quality associated with the tailings (assumed to be representative of TSF decant water quality).
- Pit water quality.
- TSF decant water.
- TSF seepage water quality.
- MIW quality associated with ELF runoff, haul roads, and hardstand areas.
- Underground workings (operational and closure).
- Rehabilitated surfaces.

1.6 Modelling Approach

Water management during the Operational Phase of the BOGP will involve discharge of only episodic runoff from haul roads and ELF surfaces. All other MIW (e.g., landform seepage) will be collected, used, and stored on site. In the Active Closure / Post Closure Phase, MIW will be treated and discharged to the receiving environment. Two models have been developed (MWM, 2025c) to reflect these phases:

- Operational Phase - Excel based models and calculations focussing on average annual water balance and runoff event discharge of MIW.
- Active Closure / Post Closure Phase - GoldSim based models and calculations, focussing on the evolution of instream water quality over time as a result of discharge of treated MIW.

Detailed stage models for years 1-13 of the BOGP (Table 1) will be developed using GoldSim⁵ prior to mining commencing (i.e., during the project pre-startup phase). This will provide an operational tool for MGL to effectively manage water during operations.

⁵ <https://www.goldsim.com>

2 PROJECT AREA DESCRIPTION

The following section summarises the relevant background information for the BOGP.

2.1 Introduction

MGL is proposing to establish the BOGP, which comprises gold mining operations, processing operations, ancillary facilities and environmental mitigation measures on Bendigo and Ardgour Stations in the Dunstan Mountains of Central Otago. The project site is located approximately 20 km north of Cromwell and will have a maximum disturbance footprint of 550 hectares.

The total Mineral Resource Estimate for the BOGP using a 0.5 g/t cut-off for open pit and 1.5 g/t for underground is 34.3 Mt at 2.1 g/t for 2.34 M oz (MGL, 2025). The Bendigo-Ophir resources occur in four deposits: Come in Time (CIT), Rise and Shine (RAS), Srex (SRX), Srex East (SRE). The majority of identified mineral resources are located within the RAS deposit. Three primary geological units are recognised at site:

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These historical workings have affected the water quality in the area. For instance, As is elevated in the Rise and Shine Creek, a tributary of Bendigo Creek, which is below these historic workings (MWM, 2025a).

The proposed BOGP will include the following components as shown in Figure 1:

- Open pits targeting the RAS, SRX, SRE, and CIT deposits.

- An underground mine targeting the RAS deposit.
- Three ex-pit engineered landforms (ELFs) – Shepherds ELF, SRX ELF, and West ELF (WELF).
- Two in-pit landforms (backfill) – CIT and SRE⁶.
- Plant and processing area, where CIL extraction technologies will be used as part of the ore recovery process.
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- Other ancillary support services / structures (e.g., roads, water management infrastructure, water treatment plants, etc).

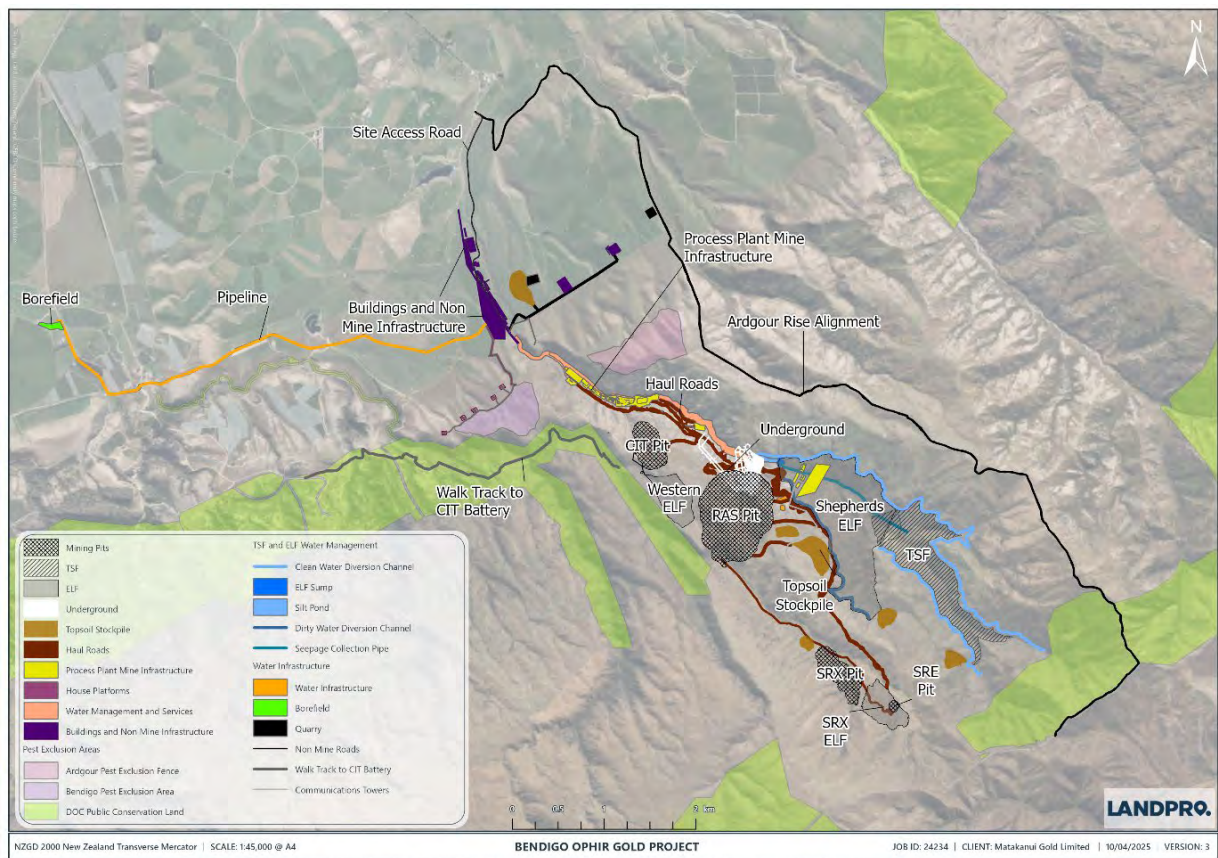


Figure 1. Bendigo-Ophir Gold Project Infrastructure

2.2 Surface Water

The project area covers several catchments and sub-catchments (Figure 2), including:

- **Shepherds Creek:** This creek runs through the project area and runs intermittently towards the Lindis River. An irrigation water-take on Shepherds Creek (RM17.301.15) downstream of SC1 monitoring site takes all available surface water in normal flow conditions, which is supplied to an irrigation dam, so the creek does not flow past this point. There is potential for groundwater to flow past this point via a thin layer of alluvial gravels along the creek bed.

⁶ Note: SRE Pit is backfilled by the SRX ELF.

- Jean Creek: This creek is an intermittent tributary to Shepherds Creek.
- Rise and Shine Creek: This creek joins Clearwater Creek south-east of the Come in Time Battery and flows into Bendigo Creek.
- Clearwater Creek: Flows into Bendigo Creek.
- Bendigo Creek: Several irrigation water-takes are in place on this creek (RM20.079.01 and RM20.079.02).

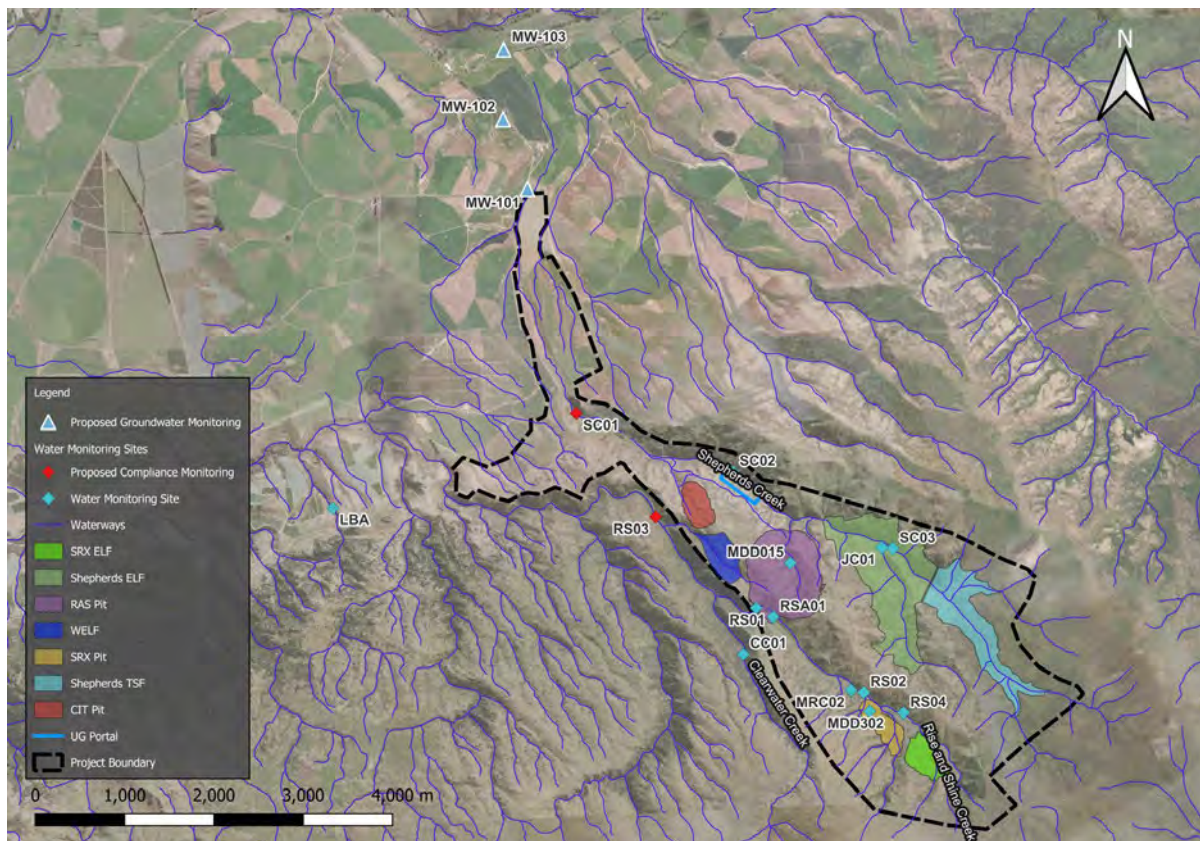


Figure 2. Bendigo-Ophir Gold Project area and water quality monitoring sites.

The proposed BOGP water quality compliance limits (Ryder, 2025) are used as a screening tool to determine whether baseline water quality data are elevated. The assessment (MWM, 2025a) indicated that:

- Shepherds Creek is elevated in copper (Cu).
- Bendigo Creek is elevated in arsenic (As), cobalt (Co), Cu, and iron (Fe).
- Groundwater is elevated in As, Cu, Fe, zinc (Zn), and on occasion strontium (Sr) within the project area. Thallium (Tl) was elevated on one occasion (although this appears anomalous).

Further details are provided in MWM (2025a).

2.3 Soils

MGL has conducted a soil study within the Rise and Shine Creek to map the distribution of As in the soils. This study utilised portable X-ray fluorescence (pXRF) and the results are presented in Figure 3.

The average crustal abundance of As is approximately 1.5 ppm (AusIMM, 2011), while the As concentrations observed in the soil within the Rise and Shine Creek valley ranged from 20 - >500 ppm. These anomalous As concentrations are likely to be associated with mineralisation that created the gold deposit.

Further studies have been completed on these As-rich soils (GRM, 2025).

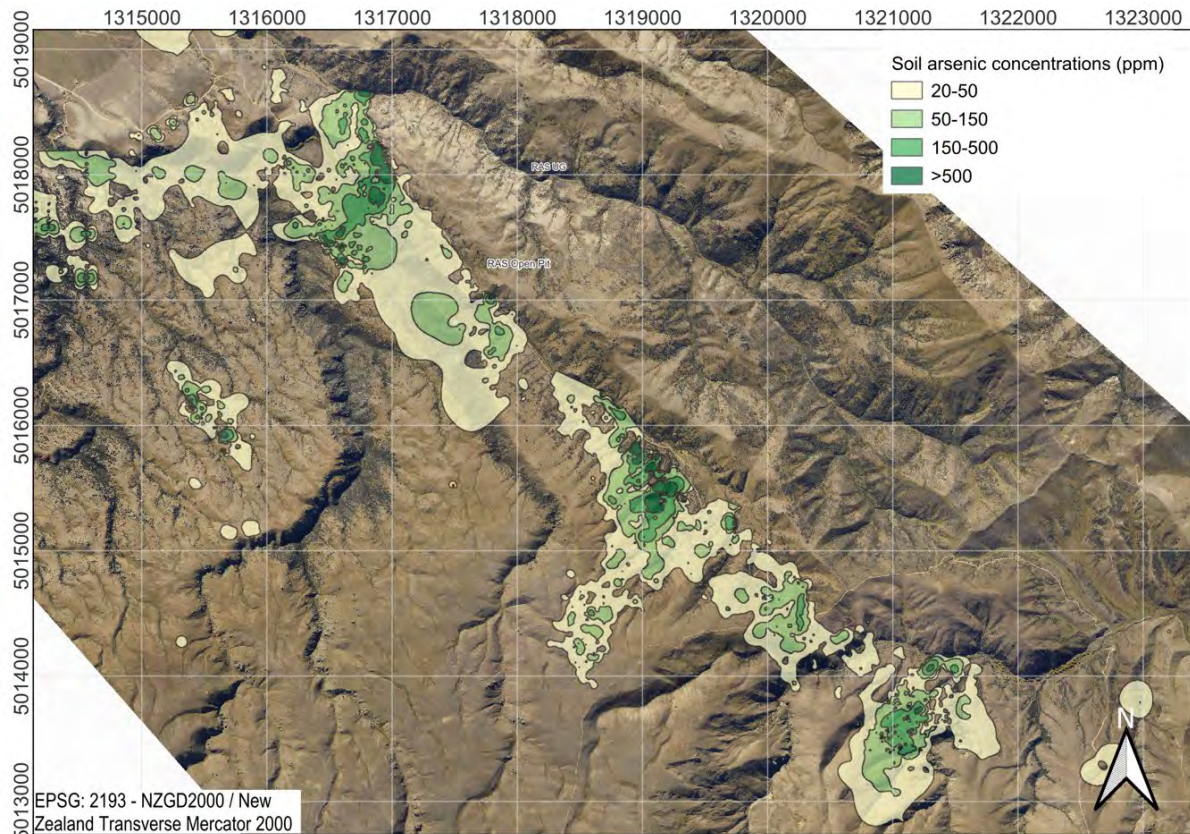


Figure 3. Arsenic concentration in soils in the study area.

Data source: Santana (2024) – GIS Shape Files

2.4 Geology

2.4.1 Regional Geology

The Dunstan Mountains are an uplifted block of the Otago Schist tilted to the northwest with remnants of a Cretaceous peneplain well preserved on its northern slopes. The Otago Schist is formed from sedimentary and minor intermediate volcanics and volcanoclastics of the Caples and Torlesse tectono-stratigraphic terranes. Greenschist facies rocks of the Otago schist are sub-divided into four textural zones based on mineralogy and mineral textures. Peak metamorphic grades in the Otago Schist occurred during the Jurassic when the Zealandia micro continent formed the outboard subduction complex of the Gondwana continental margin.

The regional geology of the Central Otago goldfields surrounding the BOGP consists of chlorite and biotite schists. The Rise & Shine Shear Zone (RSSZ), a late metamorphic deformation zone (Cox et al., 2006), runs through the project area dipping at 20-30 degrees northeast. The RSSZ occurs only in the footwall Textural Zone 4 (TZ4) schist in close association with the Thomsons Gorge Fault, which cuts and truncates the RSSZ against the unmineralised TZ3 schist (Cox et al., 2006). There is no

mineralisation associated with the Thomsons Gorge Fault itself, and Au mineralisation had ceased by the time of formation of the Thomsons Gorge Fault (c. 100 Ma) (Cox et al., 2006).

2.4.2 Project Geology

The project area contains four discrete mineral occurrences:

- Rise and Shine (RAS) deposit
- Come in Time (CIT) deposit
- Srex (SRX) deposit
- Srex East (SRE) deposit

The main mineralisation at RAS is associated with silica-siderite/ankerite alteration with minor arsenopyrite sulfides associated with the gold. In some areas a cataclastite (brecciated) network of anastomosing, post-metamorphic quartz, occur with minor sulfide veins in a halo of the core mineralisation. Allibone (2023) also identified the presence of sphalerite ((Zn,Fe)S) and galena (PbS) at the BOGP.

Locally, a number of splay faults are interpreted coming off the main structure which give a sense of structural control. These are also mineralised and are traceable for 10s to 100s of metres. Gold occurs as free gold particles, typically up to 400 µm but with some coarser visible gold. A minor gold component occurs associated with the arsenopyrite grains, but it is typically not in solid solution, giving rise to the free milling and highly gravity recoverable components expressed by metallurgical testing.

2.5 Geochemistry

All BOGP materials are classified as non-acid forming, with circum-neutral pH drainage expected from mine domains that contain the materials. However, neutral metalliferous drainage is likely to occur with elevated levels of As, sulfate (SO₄), trace metal, and nitrogenous compounds.

The most significant AMD source hazard for waste rock relates to the TZ4 and RSSZ materials, some of which will be waste rock, and some will be processed (to extract gold) producing tailings.

Data for waste rock indicates that the TZ4 and RSSZ lithologies contain ~95.3% of arsenic and 21.9% of sulfur yet represents only 9.3% of the waste rock that will be disturbed. Hence, appropriate management of TZ4 and RSSZ materials to reduce sulfide mineral oxidation is a critical step to minimise deleterious effects, i.e., manage 9.3% of the waste rock well to mitigate 95.3% of the arsenic risk in the engineered landforms (ELFs) that will contain the waste rock.

The following potential constituents of concern (PCOC) are identified and are considered in this report:

- TZ3 materials are enriched As and cobalt (Co). Antimony (Sb) is possibly elevated.
- RZ4 and RSSZ materials are enriched in As, sulfur (S). Sb is possibly elevated.
- Geochemical testing indicates that BOGP materials could generate MIW that could be elevated in aluminium (Al), As, Co, copper (Cu), chromium (Cr), iron (Fe), and zinc (Zn).
- Process water quality data suggests that Al, As, Co, Cu, Cr, Fe, molybdenum (Mo), nickel (Ni), lead (Pb), Sb, strontium (Sr), Zn, cyanide (CN), and ammoniacal nitrogen (Amm-N) may be elevated. It is noted these data are limited.

- Based on analogue data and general geoenvironmental hazards:
 - o Nitrogenous compounds (nitrate and ammoniacal nitrogen) are expected due to the use on ammonium-nitrate based explosives and cyanide.
 - o Sulfate is considered a PCOC based on sulfate being elevated at the Macraes Gold Mine, which is considered a suitable analogue site due to its similar sulfur content.

Further details are provided in MWM (2024b).

3 SOURCE TERMS – RAINFALL WATER QUALITY

This section summarises the rainfall water quality data used for the project area.

3.1 Data Source

Rainfall water quality is required as an input to the WLBM (MWM, 2024c). Further climatic information is available in Rekker (2025).

3.1.1 Rainfall Water Quality Source Term

The source term for average rainfall water quality is obtained from Nichol et al. (1997) using the Lauder collection site, which includes rainfall water quality data from 1983 to 1994. The Lauder site is located to the west of BOGP with an annual rainfall of 530 mm/year (Nichol et al., 1997) and therefore presents a reasonable dataset for rainfall water quality.

The rainfall quality data is provided in Table 2. The rainfall is slightly acidic with a pH value of 5.2 and with a low alkalinity (0.8 mg/L as CaCO₃).

Table 2. Rainfall Quality Source Term Data

PARAMETERS	UNITS	VALUE
pH	pH unit	5.2
Acidity	mg/L as CaCO ₃	2.28
Alkalinity Total	mg/L as CaCO ₃	0.81
Ca	mg/L	0.11
Cl	mg/L	0.31
K	mg/L	0.88
Mg	mg/L	0.09
Na	mg/L	0.32
NO ₃ -N	mg/L	0.06
SO ₄	mg/L	0.18

Source: Nichol et al., 1997: Table 5 (Lauder M8391) for the period 1983 – 1991 (monthly data).

These data are used as the source term for rainfall in the WLBM.

3.1.2 Assumptions

- It is assumed these data represent the reasonable concentrations of rainfall and that the average data provided are suitable.

4 SOURCE TERMS - BASELINE WATER QUALITY

This section reviews baseline water quality for the BOGP area.

4.1 Surface Water Quality

Source terms for baseline water quality have been derived from surface water quality data from the Shepherds Creek and Bendigo Creek (e.g., Rise and Shine Creek) areas, with monitoring data covering multiple locations from 2022 to 2024. The complete presentation and analysis of data, including discussion of monitoring data limitations is provided in the baseline water quality report (MWM, 2025a).

4.1.1 Shepherds Creek Catchment Source Term

Surface water quality data for Shepherds Catchment are provided in Table 3. The following observations are provided:

- Concentrations of dissolved parameters are generally lower in the upper catchment (e.g., SC03 and JC01) and are likely to be unaffected by mineralisation, which could influence SC01.
- In the upper catchment, SC03 has a larger dataset, which provides more confidence in the data.
- Data lower than the limit of reporting (LOR) are presented in Table 3 in green text as half the LOR. For the source term they are treated as a value of 0 in the WLBM.
- Average data for SC03 (as shown in Figure 2) were selected as the source term for water quality in the WLBM for the Shepherds Creek Catchment and is assumed to be reflective of water quality in the catchment (as shown by yellow data in Table 3).

Table 3. Surface water quality source terms for Shepherds Creek.

PARAMETERS	SC01 (n=25)	SC03 (n=21)	JC01 (n=6)
	AVE (mg/L)	AVE (mg/L)	AVE (mg/L)
Alkalinity (mg CaCO ₃ /L)	216.0	136.2	246.3
pH (pH units)	8.11	7.88	8.30
EC (µS/cm)	488.9	319.1	498.0
Ca	60.8	40.9	53.3
Cl	6.08	2.74	5.55
F	0.103	0.119	0.076
Mg	21.3	10.2	20.1
Na	20.3	36.2	59.0
K	2.01	1.43	1.98
TOC	2.08	2.01	4.40
Al	0.00454	0.00640	0.0070
As	0.00239	0.00079	0.00085
B	0.03304	0.0280	0.0337
Cd	0.00010	0.00011	0.00011
Co	0.00026	0.00029	0.00031
Cr	0.00056	0.00062	0.00060
Cu	0.00055	0.00055	0.00143

PARAMETERS	SC01 (n=25)	SC03 (n=21)	JC01 (n=6)
	AVE (mg/L)	AVE (mg/L)	AVE (mg/L)
Fe	0.01135	0.0215	0.00750
Hg	0.00026	0.00030	0.00029
Mn	0.00265	0.00357	0.00104
Mo	0.00051	0.00044	0.00114
Ni	0.00035	0.00036	0.00039
Pb	0.00025	0.00029	0.00034
Sb	0.00053	0.00058	0.00073
Se	0.0025	0.0029	0.0028
Sr	0.947	0.675	0.718
Tl	0.00023	0.00027	0.00026
U	0.0051	0.0022	0.006
V	0.0005	0.0005	0.0005
Zn	0.0017	0.0015	0.0025
Sulfate	40.5	14.4	18.5
Ammoniacal nitrogen	0.0103	0.0117	0.0075
Nitrate-N	0.083	0.139	0.062
TCN	0.0028	0.0032	0.0026

Note: Green data are ½ LOR and are included in the source term as '0'

4.1.2 Bendigo Creek Catchment Source Term

Surface water quality source terms for the Bendigo Creek Catchment are provided in Table 4. The following observations are provided:

- Water quality in the Rise and Shine Creek is generally poorer than the water quality in Shepherds Creek due to the historic mining activities and natural mineralisation (e.g., refer to MWM, 2025a).
- RS04 was selected (Figure 2) to represent water quality within the catchment upstream of the Rise and Shine historic mine workings (as shown by yellow data in Table 4). Average water quality data are provided Table 4.
- Data lower than the LOR are presented in Table 4 in green text as half the LOR. For the source term they are treated as a value of 0 in the WLBM.
- Average data for CC01 was selected (as shown by green data in Table 4) as the source term for water quality in the WLBM for the Clearwater Creek Catchment and is assumed to be reflective of water quality in the catchment.

Table 4. Surface water quality source terms for Bendigo Creek.

PARAMETERS	RSA1 (n=25)	RS01 (n=26)	RS02 (n=26)	RS03 (n=25)	RS04 (n=14)	CC01 (n=16)
	AVE (mg/L)	AVE (mg/L)	AVE (mg/L)	AVE (mg/L)	AVE (mg/L)	AVE (mg/L)
Alkalinity (mg CaCO ₃ /L)	107.8	87.5	65.8	39.1	72.8	14.7
pH (pH units)	7.32	7.61	7.57	7.42	7.51	7.03

PARAMETERS	RSA1 (n=25)	RS01 (n=26)	RS02 (n=26)	RS03 (n=25)	RS04 (n=14)	CC01 (n=16)
	AVE (mg/L)	AVE (mg/L)	AVE (mg/L)	AVE (mg/L)	AVE (mg/L)	AVE (mg/L)
EC (µS/cm)	211.7	181.8	151.4	86.4	165.0	34.0
Ca	28.7	26.3	19.7	11.1	23.3	3.88
Cl	2.55	2.38	2.07	1.33	1.96	0.794
F	0.096	0.086	0.082	0.057	0.059	0.055
Mg	5.22	4.82	3.61	1.99	3.74	0.844
Na	52.5	10.4	6.87	39.5	5.15	2.35
K	1.04	1.14	1.07	0.578	1.18	0.335
TOC	4.04	2.77	2.09	1.75	2.75	1.23
Al	0.00288	0.00421	0.00820	0.00756	0.00686	0.01231
As	0.0386	0.0193	0.0049	0.0085	0.001	0.0010
B	0.0188	0.0185	0.0185	0.0188	0.011	0.0175
Cd	0.00010	0.00010	0.00010	0.00010	0.00003	0.00009
Co	0.00053	0.00026	0.00025	0.00025	0.00013	0.00021
Cr	0.00058	0.00054	0.00054	0.00059	0.00026	0.00056
Cu	0.00185	0.00057	0.00063	0.00046	0.00083	0.00043
Fe	0.2048	0.0614	0.0245	0.0375	0.068	0.0293
Hg	0.00026	0.00026	0.00026	0.00026	0.00011	0.00024
Mn	0.1614	0.0211	0.0011	0.0095	0.006	0.0009
Mo	0.00034	0.00034	0.00033	0.00033	0.00022	0.00033
Ni	0.00049	0.00044	0.00041	0.00035	0.00049	0.00056
Pb	0.00025	0.00025	0.00025	0.00025	0.00008	0.00022
Sb	0.00050	0.00048	0.00048	0.00050	0.00017	0.00044
Se	0.0025	0.0024	0.0024	0.0025	0.0008	0.0022
Sr	0.381	0.358	0.266	0.136	0.315	0.042
Tl	0.00023	0.00022	0.00022	0.00023	0.00005	0.00019
U	0.00025	0.00015	0.00026	0.00012	0.00030	0.00009
V	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050
Zn	0.00466	0.00175	0.00204	0.00229	0.00142	0.00161
Sulfate	4.52	5.13	2.72	1.57	2.80	0.843
Ammoniacal nitrogen	0.0222	0.0098	0.0121	0.0092	0.013	0.0086
Nitrate-N	0.0153	0.0171	0.0308	0.0088	0.0033	0.0096
TCN	0.0028	0.0028	0.0028	0.0028	0.0013	0.0026

Note: Green data are ½ LOR and are included in the source term as '0'

Average data for RS04 (see Figure 2) was selected as the source term for water quality in the WLBM for the Rise and Shine Creek Catchment and is assumed to be reflective of water quality in the catchment.

4.1.3 Temperature Effects

The temperature of the streams at the proposed compliance monitoring sites (SC01 and RS03) were assessed to derive average summer and winter stream water temperature. These average data are used to modify toxicity for cyanide and sulfide (e.g., Ryder, 2025). These data are presented in Table 5

The WLBM does not consider temperature effects given that cyanide is not modelled, and sulfide will be a function of passive treatment in the post closure phase when further empirical data will be available to understand effects.

Table 5: Average seasonal water temperature at proposed compliance monitoring sites SC01 and RS03.

SITE ID	SEASON	AVERAGE TEMPERATURE (°C)
RS03	Summer (November – April)	10.7
	Winter (May – October)	4.4
SC01	Summer (November – April)	14.2
	Winter (May – October)	7.2

Note: Calculated from data obtained over the period 2023-2025.

4.1.4 Assumptions

The following assumptions are presented for the source term for the baseline streams:

- It is assumed that the average water quality provides a reasonable dataset to create a source term for the project area for non-impacted catchments.
- It is assumed that water quality data upstream of mineralisation is suitable as the baseline water quality with the expectation that mineralised areas will be mined.

4.1.5 Performance Monitoring

The following performance monitoring is recommended for the baseline stream water quality:

- Ongoing monitoring of water monitoring sites SC01 and RS03 including continuous flow, EC, temperature, and pH; and monthly grab samples for water quality and compliance monitoring.
- Ongoing performance monitoring of RS01 for water quality effects associated with the project and historic mining activities / natural mineralisation.
- Ongoing performance monitoring of Clearwater Creek as a control site (monthly samples for water quality).
- Comparison of water quality data and trends against agreed BOGP water quality compliance limits as proposed by Ryder (2025).

4.2 Groundwater Quality

Groundwater is implicitly included within the WLBM through the use of baseline groundwater quality data for the BOGP. However, a source term is required for inflow to the pit voids.

4.2.1 Groundwater Source Term

The source terms for groundwater are provided in Table 6. The following observations are provided:

- MDD015 (Figure 2) is located with the proposed RAS Pit shell. It also has the greatest number of samples.

- Water quality data suggests that As and Sr can be elevated in groundwater associated with the BOGP.
- Data lower than the LOR are presented in Table 4 in green text as half the LOR. For the source term they are treated as a value of 0 in the WLBM.
- Data for MDD015 (see Figure 2) was selected as the source term for groundwater quality (data shown in yellow in Table 6) and is assumed to be reflective of water quality in the catchment.

Table 6. Water quality source terms for groundwater.

PARAMETERS	MDD015 (n=18)	MRC002 (n=1)	MDD302 (n=12)
	AVE	AVE	AVE
Alkalinity (mg CaCO ₃ /L)	201.6	110.0	237.0
pH (pH units)	8.10	8.00	7.78
EC (µS/cm)	446.5	250.0	493.3
Ca	38.9	14.8	63.3
Cl	9.42	3.50	2.96
F	0.162	-	0.137
Mg	16.2	6.61	21.6
Na	43.6	27.0	7.98
K	1.44	1.88	1.42
TOC	0.300	-	0.500
Al	0.0061	0.0060	0.0038
As	0.024	0.011	0.052
B	0.0331	-	0.01
Cd	0.00008	0.0002	0.00002
Co	0.00019	0.0005	0.00001
Cr	0.0005	0.001	0.0002
Cu	0.0003	0.002	0.0002
Fe	0.0147	0.090	0.005
Hg	0.0002	0.0005	0.00008
Mn	0.0068	0.0034	0.0045
Mo	0.0004	0.0009	0.0003
Ni	0.0003	0.0005	0.0002
Pb	0.0002	0.0005	0.00005
Sb	0.0004	-	0.00018
Se	0.0018	-	0.0005
Sr	9.76	3.57	1.13
Tl	0.0003	0.0005	0.00001
U	0.0010	-	0.004815
V	0.0005	0.0005	0.0005
Zn	0.0015	0.094	0.001
Sulfate	10.3	5.40	9.59
Ammoniacal nitrogen	0.109	-	0.050
Nitrate-N	0.0051	-	0.0033
TCN	0.0023	-	0.0011

Note: Green data are ½ LOR and are included in the source term as '0'. Data in mg/L unless stated otherwise.

4.2.2 Assumptions

The following assumptions are presented for the source term for groundwater:

- It is assumed that the average water quality provides a reasonable dataset to create a source term for the project area.
- It is assumed the source term derived is appropriate for all pits within the proposed BOGP area.

4.2.3 Performance Monitoring

The following performance monitoring is recommended for the groundwater quality:

- Continue monitoring of groundwater for the project at MDD015 until mining commences to confirm baseline conditions.
- Commence monitoring of the Ardgour Aquifer groundwater quality once the monitoring bores (e.g., MWM101 – MWM 103: Figure 2) have been installed. These bores will be installed for compliance monitoring purposes, and a baseline is required to determine any effects.

5 ENGINEERED LANDFORMS

This section discusses the source term for the engineered landform (ELF) seepage at the BOGP.

5.1 Background

During the operational phase of the BOGP, surface water from the surface of the Shepherds ELF will be directed to the Shepherds Silt Pond. Water sheeted off the ELF will be diluted by high rainfall events. The water will report to the Shepherds Silt Pond for sediment retention and will then be discharged to Shepherds Creek. EGL (2025b) note that the Shepherds Silt Pond will be a large dam with a decant tower. The silt pond will have a total capacity of around 100,000 m³ (some of which will be dead storage for sediment capture).

In closure, Shepherds ELF will be capped in brown rock and topsoils. Once vegetation establishes, the risk of sediment laden water is mitigated. Shepherds Silt Pond can then be decommissioned, although it may also be used for passive treatment during the active- and post-closure phases. The decision to use this sediment pond as a passive treatment system will be subject to further studies, completed during the operational phase of the BOGP.

5.2 Literature Review - Macraes

Analysis indicates that Macraes and the BOGP have similar sulfur content and similar geology (MWM, 2025b). Sulfur content is a key consideration as to whether an analogue site is suitable as this represents the potential source hazard for AMD. Analysis of total sulfur data for tailings and waste rock at Macraes is comparable to BOGP with average waste rock being ~ 0.13 wt% S at Macraes and ~ 0.094 wt% S at BOGP (MWM, 2024b). Hence, the source hazard for sulfate in waste rock is similar for both Macraes and BOGP and is therefore a suitable analogue site.

Data provided by Golder (2011b) for silt ponds, located at the toe of waste rock stacks (WRSs) at Macraes, indicates elevated sulfate in seepage waters (Table 7). Such data provides an indication of the risks to surface waters associated with this mine domain at the BOGP.

Table 7. WRS silt pond seepage water quality from Macraes. From Golder (2011b).

PARAMETER	DEEPELL NORTH	DEEPELL SOUTH	BATTERY CREEK	NORTHERN GULLY	FRASERS WEST (NBWR)	MURPHYS CREEK	BACK ROAD	AVERAGE
Arsenic	0.011	0.00001	0.00001	0.001	0.001	0.00001	0.00001	0.0016
Sulfate	38.6	15.4	1,200	2,300	1,500	1,320	2,200	1084
Cyanide _{WAD}	0.00001	0.00001	0.00001	0.013	0.00001	0.00001	0.00001	0.0016
Copper	0.001	0.00001	0.00001	0.003	0.001	0.001	0.002	0.0010
Iron	0.170	0.00001	0.00001	0.93	0.42	0.52	0.91	0.3734
Lead	0.001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.0001
Sodium	16	10.8	36	57.7	26.2	33	56.4	29.81
Potassium	5.5	1.89	10	12	5.47	6.69	11.7	6.72
Calcium	68.5	40.2	290	434	199	250	425	215.5
Magnesium	14.5	7.7	200	360	165	204	352	164.7
Zinc	0.00001	0.00001	0.00001	0.032	0.015	0.018	0.032	0.012
Chloride	11.5	7.1	10	10.2	4.69	6.03	9.99	7.49

1. - All values presented in units of mg/L

The assessment by Golder in 2011 for Macraes did not consider the risks associated with nitrogenous compounds. Recent work in 2020 identified that nitrate can be elevated up to 10.5 mg/L in WRS seepage (OceanaGold, 2020).

Data presented in this section indicates that a number of PCOC could be elevated in WRS seepage including sulfate, nitrate, and zinc. Further details are provided in the ELF model report (MWM, 2025d) on PCOC and the potential risks for water quality from this mine domain.

5.3 Source Terms

Two source terms for the WLBM are required for the proposed engineered landforms at the BOGP including ELF surface run-off and ELF seepage. ELF surface run-off is assumed to have the source term for Mine Impacted Surfaces (Table 19). ELF seepage requires numerical modelling and is a function of the ELF average height (e.g., Navarro-Valdivia, et al., 2024). Further details of how the ELF seepage source terms were developed are provided in MWM (2025d). Modelling associated with the WLBM are discussed in MWM (2025c).

5.4 Assumptions

Assumptions relating to the source terms for ELF seepage are discussed in MWM (2025d).

5.5 Performance Monitoring

Performance monitoring is discussed in MWM (2025d).

6 PIT VOIDS

Active pits are likely to be a significant source of contaminants due to the blasting and exposure of overburden that will generate a large reactive surface area.

6.1 Literature Review – Pit Lakes

Golder (2011c) identifies that PCOC can be elevated in pit lakes at Macraes with:

- Sulfate ranging from 24 – 3,000 mg/L.
- Arsenic ranging from <0.005 – 0.8 mg/L.
- Cyanide_{WAD} ranging from <0.005 – 0.87 mg/L, which indicates that process waters are discharged to some of these pits and this would also account for the elevated sulfate in some pit voids.

These data are shown in Table 8 to Table 12 and summarise the Macraes pit water quality from Frasers Pit, Golden Bar Pit, Golden Point Pit, Innes Mills South, and Round Hill Pit. It is reasonable to expect that pit lake water quality for RAS Pit at BOGP will be comparable to the larger pits at Macraes (e.g., Frasers Pit) once developed to maximum footprint and depth due to a similar lithologies and mineralisation style.

Table 8. Pit Lake Water Quality – Frasers.

PARAMETER	MINIMUM	MEAN	95 TH PERCENTILE	MAXIMUM
pH (unitless)	7.2	8.1	8.8	9.8
Conductivity (mS/m)	320	760	1,100	1,200
Calcium	29	67	96	110
Chlorine	1.7	11	18	20
Magnesium	15	39	56	74
Potassium	2.8	7.8	16	16
Na	4.9	35	61	72
Sulfate	24	200	350	470
CN _{WAD}	<0.005	<0.013	0.018	0.15
Arsenic	<0.005	<0.18	0.42	0.80
Copper	<0.001	<0.003	0.010	0.022
Iron	<0.02	<0.17	0.60	1.2
Lead	<0.0010	<0.0010	0.0020	0.011

Source: Golder (2011d) – Appendix E.

Notes: All units in mg/L unless otherwise stated; and all data presented to two significant figures or less.

Table 9. Pit Lake Water Quality – Golden Bar Pit.

PARAMETER	MINIMUM	MEAN	95 TH PERCENTILE	MAXIMUM
pH (unitless)	7.0	8.1	8.3	8.4
Conductivity (mS/m)	270	640	810	860
Calcium	26	70	86	100
Chloride	3.7	6.6	8.5	9.6

PARAMETER	MINIMUM	MEAN	95 TH PERCENTILE	MAXIMUM
Magnesium	14	32	46	48
Potassium	1.8	4.6	7.3	8.2
Sodium	8.2	13	17	18
Sulfate	50	160	260	290
Arsenic	0.07	0.36	0.60	0.72
Copper	<0.001	<0.006	0.024	0.074
Iron	<0.02	<0.067	0.16	0.16
Lead	<0.0001	<0.001	0.002	0.005

Source: Golder (2011d) – Appendix E.

Notes: All units in mg/L unless otherwise stated; and all data presented to two significant figures or less.

Table 10. Pit Lake Water Quality – Golden Point Pit.

PARAMETER	MINIMUM	MEAN	95 TH PERCENTILE	MAXIMUM
pH (unitless)	6.7	7.5	8.1	8.3
Conductivity (mS/m)	780	2,700	4,400	4,600
Calcium	110	370	550	560
Chloride	4.1	14	22	23
Magnesium	26	192	333	345
Potassium	2.4	17	31	54
Sodium	19	130	260	280
Sulfate	200	1,600	3,000	3,000
CN _{WAD}	<0.005	NA	NA	0.040
Arsenic	<0.005	<0.039	0.15	0.17
Iron	<0.04	<0.23	0.69	0.78
Lead ^A	<0.001	NA	NA	NA

Source: Golder (2011d) – Appendix E.

Notes: All units in mg/L unless stated; all data presented to two significant figures or less; NA = not applicable; CN_{WAD} was analysed five times, with all but one below detection limit of 0.005 g/m³

^A lead was below the detection limit on each sampling occasion.

Table 11. Pit Lake Water Quality – Innes Mills South.

PARAMETER	MINIMUM	MEAN	95 TH PERCENTILE	MAXIMUM
pH (unitless)	7.3	8	8.3	8.3
Conductivity (mS/m)	1,200	2,500	3,600	3,900
Calcium	130	310	430	470
Chloride	1.8	33	86	110
Magnesium	46	100	130	140
Potassium	9.4	31	49	55
Sodium	60	180	340	360
Sulfate	400	1,400	2,100	2,300
Cyanide _{WAD}	<0.005	<0.20	0.83	0.87
Arsenic	<0.005	<0.022	0.049	0.052
Copper	<0.001	<0.016	0.057	0.060

PARAMETER	MINIMUM	MEAN	95 TH PERCENTILE	MAXIMUM
Iron	<0.050	<1.4	6.3	8.2
Lead ^{A,B}	<0.001	NA	NA	NA
Zinc ^C	<0.04	NA	NA	NA

Source: Golder (2011d) – Appendix E.

Notes: All units in mg/L unless stated; all data presented to two significant figures or less; NA = not applicable; ^A - Summary statistics were derived after excluding detection limits superseded by lower limits.

^B - lead was below the detection limit on each sampling occasion; ^C - sampled on only one occasion.

Table 12. Pit Lake Water Quality – Round Hill.

PARAMETER	MINIMUM	MEAN	95 TH PERCENTILE	MAXIMUM
pH (unitless)	7.3	7.8	8.2	8.3
Conductivity (mS/m)	560	840	1,100	1,100
Sulfate	58	200	350	370
CN _{WAD}	<0.005	<0.009	0.021	0.022
Arsenic	<0.002	<0.61	1.4	1.6
Copper ^A	<0.0005	NA	NA	NA
Iron	<0.040	<1.1	4.3	6.3
Lead ^A	<0.0002	NA	NA	NA
Zinc ^A	<0.005	NA	NA	NA

Source: Golder (2011d) – Appendix E.

Notes: All units in mg/L unless stated; all data presented to two significant figures or less; NA = not applicable.

^A copper, lead and zinc concentrations were below the respective detection limits on each sampling occasion.

As noted by Navarro-Valdivia et al. (2023) pit lakes can also be elevated in nitrogenous compounds due to the presence of blasting residues, with nitrate nitrogen concentrations peaking in the Golden Bar Pit Lake at 30 mg/L due to an initial nitrate load of 400 kg, yet steadily decreases at 20-30% per year due to biogeochemical processes (Figure 4). Similar processes are expected at BOGP within the final pit lakes. Such decreases in nitrogenous compounds are in agreement with literature (Figure 5).

Navarro-Valdivia et al. (2023) noted that the quantity of nitrogen as NH₄NO₃ was estimated to be 5.35 g/m² once the pit lake started to fill.

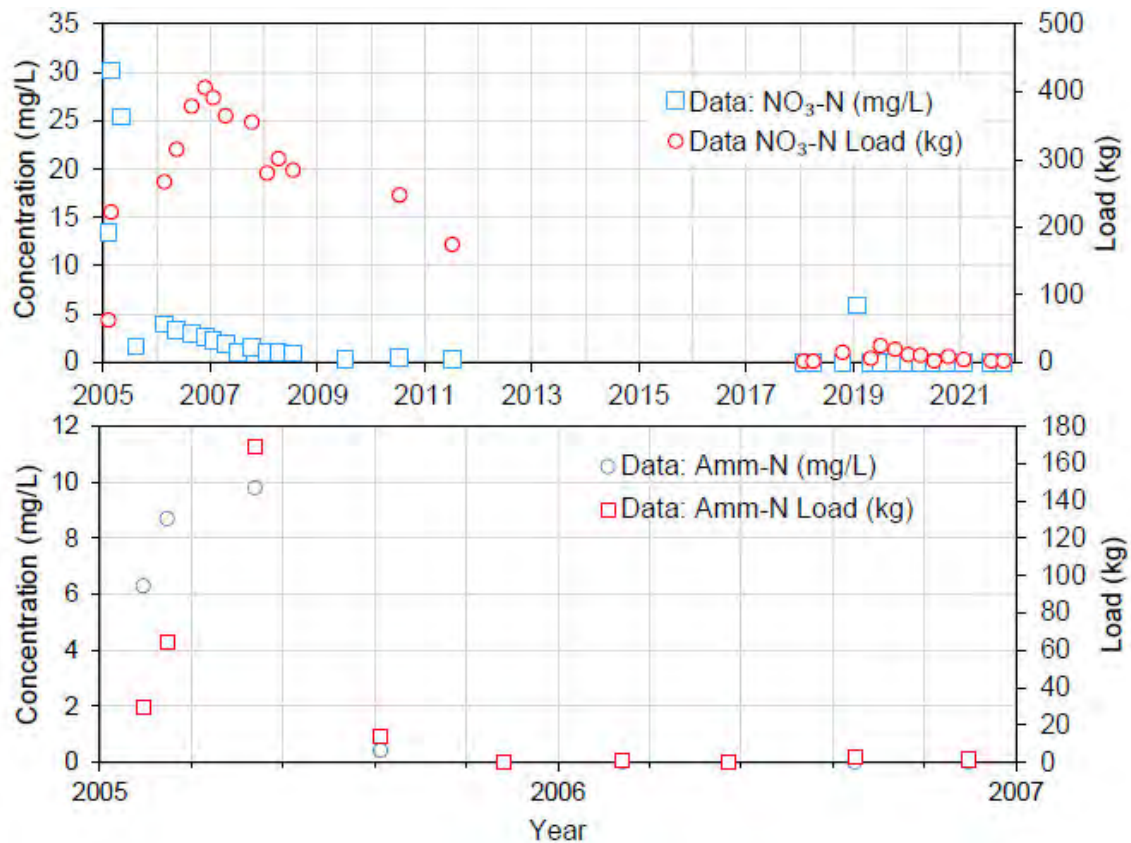


Figure 4. Golden Bar Pit Lake nitrate-N and ammoniacal-M concentrations and loads over time.

Source: Navarro-Valdivia et al. (2023)

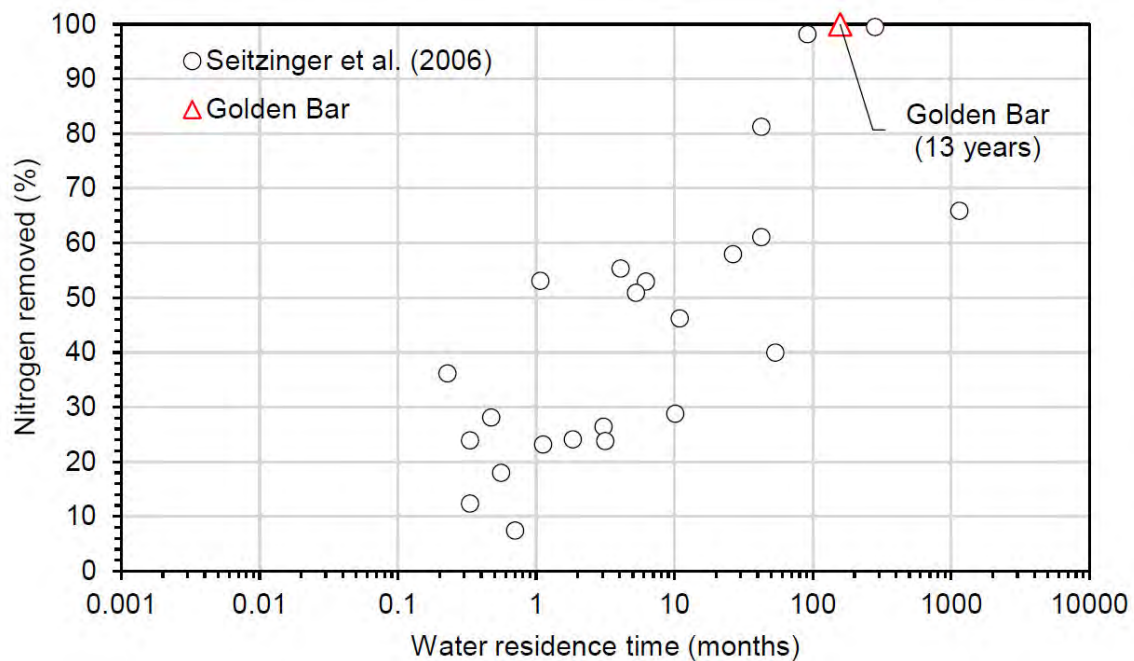


Figure 5. Lake water residence time and nitrogen removal

Source: Navarro-Valdivia et al. (2023) with data from Seitzinger et al. (2006).

6.2 Literature Review – Pit Wall Runoff

Data provided by Golder (2011d) for Frasers pit runoff water quality is comparable to Frasers Pit water quality (95th percentile), which suggest wall runoff is a good indication of pit water quality prior to dilution by other inflows (e.g., MIW, process water, rainfall) and evaporation. Results indicate that sulfate can range from 12 – 390 mg/L with a mean sulfate of 160 mg/L.

Table 13. Frasers Pit wall runoff water quality.

PARAMETER	MINIMUM	MEAN	95 TH PERCENTILE	MAXIMUM
pH (unitless)	7.6	8.2	8.4	8.5
Conductivity (mS/m)	400	640	970	1,100
Calcium	20	55	93	110
Chloride	2.9	13	20	27
Magnesium	7.8	37	78	88
Potassium	1.4	3.9	7.1	10
Sodium	4.6	33	59	63
Sulfate	12	160	320	390
Arsenic	<0.005	<0.093	0.36	0.48
Copper	<0.001	<0.0034	0.0082	0.041 ²
Iron	<0.040	9.1 ¹	21	220 ²
Lead	<0.001	<0.004	0.010	0.051 ²

Source: Golder (2011d) – Appendix F.

Notes: All units in mg/L unless otherwise stated; all results presented to two significant figures or less; Data measured at FR3 North Wall, Frasers East Wall, S452RL and W435RL.

¹ – This data point as presented as <9.1 mg/L. For this report, it is assumed that 9.1 is the mean, which appears reasonable based on the graphed information.

² – this datapoint is an outlier and appears erroneous from the graphed data in the Golder (2011d) report. All other data appear reasonable.

6.3 Description

This section describes the three pits that will be constructed as part of the BOGP. No discussion is provided on SRE pit, due to its small size and for the fact it will be backfilled by SRX ELF that will dominate any effects on water quality from the area.

6.3.1 RAS Pit

The RAS Pit design is ~200 m deep, approximately 1,000 m long in a roughly north-south direction and approximately 900 m wide (MGL, 2024). Data are provided in Table 14.

Table 14. RAS Pit Material Summary.

PIT STAGE	TOTAL TONNES	ORE TONNES	ORE GRADE	WASTE TONNES
	(Mt)	(Mt)	(g/t)	(Mt)
Shell 32	187.2	11.6	2.49	175.6
Final Design	214.0	11.9	2.42	202.1
Variance	14%	3%	-3%	15%

Source: MGL, 2024

6.3.2 SRX Pit

The SRX Pit design is ~88 m deep, 650 m long and 210 m long (MGL, 2024). Data are provided in Table 15.

Table 15. SRX Pit Material Summary.

PIT STAGE	TOTAL TONNES	ORE TONNES	ORE GRADE	WASTE TONNES
	(Mt)	(Mt)	(g/t)	(Mt)
Shell 33	8.2	1.9	0.69	6.3
Final Design	7.3	1.4	0.68	5.9
Variance	-11%	-11%	9%	-11%

Source: MGL, 2024

6.3.3 CIT Pit

Waste rock (TZ3) will be placed as backfill in the CIT Pit to return the ground to its pre-mining topography (or similar). The CIT backfill is shown in Figure 6 and indicates that the long-term groundwater level will be equivalent to the spill point of 503 m. Waste rock will be constructed as an ELF to minimise long term risks to water quality. The volume of the CIT Pit has been estimated at ~923,000 m³ and this will include 700 kt ore, 475kt soil, 2,550 kt TZ3, and 850 kt TZ4 materials⁷.

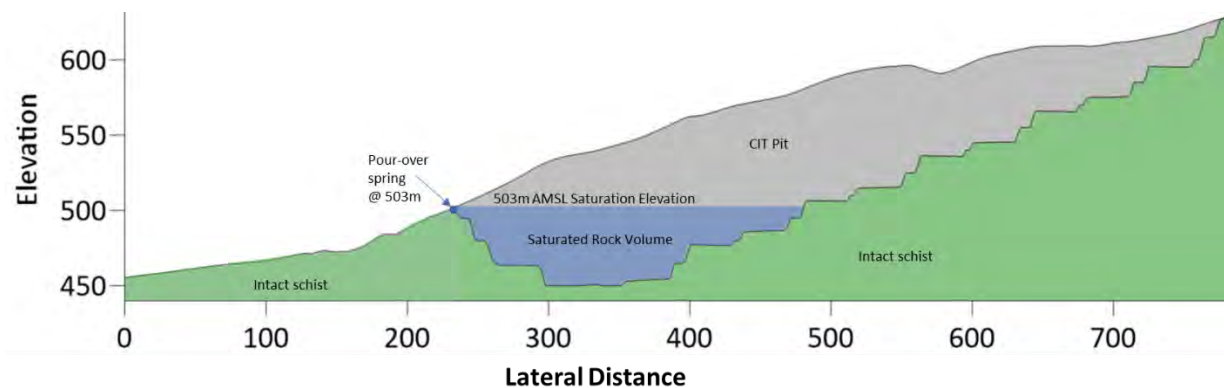


Figure 6. CIT Backfill.

Source: Rekker and Dumont, 2025

6.4 Source Terms

Definition of pit lake water quality is required for the various pits proposed at BOGP including RAS, SRX and CIT. Modelling associated with the WLBM are discussed in MWM (2025c). Inputs to the pit lake models include:

- Pit wall runoff.
- Rainfall.
- Groundwater inflow.
- Surface water.

The following sections define the derivation of source terms for pit wall runoff.

⁷ Pers. comm. Rod Redden: email dated 12 February 2025.

6.4.1 RAS and SRX Pit Wall Runoff

Data for Frasers Pit and Pit wall runoff are presented in Table 16. Generally, the concentrations in the pit lake are higher than the pit wall runoff (as evidenced by an increase in conductivity). This suggests an increase in concentration due to evaporation. Data are presented for mean and 95th percentile data and source terms for the BOGP Pit Wall runoff are based on these terms. Other data, absent from the Frasers Pit dataset are derived from column leach test data (MWM, 2025f) and analogue datasets.

Table 16. BOGP Pit Wall Runoff Source Term.

PARAMETER	FRASERS PIT LAKE WATER QUALITY		FRASERS PIT WALL RUNOFF WATER QUALITY		BOGP PIT WALL RUNOFF SOURCE TERM	
	MEAN	95 TH PERCENTILE	MEAN	95 TH PERCENTILE	MEAN ⁴	95 TH PERCENTILE ⁵
Alkalinity (mg CaCO ₃ /L)					61.3	140.5
pH (pH units)	8.1	8.8	8.2	8.4	8.2	8.4
EC (µS/cm)	760	1,100	640	970	566 ⁶	1037 ⁶
Ca	67	96	55	93	55	93
Cl	11	18	13	20	13	20
F					0.21	0.83
Mg	39	56	37	78	37	78
Na	35	61	33	59	33	59
K	7.8	16	3.9	7.1	3.9	7.1
TOC	-	-	-	-	-	-
Al					0.114	0.24
As	<0.18	0.42	<0.093	0.36	0.093	0.36
B					0.046 ³	0.104
Cd					0.0001	0.0001
Co					0.0005	0.001
Cr					0.0005	0.0005
Cu	<0.003	0.010	<0.0034	0.0082	0.0034	0.0082
Fe	<0.17	0.60	9.1 ¹	21	9.1	21
Mn					0.014	0.039
Mo					0.023	0.045
Ni					0.0009	0.003
Pb	<0.0010	0.0020	<0.004	0.010	0.004	0.010
Sb					0.027	0.14
Se					0.00025	0.00025
Sr					0.91	1.84
Tl					0.00025	0.00025
U					0.0106 ⁶	0.0162 ⁶
V					0.0005	0.0005
Zn					0.002	0.007
Sulfate	200	350	160	320	160	320
Ammoniacal-N					10 ²	10 ²
Nitrate-N					30 ²	30 ²

Note: All units in mg/L unless otherwise stated; and all data presented to two significant figures or less.

Note: Green data are ½ LOR and are included in the source term as '0' for water modelling purposes.

Source: Blue cells from Golder (2011d) – Appendix E.

Cyanide is not included as a source term for pit voids as it is assumed no tailings water and/or process water will be pumped to the pit.

1. This data point as presented as <9.1 mg/L by Golder (2011d). It is assumed for this report that 9.1 mg/L is the mean, which appears reasonable based on the graphed information in the Golder report.
2. From Navarro-Valdivia et al. (2023) – see Figure 4.
3. A total of 21 of 30 TZ4 samples are <LOR.
4. Mean of all column leach test data (CLT) data for TZ3 and TZ4 (as of 17-2-25)
5. 95th percentile of all CLT data for TZ3 and TZ4 (as of 17-2-25).
6. where there is a relationship between sulfate and the constituent for the sulfate concentration of interest, then the average of the two relationships for TZ3 and TZ4 is used (based on the presented sulfate concentration).

6.4.2 CIT Pit Backfill

Water quality for the CIT Pit Backfill is discussed in MWM (2025d) where closure water quality is dominated by the materials above the long-term groundwater level.

6.5 Assumptions

The following assumptions are presented for the source term for groundwater:

- It is assumed the Frasers pit and pit wall runoff water quality dataset is a reasonable analogue for BOGP due to a similar lithologies and mineralisation style with both mean and 95th percentile data being available.
- It is assumed that the concentrations of nitrogenous compounds will be similar to the Golden Bar Pit Lake as a comparable analogue site (same lithologies, same mineralisation style, and the same explosives that generate the ammonium-nitrate source hazard) and that these will decrease at a rate of 20-30% per year due to biogeochemical processes.
- It is assumed that the use of mean and 95th percentile column leach test data provides a suitable conservative source term for other water quality parameters absent in the analogue data to understand AMD risks.

6.6 Performance Monitoring

The following performance monitoring is recommended for the RAS and SRX pit lakes:

- Once pit lakes have evolved, it is assumed that nitrogenous compounds will be at low concentrations due to biogeochemical processes. The pit lakes should be monitored for the decay of nitrogenous compounds to validate model assumptions.
- Pit sumps should be monitored to confirm water quality trends for PCOC.
- Pumping records and the quantity of water extraction from the pits for dust extraction should be recorded to validate contaminant load models and the water balance model.

7 RAS UNDERGROUND WORKINGS

A review was undertaken of available data to determine a source term for the RAS underground workings, with the water quality and quantity being a function of groundwater flow through the underground workings and flow from the proposed RAS Pit Lake once it fills.

7.1 Literature Review – Golden Point Adit – Macraes

Data are publicly available for the Golden Point Adit, Macraes, from 1993 to 2007 when the frequency of sampling was increased to monthly water quality sampling due to the increase in flow rates from the adit in ~October 2006 (Golder, 2011d). As noted by Golder (2011d) the historic golden point underground workings intersect the Golden Point Pit, which explains the change in water quality from the 1990's to the 2000's. Pertinent available data are presented in Figure 7 and in Table 17.

Data indicates that there is a decrease in arsenic and iron concentrations across this time period, with the adit discharge being similar to the Golden Point Pit after the pit commenced draining through the workings (Table 10), although sulfate is slightly lower. Given the hydraulic connection of the adit to the pit void, only earlier data would be representative of adit seepage water quality (e.g., pre-2002) prior to the Golden Point Pit filling.

Analysis of these data (Figure 7; Table 17) suggests that adit seepage could have sulfate concentrations of ~120 mg/L; 4.1 mg/L arsenic; and 11 mg/L Fe (Table 17), which is higher than that observed at the Lower Bendigo Adit at the BOGP (Section 7.2 below). This needs consideration as part of the source term development for underground workings.

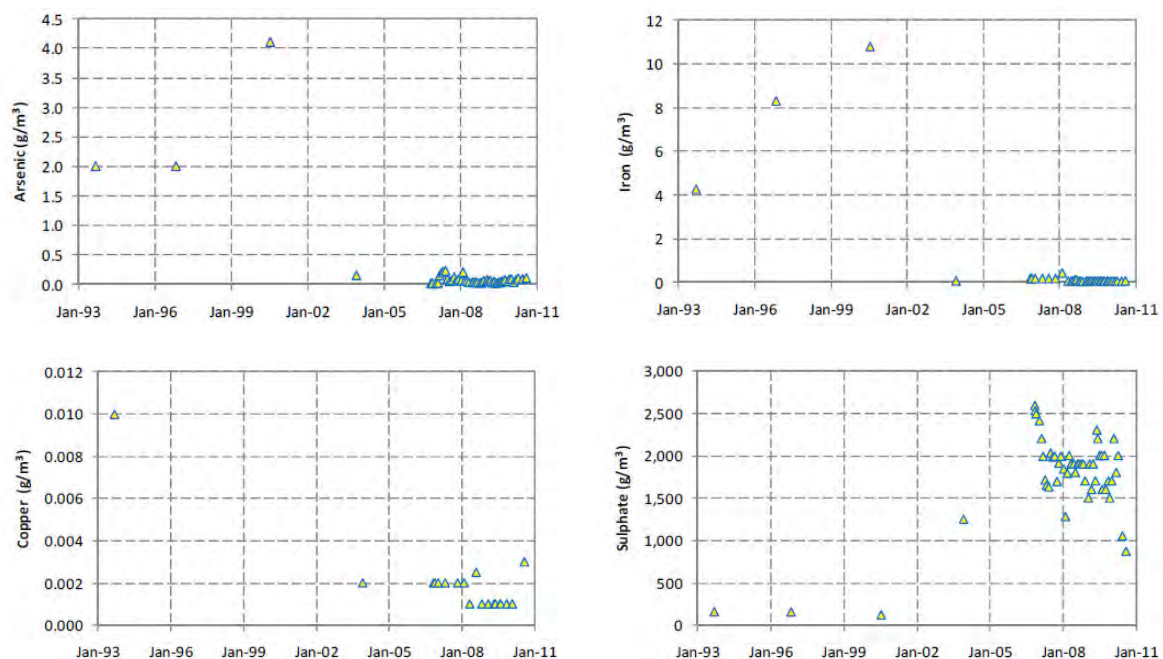


Figure 7. Golden Point Adit water quality

Source: Golder (2011d).

Table 17. Golden Point Adit Water Quality. From Golder 2011c.

PARAMETER	MINIMUM	MEAN	95TH PERCENTILE	MAXIMUM
pH (unitless)	6.8	7.2	7.6	7.7
Conductivity (mS/m)	830	3,200	3,900	4,400
Calcium	130	480	610	620
Chloride	10	13	17	18
Magnesium	28	220	300	320
Potassium	2.4	18	22	27
Sodium	18	100	160	190
Sulfate	120	1,800	2,500	2,600
CN _{WAD}	<0.001	<0.0032	0.0062	0.011
Arsenic	0.014	0.23	1.1	4.1
Copper ^A	<0.0010	<0.0016	0.0026	0.003
Iron	<0.02	<0.65	4.5	11
Lead	<0.0002	<0.0011	0.0032	0.010
Zinc ^B	<0.005	NA	NA	0.011

Golder (2011c) Notes: All units in mg/L unless stated; all data presented to two significant figures or less. NA = not applicable.

^A - summary statistics were derived after excluding detection limits superseded by lower limits.

^B - zinc was analysed twice and was below detection on one occasion.

7.2 Lower Bendigo Adit

Data are available from the MGL water quality database for the Lower Bendigo Adit (LBA), which have been reported in MWM (2025a). These data are presented in Table 18. Data indicates that moderate impacts to water quality are identified compared to groundwater data (Table 6) with COPC such as SO₄ and As being elevated.

Based on SO₄ data, results indicate that the water quality in the Bendigo adit is 4.3 times lower; and based on As data it is 3.9 times lower than the Golden Point Adit. The SO₄ ratio between the two datasets is used to derive an estimate of the source term for the RAS underground as shown in Table 18.

Column Leach Test (CLT) data was used to derive a source term for the proposed RAS Underground, where analogue data were not available, using the relationship with SO₄ to determine other water quality constituents. This analysis and the derivation of relationships for each constituent is described in MWM (2025f). Analysis indicated that concentrations are generally lower than those proposed using the ratio approach, although Al, B, Co, Cu, Mo, V, and ammoniacal N are higher (Table 18). The mean of all data (TZ3 and TZ4) was used to derive the source term for the RAS Underground (Table 18).

The following notes are provided for the data presented in Table 18:

- CLT EC (relationship data) provides a reasonable match to EC data for both the Bendigo Adit and the Golden Point Adit. This suggests similar geochemical reactions / ions in solution from scaling off SO₄.
- Alkalinity is comparable across the models, suggesting reasonable reliability.
- Calcium is low in the CLT relationship with sulfate.

- Arsenic concentrations are elevated in both models, however the data from Golden Point Adit of 4.1 is used even though this is a maximum (see Figure 7) to provide a conservative number for modelling of potential effects.

Table 18. Groundwater source term for the RAS Underground based on LBA.

PARAMETERS	Lower Bendigo Adit (this study) (mg/L)	Golden Point Adit (Macraes) (mg/L)	RAS Underground (Ratio [x4.3]) (mg/L)	RAS Underground (CLT Relationship) (mg/L) ³	RAS Underground Source Term (mg/L)
Alkalinity (mg CaCO ₃ /L)	191.4		191.4 ¹	185.1 ⁵	191.4
pH (pH units)	8.06	6.8	6.8 ²	-	6.8
EC (µS/cm)	467.6	830	830 ²	448.1 ⁶	-
Ca	53.1	130	130 ²	13.59	130
Cl	7.19	10	10 ²	2.04	10
F	0.292		1.27	0.21	1.27
Mg	15.4	28	28 ²	5.33	28
Na	19.9	18	18 ²	20.02	20.02
K	1.94		8.4	10.8	10.8
TOC	1.40				1.4
Al	0.00329		0.0143	0.114	0.114
As	1.0527	4.1	4.1	0.42	4.1
B	0.0175		0.076	0.046	0.046
Cd	0.00007		0.00030	0.0001	0.0003
Co	0.00016		0.00070	0.0005	0.0007
Cr	0.00043		0.00187	0.0007	0.00187
Cu	0.00029		0.00126	0.0005 ⁷	0.00126
Fe	0.0452		0.19652	0.04	0.196
Mn	0.0233		0.10130	0.014	0.101
Mo	0.00107		0.00465	0.023	0.042
Ni	0.00028		0.00122	0.0005 ⁷	0.00122
Pb	0.00016		0.00070	0.0005 ⁷	0.00070
Sb	0.00030		0.00130	0.027	0.027
Se	0.0017		0.0074	0.0025	0.0074
Sr	0.468		2.03	0.91	2.03
Tl	0.00012		0.00052	0.00025	0.00052
U	0.00211		0.009	0.0092 ⁶	0.092
V	0.00050		0.002	0.0005 ⁷	0.01
Zn	0.00137		0.0060	0.005 ⁷	0.006
Sulfate	27.6	120	120 ²	120	120
Ammoniacal-N	0.0061				0.0061
Nitrate-N	0.2141				0.2141

1. Uses lower Bendigo Adit values

2. Uses Golden Point Adit data

3. 'r' indicates a relationship is used as explained in MWM (2025f)

4. Mean of all column leach test data (CLT) data for TZ3 and TZ4 (as of 17-2-25) where red data are identified as a maximum and are applied to the source term for RAS underground.

5. Based on TZ3 sulfate relationship data, which provided a dataset that comparable to other data from Lower Bendigo Adit

6. where there is a relationship between sulfate and the constituent for the sulfate concentration, then the average of the two relationships for TZ3 and TZ4 is used.

7. Multiple LOR provided by various labs. The highest LOR is presented.

Note: Green data are ½ LOR and are included in the source term as '0'

7.3 Underground Working Source Term

For the WLBM two source terms are required:

- During the operational phase of the BOGP, once the underground is established there will be seepage to the underground, which will be introduced into the mine water BOGP management system.
- During the closure phases of the project there will be seepage from the RAS underground portal that will be a combination of flow from groundwater and the RAS Pit void. It is assumed that the RAS Pit Void water quality will dominant the source term (as seen at Golden Point Adit).

7.3.1 RAS Underground – Operational Phase Source Term

The source term for the RAS Underground working during the operation phase of the project are provided in Table 18.

7.3.2 RAS Underground – Closure Phase Source Term

Water quality for seepage from the RAS Underground in the closure phases of the project utilises RAS Pit Lake water quality. As shown at Macraes, adit seepage at Golden Point Adit is dominated by pit lake water quality and the same process is expected at the BOGP once the crown pillar is removed and the pit lake is connected to the underground workings. Flow will be a function of pit lake seepage flow. This mixing is managed by the GoldSim model.

7.4 Assumptions

The following assumptions are presented for the source term for the underground workings:

- It is assumed the Macraes Golden Point Adit provides a reasonable example of the effects of the mineralisation (i.e., SO_4) on underground water quality and that the data are more reliable than the Lower Bendigo Adit that may not have intersected the RSSZ. Higher PCOC data are chosen to ensure that AMD risks are considered.
- It is assumed that mean PCOC derived from column leach testing is reasonable to develop a water quality source term for the RAS underground for those parameters that are missing from the analogue dataset and would account for subtle differences in mineralisation between BOGP and Macraes.
- The WLBM (MWM, 2024c) indicates that the seepage from the RAS underground working will discharge many decades after mining operations cease. It is expected that with such residence times that nitrogenous compounds are degraded by biogeochemical reactions (e.g., Navarro-Valdivia, et al., 2023) such that the nitrate nitrogen and ammoniacal nitrogen resembles the water quality shown in Table 18.

- It is assumed that there is no first flush of contaminants from the underground workings and that the combined source terms (dominated by the pit water quality rather than water in the deeper underground workings that is unlikely to move upwards) will be reasonable to understand risks to the receiving environment and consider any appropriate management options.

7.5 Performance Monitoring

The following performance monitoring is recommended for the Underground Workings water quality:

- Install a piezometer to confirm groundwater levels and provide guidance on when discharge from the RAS underground portal might occur (with comparison to RAS Pit Lake water levels)
- Monitor the underground workings seepage water quality prior to it discharging to validate management requirements.

8 SOURCE TERMS – MINE IMPACTED WATERS

This section summarises the source terms used for general mining areas that will generate MIW.

8.1 Impacted Run-off Water Quality

A literature review of data available from Macraes was undertaken to provide empirical analogue data for MIW runoff. Golder (2011a) defines two surfaces as impacted and non-impacted where:

- Impacted surfaces include pits, ore processing areas, mine roads, unrehabilitated waste rock stacks (WRSs) and rehabilitated tailings surfaces.
- Non-impacted surfaces are those surfaces that are in a natural state but might be impacted by mine dust and the definition also include rehabilitated WRS.

The water quality associated with these surfaces is provided in Table 19 and was derived by Golder (2011c) from Frasers Pit runoff where 25th percentile data from Frasers Pit run off was used for non-impacted runoff and 50th percentile data was used for impacted runoff. For this report, we have refined the terminology to be rehabilitated WRS surfaces and mine impacted areas. Areas affected by dust would be considered mine impacted surfaces and further studies are required to define these areas and any effects (once the project is operational)

During consenting of Deepdell North Stage III Project these source terms were updated using recent empirical data (OceanaGold, 2020a; GHD, 2020) with GHD (2020) stating that these data were derived from water quality monitoring data provided by OceanaGold and represent mean values.

Table 19. MIW – Macraes

PARAMETER	REHABILITATED WRS SURFACES		MINE IMPACTED SURFACES	
Source	Golder (2011a)	OceanaGold (2020a) ¹	Golder (2011a)	OceanaGold (2020a) ¹
Units	mg/L	mg/L	mg/L	mg/L
Arsenic	0.021	0.02	0.1	0.04
Sulfate	125	470	201	930
Cyanide	0.001		0.001	
Copper	0.001	0.001	0.002	0.0012
Iron	0.05	0.14	0.135	0.032
Lead	0.0001	0.00019	0.001	0.0002
Zinc	0.005	0.001	0.005	0.001
Sodium	15		28	
Potassium	3		4	
Calcium	46		63	
Magnesium	26		34	
Chloride	6		13	
Nitrate		0.4		0.094
Ammonia		0.012		0.012

Source: Golder (2011a) and OceanaGold (2020a)

Red Text is greater than the proposed consent limits for BOGP noting the Cu has no toxicity modifying factors applied.

1 – Derived by GHD (2020)

Data are available for runoff from the Fraser Pit Wall (Table 13 and Table 16), which suggests a broad range in pit wall runoff water quality. For the purposes of this report, it is assumed that runoff from mine impacted surfaces is fairly represented by:

- TZ3 mine impacted surfaces is best represented by mean data (as shown in Table 20 below).
- TZ4/RSSZ mine impacted surfaces is best represented by 95th percentile data (as shown in Table 20 below).

However, the use of these source terms is complicated by the source of dust suppression water. Further consideration is given to whether these data are conservative and adequately reflect the potential risk to the receiving environment given these waters may discharge from site during the operational phase of the project.

8.2 Discussion – Dust Suppression Water

Water is required for dust suppression and this water can be sourced from the pit void and also groundwater bores. Dust suppression water will be applied to all haul roads, hardstands, and the operating surfaces of the engineered landforms. If the water for dust suppression is sourced from the RAS pit sump it could introduce contaminants to these surfaces from the pit water.

No management of MIW is proposed for haul roads and run-off from the ELF other than sediment management (and sediment sumps), with discharge of these waters off site during higher rainfall periods (EGL, 2025b). Hence dissolved constituents that remain in solution such as sulfate in the pit water might be elevated and affect the downstream receiving environment.

To address the potential effects of poorer water quality associated with the effects of dust suppression water derived from the pit sump, a numerical analysis was undertaken using sulfate as an indicator of effect.

8.2.1 Analysis – Dust Suppression Water

Table 19 indicates that the source terms for mine impacted surface runoff derived by Golder in 2011 and by GHD in 2020 are generally comparable except for a significant increase in sulfate from 2011 to 2020. It is unlikely that mine surfaces can generate such elevated sulfate without the ongoing addition (and evaporation) of MIW to these surfaces. For instance, pit wall runoff (which would include runoff from mineralised rock, ore zones, and waste rock has a sulfate concentration ranging from 12 – 390 mg/L; a mean of 160 mg/L; and a 95th percentile value of 320 mg/L. This is considerably lower than 930 mg/L proposed by GHD (2020). It is reasonable to assume that the elevated sulfate is related to ongoing dust control with mine water elevated in sulfate (e.g., from pit voids).

Based on flow rates into the RAS Pit of 7-14 L/s (Rekker and Dumont, 2025), and the assumption this mixes to generate the water quality observed at the Frasers Pit of (Table 8) this would result in 240 – 570 kg sulfate per day being applied to mine surfaces, which is likely to produce a comparable load to that observed at Macraes.

8.3 Source Terms: Mine Impacted Surfaces and Rehab Surfaces

The source terms are provided in Table 20. The following discussion is provided:

- Where mine surfaces do not use pit water elevated in sulfate for dust suppression, a source term derived from Frasers Pit Wall runoff is used. Data are provided for run-off from TZ3 and

TZ4/RSSZ materials. To assess stability and transport at surface conditions the original source term for TZ4/RSSZ, which had elevated iron of 21 mg/L, was assessed with PHREEQC. It was seen that through precipitation iron, copper, aluminium and lead concentrations are likely to decrease. Adsorption ratios from Raven et al. (1998) show that the iron precipitate will be sufficient to reduce arsenic concentrations to <LOR.

- For mine impacted surfaces that have pit lake water applied (that is elevated in sulfate), the source term for these surfaces is based on data in Table 19 (e.g., a sulfate concentration of 930 mg/L).
- For rehabilitation surfaces, the source term for these surfaces is based on data in Table 19 (e.g., a sulfate concentration of 470 mg/L).
- OceanaGold (2020) report that impacted and rehabilitated surfaces have ammoniacal-N concentrations of 0.012 mg/L and nitrate-N concentrations of 0.094 mg/L and 0.4 mg/L respectively based on pit water quality of 0.9 mg/L ammonia and 10.5 mg/L nitrate. Nitrate concentrations within the RAS pit have been estimated at 30 mg/L nitrate-N, and 10 mg/L ammoniacal-N. These values are used as conservative datasets to derive a source term for mine impacted surfaces that use the pit sump for dust suppression.

Table 20. Source terms: Mine Impacted Surfaces and Rehabilitated Surfaces

PARAMETER	MINE IMPACTED SURFACES (BORE WATER DUST SUPPRESSION)		MINE IMPACTED SURFACES (DUST SUPPRESSION USING PIT SUMP WATER)	REHABILITATION SURFACES
	TZ3	TZ4/RSSZ	ALL SURFACES	BROWN ROCK
Alkalinity (mg CaCO ₃ /L)	61.3	140.5	140.5 ³	140.5 ³
pH (pH units)	8.2	8.4	8.4 ⁴	8.4 ⁴
EC (µS/cm)	566 ⁶	1,037 ⁶	3,738 ⁶	1,952 ⁶
Ca	55	90.4 ⁷	22.94 ³	15.68 ⁵
Cl	13	20	17.7 ³	3.1 ⁵
F	0.21	0.83	1.14 ³	0.34 ⁵
Mg	37	76.4 ⁷	3.06 ³	1.95 ⁵
Na	33	59	94.2 ³	32.88 ⁵
K	3.9	7.1	13.64 ³	8.66 ⁵
TOC	-	-	-	2.01 ⁸
Al	0.114	0.00016 ⁷	0.438 ³	0.155 ⁵
As	0.093	0.005 ⁷	0.04	0.02
B	0.046	0.104	0.11 ³	0.064 ⁵
Cd	0.0001	0.0001	0.0001	0.0001
Co	0.0005	0.0005 ⁷	0.0005	0.0005
Cr	0.0005	0.0005	0.0005	0.0005
Cu	0.0034	0.0005 ⁷	0.0012	0.001
Fe	9.1 ¹	0.005 ⁷	0.032	0.14
Mn	0.014	0.039	0.028 ³	0.0115 ⁵
Mo	0.023	0.045	0.285 ⁶	0.147 ⁶

PARAMETER	MINE IMPACTED SURFACES (BORE WATER DUST SUPPRESSION)		MINE IMPACTED SURFACES (DUST SUPPRESSION USING PIT SUMP WATER)	REHABILITATION SURFACES
	TZ3	TZ4/RSSZ	ALL SURFACES	BROWN ROCK
Ni	0.0009	0.003	0.0005	0.0005
Pb	0.004	0.003 ⁷	0.0002	0.00019
Sb	0.027	0.14	0.155 ³	0.049 ⁵
Se	0.00025	0.00025	0.00025	0.00025
Sr	0.91	1.84	1.77 ³	0.67 ⁵
Tl	0.00025	0.00025	0.00025	0.00025
U	0.0106 ⁶	0.0162 ⁶	0.099 ⁶	0.053 ⁶
V	0.0005	0.0005	0.0005	0.0005
Zn	0.002	0.007	0.001	0.001
Sulfate	160	320	930	470
Ammoniacal-N	0.012	0.012	10 ²	0.012
Nitrate-N	0.094	0.094	30 ²	0.4

Note: All units in mg/L unless otherwise stated; and all data presented to two significant figures or less.

Note: Green data are ½ LOR and are included in the source term as '0'

Source: Blue cells from Golder (2011d) – Appendix E.

Source: Orange cells are from OceanaGold (2020a)

1. This data point as presented as <9.1 mg/L by Golder (2011d). It is assumed for this report that 9.1 mg/L is the mean, which appears reasonable based on the graphed information in the Golder report.

2. From Navarro-Valdivia et al. (2023) – see Figure 4.

3. Uses 95th percentile data from Column Leach Tests

4. Uses 95th percentile data from the Frasers Pit wall runoff.

5. Mean of all column leach test data (CLT) data for TZ3 (as of 17-2-25)

6. Where there is a relationship between sulfate and the constituent for the sulfate concentration of interest, then the TZ3 relationship is used.

7. Reduced from original runoff source term due to likely precipitate formation and adsorption as per PHREEQC equilibrium phases modelling and Raven et al. 1998.

8. TOC defined from SC01 baseline water quality.

Note: Mine impacted surfaces are defined in Section 8.1 of this report.

8.4 Assumptions

The following assumptions are presented for the source term for mine impacted surfaces:

- It is assumed that mine impacted surfaces use mean (160 mg/L) and 95th percentile (320 mg/L) SO₄ data from Frasers Pit runoff (and other available parameters) for runoff from TZ3 and TZ4 materials respectively. This is considered conservative, as concentration will remain constant for higher flow events, when there is likely to be considerable dilution.
- Where pit sump water is used for dust suppression it is assumed there is the potential to accumulate salts that could generate poor water quality. This risk is likely to be lesser at the start of operations and higher once the pit is at maximum volume and water quality is poorest. It is assumed that the empirical data provided by GHD (2020) is representative of mine impacted surfaces that utilise pit sump water for dust suppression (e.g., 930 mg/L sulfate). This

is considered conservative, as concentration will remain constant for higher flow events, when there is likely to be considerable dilution.

- It is assumed that that data from Macraes provides a reasonable estimate of runoff water quality from rehabilitated slopes (e.g., 470 mg/L sulfate) as this is based on empirical data from similar materials.
- It is assumed that the assumptions presented in Table 20 (footnotes) are reasonable in regards to the development of appropriate source terms to understand AMD risk and that the direct application of column leach test data (mean and 95th percentile) is conservative.

8.5 Performance Monitoring

The following performance monitoring is recommended for the water quality of mine impacted surfaces:

- Monitoring of water quality and flow rates of runoff from mine impacted surfaces such as haul roads and the ELF (e.g., monitoring of runoff within sediment sumps).
- Monitoring of water quality from rehabilitation surfaces (e.g., measurement of runoff water quality)

Mine impacted surfaces are released directly to the receiving environment. Hence, they represent a diffuse source of potentially poor water quality. Modelling (MWM, 2025c) suggests that there are some risks to the receiving environment, and it would be advantageous to develop a Trigger Action Response Plan (TARP) to manage this risk. One management option would be to use bore water for dust suppression rather than pit sump water.

8.6 Ore Stockpile

An ore stockpile area is proposed as part of the BOGP that will be used to blend low grade ore (LGO) and ore to supply the processing plant. The source term presented in Table 20 for mine impacted surfaces is considered appropriate if the effects require assessment. At closure the ore stockpile is removed and during operations any runoff water is returned to the process plant.

9 SOURCE TERMS – TAILINGS STORAGE FACILITY

This section describes the process to derive source terms for the WLBM for MIW from the Shepherds TSF. Two source terms are required including:

- Decant water quality – Influenced by chemical composition of the ore being processed, processing reagents, operational water management discharges to the TSF surface, recycling of process water, climatic effects including evaporation and dilution by rainfall, and geochemical processes.
- TSF seepage water quality – Influenced by the decant water quality and geochemical processes occurring as decant water migrates through the tailings to report as seepage.

9.1 Background

The proposed Shepherds TSF will retain all tailings (other than those used for paste backfill) for the BOGP. Supernatant water will be managed on top of the tailings within the decant pond. During operations the TSF will operate as a zero-release facility with sufficient freeboard to manage both operational water and the inflow design flood without discharge (EGL, 2025b). Water on the TSF will be lost via evapotranspiration or be reused in the Process Plant.

EGL (2025b) note that during operation seepage collected in the TSF and ELF underdrainage will be collected in a HDPE lined sump and will be pumped back the TSF. The HDPE lined sump is proposed to be 4,500 m³ to allow time for reestablishment of the pumps if there is a breakdown. The Shepherds Creek Silt Pond is immediately downstream of the sump and allows a contingency option (in dry conditions) if the sump filled up. As an alternative option a gravity line could be run down to the Process Plant (Note: the need for this is considered a detailed operational decision (EGL, 2025b).

During the active- and post- closures stages, seepage from the TSF and ELF will continue to collect in the underdrainage and at the toe of the ELF. This will be either sent to a water treatment plant or passive treatment ponds before discharge to Shepherds Creek.

During the active- and post- closure stages, the TSF will be fully dry capped with brown rock, topsoil, and revegetated. On the northern side of the TSF a shallow amount of water will be allowed to pond on the dry capping to attenuate flood flows and form a wetland (if desired as a final closure landform). Runoff from the top of the closure dry capping will be clean and discharge through an outlet channel around the northern edge of the ELF into Shepherds Creek.

9.2 Literature Review

Publicly available water quality data for the Macraes was reviewed to provide an analogue dataset of TSF water quality for the TSF decant surface water and TSF seepage water quality. However, the processing of ore at Macraes post ~1999 is different to that proposed at BOGP. Since 1999 Macraes have introduced a pressure oxidation (POX) stage to the ore processing plant that oxidises all sulfide minerals to sulfate liberating the refractory gold. Hence pre-1999 data is of relevance as POX of ore is not proposed at the BOGP. The tailings were originally stored in separate impoundments until 1993, with the sulfate rich cyanidation tailings stored in the Concentrate Tailings Impoundment (CTI), and the other tailings stored in the Flotation Tailings Impoundment (FTI). From 1993 onwards these were combined and stored in the Mixed Tailings Impoundment (MTI).

Hence it is anticipated that sulfate concentrations (including other contaminants associated with sulfides) in BOGP tailings water will be comparable to pre-POX water quality at Macraes. Hence, the most appropriate tailings water quality data at Macraes, as an analogue for BOGP is prior to 1999 when POX commenced. Prior to the introduction of POX sulfate concentrations were gradually increasing, but appear to have stabilized between 1994 – 1999 with an average concentration of 952 mg/L. The change in water quality following the introduction of POX is shown in Figure 8 with sulfate concentrations increasing to ~5,000 mg/L.

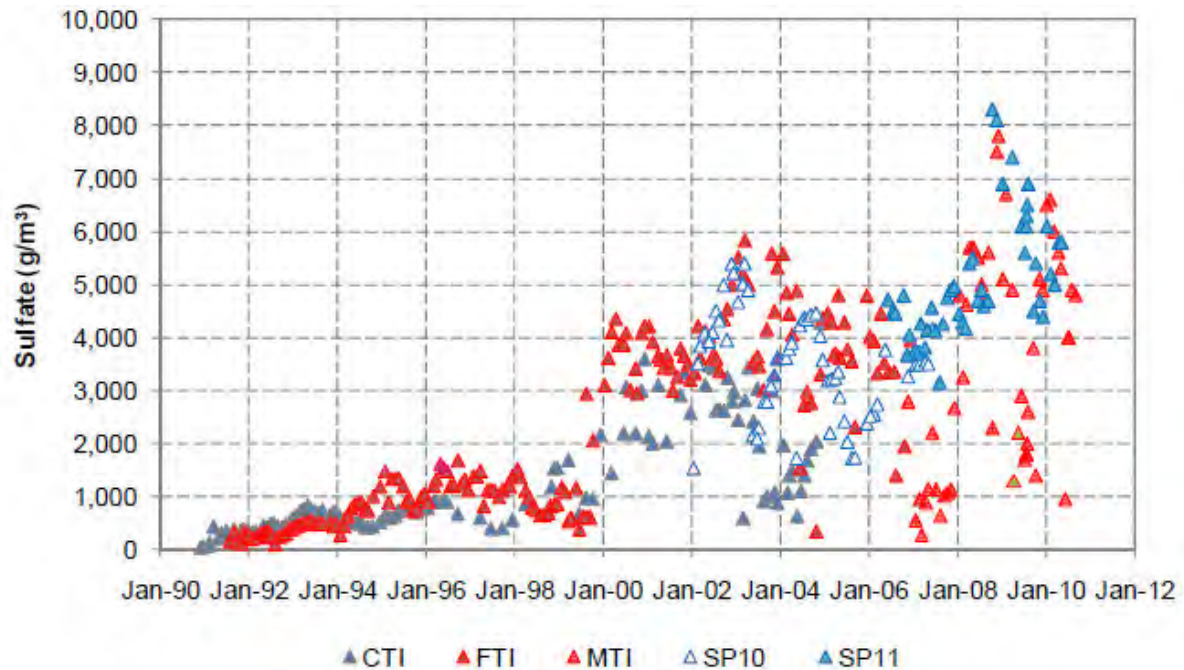


Figure 8. Macraes Gold Mine TSF Decant Water Quality - Sulfate

Source: Golder (2011d) – Appendix B

Decant water quality shows a decrease in arsenic concentrations following the introduction of POX at Macraes from 0.1 - 450 mg/L (average 39 mg/L) to ~0.1 - 5 mg/L (Figure 9). Craw and Pope (2017) indicated that this decrease in dissolved As concentrations is due to greatly increased Fe-oxyhydroxide formation associated with the POX, which provides adsorption sites for As. Dissolved iron (Fe) concentrations in the decant water remained reasonably consistent until 2002 when concentrations increased (Figure 10).

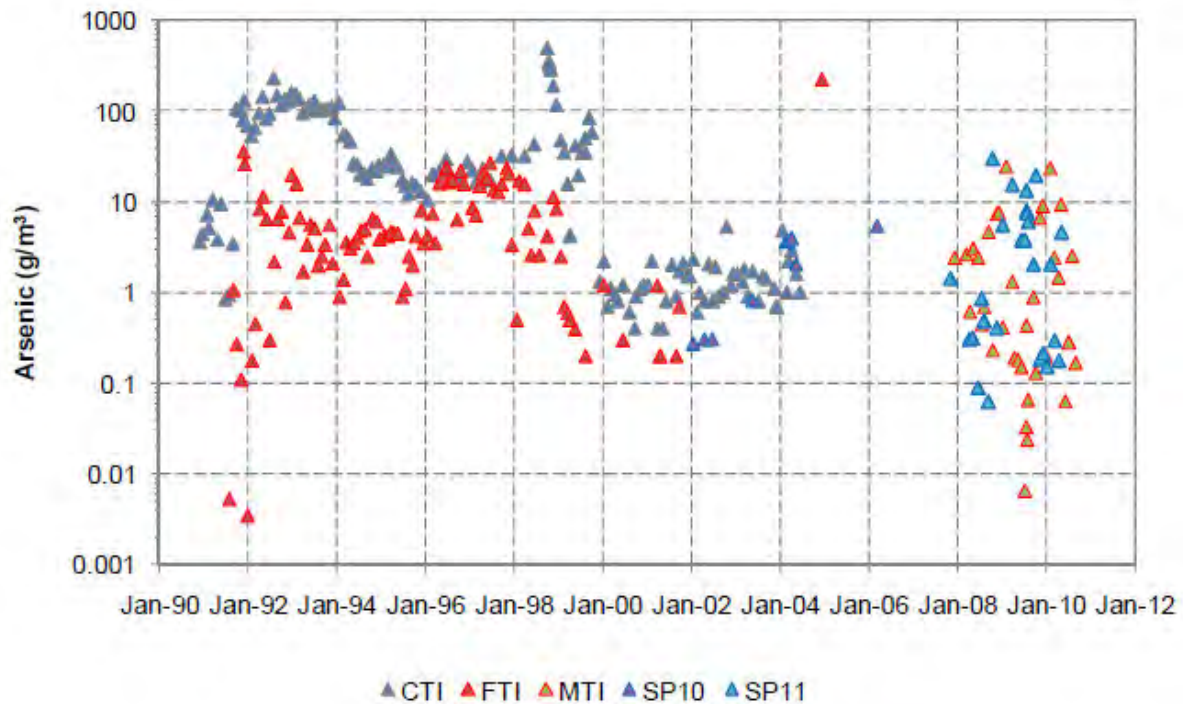


Figure 9. Macraes Gold Mine TSF Decant Water Quality - Arsenic

Source: Golder (2011d) – Appendix B

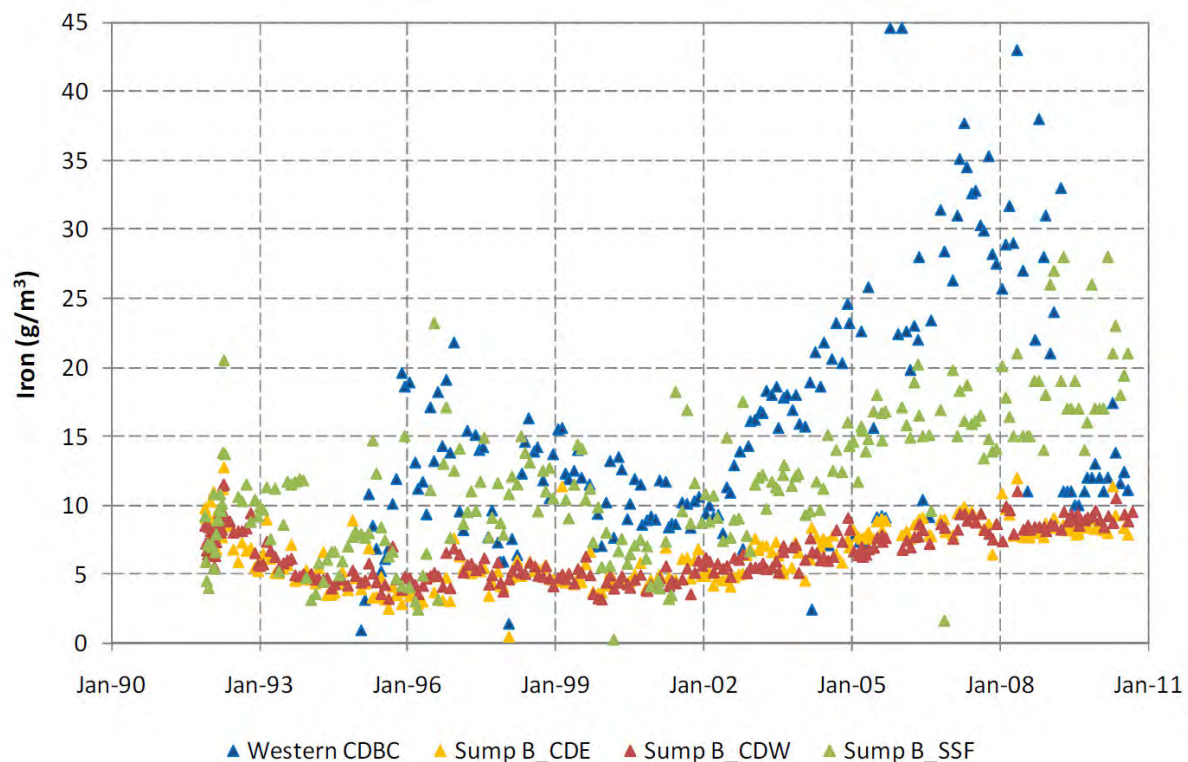


Figure 10. Macraes Gold Mine TSF Decant Water Quality - Iron

Source: Golder (2011d) – Appendix C

9.2.1 Tailings Cyanide Concentrations

Cyanide may be elevated in the BOGP TSF due to its use in the gold recovery process (e.g., MACA, 2025). Golder (2011f) not a general decline in cyanide with time for the Macraes Project (Figure 11). Data presented by Golder (2011c) indicates that operational seepage water quality for the TSF's at Macraes (TTTSF, MTI, SPI) ranged from 0.022 – 0.051 mg/L and that TSF seepage water following closure would be 0.08 mg/L. Golder (2011a) note that tailings pore water seepage post closure would be 0.35 mg/L and that operationally TSF decant water was 0.47 mg/L.

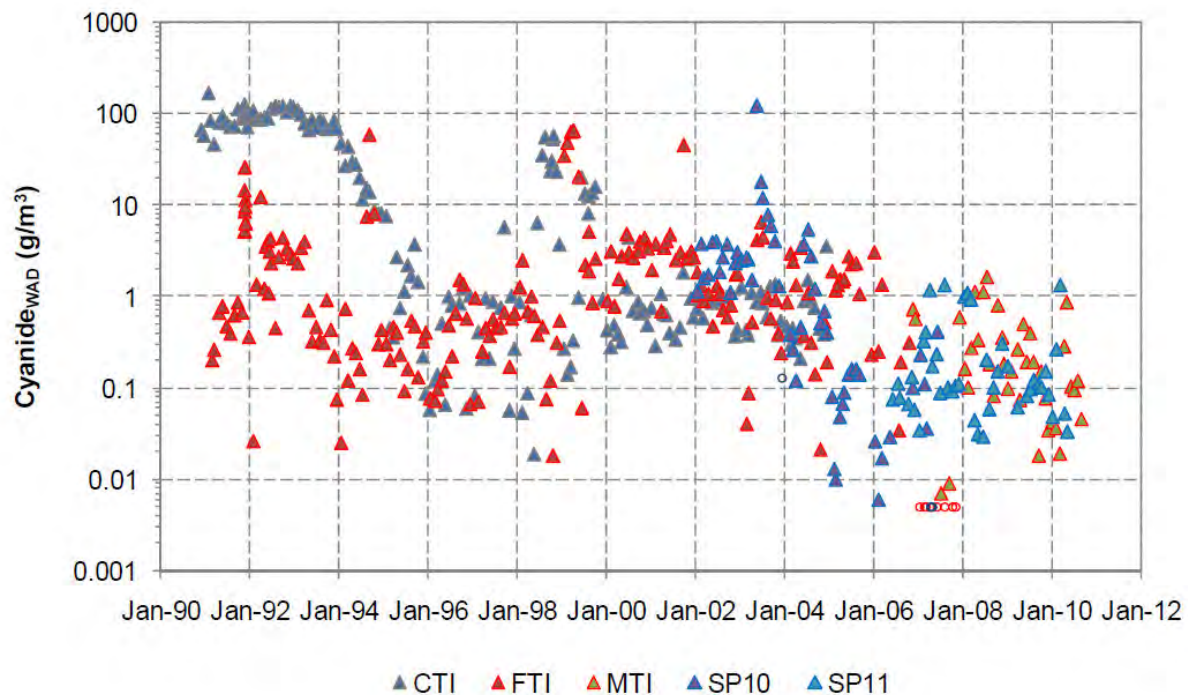


Figure 11. Cyanide – WAD – Macraes

Source: Golder 2011d

9.2.2 Geochemical Maturation of Seepage Waters

Golder (2011a,c) note that the quality of the tailings pore water, as represented by TSF drain discharges differs from that of tailings decant water due to complex hydrogeochemical interactions, which includes precipitation and dissolution reactions, adsorption and desorption processes, hydraulic residence times of pore water in the TSF, and the redox environment within the TSF.

Craw and Pope (2017) presented the water quality in the MTI decant pond and the chimney drain, which collected water that had percolated through the tailing impoundment (Figure 12). The average concentrations in the pre-POX period (1994-1999) are presented in Table 21. This data was derived from manually extracting data from Craw and Pope (2017) published graphs with WebPlotDigitizer (Rohatji, 2011), which may have a small level of imprecision.

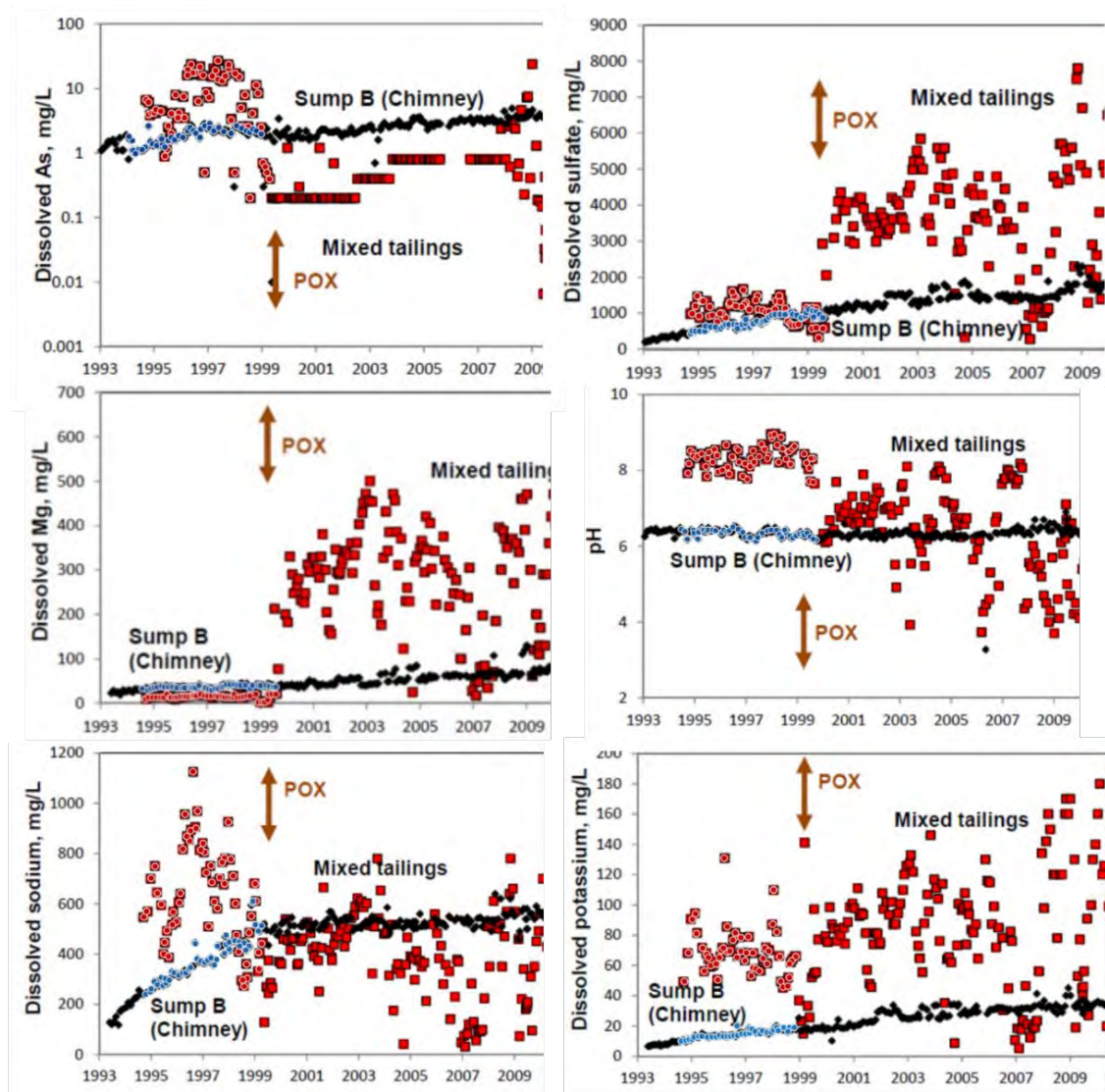


Figure 12: Macraes Tailings seepage water quality

Source: *Craw and Pope (2017)*. The blue and red dots were used for the analysis presented in this report (Table 21).

Table 21: Macraes MTI average water quality between 1994 – 1999: decant water and the outflowing chimney drain.

PARAMETER	MIXED TAILINGS IMPOUNDMENT DECANT (mg/L)	SUMP B CHIMNEY DRAIN (mg/L)	% CHANGE
Alkalinity	138.1	158.6	15%
As	8.6	1.9	-78%
Ca	98.3	69.1	-30%
Cl	342.7	173.3	-49%
K	69.1	14.9	-78%
Mg	14.8	36.9	150%
Na	634.7	383.1	-40%
Sulfate	1,049.4	734.6	-30%
pH	8.3	6.3	--

Note: pH is unitless.

Source: *Craw and Pope (2017)*.

Since the geology and processing procedure over this period was similar to what is proposed at BOGP, the derived water quality provides an indication of how the decant water quality at the BOGP may mature as it percolates through the TSF, where:

- pH decreased from an average of 8.3 to 6.3 through the MTI.
- Sulfate decreased by 30%, arsenic decreased by 78%, calcium decreased by 30%, potassium decreased by 78%, and sodium decreased by 40%.
- Alkalinity increased by 15% and magnesium concentrations increased by 150%.

Copper concentrations were not presented in Craw and Pope (2017) however they were discussed in Craw and Nelson (2000), which presented representative concentrations in the decant ponds and Sump B from when the CTI and FTI were active in 1993 (Table 22). In this period the tailings were split into different impoundments, which results in different water qualities due to the geochemical differences of the tailings. However, the trends between the difference in the average decant water quality to the average sump water quality were similar to the later data from the MTI.

Craw and Nelson (2000) indicate that the Sump B (seepage) water is made up of approximately half regional groundwater and half tailings seepage, with the two mixing beneath the tailings dam before reaching Sump B. Ca, Fe and Mg concentrations were seen to increase between the decant water and the sump water, while other analytes decreased in concentration, some by the approximate value expected amount given the groundwater dilution, and some by more, indicating other attenuation factors were occurring. Copper was seen to decrease from an average of 14.4 mg/L in the decant water to below the LOR to <0.01 mg/L, while arsenic was seen to decrease 98% from an average of 56.06 mg/L in the decant water to ~0.9 mg/L in sump B.

Golder (2011c) note that sulfate concentrations in the TSF decant water quality increased with time, which was assumed to be the result of ongoing recycling of decant water quality, evaporation, dilution, and changes to the process and water management methods over the 20 years of mining operations.

Table 22: Representative water quality in November 1993, when the CTI and FTI were active.

	DECANT		SUMP B			% CHANGE
	CTI DECANT	FTI DECANT	SUMP B CDE	SUMP B CDW	SUMP B SSF	
As (total)	110	2.1	1.1	1.3	<0.5	-98% ¹
Cu	28.2	0.67	<0.01	<0.01	<0.01	-100% ¹
Fe (total)	8	1.31	4.97	4.96	11.8	56%
Na	915	394	172	188	96.8	-77%
K	52.9	60.1	8.14	8.09	6.26	-87%
Ca	31.8	33.4	55.1	45.6	85	90%
Mg	3.8	6.4	26.9	25.3	39.1	497%
Cl	787	323	141	154	67.6	-78%
HCO ₃ ⁻	564	125	183	186	277	-37%
Sulfate	695	425	344	317	296	-43%
pH	9.8	8.4	6.4	6.5	6.2	-

All units are in mg/L other than pH, which is unitless.

1. - where readings were below the detection limit, half the detection limit was used for calculating the % change. Percent (%) change calculated from the average between the decant concentrations and the average of the Sump B measurements.

Source: Data from Craw and Nelson (2000) when the TSF was active (e.g., 1993).

9.2.3 Literature Review Summary

The following summary is provided:

- TSF water quality in the BOGP decant and seepage is expected to be comparable to pre-POX water quality at Macraes (pre-1999).
- Fe is expected to be elevated, with pre-POX water at Macraes showing average concentrations of 4.6 mg/L in decant water and 7.2 mg/L in outflowing sump water.
- Nitrate is expected to be elevated due to the use of nitrogenous compounds (e.g., ANFO, cyanide).
- Cu is expected to decrease through the TSF. Cu is added to the process water to facilitate the destruction of cyanide (MACA, 2025). Assessment of

9.3 Process Water

This section reviews the process water that will be the discharge water quality from the processing plant to the TSF. Further details on the ore processing plant are provided in MACA (2025). Mineralis (2025) provide additional discussion on the use of Cu to facilitate cyanide destruction (Appendix B).

9.3.1 Process Water Treatment

MGL (2024) state that an air/SO₂ circuit has been selected for cyanide destruction based on the relatively lower operating cost of these circuits, the less hazardous reagents required in comparison to Caros acid and the amenability shown in the testwork of the ore to this form of cyanide destruction. The circuit will reduce the weakly acid dissociable cyanide to less than 30 ppm at discharge of the TSF spigot. Current data indicates that cyanide may be elevated and MGL indicates this is being retested to confirm the cyanide destruction works. It is assumed that cyanide concentrations measured in the Macraes TSF (0.47 mg/L: Golder, 2011a) can be achieved at the BOGP and that the long-term seepage water quality post closure for Cyanide_{WAD} will be 0.35 mg/L as proposed for Macraes (Golder, 2011a).

Ferric chloride precipitation of solubilised arsenic as a ferric arsenate has been selected based on the amenability of the ore to this removal method, and the anticipated stability of the arsenate species generated (MGL, 2024). Test results indicate that as of <0.7 mg/L was achieved and that significant additional testwork is required for the arsenic removal step, including undertaking Toxicity Characteristic Leaching Procedure (TCLP) testing of solids generated in the arsenic removal process to determine the stability of the precipitate formed, and undertaking further testing to confirm the reproducibility of these results (MGL, 2024).

9.3.2 Metallurgical Test Data

This section discusses water quality data derived from metallurgical testing (MACA, 2025), which provides a source term for the expected process water. Metallurgical testing was coordinated by MACA, with final leachate analysis after detox and As removal providing an estimation of the expected water quality for the decant water in the TSF (Table 23).

Only one dataset is available for the process water quality (MACA, 2025), which introduces some uncertainty into the model. To account for this, the WLBM does not consider any improvement in water quality with time after closure to ensure MIW risks for water quality are identified and managed

appropriately in the long term. For instance, Golder (2011e) note that at Macraes following closure of the TSF it is expected that a gradual change in seepage water quality will occur that reflects a change from process water to rainwater. Golder (2011) note the infiltrating rainwater will continue to leach PCOC but that concentrations will be lower. Data presented (Golder, 2011e) indicates that in the long term, TSF seepage water quality could change from 2,769 mg SO₄/L to 2,260 mg SO₄/L, i.e., a ~20% decrease.

Table 23: Source Terms: Process water quality and tailings seepage water.

PARAMETER	DETECTION LIMIT	PROCESS WATER QUALITY ¹	OPERATIONAL TSF DECANT QUALITY ²	CLOSURE TSF SEEPAGE WATER QUALITY ⁶
Alkalinity (mg/L as CaCO ₃)	5	310	34.6	73.21
pH (pH units)	0.01	7.86	6.41	6.41
EC (µS/cm)	2	2,500	1,948	4,121
Ca	0.5	140	140	297
Cl	1	380	380	804
F	0.1	0.913	0.913	1.93
Mg	0.5	19	47 ³	99
Na	0.5	400	400	847
K	0.5	24	24	50.8
TOC	-	-	-	-
Al	0.01	0.72	<0.01	<0.01
Ag	0.001	0.0034	0.0034	0.0068
As	0.001	0.12	0.97 ⁵	2.05
B	0.02	0.39	0.39	0.825
Cd	0.0001	0.0001	0.0001	0.0002
Co	0.001	0.025	0.025	0.053
Cr	0.001	0.0068	0.003	0.0055
Cu	0.001	1 ¹⁰	0.001	0.001 ⁸
Fe	0.01	2.1	7.24 ⁴	15.3
Mn	0.001	0.28	0.28	0.59
Mo	0.001	0.12	0.066	0.14
Ni ⁹	0.001	0.32	0.32	0.678
Pb	0.001	0.013	0.013	0.0275
Sb	0.0001	0.085	0.085	0.18
Se	0.001	0.0014	0.0014	0.003
Sr	0.001	2.1	2.1	4.4
Tl	0.001	0.001	0.001	0.001
U	0.001	0.013	0.013	0.028
V	0.001	0.0018	0.0018	0.004
Zn	0.001	0.014	0.014	0.0296
Cyanide - WAD	0.01	47	0.47 ⁷	0.35 ⁷
Sulfate	1	450	450	954
Ammoniacal-N	0.005	2	2	2
Nitrate-N	0.005	<0.0050	0.005	0.005

Note: All units in mg/L unless otherwise stated.

Note: Green data are LOR and are included in the source term as '0'

Note: Red data are elevated compared to the unmodified surface water quality limits provided by Ryder (2025).

If no data are provided these are identified by ' - '.

1. – MACA (2025).

Source: Process water quality sourced from metallurgical testing – final liquor analysis from bulk leach, detox and As removal.

2. - Seepage water results are from solution modelling with PHREEQC. This modelling gives an indication of changes expected due to the saturation and therefore precipitation of certain minerals as the water sits in the decant pond.

3. - Evidence from the Macraes data indicates that this element had higher concentrations in the seepage water than the decant water. It has therefore been increased in by the same factor seen at Macraes.

4. – The Fe concentration has been increased from the concentration modelled by PHREEQC to the average Fe concentration for seepage observed at Macraes (Table 22).

5. – With Fe dissolving, it is assumed that some As may also be mobilised and the As concentration has been increased from the concentration modelled by PHREEQC (0.28 mg/L) to the average As concentration for seepage observed at Macraes (Table 22).

6. – To account for the recycling of water, transfer of water from ELF seepage, evaporative concentration, etc the closure source term was multiplied using sulfate as the scaling factor to be comparable to the sulfate concentrations seen at Macraes pre-POX, i.e., 954 mg/L as shown in Figure 8.

7. – Source: Golder (2011a) – Table 14 for Macraes

8. – Cu precipitation was simulated in PHREEQC to account for solubility limits reducing the process water concentration to <0.001 mg/L. A value of 0.001 mg/L is used as the source term to be conservative.

9. – Ni is elevated compared to ANZG(2018) guidelines – 90% trigger value of 0.013 mg/L

10. – Process water quality data (MACA, 2025) indicate that Cu in process water was 75 mg/L. This has been adjusted to 1 mg/L based on advice by Mineralis (2025), which is provided in Appendix B.

9.4 TSF Seepage Source Term

As seen from the Macraes data presented by Craw and Nelson (2000) and Craw and Pope (2017), the decant water quality will change as seepage percolates through the tailings facility. The change in water quality is the result of a complex array of processes which can include precipitation of minerals, dilution with rainwater and groundwater, dissolution of minerals within the tailings, and adsorption of metals and metalloids to clays and iron oxyhydroxides.

PHREEQC geochemical modelling software (Parkhurst and Appelo, 2013) has been used as an initial indication of how the seepage water will evolve from the process water due to the precipitation of minerals from the solution. The resulting seepage water quality is presented in Table 23. This seepage water quality may be conservative as it does not take into account any dilution or adsorption of metals within the tailings. Where the Macraes data showed an increase of concentrations in the seepage compared to the decant, likely due to dissolution or weathering of minerals within the tailings, the indicated seepage concentrations have been manually increased by the same factor. For example, magnesium concentrations were 150% higher in seepage compared to decant concentrations, so the results from the metallurgical testing have been increased by 150% for the seepage water.

Some data has been manually adjusted to higher concentrations (As and Fe) to account for the sub-oxic conditions in the TSF using data from Macraes (Table 22) to provide a conservative value.

9.5 Assumptions

The following assumptions are provided for the source terms for the TSF:

- It is assumed that the TSF seepage water quality represents the long-term risk to water quality from this mine domain and that this is adequately represented by the source term developed from the Process Water quality.

9.6 Performance Monitoring

The following performance monitoring is recommended:

- Validate the process water quality including the geochemistry of the tailings on a monthly basis to confirm water quality inputs to the WLBM and validate assumptions on the geoenvironmental hazards for the solids stream.
- Undertake monthly sampling of the TSF seepage for water quality to improve the source term for modelling of effects. This should also include continuous monitoring for EC, pH, and flow to improve the WLBM.

10 SOURCE TERMS - TREATED WATER

This section summarises the treatment of water during the Active Closure Phase and the Post Closure Phase of the BOGP.

10.1 Active Water Treatment

During the Active Closure Phase of the BOGP it is proposed that MIW are treated by the active water treatment plant (WTP). Further details of this WTP are provided in MWM (2025g) and Process Flow (2025).

10.2 Passive Water Treatment

During the Post Closure Phase of the BOGP it is proposed that MIW are treated by the passive treatment system (PTS). Further details of the PTS are provided in MWM (2025g) including effluent water quality following treatment.

11 CLOSING

MWM has developed this report to define the water quality source terms for the WLBM for the BOGP for MGL to provide a summary of inputs that will be used during the modelling process.

11.1 Water and Load Balance Model Summary

A WLBM, that contains water flow and quality data is required for the BOGP to understand potential deleterious effects on the receiving environment associated with these MIW (noting the management of TSS is covered by the sediment and erosion management plan: EGL (2025a)). The WLBM has been developed using the GoldSim modelling platform⁸. Key water quality inputs (source terms) are defined in this report, and this includes the following key model components:

- The composition of rainfall water, for understanding its interaction with project materials.
- Baseline surface water quality.
- Groundwater inflow quality (e.g., to the RAS Pit void).
- ELF seepage.
- Process water quality associated with the tailings (assumed to be representative of TSF decant water quality).
- Pit water quality.
- TSF decant water.
- TSF seepage water quality.
- MIW quality associated with ELF runoff, haul roads, and hardstand areas.
- Underground workings (operational and closure).
- Rehabilitated surfaces.

11.2 Derivation of Source Terms

Source terms were developed from a variety of sources including analogue data sources, baseline studies at the BOGP, and laboratory derived data from environmental geochemistry testing. This report provides an explanation of how the source terms for modelling were developed for the WLBM.

11.3 Water Balance Model

Water management during the Operational Phase of the BOGP will involve discharge of only episodic runoff from haul roads and ELF surfaces. All other MIW (e.g., landform seepage) will be collected, used, and stored on site. In the Active Closure / Post Closure Phase, MIW will be treated and discharged to the receiving environment. Two models have been developed, that are reported elsewhere (MWM, 2025c) to reflect these phases:

- Operational Phase - Excel based models and calculations focussing on average annual water balance and runoff event discharge of MIW.

⁸ <https://www.goldsim.com>

- Active Closure / Post Closure Phase - GoldSim based models and calculations, focussing on the evolution of instream water quality over time as a result of discharge of treated MIW.

EGL (2025b) note that the site shall maintain a water balance model representing the operational conditions on site. This should be regularly reviewed and calibrated as the site develops and be used to predict the closure situation. Detailed stage models for years 1-13 (Table 1) will be developed using GoldSim⁹ prior to mining commencing (i.e., during the project pre-startup phase). This will provide an operational tool for MGL to effectively manage water during operations.

During operation, for the site to operate without a water treatment plant the site needs to be in a net deficit water balance on average. Without a water treatment plant, the main mechanism for water loss is evapotranspiration from the tailings decant pond and dust suppression. There is water stored within the pores of the tailings. In a wet year, some water may accumulate in surplus on the TSF however in the following year the site should be able to return to normal operating conditions. If the site ends up in an accumulating surplus water balance then a water treatment plant will need to be installed as is proposed for closure. Preliminary analysis by MWM (2025c) indicates for the site to be in deficit the water pumped from pit and underground will need to be used for dust suppression on the ELF and runoff water from the catchment above the TSF will need to be diverted around the facility. Dust suppression in dry conditions is expected.

11.4 Summary

This report provides source terms that are used in the WLBm to understand potential effects for the proposed BCPC Project. It is recommended that:

- Source terms need to be validated through performance monitoring that should be ongoing through the operational and closure phases of the project.
- A detailed operational water balance model is required prior to mining commencing, which should be updated annually.
- Trigger Action Response Plans (TARPs) should be developed for BOGP. For instance, a TARP should be developed for water runoff from mine impacted surfaces that receive dust suppression water from the pit void.

⁹ <https://www.goldsim.com>

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¹⁰ https://www.researchgate.net/profile/Mike-Harvey/publication/228515438_Ten_years_of_rainfall_chemistry_in_New_Zealand/links/02bfe510ec610d5e1c000000/Ten-years-of-rainfall-chemistry-in-New-Zealand.pdf

13 LIMITATIONS

Attention is drawn to the document “Limitations”, which is included in Appendix B of this report. The statements presented in this document are intended to provide advice on what the realistic expectations of this report should be, and to present recommendations on how to minimise the risks associated with this project. The document is not intended to reduce the level of responsibility accepted by Mine Waste Management, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in doing so.

APPENDIX A ABBREVIATIONS

ABBREVIATION	DEFINITION
AMD	Acid and metalliferous drainage
BOD	Biochemical oxygen demand
CIL	Carbon-in-leach
CIT	Come in Time
CLT	Column leach test
CTI	Central tailings impoundment - Macraes
DGV	Default guideline value
DOC	Dissolved organic carbon
ELF	Engineered landform
FTI	Flotation tailings impoundment - Macraes
LOR	Limit of reporting
MAV	Maximum acceptable value
MEQ	Metal ecotox quotient
MGL	Matakanui Gold Limited
MIW	Mine impacted waters
Mt	Million tonnes
MTI	Mixed tailings impoundment – Macraes
MWM	Mine Waste Management Ltd
COPC	Constituents of potential concern
QA/QC	Quality assurance and quality control
PCOC	Potential contaminants of concern
POX	Pressure oxidation
pXRF	Portable x-ray fluorescence
RAS	Rise and Shine
RPD	Relative percent difference
RSSZ	Rise and Shine Shear Zone
SRX	Srex
SRE	Srex East
TSF	Tailings Storage Facility
TZ3	Textural zone 3 of the Otago Schist
TZ4	Textural zone 4 of the Otago Schist
UG	Underground

ABBREVIATION	DEFINITION
WAD	Weakly acid dissociable (Cyanide)
WELF	West ELF
WLBM	Water and load balance model
WRS	Waste rock stack

APPENDIX B MINERALIS REPORT

MEMORANDUM

Subject: Cyanide Detox Discharge Copper Levels
Date: 7 July 2025
Attention: Mark Mitchell
From: Katie Barns

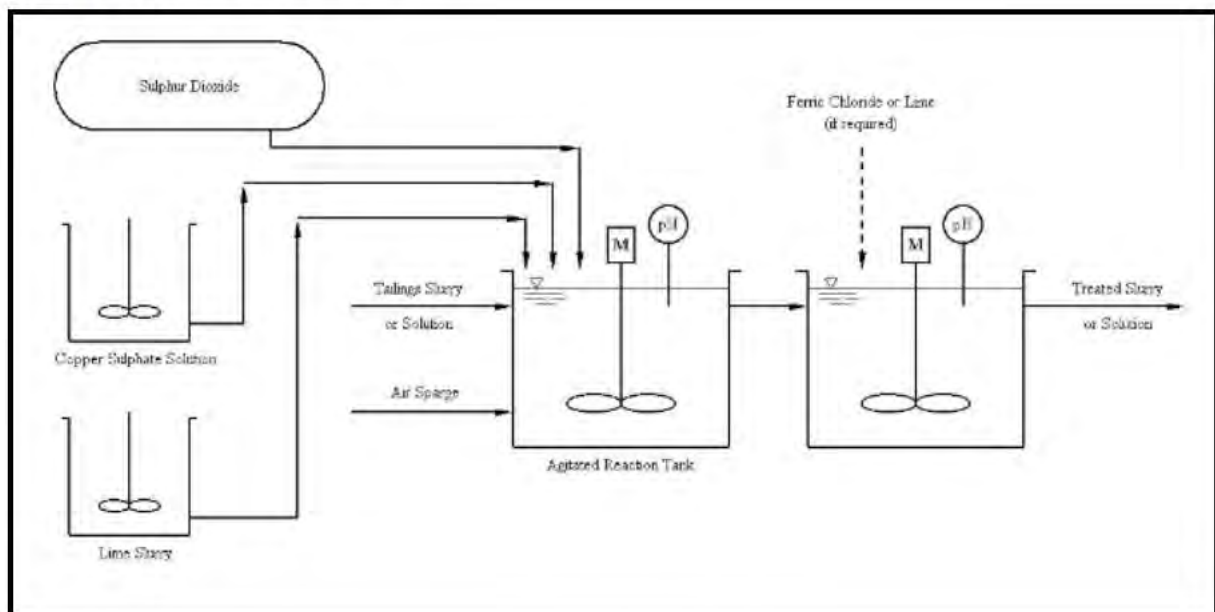
Background

Cyanide detoxification test work completed as part of the IMO test program (Santana Minerals Limited (SMI) Bendigo-Ophir Gold Project RAS & SRX Deposit Metallurgical Testwork Programs Project 6680 + 6749 February 2025) reported discharge solution copper levels up to 75mg/L. Subsequent water modelling has identified the high copper levels as an issue within the long term water balance and if discharged would require ongoing water treatment for a significant period of time following mine closure.

Full Cyanide Detox Circuit

The cyanide detoxification process proposed for the Bendigo Ophir Project is based on the INCO SO_2/AIR process shown in Figure 1.

Figure 1: INCO Process Flowsheet



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PO Box 818, Toowong, QLD 4066, Australia

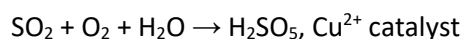
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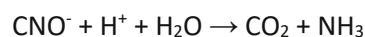
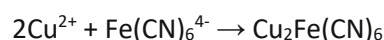
The basic chemistry of the INCO SO₂/AIR process is straight forward. In the primary reaction, weak acid dissociable cyanide (CN_{wad}), which includes free cyanide and weakly complexed metal cyanides, is oxidized to produce cyanate (OCN⁻) and sulphuric acid while releasing metals into solution. This reaction requires a small amount of copper in solution to serve as a catalyst which is usually added as copper sulphate. Acid produced in the oxidation reactions is neutralized with lime at a controlled pH of 8-9. The product of neutralization is calcium sulphate (gypsum). Iron cyanide, a strongly complexed metal cyanide, is normally the only other species of cyanide encountered in a typical mine effluent. Metals which are dissociated during the oxidation reactions (particularly copper), precipitate the iron cyanide as an insoluble salt. This precipitate is stable within a wide range of pH values. Excess metals in solution, including the spent copper catalyst, are precipitated as hydroxides. Stoichiometrically, the reactions require approximately 2.46 grams of SO₂ per gram of CN_{wad} to be oxidized although operating ranges are more typically 3.5-4.5 grams of SO₂ per gram of CN_{wad}. (Robbins 1996).

The reactions that occur in the INCO process are written in various forms but typically as

Reagents



Reactions



The reaction is normally carried out at a pH of 8-9, with lime normally required for pH control. The lime (or other alkali) requirement to control pH depends on the choice of reactant (Na₂SO₃, SMBS, SO₂). The reaction rate is extremely fast and is limited by the transfer of oxygen. Typical reaction times to achieve the required oxygen mass transfer vary from about 30 min to 2 h. Iron complexed cyanides are reduced to the ferrous state and precipitated with copper, nickel or zinc as insoluble metal-iron-cyanide complexes. Residual metals liberated from the WAD cyanide complexes are precipitated as metal hydroxides.

Benchmarking Published Operating Data

Literature searches of publicly available data show that the levels of copper in solution in the discharge of a full INCO process is typically <1mg/L from a fully operating INCO circuit (Table 1). This compares well with the solution copper levels in the INCO discharge from Oceanagold's Macraes INCO circuit which typically sits at 0.1mg/L and concurs with the expectations of other industry professionals familiar with the operation of INCO circuits in other gold operations.

Table 1: INCO process operating data

Operation		detox descript	stream	res time min	feed (mg/L)			effluent / INCO discharge (mg/L)			Reagents (g/gCN ₂)		pH	
					CNT	Cu	Fe	CNT	Cu	Fe	Cu++	SO ₂	barren	treated
Campbell Red Lake	laboratory				890	55	80	1.6	0.4	0.4	0.11	2.2	9.5	9.5
Campbell Red Lake	laboratory				665	62	35	0.7	0.5	0.2	0.07	3.6	10.5	9.8
Scottie gold mines	commercial				450	35	1.5	0.1-2	1-10	<0.5			9	8
McBean Mill	commercial				370	30	20	0.2	0.7	<0.2			11.5	9
Campbell red lake	laboratory		barren sltn	60	940	39	118	0.7	0.6	0.2	0.15	3	11.1	10
Equity	laboratory		CIP tails (30% sol)	30	195	42	25	0.4	1.1	0.2	0.25	3.8	10	8
Mount Skukum	laboratory		tailings (45% solids)	40	215	3	40	0.3	0.2	0.1	0.5	2.1	9.8	8
Lynn gold	laboratory		Pit water	20	13	1.5	0.1	0.6	0.4	0.1	0.4	4.8	8.7	9.9
Colosseum	laboratory		CIP tails (53% sol)	80	243	84	85	0.3	0.9	0.2	0	4.3	10.5	8
Kuntz	laboratory		electroplating rinse water	100	100	54	4.5	2.1	3.2	0.6	.	0.6		8.5
McBean	laboratory		barren sltn	90	404	35	26	0.3	0.5	<0.2	0	3.5	11.7	9
Skyline	laboratory		repulped talings	120	1124	455	73	1.5	2.7	0.1	0	4	10.4	8
Inco/ Golden Knight	laboratory		CIL Tailings	60	200	15	2.4	0.2	0.9	0.2	0.2	4.6	10.5	8
ERG	laboratory		pond water	40	155	88	6.5	0.1	0.3	<0.1	0	6.5	9	7.7
Westmin	laboratory		CIPtailings	120	278	24	13	0.3	0.8	0.1	0.07	5.3	10.7	8
Equity	commercial	1 stage	CIL Tailings		100	35	2	1-5	2-5	0	0.27	5.9	11	8
Mt Skukum	commercial	flotation cells	Repulp		100	5	15	0.9	1	0.2	0.25	4	11	8.2
McBean	commercial	1 stage	Barren		370	30	20	0.2	0.7	<0.2	0	4	11.5	9
Lynngold	commercial	2 stage	Pond		100	20	2	0.6	0.1	0.1	0.1	6	8.7	9.5
colosseum	commercial	1 stage	CIP Tailings		375	129	2.2	0.4	1.5	0.2	0.11	5.6	10.6	8.7
Ketza R*	commercial	1 stage*	CIP Tailings		150	8	<0.1	5	15	<0.1	0.3	6	9.8	8.4
Skyline	commercial	1 stage	Repulp		450	300	10	<0.1	2	0.3	0	6	10.5	8.1
Kuntz	commercial	multi	Rinse		150	90	2.8	0.2	1.2	<0.2	0	8	9.5	8.5
Ovacik	operation	3 stage	CIP Tailings		183				<1	<0.1	150	50	8-9	7
Detour Lake	N143-101	2 stage	CILTailings	1.5				<5			0.14	5		

* only partial detox as CN and As removed in pond

Source: Devuyst EA, Conard BR Hudson W, Commercial Operation of INCO's SO₂/Air Cyanide Removal Process, Conference on Cyanide and the Environment, Arizona, Dec 1984, Devuyst EA, Conard BR Robins G, Vergunst R, INCO SO₂/Air Cyanide Removal Process Update, World Gold '89 1999

IMO Test work

The IMO cyanide detoxification test work for Santana Minerals was completed in two test work rounds on tails generated from the master composite. Round 1 tails sample was generated without a gravity step and round 2 tails sample was generated with the inclusion of a gravity gold recovery step. The Round 1 detoxification test work was completed on a single batch sample while the round 2 work included a 1kg batch test followed by a 29kg bulk sample detoxification test.

The copper levels in test work detoxification discharge liquor were

- Round 1 Batch test work: 0.84mg/L
- Round 2 Batch test work: 32mg/L
- Round 2 Bulk test work: 75mg/L

The elevated copper levels are not typical of a full INCO installation where copper (and other metal ions) in solution after the INCO reactor would be precipitated out as metal hydroxides and levels of less than 1mg/L would be expected in the system tails. While the full test work scope is not detailed in the IMO report it appears that the test work was a single stage test completed only to determine the amenability of the RAS CIL discharge to cyanide destruction via the INCO methodology. The single test does not appear to have an additional step to precipitate out metal ions including Cu²⁺ ions to copper hydroxide as would be typical in a commercial INCO installation. Although not explicitly this precipitation of metal ions does not appear to have been part of the test work scope.

Recommendations

While copper in solution assays of 1mg/L would be a reasonable starting point for water and tails modelling work the amenability of the full INCO process for both cyanide detoxification and subsequent metal ion precipitation of the Bendigo Ophir CIL discharge for should be tested and confirmed as part of the current ALS test work plan (Quote No: 32703).

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Original INCO licenses (1996)

Owner/Project	Location	Treatment
1. Scottie Gold Mine	British Columbia	Barren and slurry
2. Carolin Mines/Ladner Creek	British Columbia	Barren and slurry
3. Dupont Exploration/Baker Mine	British Columbia	Slurry
4. Placer Dome/Equity Silver	British Columbia	Slurry
5. Inco-Queenston/McBean Mine	Ontario	Barren
6. Lynngold Inc./MacLellan Mill	Manitoba	Pond water
7. Kuntz Electroplating	Ontario	Solution
8. Lac Minerals/Colosseum Mine	California	Slurry
9. Mount Skukum Gold Mining	Yukon	Slurry
10. Canamax/Ketza River	Yukon	Slurry/Pond water
11. Skyline Explorations/Johnny Mountain	British Columbia	Slurry
12. Placer Dome/Kiena	Quebec	Slurry
13. Giant Yellowknife/E.R.G. Resources	Ontario	Pond water
14. TVX-Golden Knight/Les Mines Casa Berardi	Quebec	Slurry/Pond Water
15. Precious Plate	Ontario	Solution
16. Citadel/Surluga Mine	Ontario	Barren
17. Superfinish	Ontario	Solution
18. Westmin/Premier Gold	British Columbia	Slurry
19. Minnova Inc./Lac Shortt	Quebec	Pond Water
20. TVX/Mineral Hill Mine	Montana	Barren
21. N.A. Metals/Golden Bear Mine	British Columbia	Slurry
22. St. Andrew Goldfields/Stock Mine	Ontario	Pond water
23. Echo Bay/Kettle River	Washington State	Slurry
24. Sable Resources/Baker Mine	British Columbia	Barren
25. Muscocho/Mauntoban	Quebec	Pond water
26. Barrick/East Malartic	Quebec	Slurry
27. Sunshine/Snow Caps	California	Heap rinse
28. Barrick/Mercur	Utah	Pond Water/Slurry
29. Echo Bay/McCoy-Cove	Nevada	Slurry
30. Royal Oak/Hope Brook	Newfoundland	Slurry
31. IBM	Quebec	Solution
32. ACNC/Grant Mine	Alaska	Mill Solution
33. Citigold/Ryan Lode	Alaska	Heap Solution
34. Homestake/Nickel Plate	British Columbia	Slurry
35. AJ Perron Gold/Kerr Mill	Ontario	Slurry
36. AMAX Gold/Hayden Hill	California	Slurry
37. Battle Mountain Gold/San Luis	Colorado	Slurry
38. Placer Dome/Campbell Mine	Ontario	Pond water
39. Newmont/Yanacocha	Peru	Heap solution
40. Macraes/Flat	New Zealand	Slurry
41. Placer Dome/Detour	Ontario	Slurry
42. Peñoles/La Cienega	Mexico	Slurry
43. Homestake/McLaughlin	California	Pond water
44. Devex/Gympie	Australia	Slurry
45. Battle Mountain Gold/Kori Kollo	Bolivia	Slurry
46. Eltin-Orion/Salsigne	France	Slurry
47. Kinross Gold/Q.R.	British Columbia	Slurry
48. Barrick/Bullfrog	Nevada	Slurry
49. TVX/New Britannia	Manitoba	Slurry
50. Dome Resources/Tolukuma	Papua, New Guinea	Slurry

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MINE WASTE MANAGEMENT

GREENROAD GROUP

APPENDIX J ENGINEERED LANDFORM DESIGN PHILOSOPHY

MEMORANDUM

Recipient: Cheryl Low – Matakanui Gold Limited

From: Paul Weber – Mine Waste Management Limited

Date: 13 September 2025

Cc: Leo Navarro – Mine Waste Management Limited; Ryan Burgess – Hydro
Geochem Group Limited

Document Number: J-NZ0233-009-M-Rev3

Document Title: Engineered Landform Design Philosophy

Mine Waste Management Limited (MWM) has provided this engineered landform (ELF) design philosophy memorandum to Matakanui Gold Limited (MGL) for the management of waste rock associated with the proposed Bendigo-Ophir Gold Project (BOGP).

EXECUTIVE SUMMARY

Objectives of this Study

The objectives of this study are to:

- Summarise literature and provide industry proven methods for the design of engineered landforms for the storage of waste rock.
- Provide recommendations (design objectives) to prevent and minimise the potential risks associated with acid and metalliferous drainage (AMD) by the use of source control technologies.
- Provide preliminary recommendations (design objectives) on how waste rock could be managed within an ELF at the proposed BOGP.

Findings

Previous studies (e.g., MWM, 2025a,b,e) have indicated that a number of potential constituents of concern (PCOC) could be elevated at the BOGP including for instance, As, SO₄, Cu, Fe etc., which could have an effect on the downstream environment if not managed appropriately. One aspect of AMD management is source control to prevent sulfide mineral oxidation and the mobilisation of these oxidation products from landforms.

MGL has committed to proactive source control, using engineered landforms, which provides a foundation for sustainable waste rock management, aligning with INAP¹ (2024) principles for long-term environmental stewardship.

¹ International Network for Acid Prevention: <https://www.inap.com.au/acid-drainage>

Management

This report provides a design philosophy for the ELF to prevent the oxidation of sulfides and minimise the mobilisation of any oxidation products by water. Design objectives are incorporated into the ELF Management Plan (EGL, 2025a) and the Mine Impacted Water (MIW) Management Plan (MGL, 2025).

ELFs will use available industry proven methods (e.g., INAP, 2020, 2024) to minimise water and oxygen ingress and hence control the potential geochemical hazards at their source. The current proposed design objectives are explained in Table 1 and focus on minimising oxidation of sulfide minerals and mobilisation of oxidation products (e.g., water management).

Table 1. BOGP ELF Design Objectives

DESIGN FEATURE	ATTRIBUTE
Foundation Earthworks	- Clean water diversion to minimise water/rock interaction. - Inert – low sulfur basal materials (3 m thick) to minimise PCOC mobilisation due to basal seepage from natural springs etc. Note: Low sulfur materials (<0.02 wt% S) have been identified in drill holes near the surface of the RAS² deposit to approximately 10-15 m depth and these materials should be used for this basal layer where practicable (MWM, 2025a). - Basal underdrainage network to minimise water/rock interaction using the low sulfur (< 0.02 wt% S) materials where practicable. - ELF toe bund (or similar) to prevent advective oxygen ingress.
Clean Water Management	- Clean water diversion to minimise water/rock interaction. - ELF design to shed water as quickly as practicable. - Compaction to shed water.
Materials Management	- Development of a material classification management process. - Development of a material management process. - Minimise time between blasting and placement. - Maximise blasting opportunities to maximise grainsize of waste rock – e.g., reduce reactive surface area of higher risk materials (e.g., TZ4 / RSSZ³).
Lift Height	- Commence construction using a 4-6 m lift height. - Confirm grainsize segregation does not occur for lift heights of 4-6 m via test pitting or tip head inspections. - Maximise paddock dumping where possible. - Undertake studies to confirm whether higher lifts can be used (e.g., >4-6 m) yet advective oxygen ingress is prevented and diffusion of oxygen is limited to 20 m horizontal depth into the ELF. - Limit long term diffusive oxygen ingress to < 20 m horizontally and 15 m vertically. Confirm by performance monitoring.

² Rise and Shine

³ Textural Zone 4 and Rise and Shine Shear Zone materials

DESIGN FEATURE	ATTRIBUTE
	Validate oxygen flux rates (e.g., cover system trials) to confirm long term sulfide oxidation processes and geochemical model reliability.
Encapsulation	- Placement of RSSZ, TZ4, and high As TZ3 waste rock in the core of the ELF surrounded by lower risk TZ3 materials. - Development of perimeter bund (advective oxygen barrier) and lower permeability running surfaces constructed from TZ3 materials.
Cover System	0.2 m of topsoil/subsoil 0.3 m of moderately weathered mine rock (commonly referred to as 'Brown Rock') - Develop a cover system to limit net percolation to <20% of annual rainfall and limit oxygen flux such that closure objectives can be achieved. Further work is required.
Progressive Rehabilitation	- Up-valley construction of the ELF where practicable, to provide immediate surfaces for rehabilitation (cover system installation). - Placement of compacted brown rock, soils, and vegetation to reduce net percolation of rainfall.
Performance Monitoring	- Geochemical characterisation and quality assurance / quality control (QA/QC) - Grainsize segregation and lift height - Oxygen ingress depth - Net percolation rates - Seepage water quality and quantity

BACKGROUND

MGL is proposing to establish the BOGP, which comprises gold mining operations, processing operations, ancillary facilities and environmental mitigation measures on Bendigo and Ardgour Stations in the Dunstan Mountains of Central Otago. The project site is located approximately 20 km north of Cromwell and will have a maximum disturbance footprint of 550 hectares.

The total Mineral Resource Estimate for the BOGP using a 0.5 g/t cut-off for open pit and 1.5 g/t for underground is 34.3 Mt at 2.1 g/t for 2.34 M oz (MGL, 2025). The Bendigo-Ophir resources occur in four deposits: Come in Time (CIT), Rise and Shine (RAS), Srex (SRX), Srex East (SRE). The majority of identified mineral resources are located within the RAS deposit. Three primary geological units are recognised at site:

- RSSZ – Rise and Shine Shear Zone
- TZ3 – Lower Greenschist facies Textural Zone 3 rocks of the Otago Schist
- TZ4 – Upper Greenschist facies Textural Zone 4 rocks of the Otago Schist

The resources will be mined by open pit methods at each deposit within the project site, with underground mining methods also proposed to be utilised at RAS to access the deeper gold deposits. The majority of the mining activities, ancillary facilities and associated infrastructure will be located in the Shepherds Valley with non-operational infrastructure located on the adjoining Ardgour Terrace. The BOGP also involves the taking of groundwater from the Bendigo Aquifer for use in mining-related activities and the realignment of Thomson Gorge Road via Ardgour Station.

The following key mine facilities are proposed:

- Open pits targeting the RAS, SRX, SRE, and CIT deposits.
- An underground mine targeting the RAS deposit.
- Three ex-pit engineered landforms (ELFs) – Shepherds ELF, SRX ELF, and West ELF (WELF).
- Two in-pit landforms (backfill) – CIT and SRE⁴.
- Plant and processing area, where CIL extraction technologies will be used as part of the ore recovery process.
- A tailings storage facility (TSF) and TSF Embankment.
- Other ancillary support services / structures (e.g., roads, water management infrastructure, water treatment plants, etc).

These facilities will be placed in the catchment of Shepherds and Bendigo creeks (Figure 1).

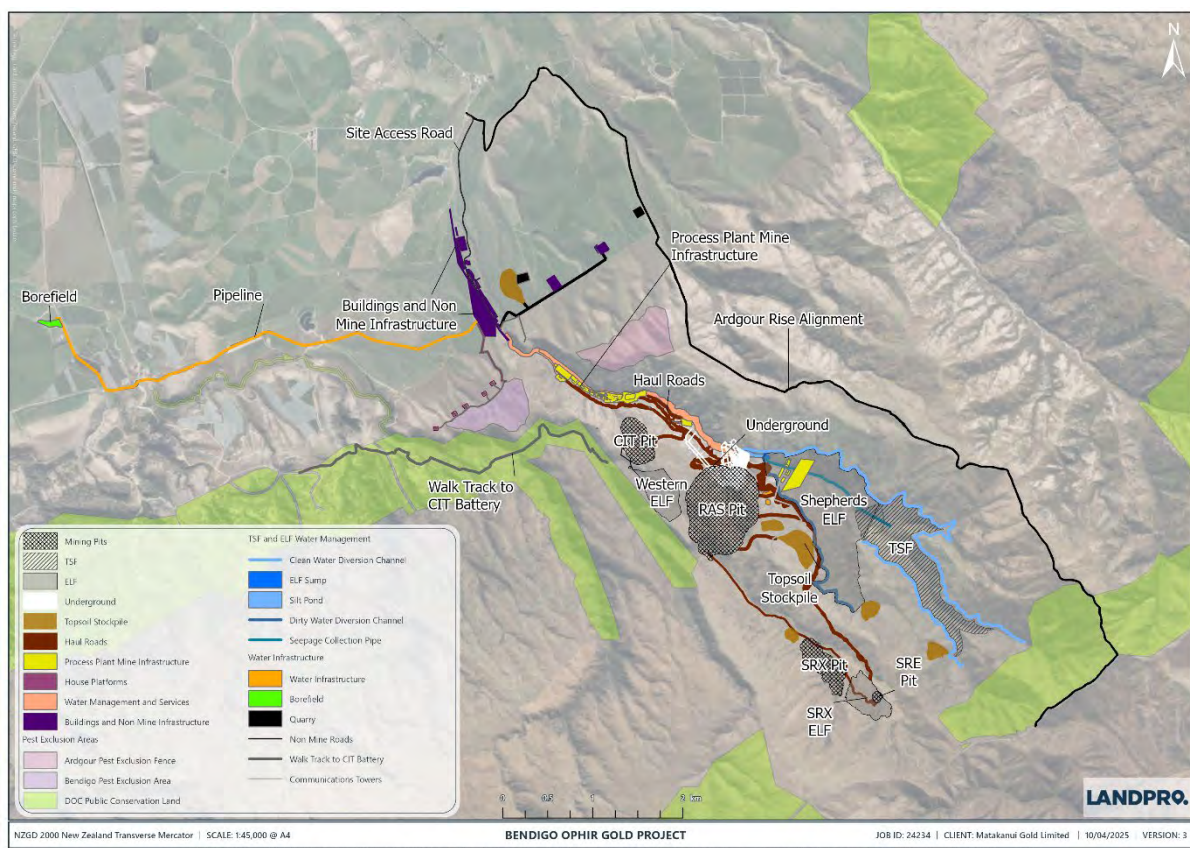


Figure 1. Bendigo-Ophir Gold Project Infrastructure.

Source: MGL (2025).

OBJECTIVES

The objectives of this study are to:

⁴ Note: SRE Pit is backfilled by the SRX ELF.

- Summarise literature and provide industry proven methods for the design of engineered landforms.
- Provide recommendations to prevent and minimise the potential risks associated with acid and metalliferous drainage (AMD) by the use of source control technologies.
- Provide preliminary recommendations on how waste rock could be managed within an ELF at the proposed BOGP.

GEOENVIRONMENTAL HAZARD CHARACTERISATION

The geoenvironmental hazards associated with the BOGP have been assessed (MWM, 2025a,b,e).

Studies indicate that the rocks associated with the project (TZ3, TZ4, and RSSZ) will not generate acid rock drainage with >350 samples tested by industry accepted acid base accounting (ABA) techniques (e.g., AMIRA, 2002). This is a function of the high acid neutralisation capacity (ANC) of the rocks associated with carbonate minerals (e.g., dolomite) and a low sulfide mineral content (e.g., arsenopyrite, pyrite) that can generate lesser acidity. The overall ABA assessment indicates that the rocks are classified as non-acid forming (NAF).

Rocks associated with the BOGP will generate neutral metalliferous drainage (NMD) elevated in PCOC such as As, Cu, Fe, SO₄ etc. Minimising sulfide mineral oxidation (e.g., arsenopyrite) and the mobilisation of oxidation products will minimise the potential effects to receiving waters.

Nitrogenous compounds such as nitrate are also expected to be elevated in seepage from blasted rock due to the use of ANFO, an ammonium-nitrate fuel oil explosive. This is not an uncommon issue in the mining industry.

It is expected that mining of the BOGP will affect waters within the project area and these effects will include:

- Neutral metalliferous drainage (NMD) with elevated sulfate and the other constituents of concern (see MWM, 2025b).
- Nitrate-rich drainage due to the use of ANFO.
- Cyanide using in mineral processing and gold recovery.

Collectively these waters are referred to as mine impacted water (MIW) to acknowledge the different contributions to poor water quality within the project area.

BOGP ENGINEERED LANDFORM - OVERVIEW

This section summarises the primary landforms for the storage of waste rock including the engineered landforms and backfill

Engineered Landform Summary: Shepherd ELF, West ELF, and SRX ELF

Overburden waste rock from the RAS deposit will be stored in the Shepherds ELF (Figure 2) and the West ELF (Figure 3) and the overburden from the SRX Pit will be stored in the SRX ELF (Figure 4).

MGL (2024) note that an ELF with a total design capacity of 103.6 million loose cubic metres (LCM) has been designed for the Shepherds Creek catchment (Figure 2). The design quantity has a contingency of roughly 12% which would account for possible changes in the swell factor or the compaction ratio following further analysis on the actual site-specific parameters.

Waste landform sequencing has been undertaken based on the assumption that arsenic concentrations are higher in the ore host rock (TZ4 and RSSZ) and for precautionary reasons it is planned to be encapsulated and capped with lower arsenic waste rock (TZ3).

A base layer and encapsulating layer of inert material is typically required, with a core of non-inert material. For this reason, the ELF has a base layer of 3 metres of TZ3 material. Low sulfur materials (<0.02 wt% S) have been identified in drill holes near the surface of the RAS deposit to approximately 10-15 m depth (MWM, 2025a) and these materials should be used for this basal layer where practicable.

The TSF dam embankment will also consist of TZ3 material. MGL (2024) propose that a minimum 20 m thick capping layer of TZ3 materials will encapsulate the ELF and higher sulfur TZ4 and RSSZ waste rock.

Backfill

Waste rock (TZ3) will be placed as backfill in the CIT Pit to return the ground to its pre-mining topography (or similar). The CIT Backfill is shown in Figure 5 and indicates that the long-term groundwater level will be equivalent to the spill point of 503 m. Waste rock will be constructed as an ELF to minimise long term risks to water quality. The volume of the CIT Pit has been estimated at ~923,000 m³.

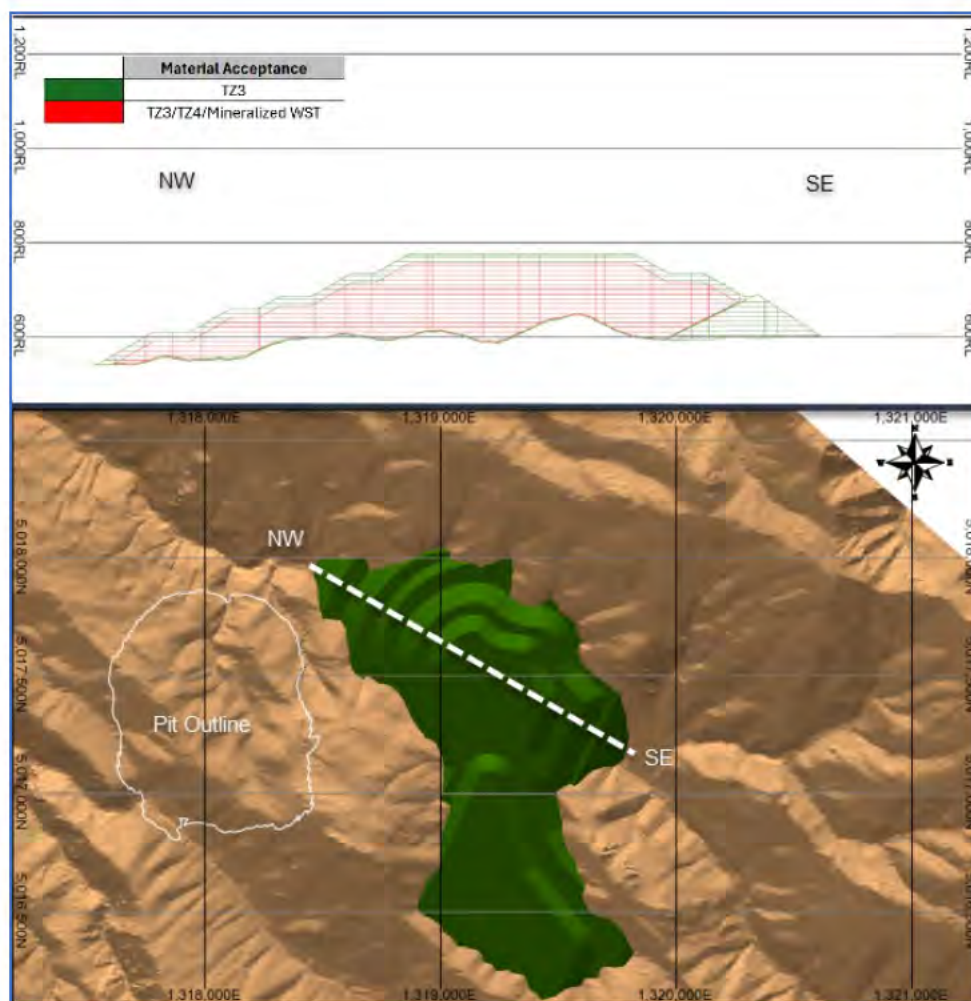


Figure 2. Shepherds ELF.

Source: MGL (2024).

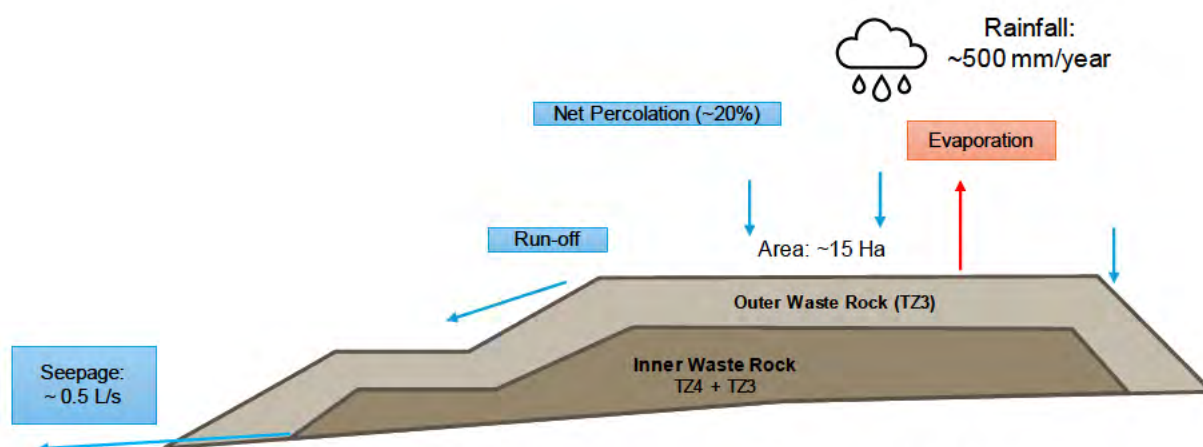


Figure 3. Conceptual (and schematic) water balance and material distribution for the WELF.

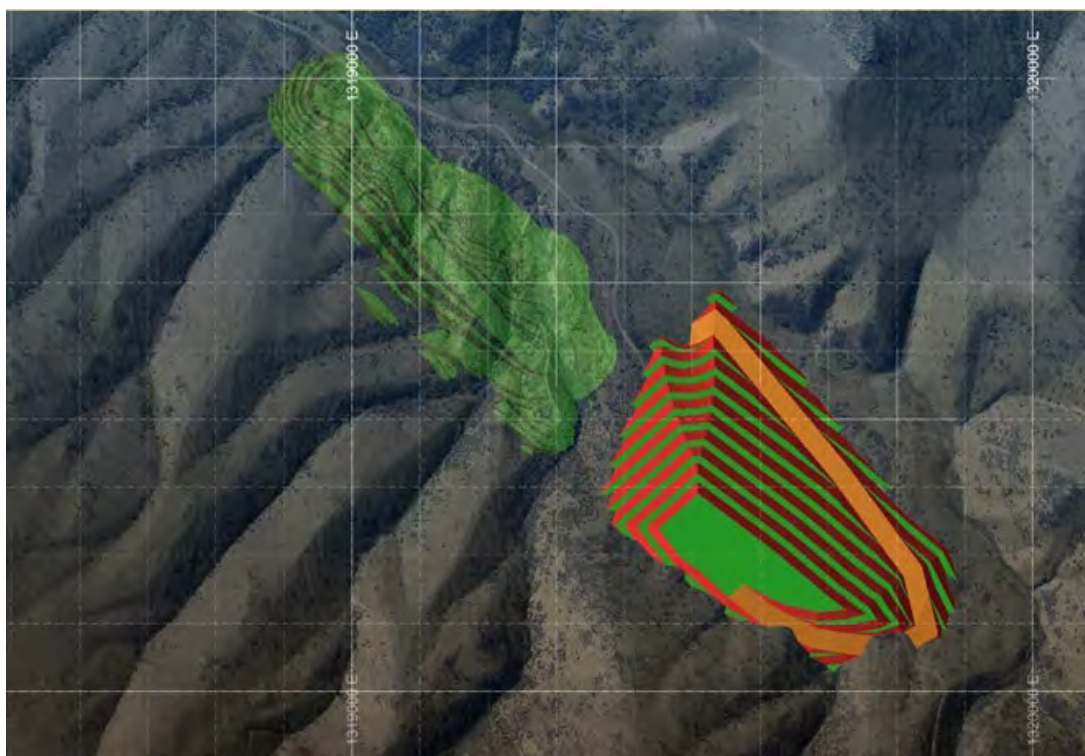


Figure 4. SRX Pit and SRX ELF

Source: MGL (2024)

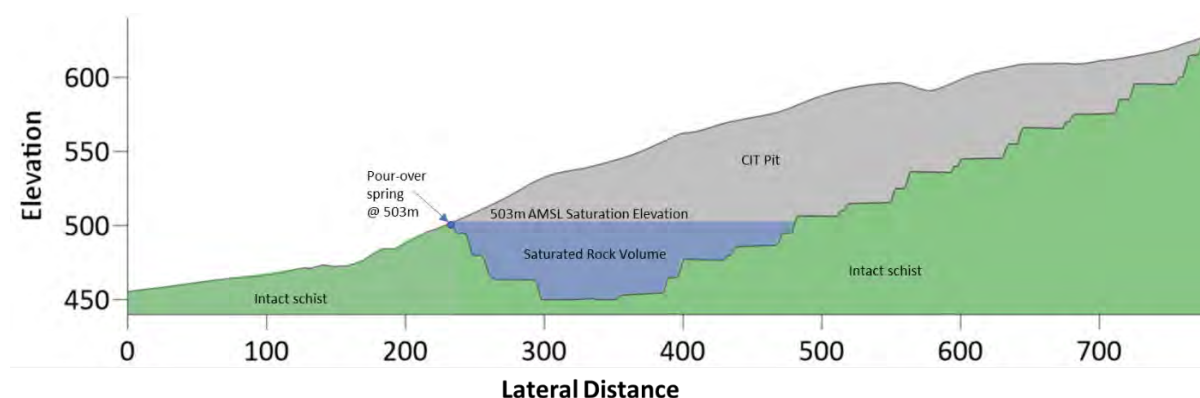


Figure 5. CIT Backfill.

Source: Rekker and Dumont, 2025

AMD MANAGEMENT APPROACH

This section describes the general approach to how AMD is managed.

Background

AMD needs to be managed to reduce health and safety risks for on-site staff and communities, reduce deleterious effects to the environment, and ensure that appropriate closure of the site is achieved at the end of mining activities. This requires six AMD management steps to be undertaken as a holistic approach to AMD management, which is based on international industry guidance (e.g., International Network for Acid Prevention (INAP), 2014; DFAT, 2016). The six AMD management steps include:

1. Set Closure Goals
2. Predict
3. Prevent
4. Minimise
5. Control and Treat
6. Monitor Performance

These steps form the basis for any comprehensive AMD Management Plan, which is often supported by a risk assessment process and the development of site-specific operational controls to manage these risks and/or uncertainties. The AMD risk assessment process is based on data obtained from AMD prediction activities and determines the engineering control requirements for the project (e.g., prevention, minimisation, control and treat).

AMD Management Approach

This section provides a high-level summary of the six steps of AMD management.

Table 2. AMD Management Steps

AMD MANAGEMENT STEP	EXPLANATION	RELATED DOCUMENTS FOR THE BOGP
Set Closure Goals	- Closure goals are set in order to minimise legacy issues associated with potential AMD sources and any in-perpetuity uncontrolled AMD from mine domains containing AMD generating materials. - These goals are reevaluated throughout the mine life against performance monitoring results.	- Closure objectives for water quality have been established (Ryder, 2025). - Baseline Water Quality (MWM, 2025c).
Predict	- Prediction is critical to understanding the potential, severity, and longevity of AMD. - Prediction is facilitated by geochemical analysis and interpretations. - A key prediction objective is to estimate water quality generated by various materials and mine domains that have the potential to generate AMD.	- Geoenvironmental Hazards Report (MWM, 2024a). - Leach testing to determine PCOC (MWM, 2025b,e).
Prevent	- Prevention of sulfide mineral oxidation, where practicable, is a key management step for AMD. - The prevention of AMD relates to reducing sulfide mineral oxidation as much as practicable by limiting the ingress of oxygen into a mine domain where it can oxidise sulfide minerals. Prevention strategies are implemented during operations to manage a future risk.	This memorandum.
Minimise	- Where prevention is not practicable, or has already occurred, the next management step involves minimising the contaminant load reporting to the receiving environment. - This often involves progressive reclamation strategies focused on minimising ongoing sulfide oxidation (potential oxidation products) and the mobilization of oxidation products with net percolation through the waste rock.	This memorandum.

Control and Treat	Although the objective is to prevent and minimise AMD, control and treat measures are an important step in managing the effects of AMD to the receiving environment.	- Water Management / Treatment Study (MWM, 2024d). - Process Flow (2025).
Monitor Performance	Performance Monitoring should be conducted to regularly evaluate how AMD management techniques are performing openly and objectively against closure goals and success criteria (ICMM, 2019).	MIW Management Plan (MGL, 2025).

SOURCE CONTROL

Prevention and minimisation of AMD can be considered engineering controls to manage the AMD source hazard. This section discusses source control technologies for the proposed engineered landforms that would contain waste rock at the BOGP.

Overview

Source control involves the prevention of sulfide mineral oxidation (where possible) and minimisation of contact water to reduce the mobilisation of oxidation products. Source control can be considered the a best practice approach to AMD management and reduces the risks of long-term AMD management by tempering the maximum potential AMD risk at closure that requires mitigation / management.

Generally waste rock dumps represent 60 - 80% of a site's AMD contaminant load (INAP, 2020) if the AMD source hazard is not managed appropriately. International case studies are available (e.g., Weber et al., 2017) to demonstrate the high proportion of AMD associated with waste rock domains. Hence there is a strong driver to incorporate waste rock into engineered landforms that address the key principles of AMD source control: Prevention and Minimisation.

Many examples of successful source control for engineered landforms are from New Zealand. INAP (2020) notes the following sites as examples:

- Cypress Coal Mine, Stockton.
- Stockton Coal Mine.
- Reddale Coal Mine.
- Escarpment Coal Mine.
- Waihi Gold Mine (Martha Mine).

Other New Zealand sites that have utilised engineered landforms include:

- Macraes Gold Mine (Coronation North Landform).
- Canterbury Coal Mine.

Prevention of Sulfide Mineral Oxidation

Waste rock that is end dumped in high lifts (>4-6 m in height) and the associated kinetic energy can result in grainsize segregation and the development of alternating coarse-textured and fine-textured bedding planes of poorly graded and well sorted material with high vertical airflow capacity (e.g., Fala et al., 2003; Wilson, 2008). This also results in an overall downward coarser grading providing higher airflow capacity deeper in the facility. In addition, the fall of rocks / cobbles from the end-tipped / dozer

pushed material results in the development of a coarse basal layer with high lateral airflow capacity that provides oxygen ingress pathways into the core of the waste rock dump (WRD) as shown in Figure 6.

The dominant process for oxygen flux is by the advective and convective flow of oxygen (temperature differences, barometric pressure differences) along coarser waste rock layers that form within poorly constructed WRD. Work completed by Brown et al. (2014) has demonstrated that in a poorly constructed WRD, advection accounts for ~90% of oxygen ingress, and that diffusion of oxygen accounts for 10%.

Hence, a key control to prevent sulfide mineral oxidation and minimise the effects on seepage waters from WRD is to prevent the advective ingress of oxygen.

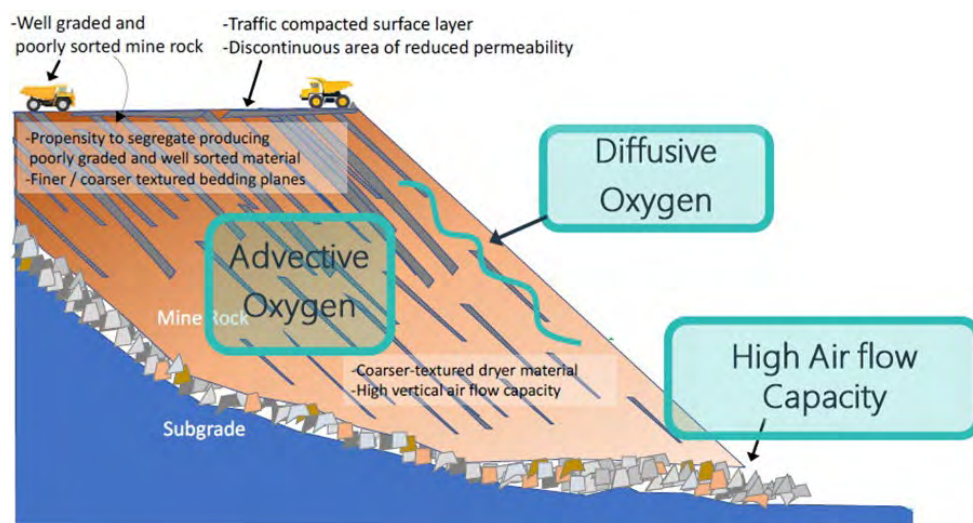


Figure 6. Advective air flow driven by grain size segregation.

Source: Meiers (2020).

The flux of oxygen into a poorly constructed WRD is typically higher than the flux of oxygen into a tailings storage facility (TSF).

- Within a TSF the oxygen flux is driven by diffusion due to the chemical gradient (no oxygen at depth versus atmospheric oxygen concentrations at the surface).
- Within a WRD the oxygen flux is often driven by the advective flow of oxygen (temperature differences, barometric pressure differences, etc) along coarser waste rock layers that form within poorly constructed WRD.

The oxygen flux (as evidenced by oxidation products) is shown in Figure 7. Hence, for the BOGP, control of oxidation is focused on the ELF rather than the TSF.



Figure 7. Diffusion of oxygen into a TSF as shown by Fe oxidation products, and advection pathways within a WRD as shown by oxidation at angle of response tipheads.

Source: Miller et al., 2003: ICARD 2003 ARD Prediction Short Course.

International research (INAP, 2020; 2024) has demonstrated that one of the most effective methods to minimise advective ingress of oxygen into WRDs is to minimise the height of the tiphead to <4 - 6 m and ensure that each lift has a compacted engineered surface, which reduces the size of the advective cell (both vertically and horizontally into the WRD; Figure 8 and Figure 9). Reducing oxygen ingress reduces sulfide mineral oxidation and hence the risks associated with AMD.

The establishment of multiple traffic compacted lifts also reduces the height of advective oxygen ingress to these cells. Further detailed design work is required to confirm that traffic air-entry layers can be achieved at BOGP, or whether additional materials / material management is required.

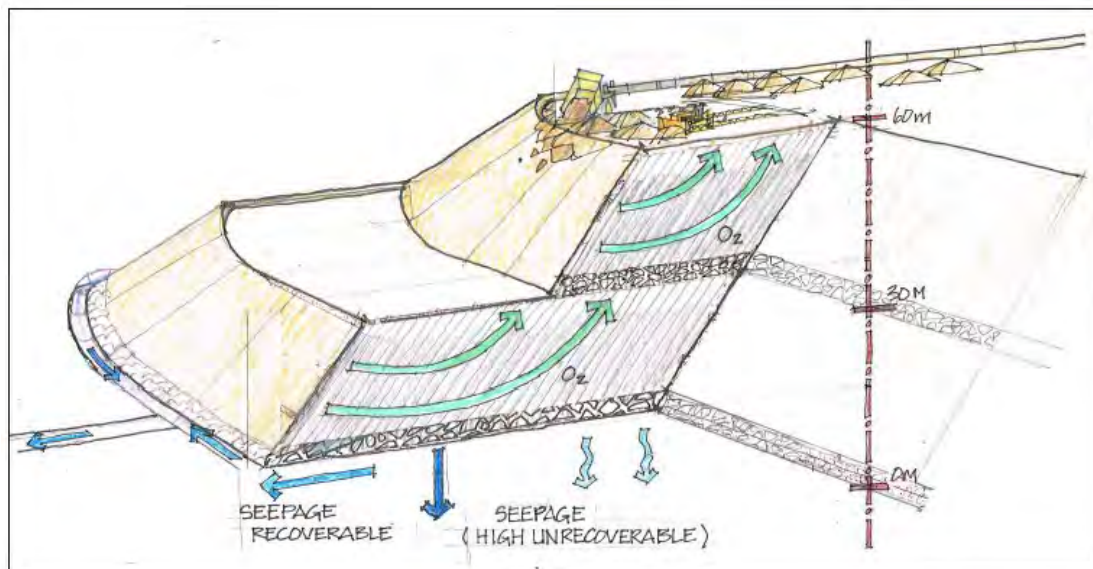


Figure 8. Conceptual gas transport regime in a WRD with no engineering controls.

Source: INAP (2024): Significant horizontal ingress along the basal chimney zone and significant vertical rise upwards along chimney zones.

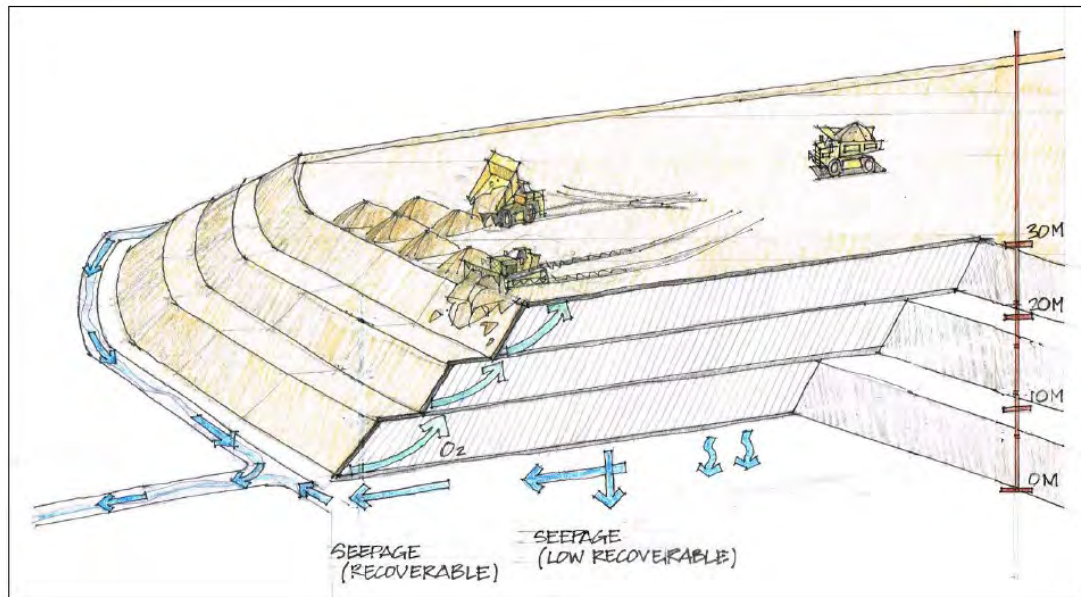


Figure 9. Conceptual gas transport regime into an ELF with trafficked air-entry disrupting running surfaces.

Source: INAP (2024): Limited oxygen ingress horizontally due to a lack of a basal rubble layer; limited vertical oxygen rise due to lower permeability running surfaces.

INAP (2024) note that an “Engineered Fill” approach “allows for the ability to more accurately model and predict O_2 ingress and the volume and quality of recoverable seepage requiring treatment over time” and that “this approach focuses on prevention, rather than a cure. This ‘Engineered Fill’ approach manages AMD “risks through implementation of source control, progressive reclamation, and cover systems, which allows for opportunities to move from active to passive water treatment over time thereby reducing asset liability, and likelihood of in-perpetuity management”.

Figure 10 shows the impact of various grain-sized materials on the gas flux rate and acidity generation (i.e., sulfide mineral oxidation). Employing techniques like short lifts and paddock dumping effectively reduces oxygen ingress, leading to reduced sulfide mineral oxidation and, consequently, mitigating the potential risks associated with AMD.

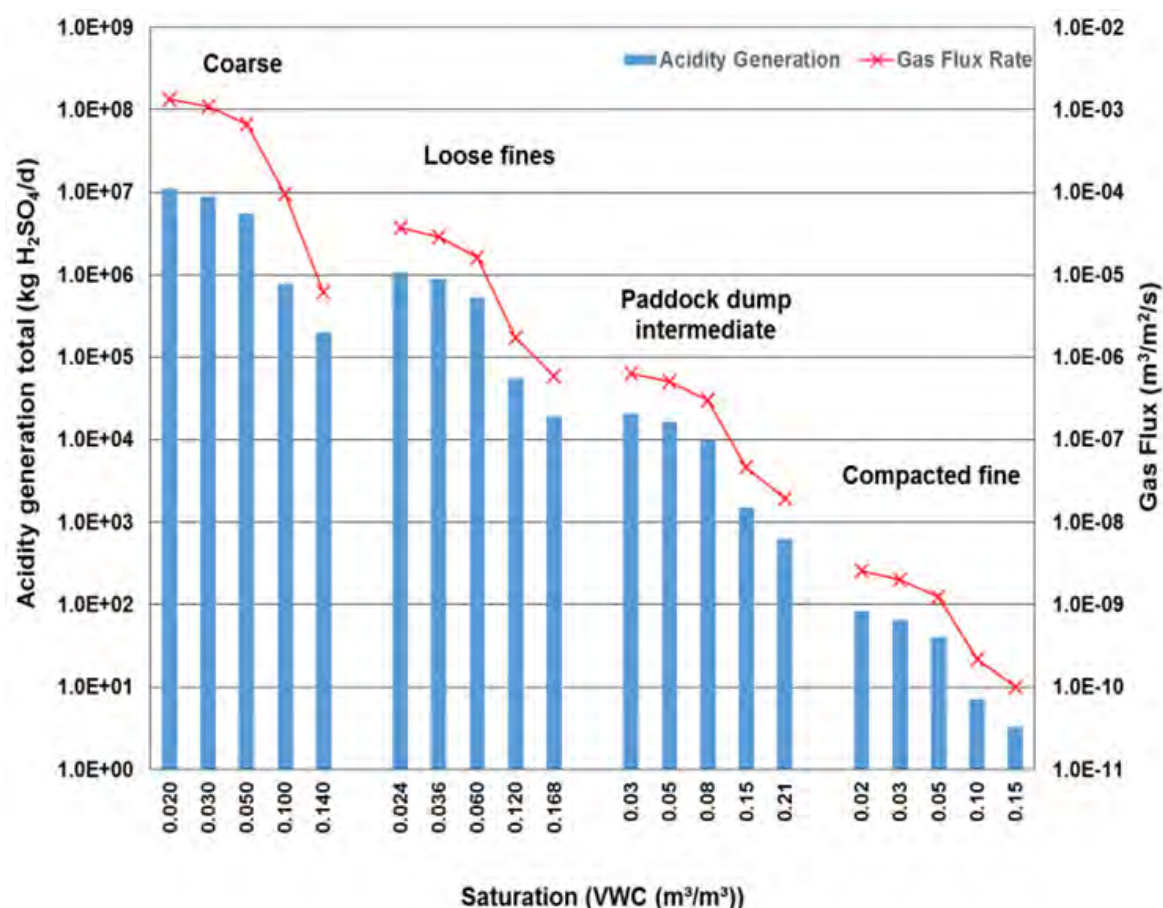


Figure 10. Grainsize segregation: high tipheads.

Source: Pearce et al (2016).

Water Management

Water flow through materials that contain sulfide oxidation products is the primary pathway for mobilisation of contaminants and the generation of AMD impacted waters. Diversion of run-on water and reducing infiltration of water into materials containing sulfide minerals, or sulfide mineral oxidation products, is a key management step for the management of AMD. Often this is site specific and is dependent on climate, topography, location of mine domains, etc.

ELF SOURCE CONTROL OPTIONS FOR THE BOGP

The following section reviews source control opportunities for the BOGP. Appropriate design objectives can then be integrated into the mine schedule and the ELF Basis of Design report (which will be developed prior to mining). Note: the guidance provided needs to be considered by a competent geotechnical engineer as being appropriate for geotechnical risks.

Foundation Earthworks

The following is recommended for the starter lift:

- Clean water upstream of the ELF could be piped through the facility as a management option during the operational phase of the mine to minimise water/rock interactions.

- Basal lift materials are likely to be in contact with topographic surface level seeps. Such materials should be inert, low sulfur, low arsenic, TZ3 materials. MGL (2024) have indicated this will be 3 m thick. Low sulfur materials (<0.02 wt% S) have been identified in drill holes near the surface of the RAS deposit to approximately 10-15 m depth (MWM, 2025a) and should be used for this basal layer where practicable.
- Prior to construction of the first starter lift, ensure a drainage pathway (underdrain) is created so that any seepage from the ELF is directed to one location. For the BOGP, seepage is likely to collect on the natural stream/topographic floor. Engineering Geology Limited (EGL) have designed this underdrainage system for Shepherds ELF and SRX ELF (EGL, 2025b).
- Materials used for the underdrain should be inert, low sulfur, low arsenic, TZ3 materials. The low sulfur (<0.02 wt% S) materials near the RAS surface (MWM, 2024a) should be used as construction materials for the underdrains where practicable.
- The underdrain will be connected to a HDPE pipe that will take seepage water from the ELF to the Shepherds Sediment Pond.
- An ELF toe bund will be constructed within the ELF. This will act as a barrier to advective oxygen flow. Underdrain pipes will be placed through this ELF toe bund in a manner that prevents oxygen ingress. The design of this is discussed by EGL (2025b).
- An ELF Sediment Pond should be constructed at the base of the starter lift to capture seepage from the ELF. The design of the ELF Sediment Pond should consider repurposing as a passive treatment system for ELF seepage at mine closure. This should include suitable maintenance access for removing sediment accumulation and potentially decant structures.

Clean Water Management

Studies have indicated that the BOGP materials are elevated in sulfate (SO₄) minerals that can be mobilised by water (MWM, 2025e). This means water flow through these materials within the ELF will mobilise this contaminant load. The following is recommended for ELF water management:

- Diversion of clean run-on water from upslope areas away from the ELF.
- Design of the ELF (batter slopes and running surfaces) to shed water as quickly as possible.
- Where practicable, avoid ponding of water on waste rock (e.g., avoid sediment sumps on ELF surfaces).
- Compaction, to design specifications, of the ELF running surfaces during operations to shed water and minimise infiltration of rainwater thus reducing the volume of seepage water and extending the wetting up time period and onset to basal and toe seepage.
- Flattening out paddock dumped materials (ideally wheel rolled or compacted) to shed water before significant rainfall events.

Materials Management

MGL (2024) state that waste rock disposal will be carried out by haul trucks approaching the Shepherds ELF from the west at various elevation levels. Track dozers will be used to push the material to form the batter slopes.

The following materials management processes need to be considered:

- Development of a materials schedule (and quantities) to ensure the correct materials are available and are placed in the correct location. This will be completed for the BOGP as part of the detailed design. This will include topsoil scheduling.
- Minimise the time between blasting and placement of mineralised waste, TZ4, RSSZ, high As TZ3 waste in the ELF. This will reduce the oxidation of sulfide materials.
- Manage the ore stockpiles as higher-risk mineralised waste, which is likely to contribute to poor water quality.
- Investigate blasting practices to increase particle size in TZ4 and RSSZ waste rock (to minimise mineral surface area exposure to oxygen (and AMD generation)). Conversely an assessment should be undertaken to look at decreasing the particle size of TZ3 materials for encapsulation purposes, although the risks of nitrogenous compounds and elevated SO₄ should also be considered for blasting to generate finer materials.
- TZ3 materials are weaker than the TZ4 materials with an UCS⁵ of ~20 MPa compared to TZ4 materials that ~ 70 MPa (EGL, 2025b). It is expected TZ3 will break down with trafficking to form a lower permeability surface compared to TZ4 materials. This may have benefits for limiting advective oxygen ingress within the proposed ELFs.
- Blasting of TZ4 / RSSZ materials may generate waste rock that has a greater proportion of clast supported materials compared to TZ3 materials, which is a higher risk for oxygen ingress (Table 3). This is another benefit for having the TZ4 /RSSZ placement zones towards the rear of the ELF.
- Develop a traffic management plan to ensure the running surfaces are thoroughly compacted to minimise vertical rise of oxygen by advective processes.

Lift Height

It is recommended that the construction process and the height of end-tips is designed to prevent grainsize segregation and minimise advective flux of oxygen. Research has shown that tipheads <4 – 6 m do not generate grainsize segregation (Fala et al., 2003; Wilson, 2008), which reduces the risk of advective oxygen flux. However, tiphead height will be specific to the project materials and further work is required to confirm that advective oxygen ingress is prevented. The following approach is proposed:

- Commence construction using a lift height of 4 - 6 m and confirm that no segregation of materials occurs at this height.

⁵ Unconfined compressive strength

- Higher lift heights might be possible. Undertake studies to confirm whether higher lifts can be used (e.g., 4-6 m) yet advective oxygen ingress is prevented and diffusion of oxygen is limited to ~20 m horizontal depth into the ELF.
- Confirm that segregation does not occur for different materials at different tiphead heights (e.g., TZ3 versus TZ4). Table 3 provides a high-level summary for the clast supported vs matrix supported ELF due to segregation processes.
- Where practicable, paddock dumping should be undertaken.
- Undertake performance monitoring to confirm depth of oxygen ingress aligns with geochemical model estimates of 20 m (MWM, 2025f), which was used to support the design objectives for the ELF (MGL, 2024).

Table 3. Clast vs matrix supported ELF.

ELF MATRIX	PROPERTIES	COMMENTS
Clast Supported	Greater porosity Greater air voids Lower density	End-tipping results in the separation of coarser and finer particles creating a material that tends to be clast supported with higher overall porosity
Matrix Supported	Lower porosity Less air voids High density	Paddock dumping and low-lift heights prevents material segregation such that the coarser materials are supported by a matrix of finer materials leading to lower porosity.

Encapsulation

The encapsulation of reactive sulfide-rich materials with low-risk materials is a proven source control technology to reduce sulfide mineral oxidation. The greater the thickness of low sulfide-bearing encapsulating material, the less oxygen diffusion from the atmosphere to the reactive materials (e.g., Figure 11), assuming that advective and convective airflow is minimised by material placement strategies.

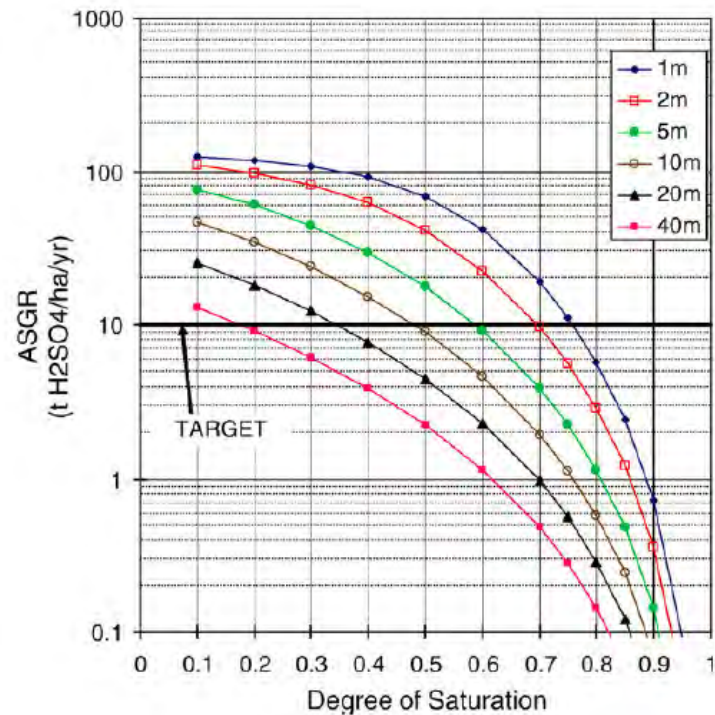


Figure 11. Acid generation rate (due to oxygen diffusion) as a function of cover thickness.

Source: Miller et al., 2010; ASGR = acid sulfate generation rate

For the BOGP the following encapsulation options should be undertaken:

- Placement of higher sulfur waste rock (TZ4, RSSZ) towards the back of each lift in a zone of limited airflow. As shown in Figure 9, this prevents higher-risk material from being within the zone of higher oxygen movement (e.g., the advective cell) near the front batter slopes of an ELF. The size of these zones and the number of individual zones will be a function of the materials schedule and 20 m is proposed as the set-back.
- Development of a perimeter bund of paddock dumped waste rock (lower sulfur TZ3 and or brown rock) at the start of each lift at the outer edge of the ELF. This can then be compacted as a toe barrier (~ 2 m high). Toe barriers have been proposed for other projects to limit oxygen ingress due to grainsize segregation (e.g., Figure 12). Further work is required to confirm the height and width of any advective toe barrier. This will be part of the detailed design.

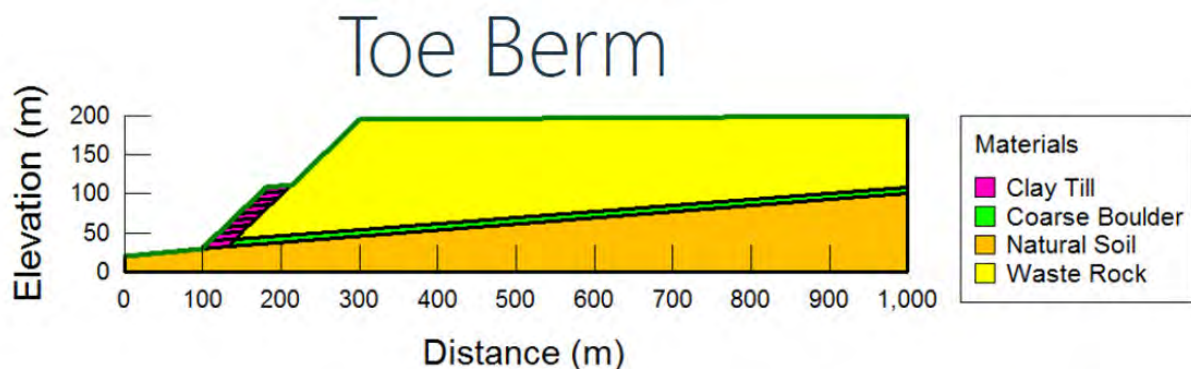


Figure 12. Advective toe barrier.

Source: Meiers (2020).

Cover System

A cover system can minimise the amount of oxygen and water flux into an ELF as well as providing a stable revegetation medium. A variety of systems are available including soil/rock covers, low permeability compacted clays barrier layers, capillary breaks, geosynthetic clay layers, and membrane technology such as polythene. A cover system should be considered one aspect of AMD management.

A cover system should be considered one aspect of AMD management. INAP (2017) notes that cover systems are designed to:

- Meet regulatory requirements
- Divert clean water and reduce the volume of impacted surface water managed on site
- Isolate chemically reactive waste material
- Limit upward movement of process-water constituents and oxidation products
- Limit influx of oxygen and oxidation of certain minerals
- Limit influx of meteoric water to limit oxidation of certain minerals, and limit leaching and dilution of oxidation products
- Control wind and water erosion of waste material as part of the overall landform stability
- Provide a growth medium as the “building blocks” for establishing vegetation and ecosystems.

Types of cover systems include (INAP, 2017):

- Erosion-protection systems
- Store-and-release systems
- Enhanced store-and-release systems
- Barrier-type systems
- Cover systems with engineered layers
- Saturated soil or rock cover systems

MWM (2025g) has provided guidance on the expected net percolation rates (i.e., % of rainfall that will enter the mine facilities) for the ELFs at the BOGP, which has been estimated at 30 – 50%. Data from Macraes (MWM, 2024) suggest lower NP may be possible, in the region of 10 to 20% of annual rainfall. Cover system design elements such as thicker layers and/or lower permeability layers at the base of the cover system could be considered to achieve NP towards the lower range (e.g., NP of 20% of annual rainfall). Further work is required to demonstrate this is achievable at the BOGP.

This flow will mobilise stored contaminants within the mine domain. For the BOGP the following is recommended:

- Utilisation of existing soils and subsoils as the growing medium.
- Brown rock and lower sulfur TZ3 materials need to be assessed for their geotechnical benefits as a cover system material to limit oxygen/water ingress.

- Further analysis is recommended as part of the ELF detailed design to understand the benefits of the cover system including a store and release system to reduce net percolation.

The long-term oxygen flux rate will determine the ongoing generation of PCOC from the ELF. Hence, the cover system and ELF construction processes should also limit oxygen flux such that closure objectives can be achieved. Further work is required to confirm oxygen flux rates through cover system trials.

Progressive Rehabilitation

Progressive rehabilitation will be a key component of the ELF construction process. This will include:

- Grading down materials from the dump crest to the toe of the batter slope and compaction with a dozer.
- Spreading cover materials (e.g., brown rock, or inert finer grained lower sulfur TZ3 materials) to achieve the agreed design specification to limit oxygen ingress / water ingress.
- Topsoiling of the batter slope (or application of suitable brown rock), hydroseeding to control soil loss and the establishment of vegetation.

PERFORMANCE MONITORING

Performance monitoring is an important aspect of AMD management and should include leading and lagging performance monitoring programs to confirm design objectives are being achieved. Performance monitoring provides the data for trigger action response plans (TARPs) in case there is a variance from the expected case and further actions are required to minimise potential effects. Performance monitoring should be designed around demonstrating success criteria (primarily based on design objectives) are being achieved and that performance can be demonstrated openly and objectively. This report suggests that performance monitoring should include, for instance:

- Monitoring of water quality and quantity at the discharge of the ELF underdrain (e.g., Shepherds ELF, SRX ELF, West ELF, CIT backfill) to understand water quality effects and confirm net percolation rates.
- Monitoring of groundwater downgradient of ELF to confirm that basal seepage is not significant.
- Monitoring of oxygen flux into the ELF using oxygen probes and/or oxygen sensors to confirm the oxygen concentration and the depth of the oxidation is < 20 m (i.e., the design objectives)
- Installation of lysimeters soil monitoring (i.e., matric suction and water content sensors) to validate net percolation rates are acceptable (i.e., < 20%) and meet design expectations.

Construction QA/QC is also required during the construction of the ELF to ensure the facility has been constructed as per the basis of design. Construction QA/QC could include for instance:

- Geochemical characterisation of materials (pre-excavation and placement) for AMD risks and risks associated with nitrogenous compounds.
- Monitoring of tipheads to confirm that grain size segregation is not occurring to ensure a matrix supported rock mass is achieved.

Performance monitoring and TARPs are a key aspect of adaptive management.

HEALTH AND SAFETY CONSIDERATIONS

Construction methodologies involving small lift heights introduce several health and safety benefits during the construction/operational phases:

- Eliminating many risks related to working on and around tipheads with significant vertical drops.
- Substituting less stable wheeled plant with highly stable tracked machines when working close to the tiphead.
- A reduction in the likelihood and consequence severity of geotechnical failures at tipheads due to restricted height.
- Lesser risk of differential settlement and areas requiring active control and management.
- Lesser reliance on catch berms to control larger rocks at the toe of the tiphead.
- A reduction in point source dust emissions through smaller drop heights leading to improved air quality for operators within the immediate vicinity and a reduction to the cumulative particulate load released to receiving environments.
- A general decrease in potential AMD effects and risks in the longer term.

SUMMARY

INAP (2020) notes that “direct and indirect measurements of acidity load from various site domains at more than 40 sites over the past 25 years have revealed that mined sulfidic waste rock typically contributes to the majority of the total acidity load (60 to 80%) from most mine sites, with a further 20 to 30% of acidity load associated with TSFs, and relatively minor contributions from other sources (e.g., underground mine void wall-rock, open cuts, heap leach facilities and other stockpiles)”. Hence the greatest long term source hazard for AMD is waste rock rather than tailings. For the BOGP, acidity and low pH are not considered an issue due to the high carbonate content, however, the risks associated with sulfide oxidation products (i.e., neutral metalliferous drainage) remain, hence the risks remain applicable for waste rock storage facilities.

To address this risk, MGL has committed to proactive source control, using engineered landforms, which provides a foundation for sustainable waste rock management, aligning with INAP (2024) principles for long-term environmental stewardship.

Several optioneering studies were completed to determine the most appropriate location for the ELF (MWM, 2025h) with consideration given to minimisation of oxygen ingress and water ingress as components of the optioneering study. The upper Shepherds Creek catchment was chosen for the Shepherds ELF, which minimised exposed surface area. ELFs will use available industry proven methods and acceptable solutions (e.g., INAP, 2020, 2024) to minimise water and oxygen ingress.

CLOSING REMARKS

Please do not hesitate to contact Paul Weber at +64 3 242 0221 or paul.weber@minewaste.com.au should you wish to discuss this memorandum in greater detail.

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APPENDIX K NET PERCOLATION ASSESSMENT

MEMORANDUM

Recipient: Cheryl Low – Environment Manager – Matakanui Gold Limited

From: Paul Weber – Principal Environmental Geochemist, Mine Waste Management Limited

Date: 12 August 2025

Cc: Ryan Burgess – Hydro Geochem Group Limited
Greg Meiers – Mine Closure Management Limited

Document Number: J-NZ0455-001-M-Rev3

Document Title: Net Percolation Assessment for the Proposed Bendigo-Ophir Gold Project Mine Waste Storage Facilities

Mine Waste Management Limited (MWM) has been engaged by Matakanui Gold Limited (MGL) to assess the net percolation (NP) (or water ingress) rates into mine waste storage facilities (MWSFs) at the Bendigo-Ophir Gold Project (BOGP). The estimated water ingress rates will be used to support an assessment of environmental effects for the BOGP and support the resource consent application under the Fast Track Act Application.

EXECUTIVE SUMMARY

Higher NP is typically associated with increased Acid and Metalliferous Drainage (AMD) load and will therefore be a key influence on AMD water collection and treatment requirements to meet closure objectives at the BOGP. The Water and Load Balance Model (WLBM) developed for the BOGP will use NP estimates provided in this assessment to understand the project risks associated with downstream water quality and treatment needs.

Objectives of this Study

- Estimate a range of potential water ingress rates into the proposed MWSFs to support an assessment of environmental effects for the BOGP.
- Make recommendations for forward works to advance cover system designs and increase confidence in expected performance.

Findings

- During operations, the uncovered ELF, with relatively coarse texture and higher permeability material will result in high NP, estimated to be in the region of 60 to 80 % of annual precipitation.
- The proposed cover system can be categorised as a water store-and-release cover system. The main driving factors are the climate and texture of the proposed cover materials. Landform and vegetation aspects are not expected to significantly influence NP.
- NP for the covered ELF and TSF is estimated to range between 30% and 50% of annual precipitation.

- Data from Macraes (MWM, 2024) suggest lower NP may be possible, in the region of 10 to 20% of annual rainfall, but further work is required to demonstrate this is achievable at the BOGP.
- Cover system design elements such as thicker layers and/or lower permeability layers at the base of the cover system could be considered to achieve NP towards the lower range (e.g., NP of 20% of annual rainfall).
- Modelling to understand potential effects of the BOGP uses 20% NP. Further work is required to validate this assumption and comprehensive cover trials are required in the first few years of operations.

Recommended Forward Works

Following development of the BOGP, it is recommended that cover system field trials, dedicated cover monitoring, and focused material characterisation be initiated following approvals to improve confidence in post-closure cover system performance.

Ultimately, the understanding gained from these studies will improve estimates of closure costs, (especially post-closure water collection and treatment requirements and longevity) and convey to external stakeholders a level of understanding of the site that demonstrates a commitment to successful closure.

ASSESSMENT SCOPE

The scope of this assessment was to develop a range of NP estimates for the following MWSFs and BOGP phases:

- Mine rock Engineered Landform (ELF) during operations.
- ELF post-closure with a cover system constructed over the surface.
- Tailings Storage Facility (TSF) post-closure with a cover system constructed over the surface.

The current BOGP mine plan includes three ELF, Shepherds ELF, Western ELF and Srex (SRX) ELF. For the purposes of this assessment, it is assumed that they share similar characteristics that would influence NP, and thus it is proposed that a single range of estimated NP values is applicable for all ELFs. The TSF during operations was excluded from the scope as the water balance will largely be influenced by active tailings deposition / process water and water management practices.

The typical process followed in cover design is shown as a flow chart in Figure 1. The scope outlined in this assessment falls into the first two steps: (i) Site and Materials Characterisation and (ii) Conceptual Design, noting that the scope of this assessment is based on a cover system design provided by others (i.e., this document does not design the cover system, only assess potential performance of said design). The WLBM that will use the estimates of NP made in this assessment will allow for Impact Analysis to identify any noncompliance and/or unacceptable risk that may necessitate changes in the current cover system design.

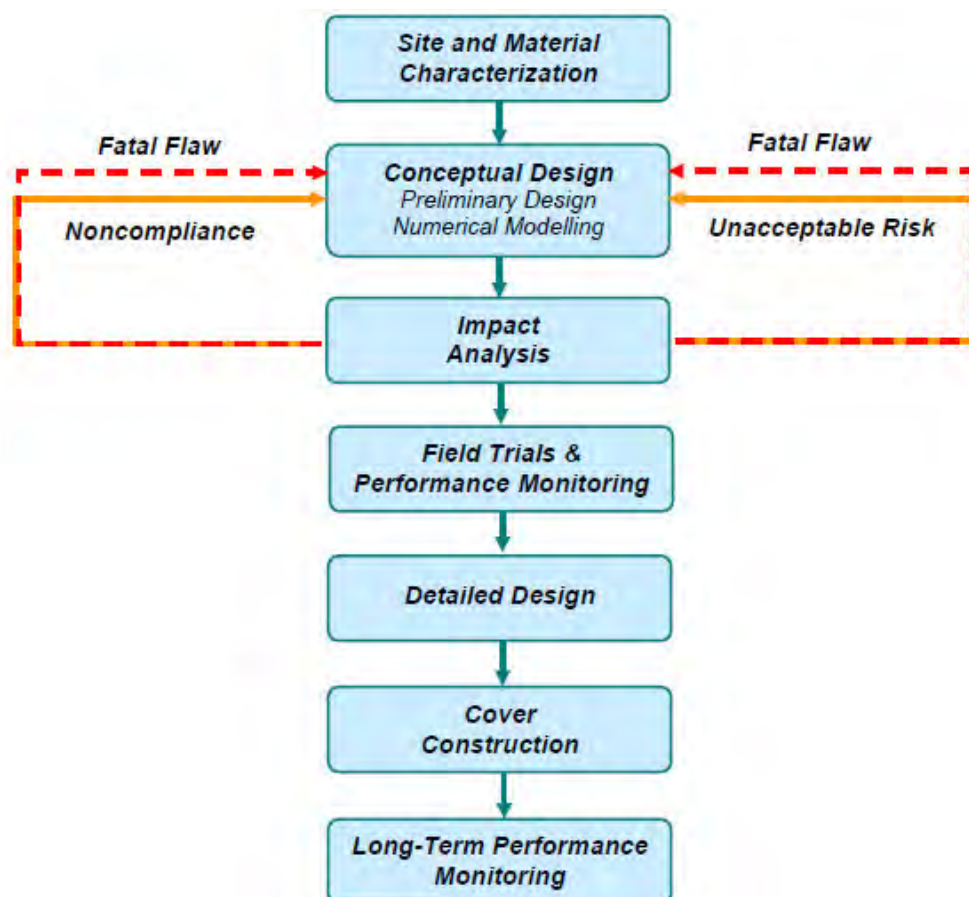


Figure 1: Typical cover design flow chart.

Source: MEND (2004).

CONCEPTUAL MODEL

This section describes key BOGP ELF material properties and aspects of the upper and lower boundary conditions used to estimate NP. ELF aspects are based on the Project Description (PD)¹ and discussions during a meeting² held with MGL and other subject matter experts.

For the purposes of this assessment, the term NP means infiltration of water that will migrate below the 'active zone' into the underlying mine waste material (see Figure 2). Within the near surface active zone, water can be subject to storage, transport, evaporation, or transpiration processes. Once NP has reached the mine waste, it could either be stored as moisture, report to groundwater, or emerge at the toe of the facility.

¹ Bendigo-Ophir Gold Project Description, Version 2. Dated 30 July 2024.

² In person meeting held 19 September 2024.

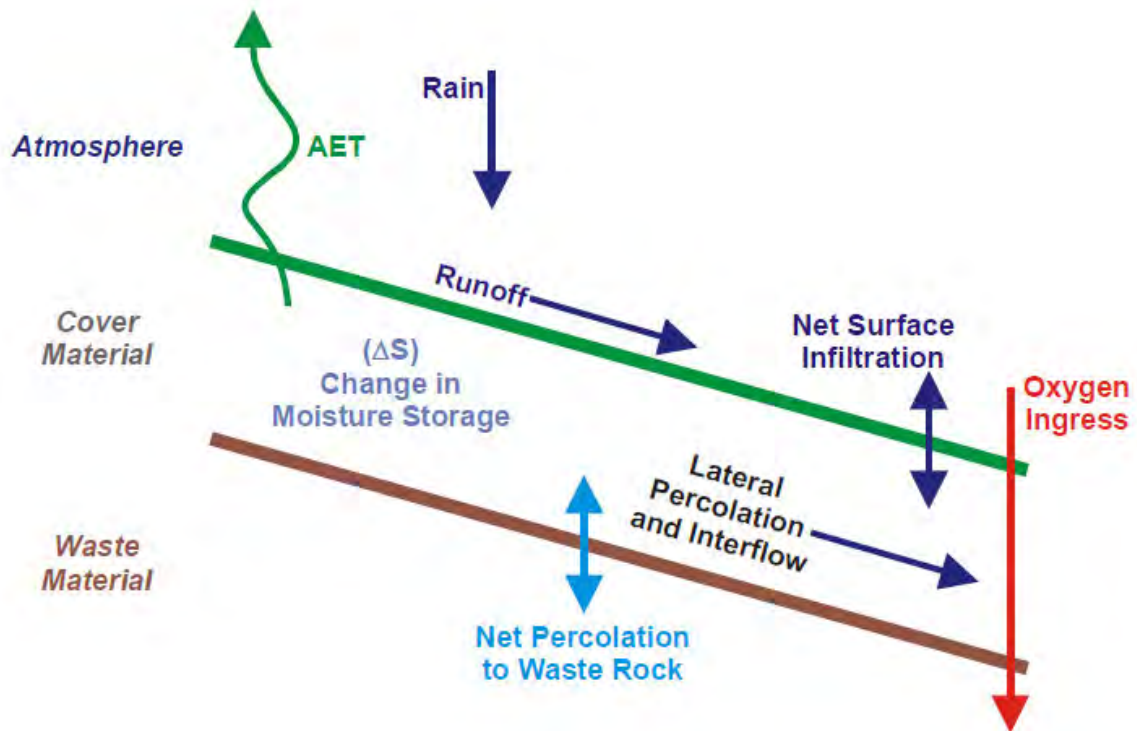


Figure 2: Net percolation conceptual illustration.

Source: MEND (2004).

Proposed Cover System

During operations, mine rock will be exposed during active placement. According to the PD, the ELF's will be built bottom up in small lifts that are end tipped with a dozer push to reduce segregation.

At closure both the ELF and TSF will have the following proposed cover system, from the top down, installed over the respective mine waste material (EGL, 2025).

- 0.2 m of topsoil/subsoil.
- 0.3 m of moderately weathered mine rock (commonly known as 'Brown Rock').

Given the upper boundary climate condition with a potential evaporation (PE) to precipitation ratio of 0.75, the cover system will reduce NP through the process of water store-and-release, where a proportion of precipitation is stored within the cover profile and then subsequently released back to the atmosphere through evapotranspiration.

Climate

At the BOGP, three meteorological stations have been installed across the project area at varying elevations. Data has been collected since November 2022. The SRX meteorological station data was used to characterise the climate for this assessment since it is at an elevation closest to where the ELF's will be positioned on the landscape. Other stations are positioned at lower elevations so are likely to be less representative, particularly for precipitation. In addition, these lower elevation stations experienced measurement malfunctions for solar radiation over a number of months in 2023.

Precipitation and PE are presented on a monthly basis in Figure 3. Precipitation was based on a synthetic rainfall record (Chater, 2024) developed for the Lake Clearview station (2006 to 2023, 17 years) and scaled to the SRX station elevation. Snowfall occurs anecdotally over winter (site meteorological stations do not measure snowfall or snowpack depth), but with mean monthly winter temperatures ranging between 2 to 5 °C, active ablation of the snowpack occurs. Overall, precipitation may be underestimated slightly, but unlikely enough to change the interpretation of climatic conditions relevant to this assessment.

PE was calculated with the Penman (1948) method, using site specific air temperature, relative humidity, wind speed, and solar radiation for the period available at the time of reporting (November 2022 through July 2025).

Calculating water surplus (Rainfall-PE)³ at different temporal scales provides an approximate indication of the climate's ability to remove water from a cover system through evapotranspiration processes (assuming negligible surface ponding or runoff). The cover systems with greater ability to store water would tend towards weekly to monthly scales and vice versa. Calculations for data between 22/11/2022 and 29/07/2025, were as follows:

- Monthly scale, 322 mm of water available for net percolation, or ~25% of rainfall that fell over this period (1,370 mm). 75% is returned to the atmosphere.
- Weekly scale, 582 mm of available for net percolation, or ~40% of rainfall. 60% is returned to the atmosphere.
- Daily scale, 1095 mm of available for net percolation, or 80% of rainfall. 20% is returned to the atmosphere.

The following observations are made based on the available climatic data:

- Based on the Köppen-Geiger classification, the climate can be characterised as temperate, without a dry season, and as having a warm summer (Cfb). Mean annual air temperature is 8 °C. Without a dry season, the process of water store-and-release will be muted over the winter where there is an observed decrease in PE.
- On an annual basis, precipitation (P) is approximately 510 mm while PE is approximately 815 mm. On average, the annual PE:P ratio is 1.6, and typically ranges between 1.3 and 2.0 over the 17-year rainfall record (PE was assumed constant given the lack of data).
- The climate is relatively dry, with a strong energy surplus (PE>P) present between September through March, and an energy deficit (PE<P) over the remainder of the year, most notably over winter.
- For cover systems that have a favourable ability to store water, 60 to 75% of infiltrating water could be removed through evapotranspiration (assuming negligible surface ponding or runoff). Conversely, cover systems that have a poorer water ability to store water (i.e., thin covers), 20 to 60% of soil water could be removed.

³ Where PE>Rainfall, water surplus is set to zero.

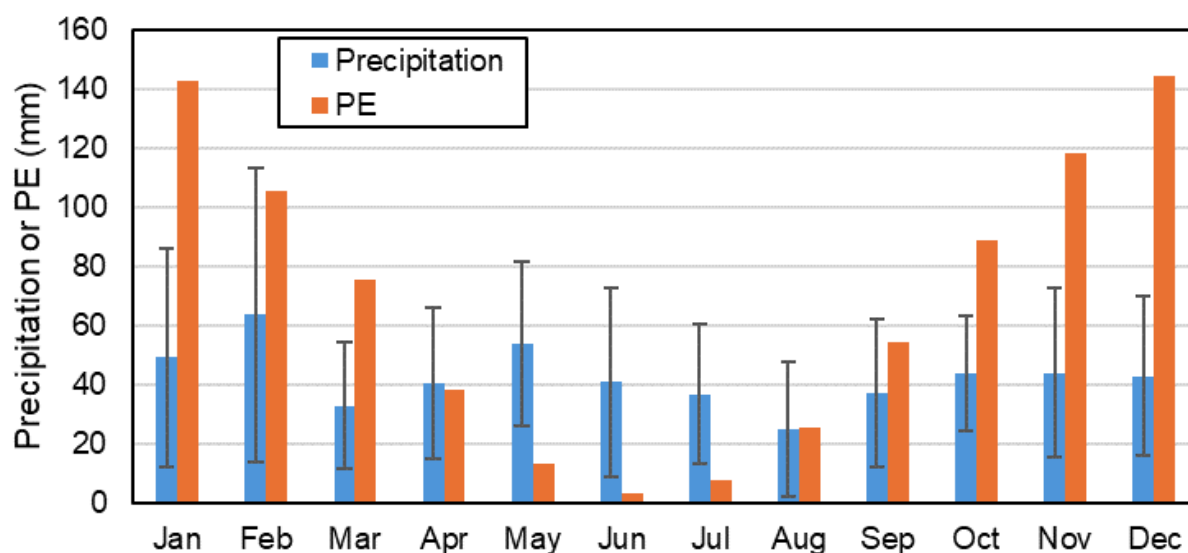


Figure 3: Monthly precipitation and PE summary.

PE=Potential Evaporation. Bars show monthly averages while error bars show rainfall standard deviation over period of record.

Material Properties

Site-specific reclamation and waste material physical material properties are not available. Based on the nearby Macraes Mine, which has a similar climate (mean annual rainfall of approximately 600 mm) and similar geological setting, mine rock is expected to be relatively coarse textured, with a high surface infiltration rate and hence reduced potential for runoff generation.

In the absence of site-specific data, the following is assumed:

- Topsoil: When stripped, it is likely to be a mixture of topsoil and upper weathered bedrock horizon. Site visit observations suggest in-situ soil is well graded and loamy (Figure 4). For the purposes of this assessment the topsoil layer is assumed to be representative of a loamy sand material, with 20% fines and relatively moderate saturated permeability ($k=10^{-5}$ m/s).
- Brown Rock: Mine rock overburden with a moderate degree of weathering, will be relatively coarse, well graded, with limited clay and silt sized particles (fines) (potentially less than 10%⁴) with and estimated saturated hydraulic conductivity of 1×10^{-4} m/s.

⁴ Provided by E. Torvelainen of Engineering Geology Limited via email 11 November 2024.



Figure 4: Topsoil (in-situ) example.

Landform

The project layout and ELF's are shown Figure 5. The following landform relevant details are highlighted:

- The ELF's and TSF will be positioned in the valley bottoms of incised valleys.
- Post-closure, the ELF's are expected to have a relatively flat top surface with minor slope to direct any runoff generated to manage water. The batter slopes of the ELF landforms will be 3(H):1(V). All ELF's will have a mixture of north, south, east and west aspects.
- Post-closure, the TSF will be relatively flat, with minor slopes to direct any runoff generated to the north side to the clean water diversion drain which is ultimately conveyed past the Shepherd's ELF back to the valley bottom downstream of the ELF toe.
- Post-closure, the ELF's will be sloped to convey any runoff that is generated off the landforms. The TSF drainage condition post-closure will be drained.

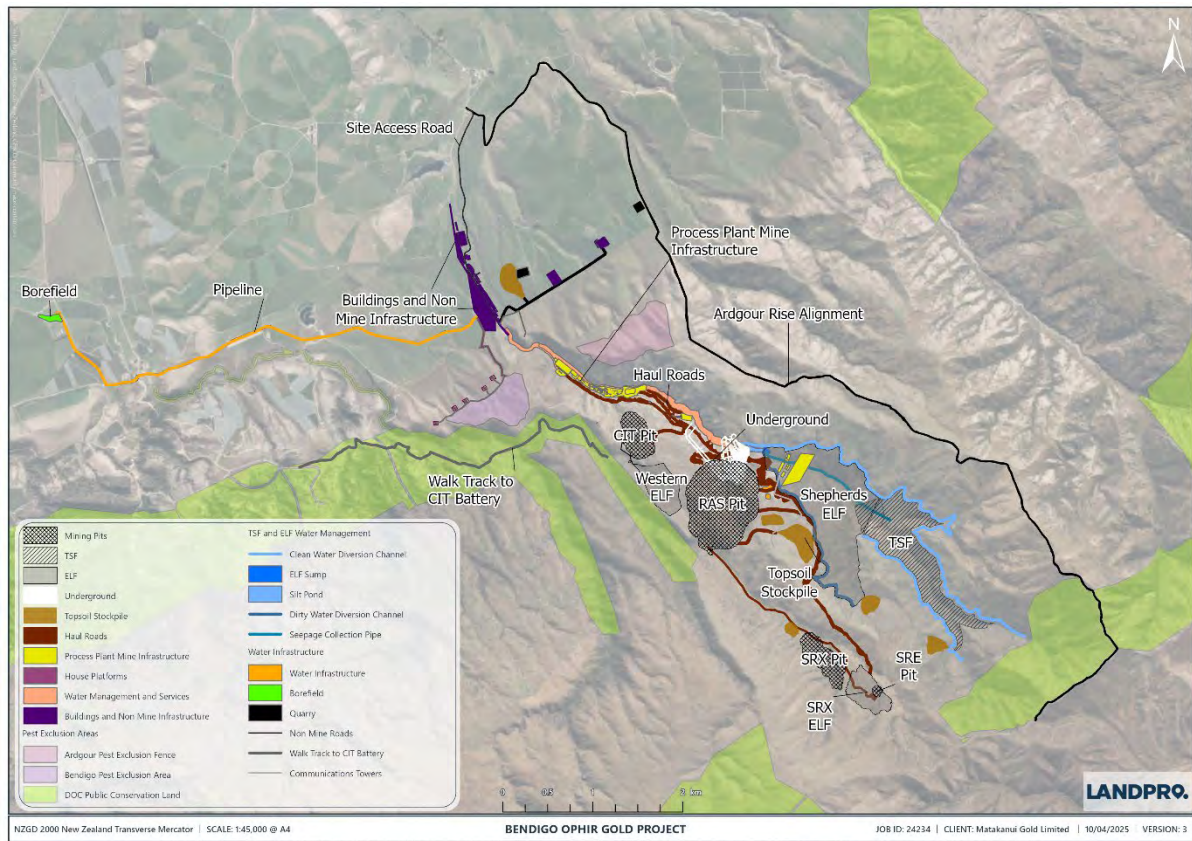


Figure 5: BOGP layout showing the TSF, Shepherds ELF, Western ELF, and SRX ELF.

Source: MGL Project Description.

Vegetation

Post-closure vegetation established over the cover systems is anticipated to be similar to the existing vegetation, notably a mixture of pasture and tussock. An example of this vegetation is shown in Figure 6.

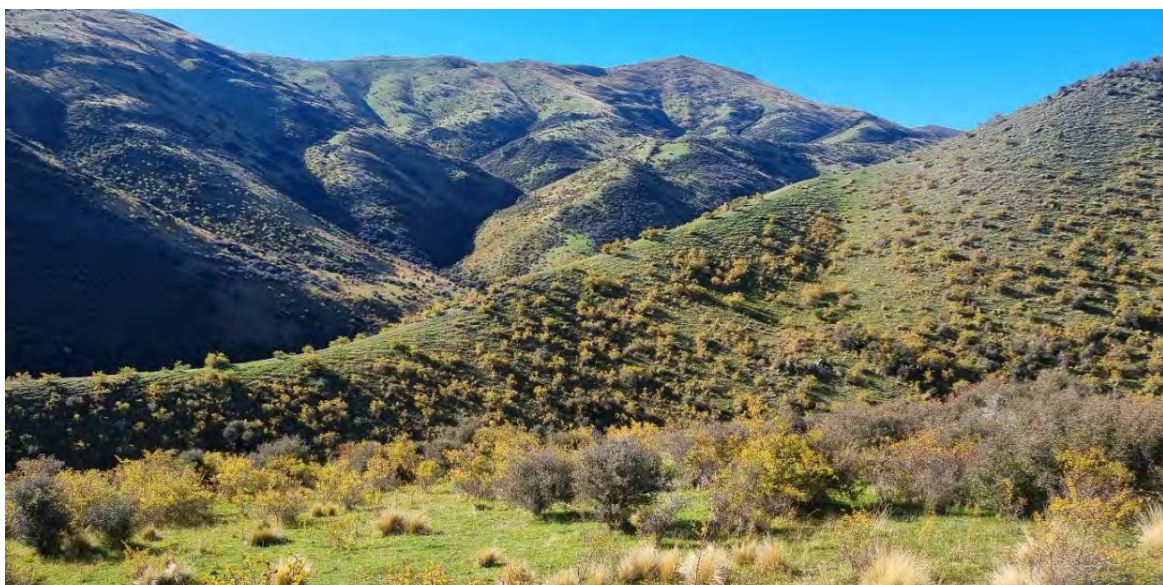


Figure 6: Existing vegetation examples for the region.

Looking approximately east.

ASSESSMENT FINDINGS

Exposed ELFs (Operations)

Although the BOGP climatic setting suggests that there is potential for PE to lower NP into exposed (or uncovered) ELF, the likely coarse texture, inferred high permeability and limited water retention capacity of the mine rock, coupled with the upper climate boundary condition, suggests a relatively high expected NP. Williams (2008) collated and reviewed worldwide data on NP into waste rock dumps and found it ranges between 50 and >85% of annual rainfall.

The bottom-up ELF construction would produce running surfaces on each lift, but the permeability needed to start appreciably diverting runoff and reducing NP, would be challenging to achieve in a consistent manner given the anticipated physical properties of the mine rock.

On balance, NP for the exposed ELF is expected to range between 60% to 80% of annual precipitation.

Rehabilitation Cover System for ELF and TSF (Post-Closure)

Industry guidance is useful to place the climatic setting into the context of expected performance for different types of cover systems. For a temperate climate and a water store-and-release cover system, INAP (2017) suggest NP performance can be expected to range between 15% to 50% of mean annual precipitation. An enhanced water store-and-release or barrier type system would likely be required to reduce NP below this range given the Köppen-Geiger Cfb climate classification.

The GARD Guide (INAP, 2014) define cover system type suitability based on climatic setting, as shown in Figure 7. Based on a PE:P ratio of 1.7, ranging between 1.3 and 2 (shown in red on Figure 7), the GARD Guide (INAP, 2014) suggests that water store-and-release cover systems are targeted for climates with a PE:P of greater than 2 and as such a cover system that includes some form of infiltration control (e.g., enhanced store and release, low permeability barrier, etc.) would improve performance (i.e., lower NP).

Williams (2008) also compiled and reviewed worldwide data on NP performance for cover systems. For water store-and-release covers, the reported NP performance was approximately 15% or less. However, these types of systems were used in more arid sites in Australia and USA, and the cover systems were much thicker (2 m or more) than proposed for the BOGP, allowing for more water store-and-release prior to NP. For example, NP for a 2 m thick store-and-release system at the Mt. Whaleback Mine in Western Australia (with a stronger PE:P ratio of roughly 8) was reported to achieve a NP of 5% to 15 % of annual rainfall. Note the influence of material texture is not factored into this comparison given the lack of data. For example, thinner covers with finer texture material can perform better than thicker and coarser material. On balance, the lower BOGP PE:P ratio suggests higher rates of NP as compared to performance observed at more arid sites as reported by Williams (2008).

MWM (2024) estimated NP into the Frasers West Waste Rock Stack at Macraes Mine to be about 12% of annual rainfall.

Factors from the conceptual model influencing potential NP ranges are summarised in Table 1. Overall, based on currently available data, it is expected the proposed cover system, a relatively thin water store-and-release cover system with relatively permeable material, will achieve a NP performance in the range of 30 to 50 % of annual precipitation. Data from Macraes (i.e., MWM, 2024) suggest lower NP in the range of 10 to 20% of annual rainfall may be possible, but further work is required to

demonstrate this is achievable (see the Recommendations section for further details). Cover system design elements such as thicker layers and/or lower permeability layers at the base of the cover system could be considered to achieve NP towards the lower range (e.g., NP of 20% of annual rainfall).

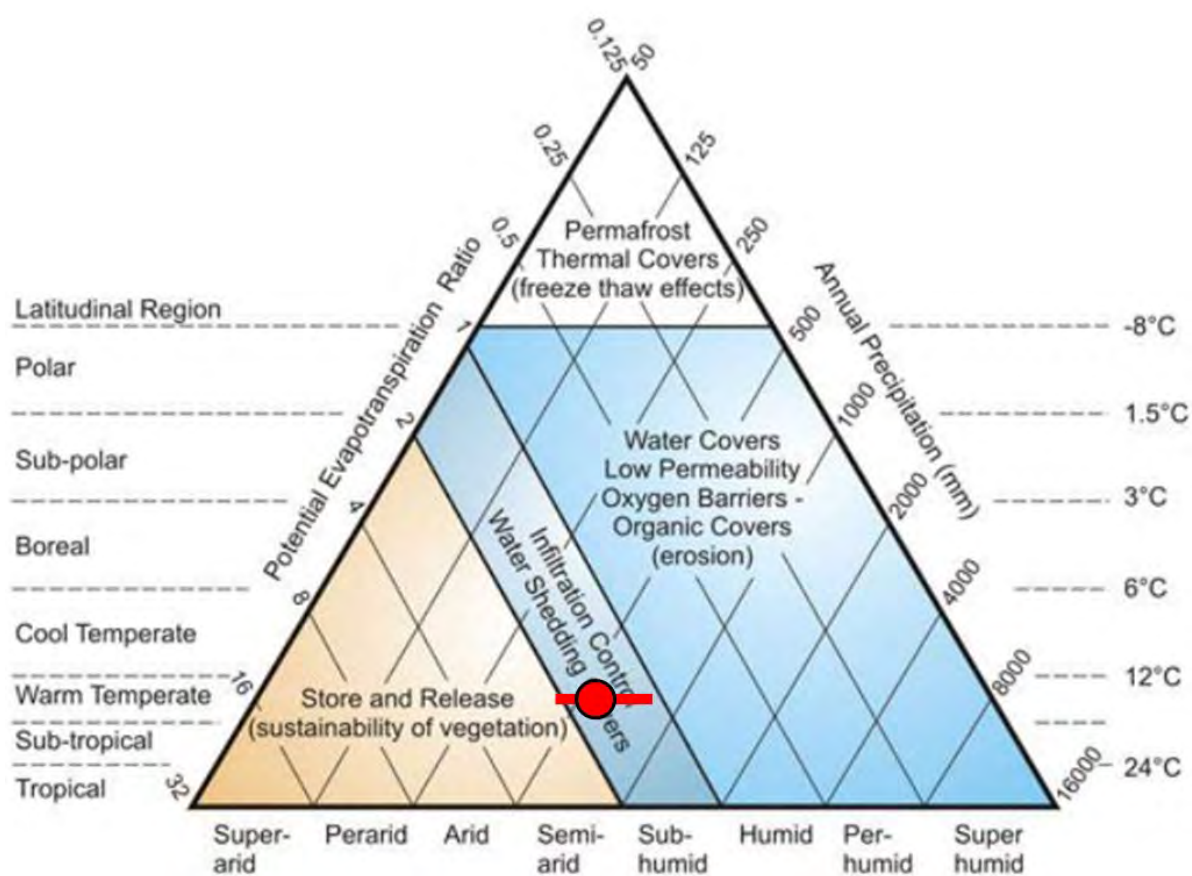


Figure 7: Climatic conditions to support water store-and-release cover systems.

Note: the red circle represents the long term annual average climatic conditions, while the bar show the typical annual variability.

Source: INAP (2014).

Table 1: Estimated performance of a water store-and-release cover system.

PARAMETER	REMARK	NET PERCOLATION
Climate	- Temperate, without dry season, warm summer (Cfb). - Gard Guide recommends barrier type cover system. - The estimated performance based on INAP (2017) seems reasonable.	20% to 50%
Materials	- Cover material to be moderately weathered coarse mine rock and topsoil with modest fines content, possible less than 20%, with limited clay minerals. - Nominally thin cover profile with reduced water storage. - This would support a NP towards the higher end of the range from climate alone.	Lower NP estimate scaled upward based on materials to 30% to 50%
Landform	- Landform unlikely to have high degree of influence on NP due to anticipated relatively high surface permeability. Range unchanged from materials. - Both the ELF and the TSF are largely flat or north facing, so likely have similar PE. - ELF has steeper slopes while TSF is much flatter so runoff likely higher for ELF. - Overall, ELF NP could be lower than that of the TSF but may not be substantially different if surface permeability is relatively high. - Long-term lower boundary condition within the TSF not considered assessment.	Landform not considered to change estimated NP range 30% to 50%
Vegetation	- Mixture of grassland and evergreen species. - Vegetation will promote evapotranspiration during the growing season however this may be limited due to the relatively coarse textured cover material and low winter PE. - Overall, vegetation is unlikely to greatly influence NP compared to other parameters.	Vegetation considered to be healthy and not increase NP range 30% to 50%

CONCLUSIONS

Findings from the NP assessment for the uncovered and covered MWSFs are as follows:

- During operations, the uncovered ELF, with relatively coarse texture and higher permeability material will result in high NP, estimated to be in the region of 60 to 80 % of annual precipitation.
- The proposed cover system can be categorised as a water store-and-release cover system. Industry guidance (INAP, 2014, 2017) suggest it will not perform as well as infiltration control type systems due to the reduced atmospheric demand for water over the winter period.
- Post-closure, NP for the covered ELF and TSF is estimated to range between 30% and 50% of annual precipitation. The main driving factors are the climate and texture of the proposed cover materials. Landform and vegetation aspects are not expected to significantly influence NP.
- Data from Macraes (MWM, 2024) suggest lower NP may be possible, in the region of 10 to 20% of annual rainfall, but further work is required to demonstrate this is achievable at the BOGP. Cover system design elements such as thicker layers and/or lower permeability layers at the base of the cover system could be considered to achieve NP towards the lower range (e.g., NP of 20% of annual rainfall).

- Given the ELF's have greater proportions of north facing slopes that will increase PE, and have steeper slope angles that would increase runoff, NP for the ELF could be lower than the TSF (valley bottom position and flat slopes). However, if surface permeabilities are relatively high as anticipated, the difference in NP may not be substantial.

RECOMMENDATIONS

If further studies indicate improved cover system performance is required, in terms of treatment requirements or downstream water quality, the following recommendations can be considered:

- Material textural properties are based on anecdotal evidence and could be finer texture than currently assumed. In general, finer textured materials would tend to improve NP performance (i.e., reduce estimated NP toward the lower end of ranges provided). As such, incorporation of site-specific particle size distribution data would refine the assessment.
- Numerical simulations are completed to better assess sensitivity to the upper and lower boundary condition and material properties on simulated performance. Modelling may be able to demonstrate more favourable performance (i.e., expected performance is closer to 30% of annual precipitation than 50%).
- Alternate cover system designs could be considered. For example, thicker cover layers, enhanced water store-and-release systems, or low permeability barrier type systems would improve expected performance.

Following development of BOGP it is recommended that cover system field trials, dedicated monitoring, and focused material characterisation be initiated following approvals to improve confidence in post-closure cover system performance and allow for detailed design (i.e., as shown in Figure 1).

Ultimately, the understanding gained from these studies will improve estimates of closure costs, (especially post-closure water collection and treatment requirements and longevity) and convey to external stakeholders a level of understanding of the site that demonstrates a commitment to successful closure.

CLOSING REMARKS

Please do not hesitate to contact Paul Weber at [REDACTED] or [REDACTED] should you wish to discuss this memorandum in greater detail.

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**APPENDIX L ENGINEERED LANDFORM WATER QUALITY FORECAST
REPORT**

Engineered Landform Water Quality Forecast Model Report

Bendigo-Ophir Gold Project

13 September 2025

J-NZ0457-002-R-Rev1



MATAKANUI
GOLD LIMITED 

Engineered Landform Water Quality Forecast Report

Bendigo-Ophir Gold Project

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EXECUTIVE SUMMARY

Mine Waste Management Limited (MWM) has prepared this report on the geochemical modelling of the proposed engineered landforms (ELFs) at the Bendigo-Ophir Gold Project (BOGP) for Matakanui Gold Limited (MGL) to understand potential effects on water quality from these mine domains. The modelling supports proactive source control and provides a foundation for sustainable waste rock management, aligning with INAP¹ (2024) principles for long-term environmental stewardship. Data are used in the water and load balance model (MWM, 2025b) to understand the effects on the receiving environment and provide improved management opportunities for ELF seepage.

Objectives of this Study

The purpose of this report is to present the geochemical modelling undertaken to estimate seepage water quality for the Shepherds ELF, SRX ELF, Come in Time (CIT) Backfill, West ELF, and Shepherds Creek (SCK) Fill during operations and during the active closure and post closure phases of the BOGP. The objectives of this report are as follows:

- Develop a conceptual geochemical model for each ELF.
- Estimate water quality seepage from the ELFs during operations and the active closure and post closure phases of the BOGP.
- Provide recommendations for management of ELF seepage based on model results.

Findings

MGL will place waste rock in ELFs to minimise long term risks associated with sulfide mineral oxidation and the release of potential constituents of concern (PCOC). Further details on the design philosophy for ELFs are provided in MWM (2025f)

The materials associated with the BOGP will generate neutral metalliferous drainage and may have elevated PCOC such as arsenic (As), sulfate, (SO₄), and trace metals. Nitrogenous compounds are also likely to be elevated. Collectively the waters are referred to as mine impacted waters (MIW).

If waste rock was managed by traditional waste rock stack construction methods that did not manage advective oxygen ingress along basal rubble zones created by high tipheads (>10 – 20 m in height) and grainsize segregation, then Shepherds WRS seepage water quality could be > 6,000 mg/L sulfate. By minimising oxygen ingress to the outer 20 m of the proposed ELFs, a significant reduction in sulfate (and other PCOC) are expected.

Modelling indicates that peak sulfate concentrations for the Shepherds ELF could be reduced by ~80% to approximately ~1,120 mg/L by using best practicable management methods for waste rock storage.

Management

This study has identified and recommends the following management opportunities that will minimise the long-term risks to water quality for waste rock storage at the BOGP:

¹ International Network for Acid Prevention: <https://www.inap.com.au/acid-drainage>

- Proceed with the proposed ELF design, ensuring low As TZ3 materials encapsulate high-sulfur materials (TZ4) to minimise oxygen ingress.
- Proceed with short lift heights at 5 m height and confirm that grainsize segregation is minimised and that oxygen is reduced to < 5% after 10-20 m horizontal distance into the ELF and that the oxygen profiles (from oxygen probe monitoring) demonstrate that oxygen ingress is diffusion controlled. Higher heights may be possible if advective oxygen ingress is prevented by engineering controls.
- Install cover systems to further mitigate risks as the final landform is created. Consider cover systems to minimise net percolation as this is a key driver of long term PCOC load.
- Establish a comprehensive monitoring program for water quality, oxidation rates, and cover system performance. Adapt management strategies based on observed trends and evolving conditions.
- Continue validating laboratory-to-field scaling factors using site-specific data, particularly for TZ3 and TZ4 materials, to refine long-term predictions.

General Background

MGL is proposing to establish the BOGP, which comprises a new gold mine, ancillary facilities and environmental mitigation measures on Bendigo and Ardgour Stations in the Dunstan Mountains of Central Otago. The project site is located approximately 20 km north of Cromwell and will have a maximum disturbance footprint of 550 hectares.

The total Mineral Resource Estimate for the BOGP using a 0.5 g/t cut-off for open pit and 1.5 g/t for underground is 34.3 Mt at 2.1 g/t for 2.34 M oz (MGL, 2025). The Bendigo-Ophir resources occur in four deposits: Come in Time (CIT), Rise and Shine (RAS), Srex (SRX), Srex East (SRE). The majority of identified mineral resources are located within the RAS deposit. Three primary geological units are recognised at site:

- RSSZ – Rise and Shine Shear Zone
- TZ3 – Lower Greenschist facies Textural Zone 3 rocks of the Otago Schist
- TZ4 – Upper Greenschist facies Textural Zone 4 rocks of the Otago Schist

The resources will be mined by open pit methods at each deposit within the project site, with underground mining methods also proposed to be utilised at RAS to access the deeper gold deposits. The majority of the mining activities, ancillary facilities and associated infrastructure will be located in the Shepherds Valley – which includes a conventional carbon-in-leach (CIL) gold processing plant and water treatment plant, a tailing storage facility, three engineered landforms, internal haul roads, topsoil stockpiles, water pipelines, underground utilities and electrical supply - with non-operational infrastructure located on the adjoining Ardgour Terrace. The BOGP also involves the taking of groundwater from the Bendigo Aquifer for use in mining-related activities and the realignment of Thomson Gorge Road via Ardgour Station.

The proposed BOGP will include the following components:

- Open pits targeting the RAS, SRX, SRE, and CIT deposits.

- An underground mine targeting the RAS deposit.
- Three ex-pit engineered landforms (ELFs) – Shepherds ELF, SRX ELF, and West ELF (WELF).
- Two in-pit landforms (backfill) – CIT and SRE ².
- Plant and processing area, where CIL extraction technologies will be used as part of the ore recovery process. This includes ~ 5 m of TZ3 fill and is referred to as SCK Fill.
- A tailings storage facility (TSF) and TSF Embankment.
- Other ancillary support services / structures (e.g., roads, water management infrastructure, water treatment plants, etc).

Mine Impacted Water

A geochemical model is required to understand the effect on the receiving environment of the MIW and forecast the water quality from the proposed ELFs, as traditional waste rock stacks (WRS) generally represent the greatest source of contaminants for any mining project (e.g., INAP, 2020).

Model Development

The following modelling methods were used:

Data and Methodology: The geochemical model risks were informed by data from acid-base accounting (ABA), total sulfur analysis, and chemical assay of waste rock samples, as well as AMIRA (2002) column leach test (CLT) data. The geochemical behaviour was modelled under three scenarios:

1. A traditional WRS with high lift heights and complete oxidation of materials: This model was used to calibrate the model water quality estimates to empirical datasets.
2. An ELF constructed with limited oxygen ingress – 10 m horizontal oxidation shell.
3. An ELF constructed with limited oxygen ingress – 20 m horizontal oxidation shell.

Sulfur Reservoir Estimation: Reactive fractions of waste rock within the WRS and ELF models were defined, using a non-reactive fraction of 0.9 to account for field-scale mineral accessibility ³. Sulfur reservoirs were split into stored oxidation products (SOP) and long-term sulfide sources that was based on CLT data.

Oxidation and Release Rates: Sulfate and metal release rates were calculated for the TZ3 and TZ4 lithological units from CLT data. CLT data showed that TZ4 was found to release sulfate at a rate six times higher than TZ3 due to its higher sulfur content and mineral reactivity.

Time Lag to Peak Concentration: A delay between waste rock placement and peak solute concentrations reporting as seepage from the structures is expected. Peak sulfate concentrations, a function of average ELF height, were determined for Shepherds ELF (~27 years), SRX ELF (~5 years),

² Note: SRE Pit is backfilled by the SRX ELF.

³ This non-reactive fraction is comparable to international literature (e.g., Linklater et al., 2017).

CIT ELF (~4 years), WELF (~10 years), and SCK Fill (~3 years) based on analogue data from Macraes (e.g., MWM, 2024a).

Adjustment Factors: To align lab results with analogue data from Macraes, a release rate adjustment factor of 0.8575 was applied to oxidising materials (i.e., 10% of the materials in the WRS). These adjustments allowed the model to simulate realistic peak sulfate concentrations for a traditional WRS (e.g., ~6,200 mg/L for Shepherds WRS).

Mobilisation: Oxidation products are driven by net percolation, which has been estimated at 20% of rainfall (MWM, 2025c).

Solubility Controls: PHREEQC geochemical modelling (Parkhurst and Appelo, 2003) was used to apply mineral solubility limits and simulate precipitation of secondary minerals. Assumptions included dolomite buffering and elevated CO₂ in porewaters (due to carbonate dissolution within the WRS / ELF).

Summary

The study indicates that:

- Water quality is expected to be circum-neutral pH with low acidity. This is due to the abundance of carbonate minerals and a low sulfide content.
- When the results for the two scenarios overlap (e.g., 10 m and 20 m oxidation zones), it indicates that the solutes originate from short-term release, where oxidation has no impact on the results, and therefore, results are the same.
- The first 50 years are strongly influenced by the short-term release of SOP. This is particularly evident for nitrate-nitrogen (NO₃-N), boron (B), cobalt (Co), and zinc (Zn), which are generally elevated and are associated with SOP (see Table 14). Reducing water ingress would reduce the rate that these PCOC are mobilised.
- Sulfate concentrations are > 500 mg/L for the Shepherds ELF, SRX ELF, and WELF. Sulfate concentrations are < 500 mg/L in the CIT backfill and the SCK Fill.
- Nitrate-N concentrations are > 2.4 mg/L in seepage from all waste rock disposal areas. Duration of elevated nitrate in seepage is expected to range from 25 – 100 years but may be shorter due to biogeochemical processes that would remove the nitrate.
- Results indicate that the following trace metals: Co, Mo, Mn, Se, Sb, Sr, U, and Zn, are generally over the respective water quality reference limits.
- Results indicate that Al, B, Cd, Cr, Cu, Hg, and Pb, are below the respective water quality reference limits in all cases. These PCOC are not considered an issue for this mine domain.
- Constant concentrations are assumed for As (0.2 mg/L) and Fe (7.6 mg/L) based on empirical data for sub-oxic conditions (e.g., Globe Progress Waste Rock Stack, Hayton et al., 2022). These concentrations are above the proposed water quality reference limit (Ryder, 2025) and will require management. The SCK Fill assumes full oxidation, which results in low Fe concentrations.

Conclusions

- ELF construction to limit oxygen ingress significantly improve water quality outcomes over traditional WRS by limiting oxygen ingress and reducing the oxidation of higher sulfur materials.
- Net percolation rates drive the mobilisation of soluble contaminants.
- This modelling supports proactive source control and provides a foundation for sustainable waste rock management, aligning with INAP (2024) principles for long-term environmental stewardship.

Performance Monitoring

- Confirm the sulfur content of materials placed in the ELF ensuring that lower sulfur TZ3 materials are placed on the outside of the ELF. Testing should include shake-flask testing to validate the quantity of sulfate and nitrogenous compounds present in blasted rock.
- Confirm that oxygen ingress is excluded from the core of the ELF by the construction of oxygen probes into each lift during construction of the ELF.
- Confirm water quality for ELF seepage aligns with geochemical models including sulfate and nitrate. Update models where significant differences are observed.
- The geochemical model relies on laboratory data and analogue assumptions; field validation is required. The model requires updating once the CLT is complete as early data can bias results towards higher loads.
- If performance monitoring indicates unacceptable loads, then adaptive management options should be considered including additional source control actions (e.g., engineered cover systems), reducing oxidation depth to 10 m into the ELF, a longer period of active treatment and/or the development of passive treatment systems to manage the PCOC concentrations and loads.

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1 INTRODUCTION

Mine Waste Management Limited (MWM) has prepared this report on the geochemical modelling of the proposed engineered landforms (ELFs) at the Bendigo-Ophir Gold Project (BOGP) for Matakanui Gold Limited (MGL) to understand potential effects on water quality from these mine domains. The modelling supports proactive source control and provides a foundation for sustainable waste rock management, aligning with INAP⁴ (2024) principles for long-term environmental stewardship. Data are used in the water and load balance model (MWM, 2025b) to understand the effects on the receiving environment and improved management opportunities for ELF seepage.

1.1 Project Description

MGL is proposing to establish the BOGP, which comprises a new gold mine, ancillary facilities and environmental mitigation measures on Bendigo and Ardour Stations in the Dunstan Mountains of Central Otago. The project site is located approximately 20 km north of Cromwell and will have a maximum disturbance footprint of 550 hectares.

The total Mineral Resource Estimate for the BOGP using a 0.5 g/t cut-off for open pit and 1.5 g/t for underground is 34.3 Mt at 2.1 g/t for 2.34 M oz (MGL, 2025). The Bendigo-Ophir resources occur in four deposits: Come in Time (CIT), Rise and Shine (RAS), Srex (SRX), Srex East (SRE). The majority of identified mineral resources are located within the RAS deposit. Three primary geological units are recognised at site:

- RSSZ – Rise and Shine Shear Zone
- TZ3 – Lower Greenschist facies Textural Zone 3 rocks of the Otago Schist
- TZ4 – Upper Greenschist facies Textural Zone 4 rocks of the Otago Schist

The resources will be mined by open pit methods at each deposit within the project site, with underground mining methods also proposed to be utilised at RAS to access the deeper gold deposits. The majority of the mining activities, ancillary facilities and associated infrastructure will be located in the Shepherds Valley – which includes a conventional carbon-in-leach (CIL) gold processing plant and water treatment plant, a tailing storage facility, three engineered landforms, internal haul roads, topsoil stockpiles, water pipelines, underground utilities and electrical supply - with non-operational infrastructure located on the adjoining Ardour Terrace. The BOGP also involves the taking of groundwater from the Bendigo Aquifer for use in mining-related activities and the realignment of Thomson Gorge Road via Ardour Station.

The proposed BOGP will include the following components:

- Open pits targeting the RAS, SRX, SRE, and CIT deposits.
- An underground mine targeting the RAS deposit.
- Three ex-pit engineered landforms (ELFs) – Shepherds ELF, SRX ELF, and West ELF (WELF).
- Two in-pit landforms (backfill) – CIT and SRE⁵.

⁴ International Network for Acid Prevention: <https://www.inap.com.au/acid-drainage>

⁵ Note: SRE Pit is backfilled by the SRX ELF.

- Plant and processing area, where CIL extraction technologies will be used as part of the ore recovery process.
- A tailings storage facility (TSF) and TSF Embankment.
- Other ancillary support services / structures (e.g., roads, water management infrastructure, water treatment plants, etc).

These facilities will be placed in the catchment of Shepherds and Bendigo creeks (Figure 1).

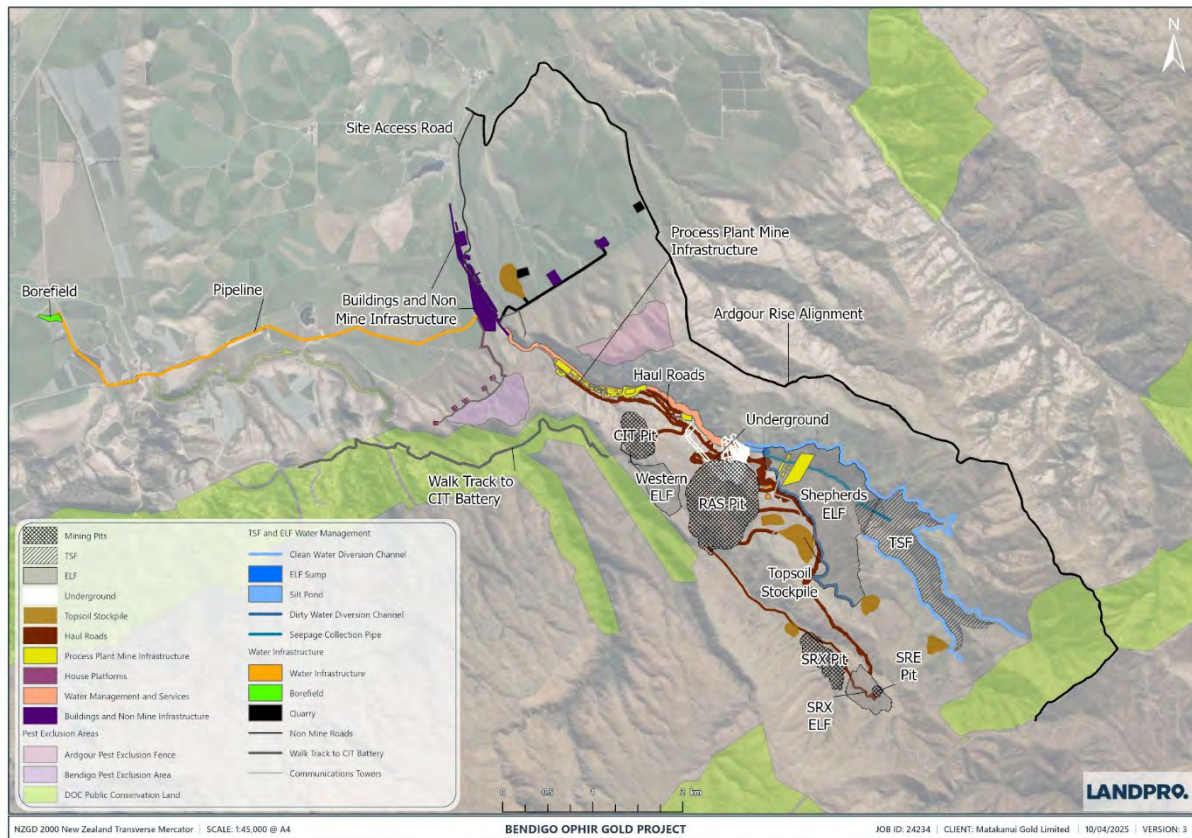


Figure 1. Bendigo-Ophir Gold Project Infrastructure

1.2 Geology

1.2.1 Regional Geology

The Dunstan Mountains are an uplifted block of the Otago Schist tilted to the northwest with remnants of a Cretaceous peneplain well preserved on its northern slopes. The Otago Schist is formed from sedimentary and minor intermediate volcanics and volcanoclastics of the Caples and Torlesse tectono-stratigraphic terranes. Greenschist facies rocks of the Otago schist are sub-divided into four textural zones based on mineralogy and mineral textures. Peak metamorphic grades in the Otago Schist occurred during the Jurassic when the Zealandia micro continent formed the outboard subduction complex of the Gondwana continental margin.

The regional geology of the Central Otago goldfields surrounding the BOGP consists of chlorite and biotite schists. The Rise & Shine Shear Zone (RSSZ), a late metamorphic deformation zone (Cox et al., 2006), runs through the project site dipping at 20-30 degrees northeast. The RSSZ occurs in the

Textural Zone 4 (TZ4) schist in close association with the Thomsons Gorge Fault, which cuts and truncates the RSSZ against the unmineralised TZ3 schist (Cox et al., 2006). There is no mineralisation associated with the TGF itself, and Au mineralisation had ceased by the time of formation of the TGF (c. 100 Ma) (Cox et al., 2006).

1.2.2 BOGP Geology

Gold mineralisation occurs along the Rise and Shine Shear Zone (RSSZ) within the Otago Schist. The Rise and Shine Shear Zone (RSSZ) has been traced for 1.7 km north-northeast beneath the unconforming TZ3 cover rocks with the bulk of the mineralisation sitting beneath 150-300 m of the lower sulfur cover rock (TZ3). The flat lying and flat plunging deposit sits within a zone up to 400 m wide and can be up to 90 m in thickness (typically 30 – 40 m).

The Thomson Gorge Fault is a post metamorphic, post mineralisation cataclastic fault zone developed primarily along the hanging wall of the RSSZ. It separates chlorite rich, TZ3 schists in the hanging wall from biotite rich TZ4 schists in the shear zone and foot wall. The main mineralisation at RAS is associated with silica-siderite/ankerite alteration with minor arsenopyrite sulfides associated with the gold. In some areas a cataclastite (brecciated) network of anastomosing, post-metamorphic quartz, occur with minor sulfide veins in a halo of the core mineralisation. Allibone (2023) also identified the presence of sphalerite ((Zn,Fe)S) and galena (PbS) at the BOGP.

Locally, a number of splay faults are interpreted coming off the main RSSZ structure which give a sense of structural control. These are also mineralised and are traceable for 10s to 100s of metres. Gold occurs as free gold particles, typically up to 400 µm but with some coarser visible gold. A minor gold component occurs associated with the arsenopyrite grains, but it is typically not in solid solution, giving rise to the free milling and highly gravity recoverable components expressed by metallurgical testing.

1.3 Environmental Geochemistry

The BOGP gold deposit is located within the Otago Schist, near Cromwell, New Zealand, and is associated with the mineralised Rise and Shine Shear Zone (RSSZ). Gold mineralisation within the RSSZ and TZ4 is dominated by elevated sulfur (S) and arsenic (As) (e.g., the mineral arsenopyrite) compared to TZ3 materials

The mineralisation associated with the BOGP and natural weathering of the gold deposit has contributed to baseline water quality being elevated in some metals, which has been exacerbated by historical legacy mining activities, leading to streams in the project area being enriched in potential constituents of concern (PCOC) that include for instance, As, Co, Cu, Fe, U, and Zn that are elevated compared to proposed resource consent water quality limits (Ryder, 2025) and some others identified as being elevated on an infrequent basis such as Al, Cd, Mn, Pb, Sr, and Tl. Similarly, groundwaters are elevated in Sr.

Studies indicate that the rocks associated with the project (TZ3, TZ4, and RSSZ) will not generate acid rock drainage with >350 samples tested by industry accepted acid base accounting (ABA) techniques (e.g., AMIRA, 2002). This is a function of the high acid neutralisation capacity (ANC) of the rocks associated with carbonate minerals (e.g., dolomite) and a low sulfide mineral content (e.g., arsenopyrite, pyrite) that can generate lesser acidity. The overall ABA assessment indicates that the rocks are classified as non-acid forming (NAF).

Nitrogenous compounds such as nitrate are also expected to be elevated in seepage from blasted rock due to the use of ammonium-nitrate fuel oil (ANFO) based explosive. This is not an uncommon issue in the mining industry.

It is expected that mining of the BOGP could affect surface- and ground- waters within the project area and these effects will include:

- Elevated total suspended solids (TSS).
- Neutral metalliferous drainage with elevated sulfate (SO_4) and the certain PCOCs such as As, Fe, and trace metals.
- Nitrate-rich drainage due to the use of ANFO as a bulk explosive during blasting activities.

Collectively these waters are referred to as mine impacted water (MIW) to acknowledge the different contributions to poor water quality within the project area. This report assesses the effects of PCOC and nitrate-rich drainage.

1.4 Climate

The site is situated within the Otago semi-alpine region. As a result, the climate is strongly seasonal, comprising of frosts and snow between Autumn and Spring, and dry and hot summer months (with temperatures frequently exceeding 30°C). Rainfall in the region varies spatially, typically decreasing with increasing distance from the Southern Alps (KSL, 2025).

Site recorded data indicates a mean annual rainfall that ranges from 441 to 506 mm depending on elevation. Rainfall remains broadly constant throughout the year ranging from 30 – 50 mm per month except for the months of July and August in which rainfall is notably lower. Dry spells of up to two weeks are also common in these months. Evapotranspiration is strongly seasonal with the reported long-term average ranging from approximately 6 mm in July to 136 mm in January. Due to evapotranspiration exceeding rainfall in the summer months, with the exception of storm events, runoff typically only occurs in the winter months (Santana, 2024).

Rainfall water quality is required as an input to the water and load balance model (MWM, 2025b). Further climatic information is available in Rekker (2025).

1.5 Rehabilitation

The engineered landform will be progressively rehabilitated with compacted batter slopes, brown rock and soil to support the BOGP vegetation requirements. Previously work has indicated that net percolation (i.e., % of rainfall) into the various engineered landforms will be 20-50% (MWM, 2025c). The geochemical model uses 20% as a conservative estimate of net percolation rates.

1.6 Report Objectives

The purpose of this report is to present the geochemical modelling undertaken to estimate seepage water quality for the Shepherds ELF, SRX ELF, Come in Time (CIT) Backfill, West ELF, and Shepherds Creek (SCK) Fill during operations and into the active closure and post closure phases of the BOGP. The objectives of this report are as follows:

- Develop a conceptual geochemical model for each ELF.

- Estimate water quality seepage from the ELF's during operations and into the active closure and post closure phases of the BOGP.
- Provide recommendations for management of ELF seepage based on model results.

2 LITERATURE REVIEW AND MODEL ASSUMPTIONS

This section reviews previous studies to support the development of a conceptual geochemical modelling process for the proposed ELF at the BOGP.

2.1 Analogue Site - Macraes

Analogue sites with comparable lithologies, mineralisation, and alteration styles are useful analogue sites to understand / identify potential geoenvironmental hazards and subsequent effects on water quality.

The Macraes Gold Mine (Macraes), near Macraes Flat, Otago has been operating for over 30 years and the gold deposit is also associated with the TZ3 / TZ4 boundary within the Otago Schist. A large quantity of publicly available information is available on Macraes.

Gold mineralisation is developed within TZ3 Otago Schist within the Hyde - Macraes Shear Zone. The Macraes Gold Project has mined portions of the HMSZ via open pit and underground methods for a period in excess of 30 years (since 1990) and continues to the present day. MWM consider the geochemistry of mineralised and unmineralised rock at the Macraes operation to be analogous to BOGP. The site therefore provides an appropriate analogue site to consider geoenvironmental hazards.

2.1.1 Sulfur Content

Sulfur content is a key consideration as to whether an analogue site is suitable as this represents the potential source hazard for acid and metalliferous drainage (AMD).

Analysis of total S data for tailings and waste rock at Macraes is comparable to BOGP with average waste rock being ~ 0.11 to 10.16 wt% S at Macraes (Figure 2) and ~ 0.094 wt% S at BOGP (Figure 3). Data presented by MWM (2024) as part of the MP4 resource consent application (RM24.184) for Macraes indicates that average sulfur for the waste rock samples ranged from 0.11 to 0.16 wt%, which agrees with Weightman (2020).

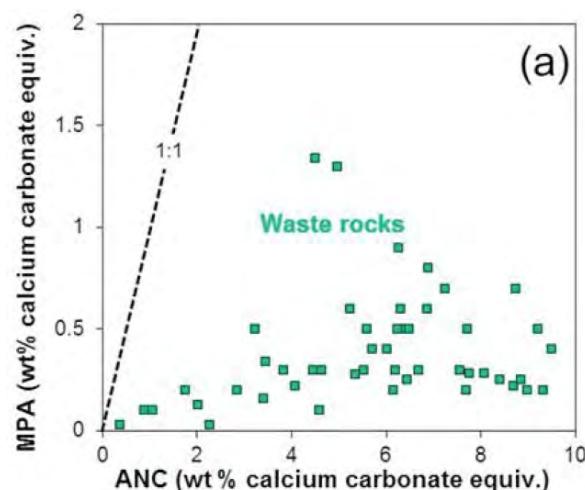


Figure 2. Sulfur content for Macraes waste rock.

Source: Weightman (2020). Note: Where Maximum Potential Acidity (MPA) = wt% S x 30.6 (units in kg H₂SO₄/t); wt% S can be determined by conversion from MPA (in wt% CaCO₃/t equivalence). Assumption that a MPA of 0.4 wt% CaCO₃ is the average of the data provided. ANC = acid neutralisation capacity. If the ANC > MPA then the rock is non-acid forming.

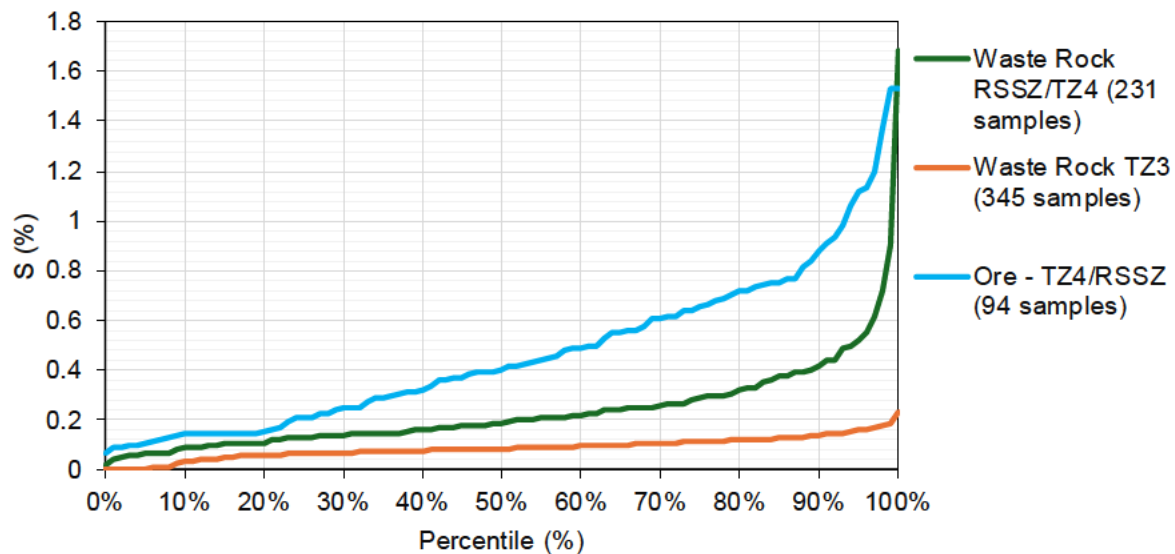


Figure 3. Total sulfur distribution curve for BOGP materials.

Source: MWM (2025a)

Assumption #1: Macraes is a suitable analogue site for potential water quality effects from waste rock at the BOGP due to similar sulfur content.

2.1.2 Waste Rock Stack Seepage

Data provided by Golder (2011a) for silt ponds, located at the toe of WRS at Macraes, indicates elevated sulfate in seepage waters (Table 1). Such data provides an indication of the risks to surface waters associated with this mine domain. The assessment by Golder in 2011 for Macraes did not consider the risks associated with nitrogenous compounds. Recent work in 2020 identified that nitrate can be elevated up to 10.5 mg/L in WRS seepage (OceanaGold, 2020).

Table 1. WRS silt pond seepage water quality from Macraes Gold Mine. From Golder (2011a).

PARAMETER (1)	DEEPELL NORTH	DEEPELL SOUTH	BATTERY CREEK	NORTHERN GULLY	FRASERS WEST (NBWR)	MURPHYS CREEK	BACK ROAD	AVERAGE
Arsenic	0.011	0.00001	0.00001	0.001	0.001	0.00001	0.00001	0.0016
Sulfate	38.6	15.4	1,200	2,300	1,500	1,320	2,200	1084
Cyanide _{WAD}	0.00001	0.00001	0.00001	0.013	0.00001	0.00001	0.00001	0.0016
Copper	0.001	0.00001	0.00001	0.003	0.001	0.001	0.002	0.0010
Iron	0.170	0.00001	0.00001	0.93	0.42	0.52	0.91	0.3734
Lead	0.001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.0001
Sodium	16	10.8	36	57.7	26.2	33	56.4	29.81
Potassium	5.5	1.89	10	12	5.47	6.69	11.7	6.72
Calcium	68.5	40.2	290	434	199	250	425	215.5
Magnesium	14.5	7.7	200	360	165	204	352	164.7
Zinc	0.00001	0.00001	0.00001	0.032	0.015	0.018	0.032	0.012
Chloride	11.5	7.1	10	10.2	4.69	6.03	9.99	7.49

1. - All values presented in units of mg/L

2.2 Macraes WRS Seepage Water Quality: Height Relationship

Babbage (2019) completed an assessment of waste rock stack (WRS) seepage water quality at Macraes as part of the Oceana Gold (New Zealand) Limited Application RM20.024 to the Otago Regional Council (ORC).

Data are available for Ca, Mg, and SO₄ with SO₄ data being presented below in Figure 4. Babbage (2019) assessed various physical parameters of each WRS including WRS footprint, volume of waste rock, and height of the WRS. Analysis indicated there is a relationship between average height of the WRS, its age, and sulfate concentrations in WRS seepage (Figure 5).

Sulfate concentrations are a useful guide to other water quality effects and often very good correlations exist between sulfate, EC⁶, and other potential constituents of concern (PCOC) such that PCOC concentrations can be forecast from sulfate concentration.

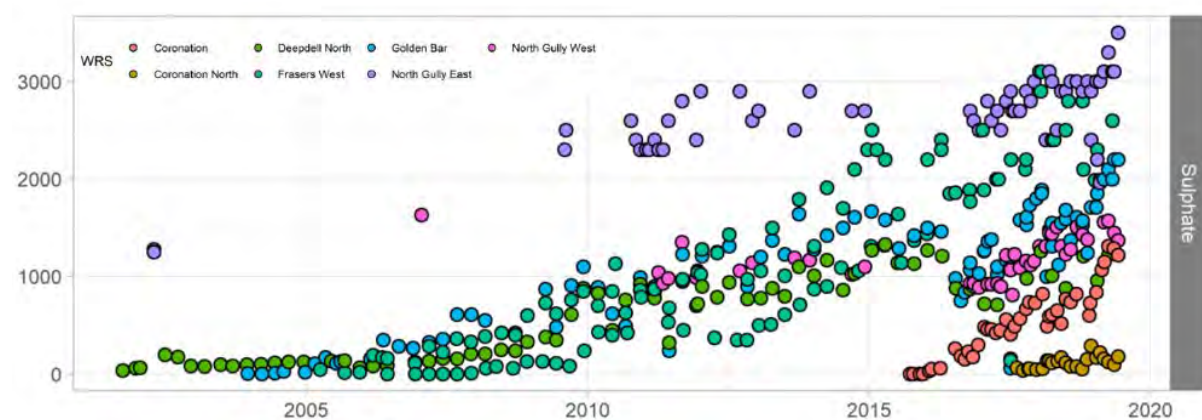


Figure 4. WRS seepage sulfate concentrations, Macraes Gold Mine.

Source: Babbage (2019): Available: <https://www.orc.govt.nz/consents-and-compliance/current-notified-applications/oceana-gold-new-zealand-limited-rm20024/>

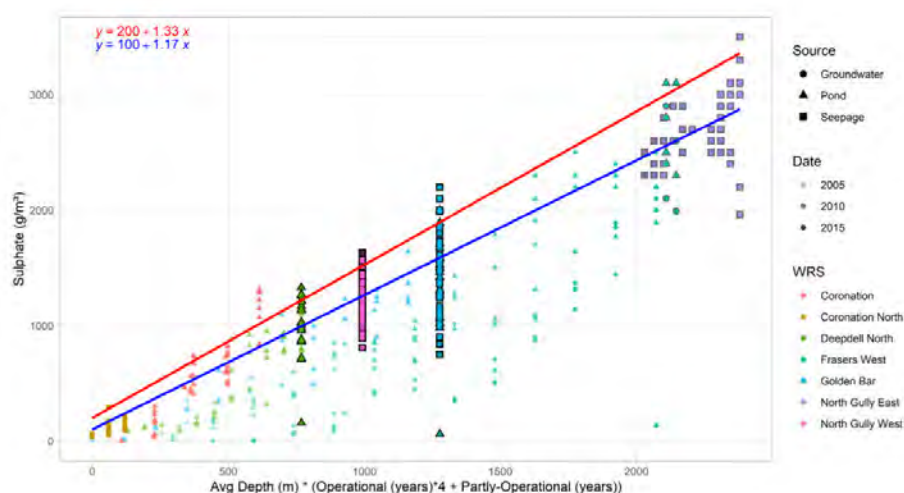


Figure 5. WRS seepage sulfate concentrations as a function of WRS age and average WRS height.

Source: Babbage (2019): Available: <https://www.orc.govt.nz/consents-and-compliance/current-notified-applications/oceana-gold-new-zealand-limited-rm20024/>

⁶ Electrical conductivity

Data presented in the Babbage (2019) report indicates that the average height of WRS at Macraes (in 2019) ranged from 15 m to 37 m with higher WRS generating higher sulfate concentrations. WRS at Macraes are mostly built using traditional WRS construction methods (e.g., tipheads > 10 - 20 m in height that can create grainsize segregation).

Recent work MWM (2024b) demonstrated a relationship between average WRS height and sulfate concentration using similar data sets to Babbage (2019).

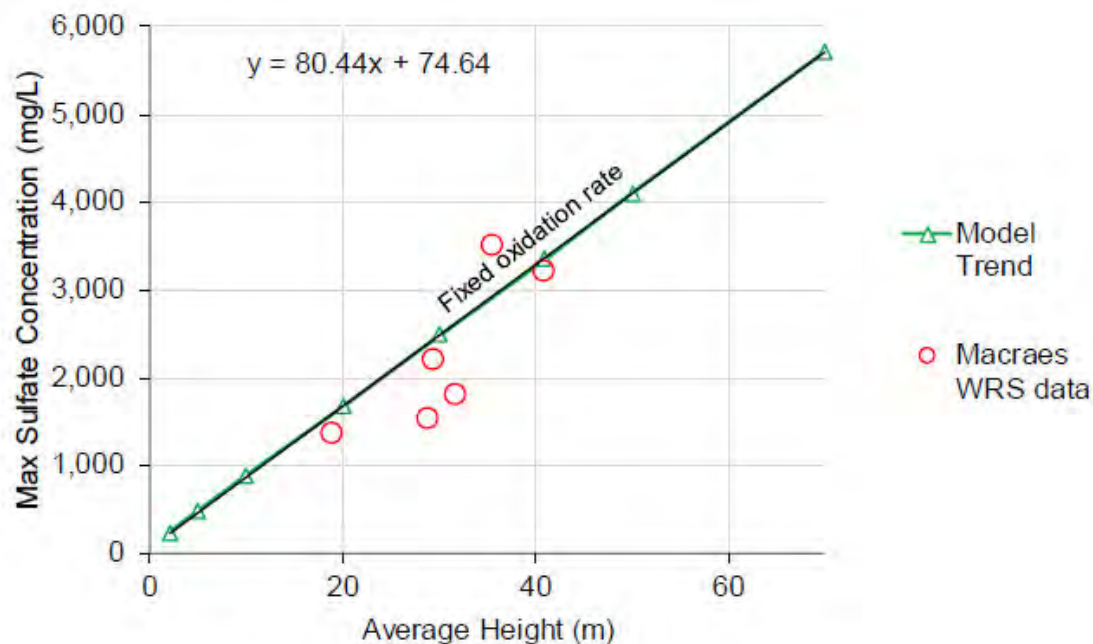


Figure 6. Average WRS height versus maximum sulfate concentrations at Macraes.

Source: Mine Waste Management (2024b): <https://www.orc.govt.nz/consents-and-compliance/current-notified-applications/oceana-gold-new-zealand-limited-rm24184/>

Given that the source hazard (e.g., total sulfur content) at BOGP is comparable to Macraes, and rock properties are similar (non-acid forming) it is reasonable to assume that if waste rock stacks are built at BOGP then sulfate concentrations would be a function of the WRS average height and have similar concentrations to those reported at Macraes (Figure 6). However, the BOGP propose to construct ELF's to minimise the advective flux of oxygen along coarse basal layers created by end-tipping and subsequent grainsize segregation.

Assumption #2: WRS seepage water quality at BOGP can be forecast as a function of WRS height using published empirical data from Macraes.

2.3 Concentration Versus Flow

Previous work (e.g., Mackenzie, 2010; Weber et al., 2015) has demonstrated that although contaminant concentration in seepage from waste rock stacks can remain approximately constant irrespective of flow rate, with increasing flow, the contaminant load increases proportional to flow rate (Figure 7, Figure 8). This demonstrates that the waste rock has a large reservoir of stored oxidation products that is mobilised by greater water flow through the materials driving an approximate constant concentration.

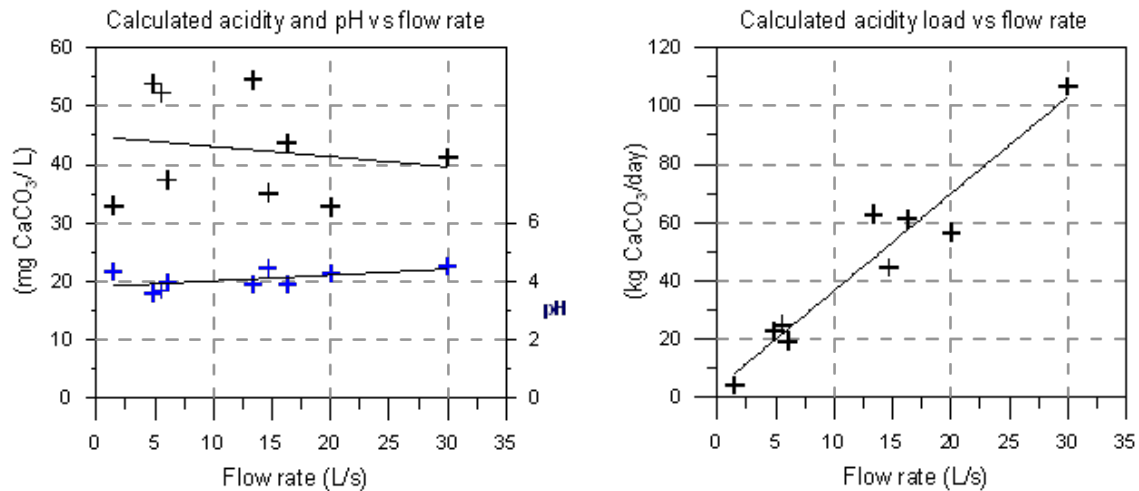


Figure 7. Fanny Creek Side Cast, Island Block Mine, West Coast

Source: Mackenzie (2010).

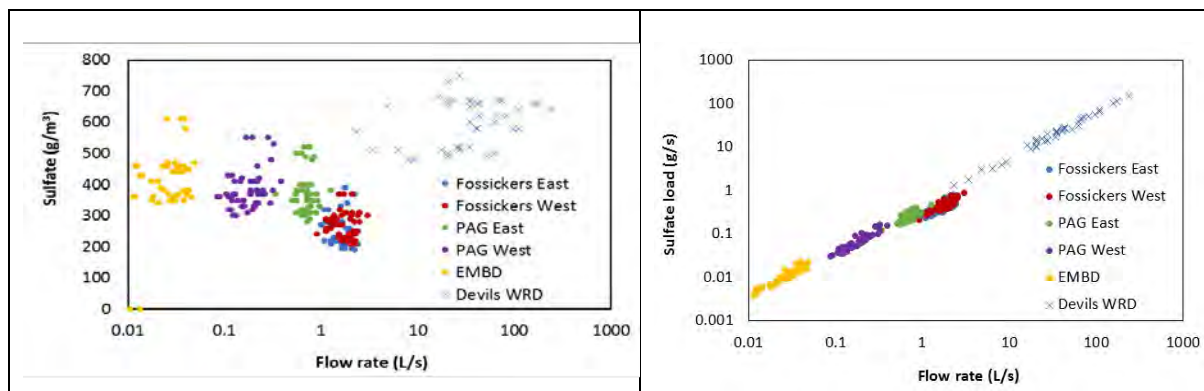


Figure 8. Globe Progress Mine, West Coast

Source: Weber et al. (2015)

Assessment of flow and quality data for the Frasers West WRS (FWWRS) at Macraes (MWM 6) indicates that the key driver of sulfate load is flow rate, with minor variance in sulfate concentration (Figure 9). Again this supports modelling constant concentration (for daily time steps in any model).

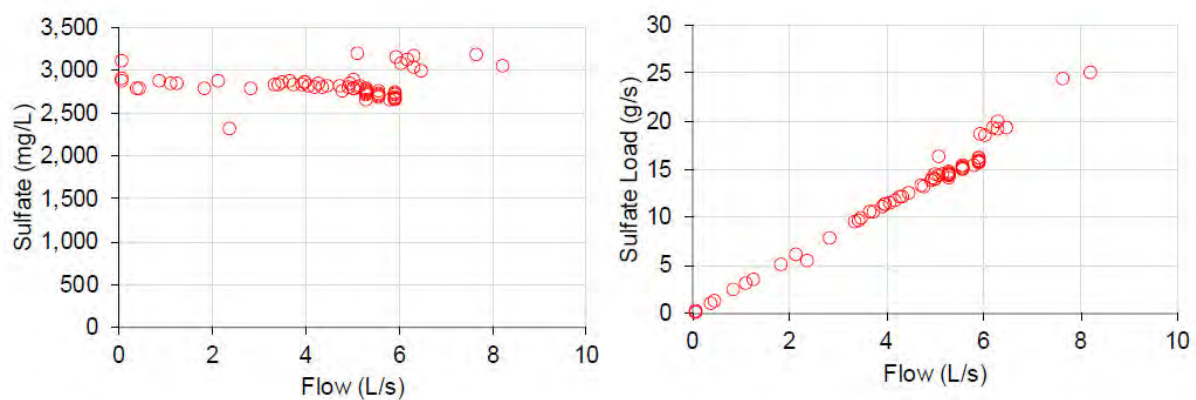


Figure 9. FWWRS seepage rates and interpolated sulfate concentration data.

Source: MWM (2024b).

Hence, numerical modelling of the proposed ELF's at the proposed BOGP will use constant concentration, with the assumption that each unit of waste rock contains a reservoir of stored oxidation products that will be mobilised by increasing flow. Decline in concentration is a function of the exhaustion of sulfides in any oxidising materials during the operational and active post closure phases of the project.

Assumption #3: WRS seepage water quality remains constant for daily time-step modelling.

2.4 Oxygen Ingress

Generally, WRS represent 60 - 80% of a site's AMD contaminant load (INAP, 2020; 2024) if the AMD source hazard is not managed appropriately. International case studies are available (e.g., Weber et al., 2017) to demonstrate the high proportion of AMD associated with waste rock domains. Hence there is a strong driver to incorporate waste rock into engineered landforms that address the key principles of AMD source control: Prevention and Minimisation.

2.4.1 Waste Rock Stacks

Waste rock that is end dumped in high lifts (>4-6 m in height) and the associated kinetic energy can result in grainsize segregation and the development of alternating coarse-textured and fine-textured bedding planes of poorly graded and well sorted material with high vertical airflow capacity (e.g., Fala et al., 2003; Wilson, 2008). This also results in an overall downward coarser grading providing higher airflow capacity deeper in the facility. In addition, the fall of rocks / cobbles from the end-tipped / dozer pushed material results in the development of a coarse basal layer with high lateral airflow capacity that provides oxygen ingress pathways into the core of the waste rock stack (WRS).

The dominant process for oxygen flux is by the advective and convective flow of oxygen (temperature differences, barometric pressure differences) along coarser waste rock layers that form within poorly constructed WRS. Work completed by Brown et al. (2014) has demonstrated that in a poorly constructed WRS, advection accounts for ~90% of oxygen ingress, and that diffusion of oxygen accounts for 10%.

Hence, a key control to prevent sulfide mineral oxidation and minimise the effects on seepage waters from WRS is to prevent the advective ingress of oxygen.

2.4.2 Engineered Landforms

International research (INAP, 2020; 2024) has demonstrated that one of the most effective methods to minimise advective ingress of oxygen into WRSs is to minimise the height of the tiphead to <4 - 6 m and ensure that each lift has a compacted engineered surface, which reduces the size of the advective cell (both vertically and horizontally into the WRS). Reducing oxygen ingress reduces sulfide mineral oxidation and hence the risks associated with AMD.

INAP (2024) note that an "Engineered Fill" approach *"allows for the ability to more accurately model and predict O₂ ingress and the volume and quality of recoverable seepage requiring treatment over time"*. This 'Engineered Fill' approach manages AMD *"risks through implementation of source control, progressive reclamation, and cover systems, which allows for opportunities to move from active to passive water treatment over time thereby reducing asset liability, and likelihood of in-perpetuity management"* (INAP, 2024).

Further details on ELF construction methods for BOGP are provided in MWM (2025f).

2.4.3 Model Development

For BOGP modelling purposes, it is assumed that oxygen flux will be limited horizontally through the ELF batter slopes by controlling the advective flux of oxygen using appropriate engineering controls (e.g., lifts heights < 5 m). For modelling purposes, the design assumptions are:

2.4.3.1 20 m Wide ELF Oxidation Zones (ELF – 20 m Model)

- 20 m horizontally into each ELF lift will be oxidising (aligns with previous New Zealand case studies that show 5 - 15 m can be achieved).
- Based on an angle of repose of 37° , the vertical oxidising distance is 15 m (with 20 m used horizontally for modelling purposes).
- On flat surfaces (e.g., running lifts) the depth is 15 m to account for better compaction of materials due to vehicle movements. A graphical representation of the outer oxidising zones is shown in Figure 10.

2.4.3.2 10 m Wide ELF Oxidation Zones (ELF – 10 m Model)

- 10 m horizontally into each ELF lift will be oxidising (aligns with previous New Zealand case studies that show 5-15 m can be achieved but is considered an optimistic lateral distance).
- Based on an angle of repose of 37° , the vertical oxidising distance is 8 m (with 10 m used horizontally for modelling purposes).
- On flat surfaces (e.g., running lifts) the depth is 8 m.
- This scenario would reduce the volume of material exposed to oxidation.

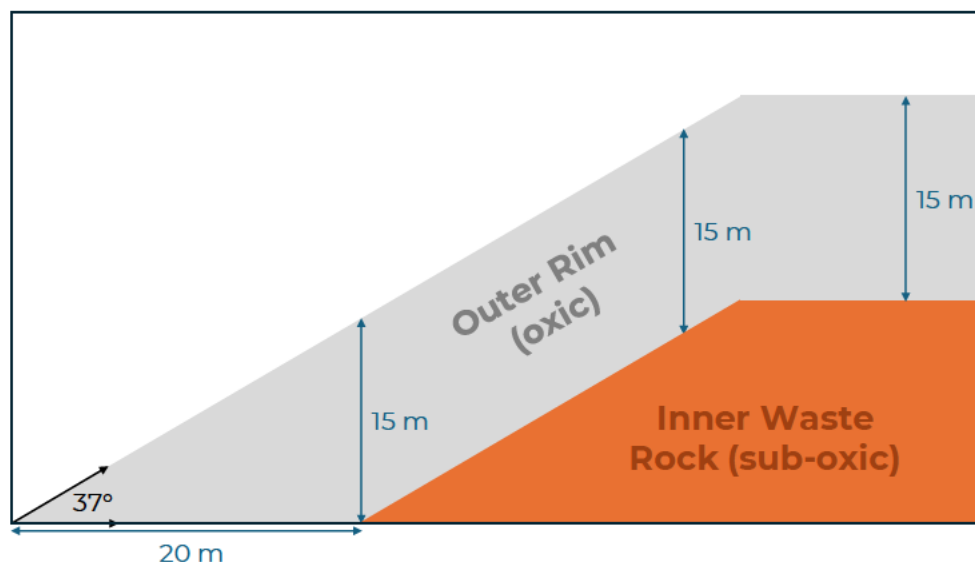


Figure 10. Graphic representation of the outer rim and horizontal ingress of oxygen at 20 m.

A nominal value of 20 m introduces a safety factor for batter slopes compared to data from other sites in New Zealand. This is a key design criterion for the project. However:

- Detailed design for the ELFs is required to demonstrate how this will be achieved.

- Performance monitoring during construction is required to confirm that these design criteria are being met.
- Geochemical models should be adjusted to the future measured oxidation depth and oxygen flux (through the cover system).

Assumption #4 – That ELF design and construction (including cover system) will limit oxygen ingress to a depth of 20 m horizontally and 15 m vertically once the ELF is constructed (and rehabilitation is completed).

2.5 Scaling Factors

Many projects rely on a first principles approach, scaling laboratory data to the field (e.g., Kempton, 2012; Linklater et al., 2017) to determine WRS water quality. Such analyses consider physicochemical issues such as moisture content, particle size, temperature, mobility of PCOC, oxygen concentrations, and solute attenuation (e.g., precipitation). Scaling lab data to the field can introduce several uncertainties that influence model results.

For the BOGP WRS / ELF geochemical models, the modelling process is simplified by relying on appropriate analogue empirical data from Macraes (e.g., Figure 6) with minor geochemical adjustments:

- It is expected that parts of the ELF contain materials that are effectively unreactive and do not contribute to the contaminant load or water chemistry. Price (1997) notes that >75% of the mass in a WRS occurs as coarse particles in which the mineralogy is almost entirely occluded from oxygen and water with drainage chemistry being controlled by a relatively small portion of the mass which is finer grained particles. Malmström et al. (2000) noted that ~65% of the water in a waste rock stack was mobile and 35% was immobile at the Aitik Copper mine, Sweden. At the Island Copper Mine (Vancouver), Lopez et al. (1997) notes that only 42% of the total area of the pile contributes to flow. Such studies indicate that 35 – 58% of water interacting in a waste rock stack may be immobile and will not contribute to drainage water chemistry.
- The assumed non-reactive portion of the waste rock used in the models presented in this report is 90%. This is assuming that coarser material will decrease the amount of minerals or sulfides reacting with water. The water passing through the reactive portion is assumed to fully react. Consequently, this 10% reactive fraction is considered fully available for the release of stored oxidation products and long-term solute generation.
- A scaling factor was applied for the long-term generation of solutes that were obtained from the column leach tests to calibrate using analogue empirical data.
- Scaling of sulfate for the reactive fraction (a key indicator of AMD and poor water quality) is derived from empirical data from Macraes, which provides the ability to scale other PCOC based on column leach test data correlations for the project area. This resulted in a general scaling factor (from laboratory to field)
- This general scaling factor affects sulfate and elements associated with the long-term release rates.
- To align lab results with analogue data from Macraes, a release rate adjustment factor of 0.8575 was applied to reactive oxidising materials (e.g., 10% of the materials in the WRS). These

adjustments allowed the model to simulate realistic peak sulfate concentrations for a traditional WRS (e.g., ~6,200 mg/L for Shepherds WRS).

- Linklater et al. (2017) applied several scaling factors to WRS materials, including surface area correction, fraction flushed by contact water, temperature correction, and oxygen availability. Combined, these factors result in an overall multiplier of 0.012, which is nearly two orders of magnitude lower than full reactivity. In our case, the adjustment is approximately one order of magnitude; 0.1 for short-term release, multiplied by an additional 0.8575 for long-term release, yielding an overall factor of 0.08575 for the long-term release.
- PHREEQC modelling (Parkhurst & Appelo, 2013) was conducted to consider solubility control for some solutes (e.g., precipitation).

Assumption #5 – The scaling approach using CLT data to forecast sulfate and other PCOC is appropriate to understand geochemical risks for the engineered landforms.

2.6 Nitrogenous Compounds

This section identifies the source hazards associated with the use of ANFO for blasting and the potential effects on ELF Seepage waters. Derivation of nitrate loads is complicated for modelling as geochemical test work is undertaken on drillcore that has not been blasted. Hence a reliance on literature is required.

2.6.1 Literature Review

Nitrogenous compounds from waste rock in mining operations are often a byproduct of blasting agents, such as ammonium nitrate-fuel oil (ANFO), used during extraction. These compounds can leach into surrounding water systems contributing to elevated levels of nitrate and ammonia in nearby groundwater and surface water. Data presented by OceanaGold (2020) indicates that nitrate can be 10.5 mg/L in WRS ponds at Macraes.

As noted by Navarro-Valdivia et al. (2023) pit lakes can also be elevated in nitrogenous compounds due to the presence of blasting residues, with nitrate nitrogen concentrations peaking in the Golden Bar Pit Lake at 30 mg/L due to an initial nitrate load of 400 kg yet steadily decreases at 20-30% per year due to biogeochemical processes. Navarro-Valdivia et al. (2023) noted that the quantity of nitrogen as NH_4NO_3 was estimated to be 5.35 g/m² once the pit lake started to fill.

Navarro-Valdivia et al. (2024) indicated that there was a poor relationship between sulfate and nitrate in WRS seepage at Macraes ($R^2 = 0.43$) and that the median nitrate nitrogen value was 12.6 mg/L (equivalent to a concentration of ~56 mg/L nitrate).

Dockrey et al. (2015) report nitrate nitrogen ($\text{NO}_3\text{-N}$) concentrations in coal waste rock seepages from 5 to over 100 mg/L depending on the size and age of the waste rock dump. Bailey et al. (2013) reports that measured NO_3 in seepage outflows at a diamond mine were 2,000 mg/L. Schmidt and Moffett (1979) report that concentrations of NO_3^- in mine effluent from uranium mines ranged from 60 to 80 mg/L.

Weber et al. (2021) report a range of nitrate concentrations (Figure 11) with nitrate concentrations of 68 mg/L for drainage from a waste rock dump (WRS) for an orogenic gold mine.

Mine Type	Mine Domain	Nitrate Concentrations mg/L as NO ₃
Iron Ore	TSF	220
Diamond	WRD - test pile	2000
Diamond	WRD - test pile	4000
Orogenic Gold	WRD	68
Epithermal Gold	Low Grade Ore Stockpiles	0.14
Volcanic Massive Sulfide	Underground	285
Volcanic Massive Sulfide	Underground	5
Porphyry Copper	WRD	<2
Diamond	WRD	90 -230
Coal Mine	WRD Catchment Drainage	<1
Platinum	Pit	377
Platinum	WRD	440

Figure 11. Nitrate concentrations from various studies, mine type, and mine domains

Source: Weber et al. (2021).

MWM (2024a) assessed nitrate data for WRS at Macraes. Available data suggests maximum NO₃-N concentrations could be up to 35-40 mg/L (Figure 12) and that nitrate-N can be ~2.5 to ~22 mg/kg in blasted waste rock at Macraes (Figure 13).

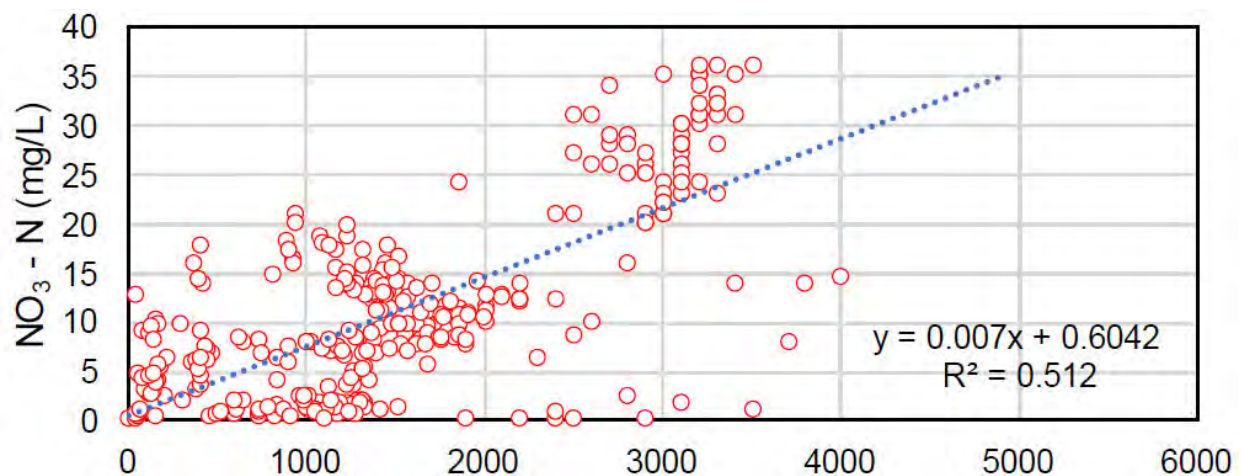


Figure 12. Sulfate versus nitrate-N concentrations for Macraes WRS.

Note: X axis is sulfate in mg/L

Source: MWM (2024a): Appendix I.

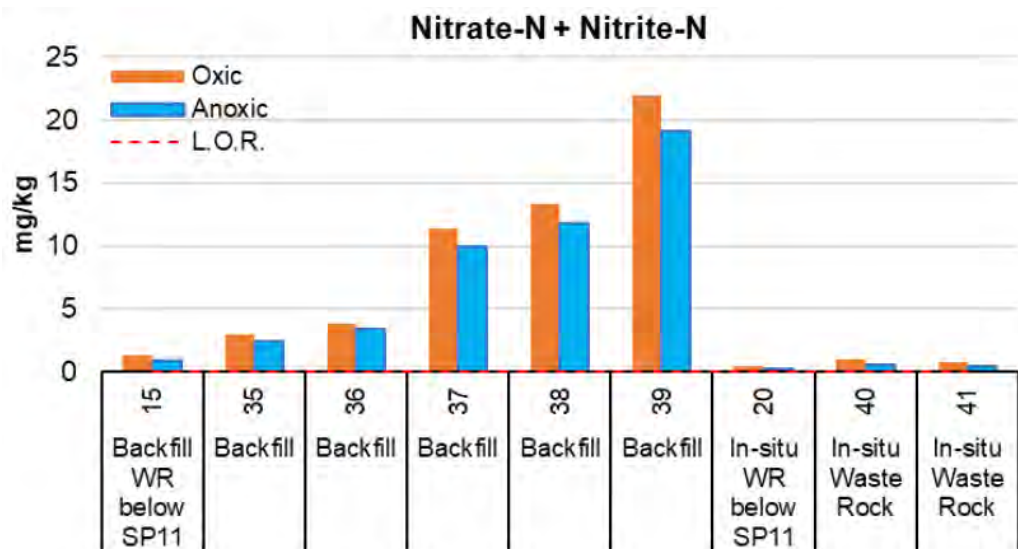


Figure 13. Shake flask extraction data for blasted backfill at Macraes.

Source: MWM (2024a).

Studies have been completed at the Argyle Diamond Mine, Western Australia on nitrate effects due to the use of ANFO (Borden et al., 2022) with nitrate concentrations in the ICI WRS seep reaching a mean peak of 300 mg/L in 2004 to 2007 declining to 170 mg/L between 2017 and 2020. The authors note that these mean values do not capture the full variability in nitrate concentration within each year, however a strong declining concentration was observed over the 20-year monitoring period. Data indicated that dry season nitrate concentrations were higher than wet season nitrate concentrations (Figure 14). Borden et al. (2022) note that:

- The higher concentrations and loads observed prior to 2015 (Figure 15) were a function of open pit mining and a greater quantity of ANFO being used with peak nitrate concentrations in WRS seeps coinciding with peak waste rock production in 1999 to 2005.
- Peaks nitrate loads during operations are a function of rapid flushing of high permeability zones.
- Long term nitrate loads are a function of finer grained low permeability zones that are not flushed by high rainfall events.
- Data for the WRS seeps suggests that toe seepage water quality will meet chronic nitrate guideline requirements (2.4 mg/L) in two to three decades.

These data suggest that for Argyle:

- Nitrate concentrations did not start to decrease till 2015, a decade after open pit operations ceased.
- Based on 20 years of monitoring data the effects of elevated nitrates are expected for another two to three decades. This suggests the effects of nitrate could last for 50 years once opencut mining ceases.

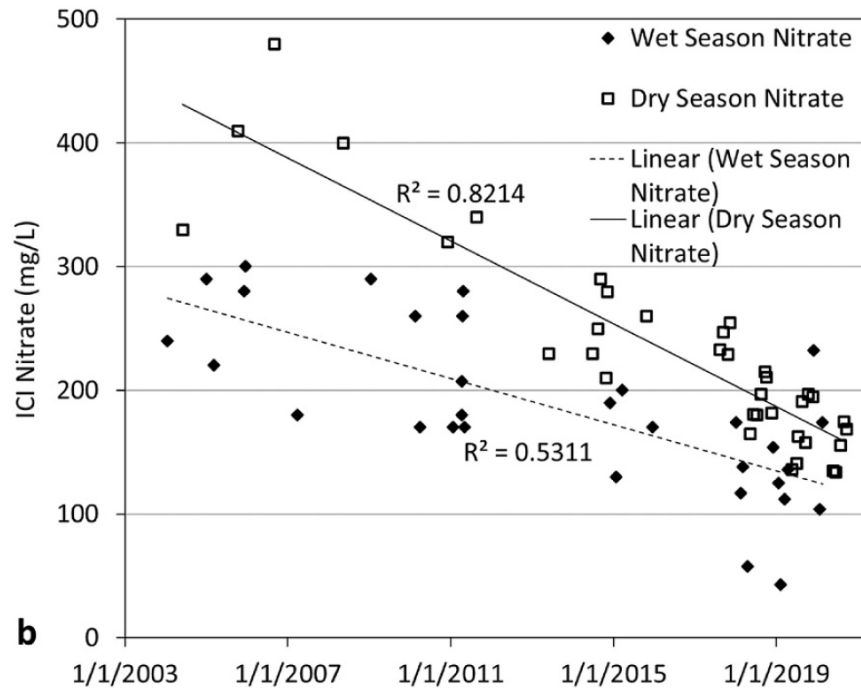


Figure 14. Nitrate concentrations for the ICI WRS seep (Argyle Diamond Mine).

Source: Borden et al. (2022).

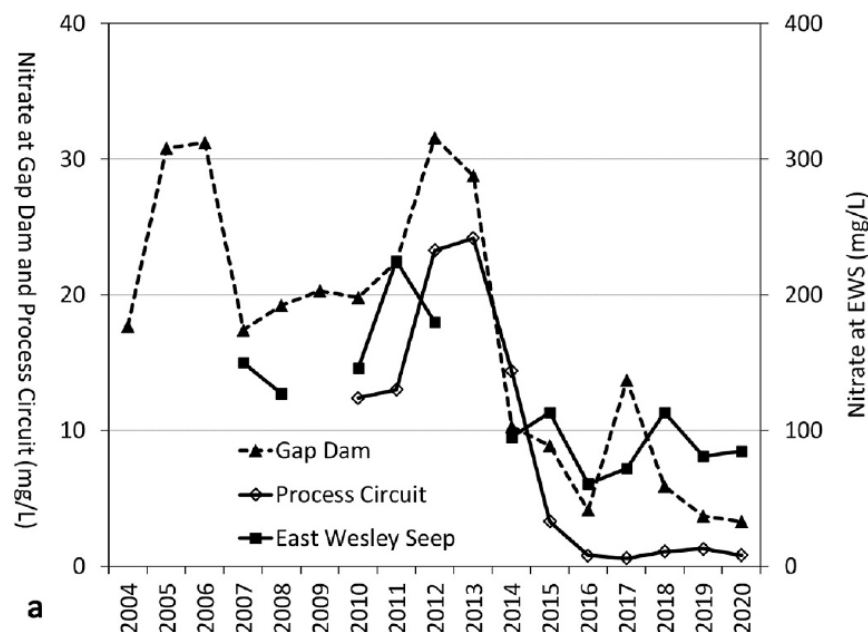


Figure 15. Nitrate concentrations for Gap Dam, the process circuit, and East Wesley Seep – Argyle Diamond Mine.

Source: Borden et al. (2022).

Elevated nitrate in ELF seepage is expected to last for decades, unlike the effects of AMD which are expected to last for centuries. For instance, (Mahmood et al. (2017) notes that, as an example, a 100 m high dump, placed at an average volumetric water content of 10% and flushed at a net percolation rate of 750 mm/year would take approximately 13 years to release most of the initial nitrate within the

dump. Data for Argyle suggest that 50 years is a reasonable timeframe to meet water quality criteria (e.g., nitrate-N concentrations of 2.4 mg/L).

2.6.2 Model Inputs

Given that the average height of the Shepherds ELF is nearly twice that of the highest WRS at Macraes, it is assumed that the peak concentration will also be roughly double. Based on this assumption, a peak nitrate-N concentration of ~80 mg/L is expected for the Shepherds ELF. For modelling purposes, it is assumed that 90% of this nitrate-N is mobilised over ~50 years for all structures, although the time to peak concentration can extend this period once the tallest parts of the ELF are contributing load.

A nitrogen content (as NH_4NO_3) of 16.6 mg/kg was assigned to reactive waste rock within each ELF to enable the peak nitrate-N concentrations of 80 mg/L to occur. This load is comparable to the data available at Macraes (Figure 13).

Assumption #6 – That ELF seepage waters will be elevated in nitrate for many decades and that the peak concentration is expected to be ~ 80 mg $\text{NO}_3\text{-N/L}$ in the Shepherds ELF seepage waters.

Assumption #7 – That model data suggests the initial load of nitrogen (NH_4NO_3) is 16.6 mg/kg.

Assumption #8 – That 90% of nitrogen is mobilised over ~50 years once the tallest part of the structure starts contributing load.

3 ELF CONCEPTUAL GEOCHEMICAL MODEL

This section explains the conceptual geochemical models for the proposed BOGP ELFs.

3.1 Engineered Landform Summary: RAS, SRX, and WELF

Overburden waste rock from the RAS deposit will be stored in the Shepherds ELF (Figure 16) and in the West ELF (WELF), and overburden from the SRX Pit will be stored in the SRX ELF (Figure 17):

- For the Shepherds ELF, the selected storage area, located downstream of the TSF, avoids terrain constraints, minimises the risk of sterilising nearby satellite deposits and will also act as a buttress to enhance TSF stability while accommodating 103.6 million loose cubic metres (LCM) of waste, including 3.2 million LCM from the TSF dam (MCL, 2024). The design includes a 12% contingency for changes in swell or compaction factors based on site-specific parameters.
- For the SRX ELF, the selected storage area is on top of the SRE Pit and is located upstream of the SRX pit to minimise the risk of sterilising nearby satellite deposits

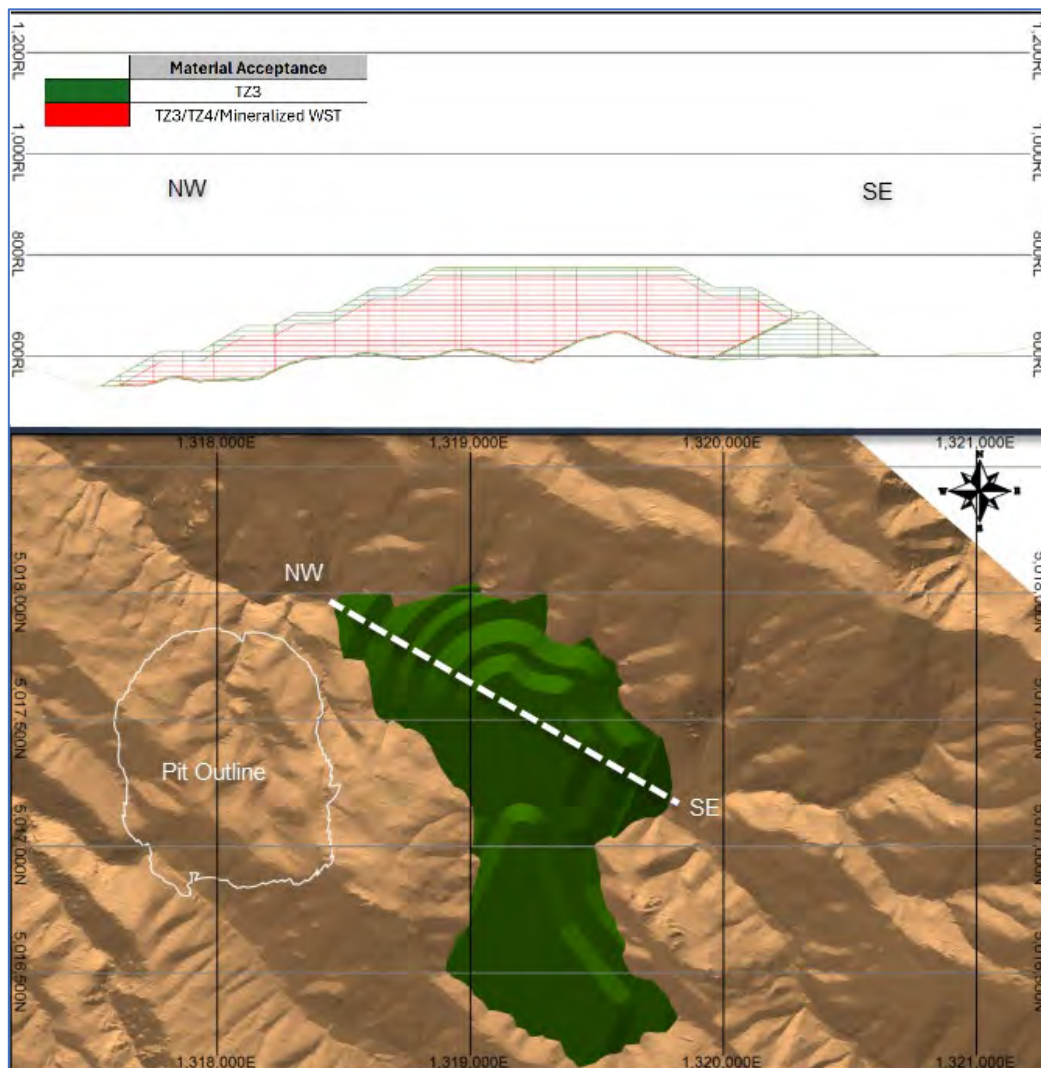


Figure 16. Shepherds ELF.

Reference: MGL (2024).

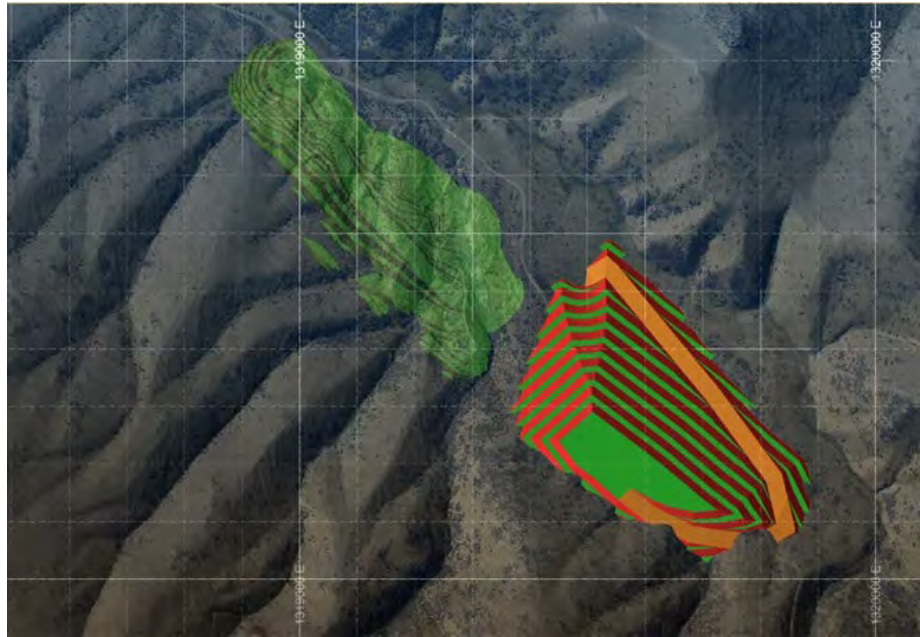


Figure 17. SRX Pit and SRX ELF

Source: MGL (2024).

Waste landform sequencing has been undertaken based on the assumption that arsenic concentrations are higher in the ore host rock (TZ4 and RSSZ) and for precautionary reasons it is planned to be encapsulated and capped with lower arsenic waste rock (TZ3). A base layer and encapsulating layer of inert material is typically required, with a core of non-inert material. For this reason, the ELF has a base layer of 3 metres of TZ3 material. The TSF dam embankment will also only consist of TZ3 material. Santana (2024) proposes that a 20 m thick low sulfur capping layer of TZ3 materials will encapsulate the ELF.

Mine schedules for RAS and SRX are shown in Table 2 and Table 3.

Table 2. RAS Pit mine schedule.

COMPONENT	TOTAL ROCK MINED	TOTAL WASTE	TZ3 TONNES	TZ4 TONNES	SOIL	ORE
Unit	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)
Year						
-2	10,200	10,200	9,417	0	783	0
-1	30,572	30,363	29,967	149	247	209
1	25,859	24,437	20,456	3,139	842	1,422
2	24,612	21,438	16,804	4,344	291	3,173
3	24,493	22,680	19,717	2,815	148	1,813
4	24,300	23,060	20,939	1,613	508	1,240
5	24,300	24,007	22,636	1,339	33	293
6	24,267	21,880	19,530	2,184	166	2,387
7	23,112	21,575	19,401	2,171	3	1,537
8	2,258	1,355	1,019	336	0	902
Total	213,972	200,996	179,886	18,089	3,021	12,976

Reference: Santana, 2024

Table 3. SRX Pit mine schedule.

COMPONENT	TOTAL ROCK MINED	TOTAL WASTE	TOTAL TZ3	TOTAL TZ4	TOTAL SOIL MINED	ROM MINED (>0.30g/t Au)
Unit	(kt)		(kt)	(kt)	(kt)	(kt)
Months						
1	209	80	33	47	80	0
2	209	121	79	42	51	15
3	209	105	84	21	49	26
4	309	204	185	19	61	34
5	350	237	209	28	36	47
6	350	257	253	4	59	9
7	350	224	202	22	30	75
8	350	228	214	14	64	32
9	350	255	211	44	3	84
10	350	290	277	13	30	27
11	350	216	199	17	44	73
12	350	284	247	37	3	60
13	350	299	289	10	10	38
14	350	191	162	29	54	95
15	350	269	227	42	0	70
16	350	299	292	7	2	47
17	350	239	211	28	28	82
18	350	272	234	38	0	74
19	350	242	226	16	11	94
20	350	235	205	30	10	99
21	350	232	212	20	0	111
22	350	167	104	63	0	164
23	108	35	21	14	0	69
Total	7,344	4,981	4,377	606	625	1,428

Reference: Santana, 2024

3.2 Backfill

Two pit backfills will be created:

- Waste rock will be placed in the SRE pit as backfill as part of constructing the SRX ELF. It is assumed the quality of materials is negligible and the ELF seepage water quality will be dominated by the SRX ELF.
- Waste rock will be used to backfill the CIT Pit to provide a more natural surface for mine closure. This will create rock that will be saturated by groundwater and also an ELF that sits above this. The CIT ELF model addresses these components.

No mine plan was provided for CIT, however, total estimated quantities are provided in Table 4.

Table 4. CIT Pit material quantities.

ORE (kt)	SOIL (kt)	TZ3 (kt)	TZ4 (kt)	TOTAL ROCK MINED (kt)
700	475	2,550	850	4,575

3.3 Shepherds Creek Fill Area

A platform composed of TZ3 material will be placed in Shepherds Creek to serve as a foundation for the processing plant area. The volume of fill used is approximately 1.1 Mm³, which is considered significant, as it is comparable to the volume of the Come in Time backfill (1.5 Mm³). Given its scale, the fill is deemed geochemically relevant and is therefore included in the water and load balance model (WLBm) as an additional waste rock domain. The corresponding material volume, tonnage, and area are shown in Table 5.

Table 5. CIT Pit material quantities.

VOLUME (m3)	TONNAGE (kt)	AREA (kt)
1,109,758	2,264	2,550

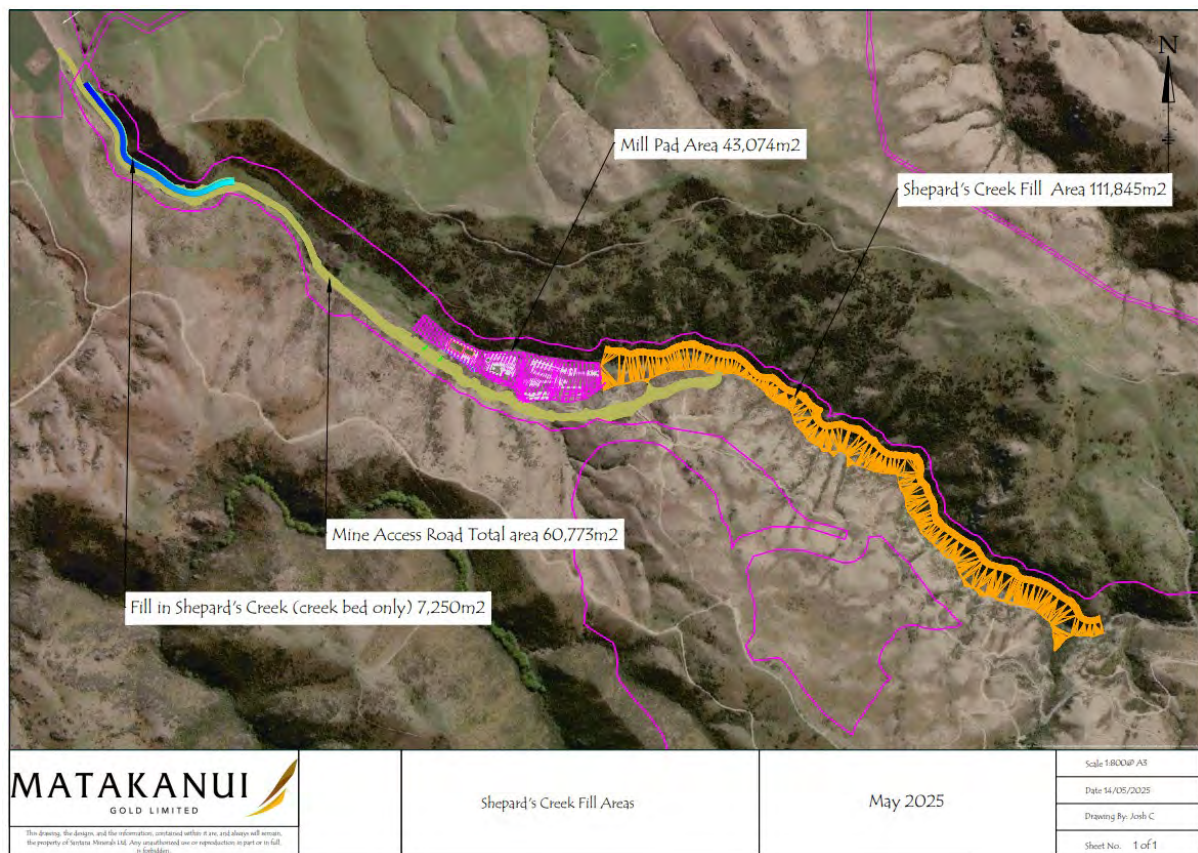


Figure 18. Shepherds Creek Fill Area Fill location.

Source: MGL (2025)

3.4 Cover System

The ELF will be progressively rehabilitated with compacted batter slopes, brown rock and soil to support the BOGP vegetation requirements. Previously work has indicated that net percolation (i.e., % of rainfall) into the various engineered landforms will be 20-50% (MWM, 2025c).

The impact of the landform, including the cover systems, on net percolation (NP) is expected to be minimal due to the high surface permeability of the materials. Both the ELF and TSF are predominantly flat or north-facing, which will result in similar potential evapotranspiration (PE). However, the steeper slopes of the ELF are likely to generate more runoff than the flatter TSF, potentially leading to slightly

lower NP for the ELF. Nevertheless, this difference is not expected to be significant, as surface permeability is likely to remain high.

Based on the findings in the report, the estimated baseline NP post-closure of 20% is used for modelling purposes.

3.5 Water Soluble PCOC

Most rocks, following blasting contain stored water soluble PCOC that can be mobilised by the flow of water through these materials (e.g., net percolation). PCOC include nitrogenous compounds derived from blasting residues, and stored oxidation products (SOP) generated by sulfide mineral oxidation or due to a natural mineral dissolution by percolating waters (e.g., gypsum).

Two processes are considered in the model:

- **SOP Dissolution:** This process involves the release of solutes through the dissolution of readily available soluble minerals such as anglesite. The release of solutes occurs only in the short term due to flushing of these PCOC by net percolation through the ELF.
- **Oxidation:** This refers to the oxidation of sulfides in zones of the ELF that have oxygen available, resulting in the generation of sulfate and associated solutes over the long term.

3.6 Oxygen Ingress

The WRS base case scenario is modelled with no oxygen exclusion with the assumption that all materials generate a similar amount of sulfate from water soluble PCOC, which is then ongoing from sulfide mineral oxidation.

Scenarios are run for the three engineered landforms (Shepherds, SRX, WELF) where the depth of oxidation is limited to 10 m and 20 m depth into the ELF (as explained in Section 2.4.3), and for the CIT backfill as well. From a modelling perspective, this does not affect the presence of water soluble PCOC.

3.7 Conceptual Domain Models

Four key waste rock disposal domains are proposed for the BOGP: Shepherds ELF, SRX ELF, West ELF, and CIT backfill. While they share common characteristics, they differ in material quantities, dimensions, and area. Waste rock fill is also used within Shepherds Creek as fill for the BOGP infrastructure area (e.g., processing plant). Given the quantities of materials required this has also been modelled to understand seepage water quality.

Seepage is generated from rainfall infiltration, with net percolation assumed to be 20%. Consequently, average ELF seepage rates depend on the area of each ELF and the assumed net percolation. The toe seepage flow rate is calculated in the GoldSim water balance, based on the assumption that seepage flow rates drive the load, independent of concentration. That is, while seepage flow rates may vary, the concentration is expected to remain constant (see Section 2.3).

It is assumed that the ELFs will have an oxidising outer rim composed of the geological unit TZ3, while the inner core will consist of TZ3 and TZ4. The inner material will not oxidise but will release short-term SOP, which will be available for dissolution upon interaction with infiltrating rainfall. The outer rim undergoes both ongoing oxidation of minerals (or long-term release) and SOP dissolution. Quantification of the SOP are derived from column leach tests and are detailed in Section 4.2.

Since each ELF has different dimensions, the outer rim represents a different fraction of the total volume of each ELF. Given that the Shepherds ELF is the largest, its proportion differs accordingly. CIT is assumed to have similar proportions as SRX, as they both have similar material quantities.

The core of the ELF is assumed to experience SOP dissolution without oxidation (noting that the SOP is derived from ~20 weeks of data from the column leach test⁷), while the outer rim (i.e., the oxidising zone) undergoes both ongoing oxidation of sulfide minerals and SOP dissolution. For modelling purposes, it is also assumed that TZ4 is located within the core of the ELF, meaning only TZ3 is present and therefore oxidises in the outer rim.

Modelling was based on earlier material quantity estimates for SRX and Shepherds, as shown in Table 6. These estimates differ slightly from those provided in the pre-feasibility study (PFS) completed in late 2024 (MGL, 2024). However, these differences are not considered significant in assessing potential effects on water quality.

Table 6. Material quantities (excluding soil).

PIT/DOMAIN	MATERIAL	QUANTITY (KT)
SRX	TZ3	4,377
	TZ4	606
	TZ3+TZ4	4,983
Shepherds	TZ3	179,886
	TZ4	18,089
	TZ3+TZ4	197,975
CIT	TZ3	2,550
	TZ4	850
	TZ3+TZ4	3,400
West ELF	TZ3	10,732
SCK Fill	TZ3	2,264

Soil volumes were not included in the model, as the interaction of water with soils, which are essentially weathered rock, represents baseline conditions. Furthermore, soil is intended for use as a cover material for the ELFs. Consequently, the material quantity assessment includes only TZ3 and TZ4, explicitly excluding soil from the calculations.

3.7.1 Shepherds ELF

The Shepherds ELF contains 197,975 kt of waste rock, being primarily composed of TZ3 (179,886 kt, representing the 90.86% of the material), and a minor part of TZ4 (18,089 kt, or 9.14% of the material). Based on topographical differences between the designed ELF surface and the base topography, it was determined that the outer rim of the ELF accounts for:

- ~18.62% of the material for a 20-m oxidising rim (and 15 m vertically).
- ~9.60% for a 10-m oxidising rim (and 8 m vertically).

⁷ Ongoing data collection from the CLT that will be run for 12 months will validate these results.

The area of the Shepherds ELF is approximately 115 Ha. Assuming a net percolation rate of 20%, the average seepage is estimated at ~3.7 L/s.

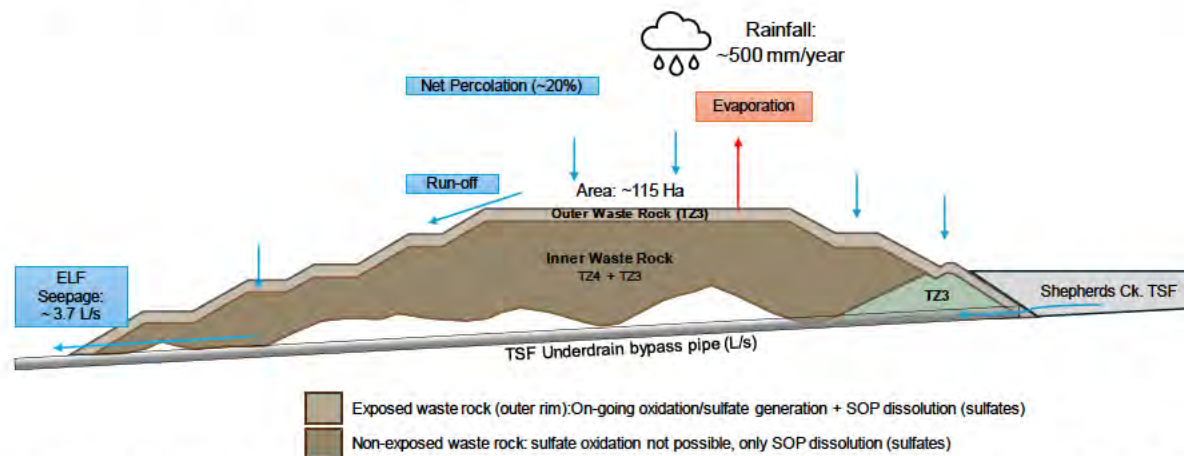


Figure 19. Conceptual (and schematic) water balance and material distribution for the Shepherds ELF.

A distinct feature of the Shepherds ELF is that it serves as the embankment for the TFS. However, seepage from the TFS will not interact with the waste rock in the Shepherds ELF, as it will be captured by an underdrain and will be passed through the ELF. It is expected that these seepage paths mix at the Shepherds Seepage Pond. This will reduce the PCOC load mobilised from the Shepherds ELF.

3.7.2 SRX ELF

The SRX ELF contains 4,984 kt of waste rock, being primarily composed of TZ3 (4,378 kt or 87.84% of the material) and a minor presence of TZ4 (606 kt or 12.15%). Based on topographical differences between the designed ELF surface and the base topography, it was determined that the outer rim of the ELF accounts for:

- ~58.98% of the material for a 20-m oxidising rim (and 15 m vertically).
- ~33.77% for a 10-m oxidising rim (and 8 m vertically).

The area of the SRX ELF is approximately 15.6 Ha. Assuming a net percolation rate of 20%, the average seepage is estimated at ~0.5 L/s.

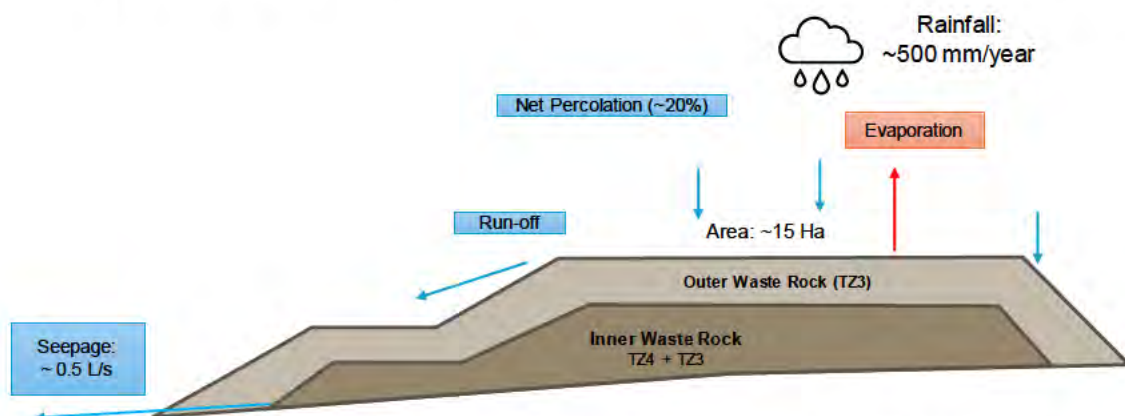


Figure 20. Conceptual (and schematic) water balance and material distribution for the SRX ELF.

3.7.3 West ELF

The WELF contains 10,732 kt of waste rock, composed entirely of TZ3 material. Assuming similar proportions between outer and inner waste rock as those calculated for SRX, the following distribution is estimated.

- ~58.98% of the material for a 20-m oxidising rim (and 15 m vertically), which represents 6,329 kt
- ~33.77% for a 10-m oxidising rim (and 8 m vertically), which represents 3,624 kt
- The area of the WELF is approximately 17.5 Ha. Assuming a net percolation rate of 20%, the average seepage is estimated at 0.56 L/s. The conceptual and schematic water balance and material distribution for this domain are shown in Figure 21.

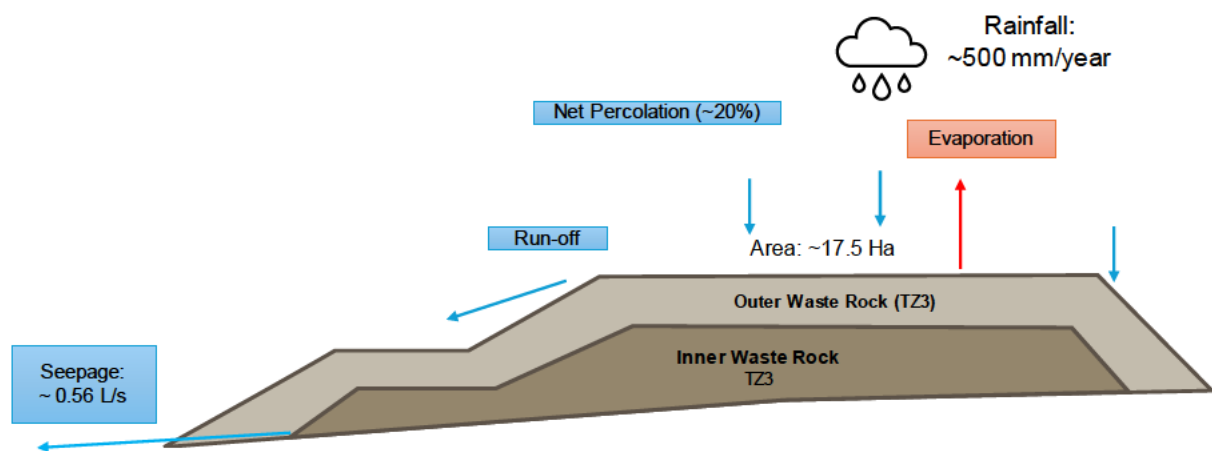


Figure 21. Conceptual (and schematic) water balance and material distribution for the WELF.

3.7.4 CIT Backfill

Unlike the ELFs, the CIT backfill consists of waste rock being backfilled into the CIT Pit void. It is assumed that once the material is backfilled, its pores will be filled by two water sources: infiltration from rainfall through the waste rock and groundwater inflow from the pit walls. When this pore water reaches the pit's overflow level (~503 mRL), it will emerge through the waste rock as seepage.

Below 510 mRL⁸, the pit void has a volume of 922,930 m³. Assuming a backfill density of 2.16 t/m³, the total capacity is up to 1,993,529 t. The water volume capacity is estimated using a pore space fraction of 0.3, meaning 30% of the void volume is available for water.

Considering that the total waste rock mass (TZ3 and TZ4) in the CIT backfill of 3,400,000 t, approximately 58.6% of the material will be submerged. When this occurs, ongoing oxidation (or the long-term release of solutes) is assumed to cease. However, similar to the inner portions of the ELFs, the short-term release solutes (SOP) will remain available for dissolution.

A conceptual (and schematic) water balance is shown in Figure 22 for CIT Pit, while Figure 23 shows the amount of waste rock that is flooded with time (i.e., below the phreatic surface). This estimation is an output of the water balance model, due to its dependence on the current water level of the pore

⁸ Note: 510 mRL is used as a rounded value, as pit dimension staging is provided in 10 m increments.

volume filling and is used in the model to quantify how much rock has ceased oxidising. This means that 42 months post closure the level of the pore water has reached the 510 mRL and no more material can be submerged.

The groundwater inflow rate is assumed to be 1 L/s when the pore volume is fully flooded at 510 mRL (Rekker and Dumont, 2025). Therefore, the total expected flow rate from the pit volume is approximately 1.88 L/s. However, the flow rates are calculated on the water balance and will vary day to day.

In this report, the estimated water quality corresponds exclusively to the 0.88 L/s component. However, in the water balance load model, the overall water quality from this backfill accounts for the mixing between seepage from the waste rock and groundwater inflow.

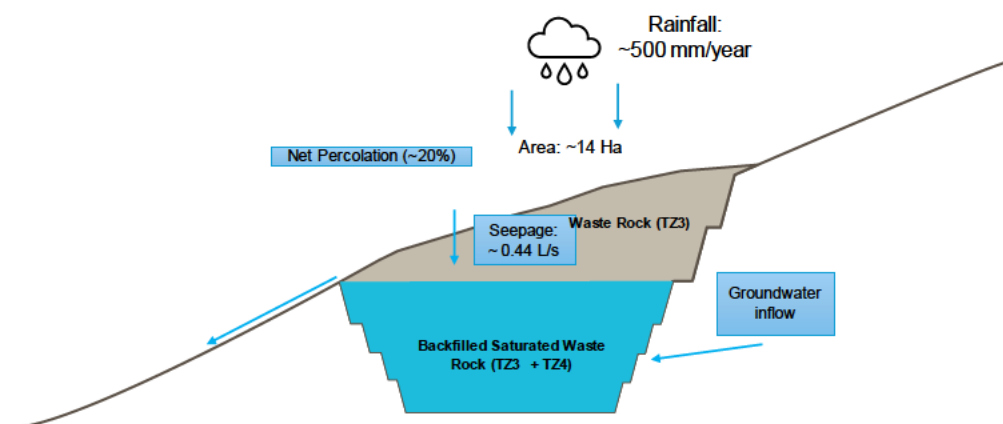


Figure 22. Conceptual (and schematic) water balance and material distribution for the Come in Time backfilled pit.

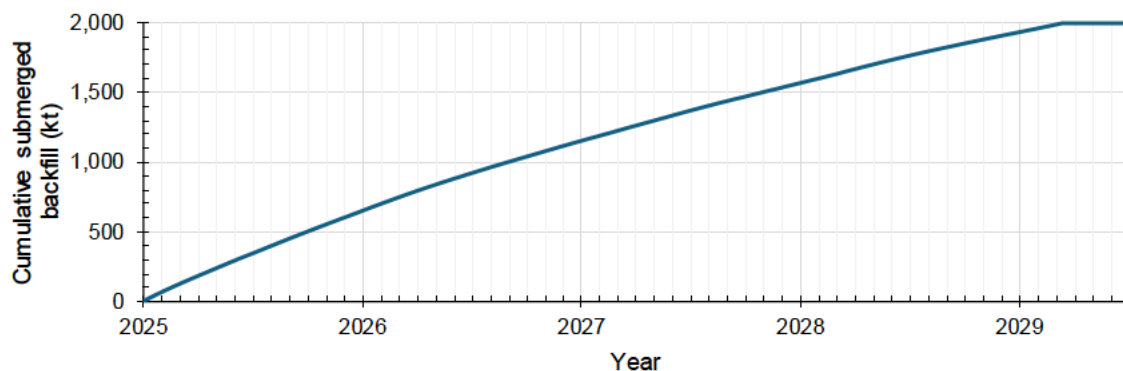


Figure 23. CIT cumulative backfill material below 510 mRL.

3.7.5 SCK Fill

The SCK Fill contains 2,264 kt of waste rock, composed entirely of TZ3 material. It is the smallest waste rock domain in terms of volume, area, and average height. Due to its elongated distribution along the creek, it is assumed that there will be no inner zone of low oxygen (e.g. sub-oxic conditions), and therefore the entire volume is expected to be reactive. The conceptual and schematic water balance and material distribution for this domain are shown in Figure 24.

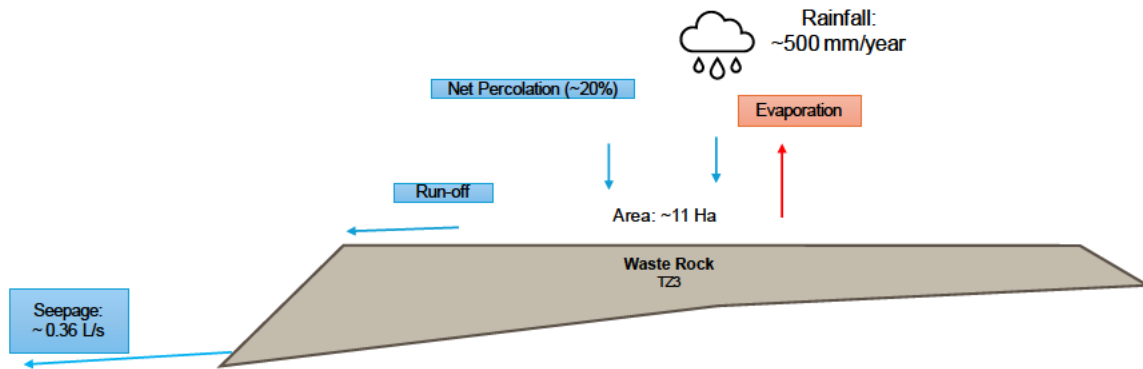


Figure 24. Conceptual (and schematic) water balance and material distribution for the SCK Fill.

Due to the presence of installations on top of the SCK Fill, the net percolation rate could potentially be lower than that assumed for the other waste rock domains. As a result, seepage may also be lower. However, the extent of this reduction is difficult to estimate. Therefore, for modelling purposes, it is assumed to behave similarly to the other domains. The average seepage flow rate is estimated at 0.36 L/s.

4 ELF GEOCHEMICAL MODELLING PROCESS

This section describes the geochemical modelling process utilised to estimate base case water quality for a WRS and the estimated water quality for the proposed ELF's at BOGP.

4.1 Data Sources

Data was obtained from MWM (2025a,d) including:

- 388 samples tested for ABA where total sulfur is used for sulfur reservoir calculations.
- 349 samples for chemical composition by 4-acid digestion and ICP-MS.
- 6 Column Leach Tests to quantify the initial stored oxidation products and long-term oxidation rates.

4.2 Modelling Approach

4.2.1 Scenarios Definition

Three scenarios are developed in this report. The first scenario corresponds to a scenario where a WRS is constructed (mine domain is fully oxidising) rather than an ELF. This scenario was developed to calibrate the modelled seepage water quality against empirical data from Macraes, assuming full oxidation of materials.

Two scenarios were then developed to estimate the expected seepage water quality under ELF-specific construction conditions. The BOGP ELF's will be built in short lifts to minimize oxygen ingress, meaning that only the outer rim of the ELF will be exposed to oxidation. This oxidation rim inherits the oxidation properties and assumptions from the WRS scenario, while the inner portion follows short-term release dynamics, where solute release is driven by water flow rather than oxidation.

For the ELF's, two oxygen ingress scenarios are considered: 20 meters and 10 meters of horizontal oxygen ingress as explained in Section 2.4.3.

4.2.2 Sulfur Reservoir Estimation

The following modelling approach was undertaken to define the initial SOP reservoirs

1. Define the quantities of TZ3 and TZ4 waste rock (Section 3), e.g., for the Shepherds ELF these amounts are 179,886 kt and 18,089 kt respectively.
2. Define the non-reactive fraction that represents the fraction of the material that is not part of the reaction due to the heterogeneous nature of waste rock (further details are provided in Section 4.2.5). This is set to 0.9 meaning that 10% of the material is available for interaction, hence, for the Shepherds ELF:
3. Reactive TZ3 waste rock: $179,886 \text{ kt} \times 0.1 = 17,989 \text{ kt}$
4. Reactive TZ4 waste rock: $18,089 \text{ kt} \times 0.1 = 1,809 \text{ kt}$
5. Determine how much sulfur is present that will be considered reactive. This is calculated by using the total sulfur content of the TZ3 and TZ4 material, which have been determined by

previous studies (MWM, 2025a) and is 0.088 wt% and 0.236 wt% respectively, therefore for the Shepherds ELF:

- o Total sulfur reservoir in TZ3: $0.088\% \times 17,989 \text{ kt} = 15,830 \text{ t}$.
 - o Total sulfur reservoir in TZ4: $0.236\% \times 1,809 \text{ kt} = 4,269 \text{ t}$.
6. The following calculation was undertaken to determine the quantities of sulfate and sulfide sulfur to understand the initial load of stored oxidation products (i.e., short-term sulfate load) and sulfide, associated with the long-term release due to oxidation of sulfides.
 7. The amount of initial sulfate sulfur load is determined by the amount released in the AMIRA columns up to week 20 (further details are provided in Section 4.2.6).
 8. For TZ3 it was determined that the initial load (sulfur as sulfate) is on average 2.19% of the total sulfur. For TZ4, this was calculated as 0.73%. The following calculations are provided for the Shepherds ELF:
 9. Total sulfate sulfur reservoir for TZ3: $2.19 \text{ wt}\% \times 15,830 \text{ t} = 347 \text{ t}$.
 10. Total sulfate sulfur reservoir for TZ4: $0.73 \text{ wt}\% \times 4,269 \text{ t} = 31 \text{ t}$.
 11. Therefore, sulfide sulfur for TZ3 is 15,483 t and for the TZ4 it is 4,238 t.
 12. Note: Due to the large quantity of rock, TZ3 has the largest SOP load, by an order of magnitude.
 13. Reservoir calculations are then undertaken for all scenarios (Traditional WRS, ELF - 20 m model, ELF - 10 m model) for the Shepherds ELF, SRX ELF, WELF, and CIT backfill and data are provided in the following tables. For the SCK Fill (Table 11) only the WRS scenario is presented, as it was assumed to be fully oxid. Note that the SOP (or short-term sulfate load reservoir) remains the same across all scenarios, as it is not dependent on oxygen availability. Hence, only the sulfide reservoirs are affected.

Table 7. Sulfur reservoir calculations for the Shepherds ELF.

SCENARIO	COMPONENT	TZ3	TZ4	TZ3+TZ4
Total Waste Rock	Waste Rock Quantity (kt)	179,886	18,089	197,975
Waste Rock Stack Case	Reactive Waste Rock (kt)	17,989	1,809	19,798
	Sulfur reservoir (t)	15,830	4,269	20,099
	S as Sulfides (t)	15,483	4,238	19,721
	S as SOP (t)	347	31	378
ELF - 20 m model	Waste Rock in Outer Rim (20-m Ox) (kt)	36,866	0	36,866
	Reactive Outer Rim (kt)	3,687	0	3,687
	Sulfur Reservoir in Outer Rim (t)	3,244	0	3,244
	S as Sulfides (t)	3,173	0	3,173
	S as SOP (t)	347	31	378
ELF - 10 m model	Waste Rock in Outer Rim (10-m Ox) (kt)	19,011	0	19,011

SCENARIO	COMPONENT	TZ3	TZ4	TZ3+TZ4
	Reactive Outer Rim (kt)	1,901	0	1,901
	Sulfur Reservoir in Outer Rim (t)	1,673	0	1,673
	S as Sulfides (t)	1,636	0	1,636
	S as SOP (t)	347	31	378

Table 8. Sulfur reservoir calculations for the SRX ELF.

SCENARIO	COMPONENT	TZ3	TZ4	TZ3+TZ4
Total Waste Rock	Waste Rock Quantity (kt)	4,378	606	4,984
Waste Rock Stack Case	Reactive Waste Rock (kt)	438	61	498
	Sulfur reservoir (t)	385	143	528
	S as Sulfides (t)	377	142	519
	S as SOP (t)	8.4	1.0	9.5
ELF - 20 m model	Waste Rock in Outer Rim (20-m Ox) (kt)	2,939	0	2,939
	Reactive Outer Rim (kt)	294	0	294
	Sulfur Reservoir in Outer Rim (t)	259	0	259
	S as Sulfides (t)	253	0	253
	S as SOP (t)	8.4	1.0	9.5
ELF - 10 m model	Waste Rock in Outer Rim (10-m Ox) (kt)	1,683	0	1,683
	Reactive Outer Rim (kt)	168	0	168
	Sulfur Reservoir in Outer Rim (t)	148	0	148
	S as Sulfides (t)	145	0	145
	S as SOP (t)	8.4	1.0	9.5

Table 9. Sulfur reservoir calculations for the CIT ELF backfill.

SCENARIO	COMPONENT	TZ3	TZ4	TZ3+TZ4
Total Waste Rock	Waste Rock Quantity (kt)	2,550	850	3,400
Waste Rock Stack Case	Reactive Waste Rock (kt)	255	85	340
	Sulfur reservoir (t)	224	201	425
	S as Sulfides (t)	219	199	419
	S as SOP (t)	4.9	1.5	6.4
ELF - 20 m model	Waste Rock in Outer Rim (20-m Ox) (kt)	2,005	0	2,005
	Reactive Outer Rim (kt)	201	0	201
	Sulfur Reservoir in Outer Rim (t)	176	0	176
	S as Sulfides (t)	173	0	173

SCENARIO	COMPONENT	TZ3	TZ4	TZ3+TZ4
	S as SOP (t)	4.9	1.5	6.4
ELF - 10 m model	Waste Rock in Outer Rim (10-m Ox) (kt)	1,148	0	1,148
	Reactive Outer Rim (kt)	115	0	115
	Sulfur Reservoir in Outer Rim (t)	101	0	101
	S as Sulfides (t)	99	0	99
	S as SOP (t)	4.9	1.5	6.4

Table 10. Sulfur reservoir calculations for the WELF.

SCENARIO	WASTE ROCK UNIT	TZ3	TZ4	TZ3+TZ4
Total Waste Rock	Waste Rock Quantity (kt)	10,732	0	10,732
Waste Rock Stack Case	Reactive Waste Rock (kt)	1,073	0	1,073
	Sulfur reservoir (t)	944	0	944
	S as Sulfides (t)	924	0	924
	S as SOP (t)	21	0	21
ELF - 20 m model	Waste Rock in Outer Rim (20-m Ox) (kt)	6,330	0	6,330
	Reactive Outer Rim (kt)	633	0	633
	Sulfur Reservoir in Outer Rim (t)	557	0	557
	S as Sulfides (t)	545	0	545
	S as SOP (t)	21	0	21
ELF - 10 m model	Waste Rock in Outer Rim (10-m Ox) (kt)	3,624	0	3,624
	Reactive Outer Rim (kt)	362	0	362
	Sulfur Reservoir in Outer Rim (t)	319	0	319
	S as Sulfides (t)	312	0	312
	S as SOP (t)	21	0	21

Table 11. Sulfur reservoir calculations for the SCK Fill

SCENARIO	WASTE ROCK UNIT	TZ3	TZ4	TZ3+TZ4
Total Waste Rock	Waste Rock Quantity (kt)	2,264	0	2,264
Waste Rock Stack Case	Reactive Waste Rock (kt)	226	0	226
	Sulfur reservoir (t)	199	0	199
	S as Sulfides (t)	195	0	195
	S as SOP (t)	4.4	0.0	4.4

4.2.3 Release Rates

Release rates are obtained from CLT data. Since each sample in the CLTs has a different total sulfur value, sulfur loss is calculated as a percentage of sulfur per month. The following process was followed:

1. Convert the total sulfur content from percentage to mg/kg ⁹.
2. Estimate the total sulfate (SO₄) released from the CLT up to week 20 and convert it to sulfur ¹⁰, which indicated that the average SO₄-S production up to week 20 of the CLT is 20.97 mg/kg for TZ3 and 22.07 mg/kg for TZ4 ¹¹.
3. Determine what percentage of the total sulfur that is represented by SO₄-S.
4. Calculate the amount of sulfide sulfur by subtracting SO₄-S from the total sulfur.
5. Determine the SO₄-S release rate by calculating the slope of cumulative SO₄ generation per week from week 20 onwards, converting it to mg/kg/month, and division by 2.996 to present data as SO₄-S.
6. Divide this value by the amount of sulfide-S to determine how much SO₄-S is released in the early stages of oxidation. Since sulfide-S will deplete over time, the release rate (and consequently the concentrations) will also decline with time, which is accounted for by the model.

These data (and the calculation process) are presented in Table 12. Results shown that TZ4 releases approximately 6 times the amount of sulfate released by TZ3, in part because the amount of total sulfur is higher (around 3 times higher), and also because the rock is more reactive (approximately 2 times higher). This supports the hypothesis that TZ4 materials should be placed in the core of the ELF away from oxygen.

Figure 25 shows the cumulative amounts of sulfate released over time. It is possible to see graphically that the amount of sulfate released in the first weeks is higher for TZ3, but after week 12, there is a clear change in the quantity of generated sulfate for this geological unit.

It is assumed a limit at week 20 for the initial amount of sulfate sulfur to account for on-going oxidation on field conditions before the material being placed on the ELFs

⁹ by multiplying by 10,000.

¹⁰ Based on molecular weights (i.e., by dividing by 2.996)

¹¹ 20 weeks was considered a reasonable time-period as an inflection was identified in TZ3 cumulative sulfate plots indicating a change in reaction kinetics (Figure 25) from short term kinetic rates to long term kinetic rates. 20 weeks was also considered a reasonable time frame for materials exposed in the field prior to being excluded from oxygen.

Table 12. Column leach test data for TZ3 and TZ4 oxidising materials.

Sample ID	TZ3 - S: 0.113% (MG19838)	TZ3 - S: 0.1025% (MG19875/76)	TZ3 - S: 0.0885% (MG43524/25)	TZ4/RSSZ - S: 0.488% (MG46045)	TZ4/RSSZ - S: 0.267% (MG40061)	TZ4/RSSZ - S: 0.226% (MG37922)	Average TZ3	Average TZ4
Total Sulfur (%)	0.113	0.1025	0.085	0.488	0.267	0.226	0.10017	0.327
Total Sulfur (mg/kg)	1130	1025	850	4880	2670	2260	1001.67	3270
SOP as Sulfur week 20 (mg/kg)	12.101	23.430	27.370	24.354	23.838	18.019	20.967	22.071
Sulfide-S (mg/kg)	1117.9	1001.6	822.6	4855.6	2646.2	2242.0	980.7	3247.9
SO ₄ -S as a percent of total S (%)	1.071	2.286	3.220	0.499	0.893	0.797	2.192	0.730
SO ₄ release rate (mg/kg/week)	0.279	0.948	1.045	5.633	4.180	3.007	0.757	4.273
SO ₄ -S release rate (mg/kg/month) ¹	0.404	1.371	1.511	8.146	6.046	4.349	1.095	6.180
Release rate (%/month) ²	0.036	0.137	0.184	0.168	0.228	0.194	0.119	0.197

1 – based on slope;

2 – normalised to wt% S

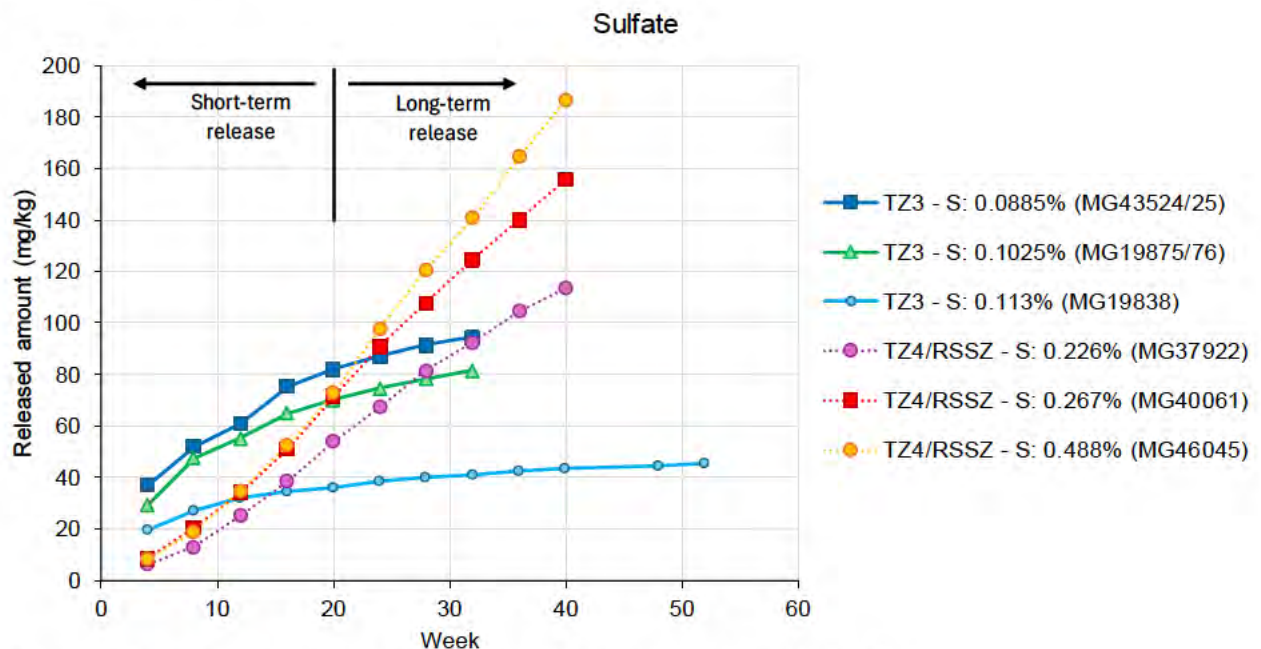


Figure 25. Cumulative released amount for sulfate based on the AMIRA CLT.

4.2.4 Time Lag to Peak Concentrations and Adjustments to Empirical Data

A time lag to peak PCOC concentration is expected for the proposed ELF. Several physical and hydrological properties influence this behaviour including:

- The rate of WRS construction, its height, and geometry can affect water infiltration and residence time, with taller or more compacted WRS promoting longer contact times with reactive materials.
- Preferential flow paths, such as fractures or loosely compacted zones, can create localised areas of rapid transport, altering concentration trends.
- The hydraulic properties of the waste rock, including permeability and porosity, determine how water moves through the system and interacts with reactive minerals. Granulometry and particle size distribution also play a role, as finer materials can retain water longer, enhancing dissolution and sulfate release.

Given the complexity of how water moves through such materials and the time lag to peak concentrations, empirical data and analogue models were used to estimate both the time required to reach peak concentrations and the magnitude of those peaks.

Data from Macraes (e.g., Babbage, 2019) indicates that these peaks develop over several years. For the Frasers West WRS (an average height of ~ 40.9 m: Navarro et al., 2024), it took approximately 14 years to reach peak concentrations. Assuming this timing corresponds to when the tallest portion of the waste rock stack begins contributing to seepage quality, we estimate that the peak concentrations for Shepherds ELF will occur between 25 and 30 years after construction begins. This estimate is based on the fact that the average height of the Shepherds ELF is approximately twice that of the Frasers West WRS. Hence, using height data to scale to time lag to peak concentration, the time lag to peak sulfate concentration for SRX ELF is 5 years; CIT ELF backfill is 4 years; WELF is 10 years, and 3 years for the SCK fill.

In addition, based on the analysis of peak concentrations at Macraes (MWM, 2024a), the estimated sulfate peak concentrations have been calculated for a comparable WRS and are shown in Table 13 along physical characteristics of the ELFs.

Table 13. Summary of ELF physical characteristics and SO₄ (mg/L) if constructed as a WRS.

ELF PARAMETER	SHEPHERDS	SRX	CIT	WELF	SCK FILL
Volume (m ³)	91,655,093	2,306,944	1,574,074	5,260,808	1,109,758
Quantity (kt)	197,975	4,983	3,400	10,732	2,264
Area (m ²)	1,155,423	155,592	137,925	175,128	111,845
Average height (m)	79	15	11 (5) ²	30	10
Estimated flow rate (L/s)	3.7	0.5	0.44	0.56	0.36
Years until peak concentration	27	5	4	10	3
Expected WRS sulfate peak concentration (mg/L) – no engineering controls ¹	6,206	1,160	861 (460) ²	2,350	776

1. – Sulfate concentrations are for a traditional WRS with no engineered controls.

2. – Numbers in brackets represent the average height and sulfate concentration of the CIT WRS above the phreatic surface.

The time lag to peak concentrations is incorporated into the model by assuming a normal distribution for the material generating the loads. This means that solute release begins progressively from the start, with the majority of the material (99%) undergoing interaction by year 40 for the Shepherds ELF model. This is represented graphically on Figure 26. It is worth noting that this adjustment does not affect the total released load as a whole, it only affects when the load is released.

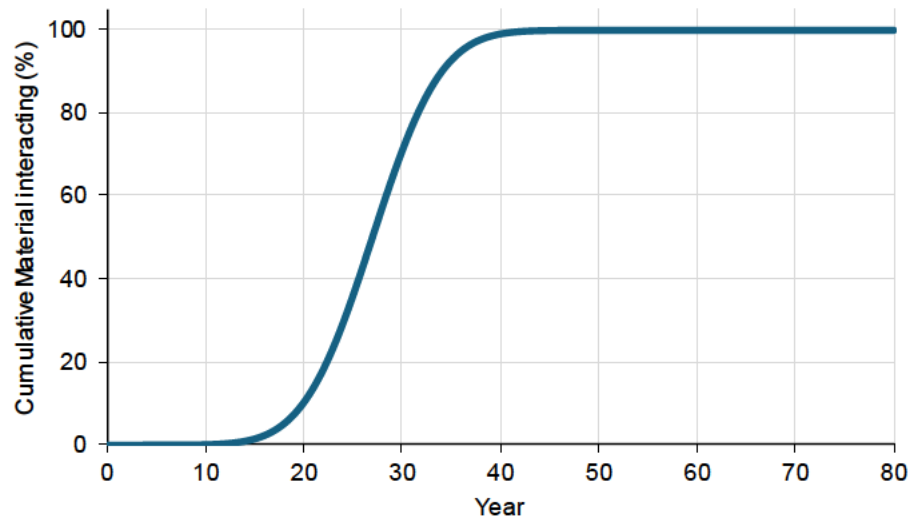


Figure 26. Cumulative percentage of waste rock material releasing solutes over time.

The effect on the sulfate concentration for the Shepherds WRS geochemical model is shown on Figure 27 where there is no scaling of data for any time lag to peak concentration. Without a time lag, all materials immediately release solutes from the start of the model and decays over time due to the exhaustion of available solutes, which is caused by both short-term and long-term sulfate release.

The introduction of a time lag to acid onset and an adjustment to the quantify of material contributing to solutes attenuates this peak concentration and generates the load later in the model. Note: these results are prior to the scaling of non-reactive material or column leach test concentrations to match empirical datasets (discussed in the next section).

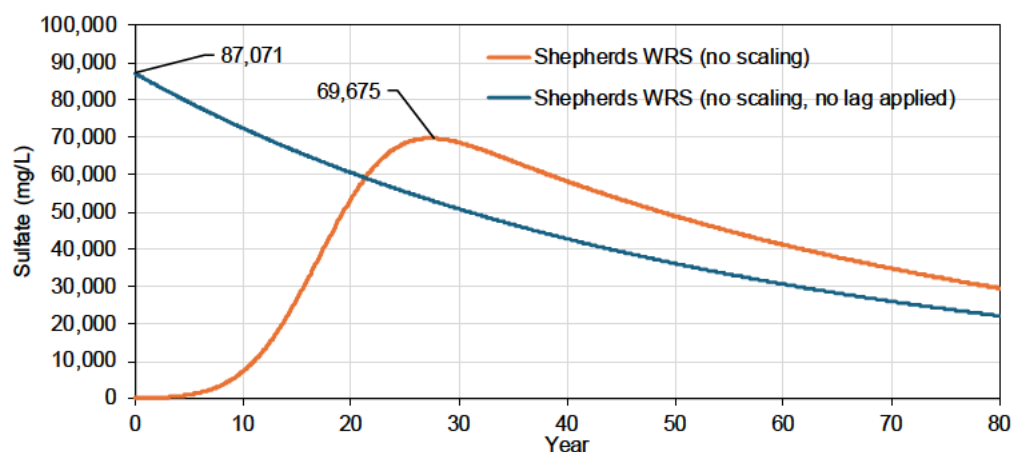


Figure 27. Comparison of model output for Shepherds WRS with no time lag to peak concentration and a time lag scenario.

4.2.5 Adjustments to Match Empirical Data: Waste Rock Stack Height

PCOC concentration is a function of WRS height. This process is based on analogue data from Macraes (Section 2.2), which shares similar geochemical characteristics and climatic conditions. The ELF model is based on the assumption that the expected average WRS sulfate concentrations peak correlates with the average height of the WRS. This approach is undertaken to develop the Traditional WRS model and assumes oxygen is freely available through the WRS.

The key driver for peak sulfate in the BOGP modelling is based on the height versus sulfate relationship (Navarro-Valdivia et al., 2024), which is shown in Table 13. Two adjustment factors are implemented to align the model:

1. The first factor to consider is the reactive material fraction. In laboratory conditions, such as those used in CLTs, a high percentage of minerals are available for reaction due to sample preparation, which often involves grinding the material to increase surface area. However, in the field, waste rock is coarser (e.g., boulders). Minerals within the inner parts of these boulders are not expected to be available for reaction in the short and long term. Additionally, preferential flow paths form during infiltration, and these paths will only interact with the minerals they come into direct contact with, further limiting the availability of reactive materials. The non-reactive material fraction was set to 0.9, which therefore decrease the peak sulfate concentration to ~7,000 mg/L (e.g., 10% of 70,000 mg SO₄/L).
2. The second factor to consider is an adjustment to the release rate of sulfate. The release rate adjustment factor specifically modifies the long-term release rates (e.g., derived from oxidation). This adjustment is made to align the release rates derived from CLT data with the expected sulfate peak from empirical data. The adjustment factor to the long-term release rates was set to 0.8575 to match the ~6,200 mg/L sulfate peak that is expected from the height versus peak sulfate concentration model (e.g., Figure 6).

The effect of the non-reactive fraction factor and the long-term release rates factor are shown in Figure 28.

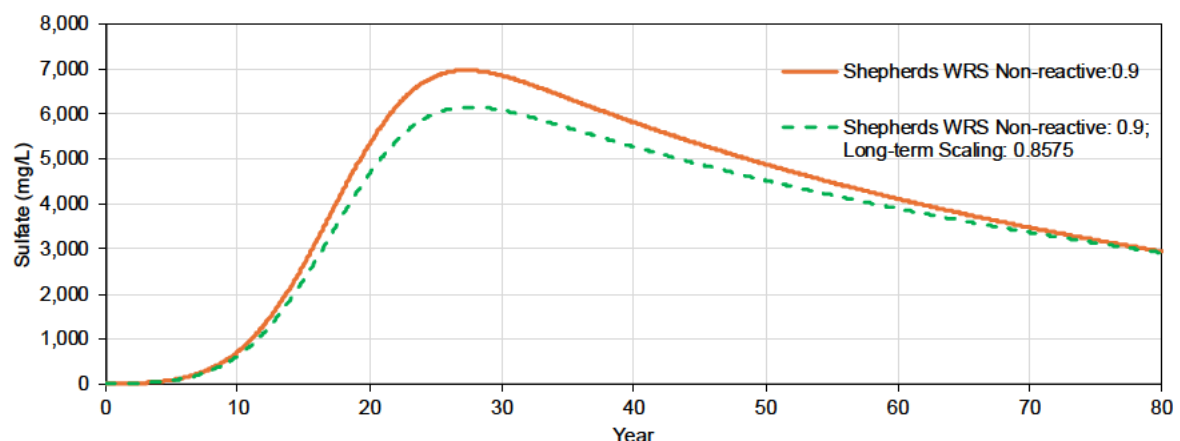


Figure 28. Adjustment Factors to match empirical data models: Traditional WRS.

Green line: Sulfate concentration for the non-reactive fraction set at 0.9.

Orange line: Sulfate concentration with non-reactive fraction set at 0.9 and long-term release rates adjusted with a factor of 0.8575 to match the ~6,200 mg/L expected sulfate peak.

4.2.6 Other Solute Release Calculations

Six AMIRA (2002) CLTs were conducted to quantify oxidation rates and solute release from TZ3 and TZ4 materials. Time series plots for sulfate are shown in Figure 25. The cumulative solute generation, expressed in milligrams of solute per kilogram (mg/kg) of rock, was calculated for each element.

The short-term release of contaminants was estimated using the intercept of the linear trend from the long-term decay. However, this approach differed for sulfate, where the total sulfate released up to week 20 was used instead. This exception was made because the TZ4 samples exhibited a negative intercept, suggesting an absence of initial sulfate load. Given that waste rock is expected to be exposed to the atmosphere (oxygen) before placement in the ELF and then will not be excluded from oxygen immediately, it was determined that sulfate generation would occur for up to 20 weeks prior to deposition, which also matched the SOP inflection point suggesting a change in kinetic rates (Figure 25), e.g., for example, a change from dissolution driven process to slower oxidation driven processes.

The long-term release rate was estimated by calculating solute generation from week 20 onward, with some exceptions. These exceptions were based on observed decay trends for specific solutes.

Since there is no empirical quantification of the total solute release over the long term for solutes other than sulfate, it was assumed that the solute decay follows the same pattern as sulfide decay. While this assumption may be conservative, implying that solute release persists for as long as sulfides, it provides a conservative estimate for long-term environmental impact assessments. This ensures that potential risks are not underestimated, even if the actual release duration may be shorter.

Three specific exceptions for solute behaviour are shown in Figure 29. Ongoing CLT will confirm whether the approaches presented below are appropriate:

- Molybdenum follows a similar pattern to sulfate; however, a slight decrease in CLT release rates is observed from week 32 onwards. The release rate for Mo was determined using the slope of the last three cycles to consider long term release rates.
- Uranium has a decreasing trend in CLT for TZ3 materials. The trend from week 28 onward is used for TZ3. TZ4 has very little U and all the released mass is assumed to be released in the short term.
- Boron release appears to cease in all CLT over time. Consequently, its long-term release rate is assumed to be zero, and the total amount released is attributed to short-term release.

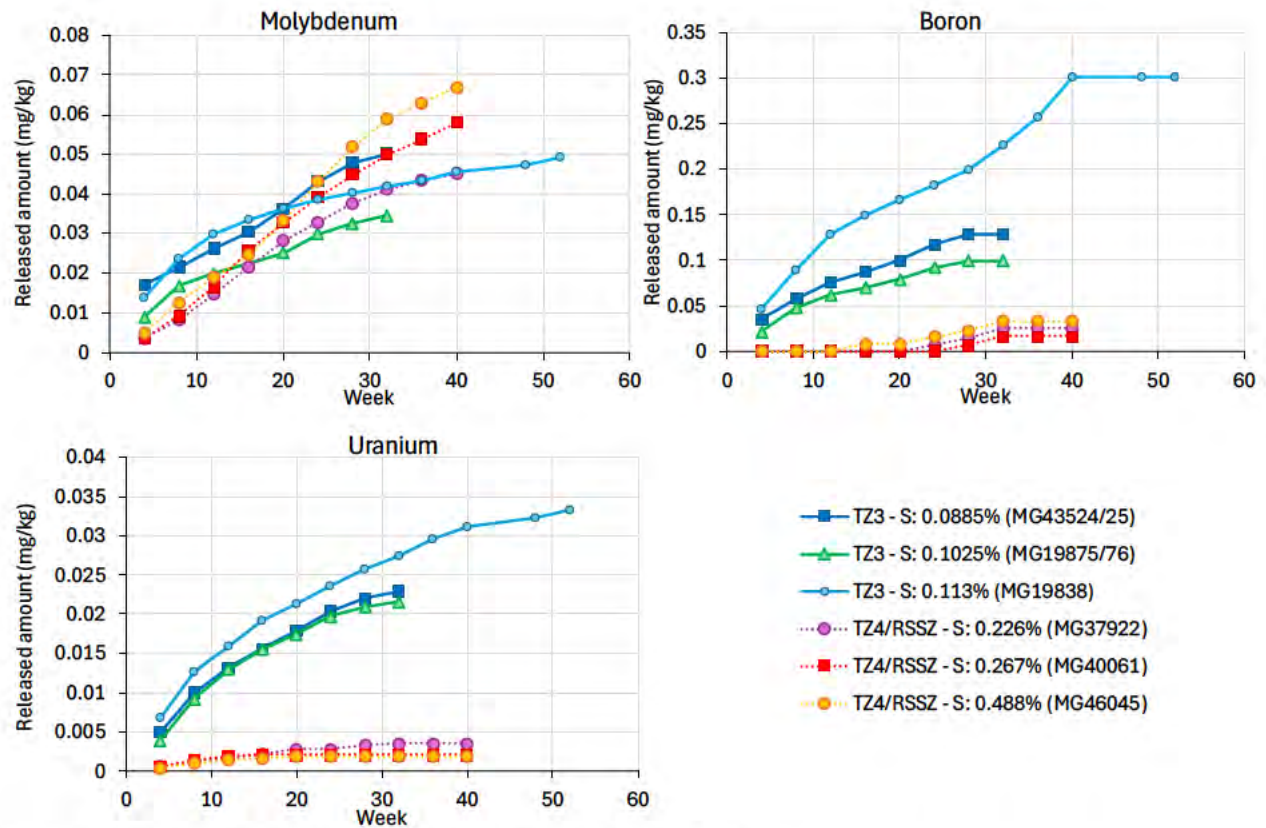


Figure 29. Cumulative CLT solute release rates for B, Mo, and U.

Table 14 summarises the average release rates for solute based on the CLT data for short and long terms for each lithological unit.

Table 14. Average short-term and long-term release rates for TZ3 and TZ4.

PARAMETER	SHORT-TERM RELEASE (mg/kg) ¹		LONG-TERM RELEASE (mg/kg/week)	
	TZ3	TZ4	TZ3	TZ4
Alkalinity	100.6841	8.457784	4.888945	1.100828
F	0.684865	0.064659	0.008621	0.00124
Cl	7.462766	0.842568	0.028704	0.020857
SO ₄	58.28484	47.46398	0.757372	4.273423
P	0.240219	0	0.002427	0.004354
Al	0.341493	0.038954	0.005617	0.003156
SO ₄	0.01508	0.00279	0.002833	0.0002
As	0.0283	0	0.016346	0.052076
Ba	0.006932	0.001595	0.001158	0.000722
B	0.176198	0.025042	0	0
Cd	0	0	0	0
Ca	0	0	1.354358	0.823776
Cr	0.000884	0.000432	0	0
Co	0.038286	0	0	3.7E-05
Cu	0.004143	0	0.000106	7.12E-06

PARAMETER	SHORT-TERM RELEASE (mg/kg) ¹		LONG-TERM RELEASE (mg/kg/week)	
	TZ3	TZ4	TZ3	TZ4
Fe	0.193134	0.00764	0.001586	0.000413
Pb	0.000246	0	0	0
Mg	0.094851	0	0.161223	0.620839
Mn	0.008974	0.006485	0.000678	0.000747
Hg	5.57E-05	0	0	0
Mo	0.024109	0.02288	0.00058	0.000844
Ni	0.001733	0.000484	0	6.38E-06
K	1.855408	4.621057	0.591858	0.558662
Se	0.00207	0	0.000144	0
Ag	0	0	0	0
Na	65.56925	7.088255	0.612655	0.182891
Sr	0.145743	0.110983	0.042898	0.058856
Tl	0	0	0	0
Sn	0	0	0	0
Ti	0.005641	0	1.86E-05	0
U	0.018802	0.0025	0.000186	0
V	0.006116	7.09E-05	9.87E-05	0
Zn	0.003452	0	0	0

For calculation purposes, any value below the limit of reporting was assumed to be zero.

Note: Nitrate-N cannot be determined from CLT as the materials have not been blasted. Nitrate-N loads of 16.6 mg/kg are used in the model (see Section 2.6.2).

1. - It is assumed that ~90% of the SOP load is mobilised over 50 years to align with the mobilisation of nitrate-N.

4.2.7 Solubility Controls (PHREEQC)

Once the solute concentration is estimated, the resulting concentrations are modelled using the geochemical modelling code PHREEQC version 3.7 (Parkhurst & Appelo, 2003) with the minteq.v4 database. The objective of this step is to apply solubility controls to the concentrations and precipitate supersaturated minerals, such as Fe, Al, and Cu hydroxides, as well as other hydroxysulfates and sulfates. This is achieved using the EQUILIBRIUM_PHASES keyword in PHREEQC simulations.

Certain assumptions are made, including the presence of excess dolomite in the reaction to help calculate and regulate pH. This assumption is possible, since mineralogical analyses (MWM, 2025a) identified dolomite as the main carbonate phase. Additionally, the ABA data indicates that the acid neutralisation capacity (ANC) exceeds the maximum potential acidity (MPA) by a ratio of 3 and higher, indicating a sufficient carbonate presence to neutralise the acid generated from sulfides.

Table 15. Equilibrium phases in the geochemical modelling for solubility controls.

PHASE	REACTIONS	LOG K
Dolomite(ordered)	$\text{CaMg}(\text{CO}_3)_2 = \text{Ca}^{+2} + \text{Mg}^{+2} + 2\text{CO}_3^{-2}$	-17.09
$\text{CO}_2(\text{g})$	$\text{CO}_2 + \text{H}_2\text{O} = 2\text{H}^+ + \text{CO}_3^{-2}$	-18.147
Ferrihydrite	$\text{Fe}(\text{OH})_3 + 3\text{H}^+ = \text{Fe}^{+3} + 3\text{H}_2\text{O}$	3.191
Basaluminite*	$\text{Al}_4(\text{OH})_{10}\text{SO}_4 + 10\text{H}^+ = 4\text{Al}^{+3} + \text{SO}_4^{-2} + 10\text{H}_2\text{O}$	22.7

PHASE	REACTIONS	LOG K
Fluorite	$\text{CaF}_2 = \text{Ca}^{+2} + 2\text{F}^-$	-10.5
Al(OH) ₃ (am)	$\text{Al(OH)}_3 + 3\text{H}^+ = \text{Al}^{+3} + 3\text{H}_2\text{O}$	10.8
Gibbsite	$\text{Al(OH)}_3 + 3\text{H}^+ = \text{Al}^{+3} + 3\text{H}_2\text{O}$	8.291
Celestite	$\text{SrSO}_4 = \text{Sr}^{+2} + \text{SO}_4^{-2}$	-6.62
Gypsum	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O} = \text{Ca}^{+2} + \text{SO}_4^{-2} + 2\text{H}_2\text{O}$	-4.61
Strontianite	$\text{SrCO}_3 = \text{Sr}^{+2} + \text{CO}_3^{-2}$	-9.27
Hydroxylapatite	$\text{Ca}_5(\text{PO}_4)_3\text{OH} + \text{H}^+ = 5\text{Ca}^{+2} + 3\text{PO}_4^{-3} + \text{H}_2\text{O}$	-44.333
Malachite	$\text{Cu}_2(\text{OH})_2\text{CO}_3 + 2\text{H}^+ = 2\text{Cu}^{+2} + 2\text{H}_2\text{O} + \text{CO}_3^{-2}$	-5.306
Barite	$\text{BaSO}_4 = \text{Ba}^{+2} + \text{SO}_4^{-2}$	-9.98
Cupricferrite	$\text{CuFe}_2\text{O}_4 + 8\text{H}^+ = \text{Cu}^{+2} + 2\text{Fe}^{+3} + 4\text{H}_2\text{O}$	5.9882
Fluorapatite*	$\text{Ca}_5(\text{PO}_4)_3\text{F} + 3\text{H}^+ = 5\text{Ca}^{+2} + 3\text{HPO}_4^{-2} + \text{F}^-$	-17.6
Alunite	$\text{KAl}_3(\text{SO}_4)_2(\text{OH})_6 + 6\text{H}^+ = \text{K}^+ + 3\text{Al}^{+3} + 2\text{SO}_4^{-2} + 6\text{H}_2\text{O}$	-1.4
K-Autunite	$\text{K}_2(\text{UO}_2)_2(\text{PO}_4)_2 = 2\text{UO}_2^{+2} + 2\text{K}^+ + 2\text{PO}_4^{-3}$	-48.244
Na-Autunite	$\text{Na}_2(\text{UO}_2)_2(\text{PO}_4)_2 = 2\text{UO}_2^{+2} + 2\text{Na}^+ + 2\text{PO}_4^{-3}$	-47.409
Calcite	$\text{CaCO}_3 = \text{Ca}^{+2} + \text{CO}_3^{-2}$	-8.48
Quartz	$\text{SiO}_2 + 2\text{H}_2\text{O} = \text{H}_4\text{SiO}_4$	-4
Pyromorphite	$\text{Pb}_5(\text{PO}_4)_3\text{Cl} = 5\text{Pb}^{+2} + 3\text{PO}_4^{-3} + \text{Cl}^-$	-84.43
PbMoO ₄	$\text{PbMoO}_4 = \text{Pb}^{+2} + \text{MoO}_4^{-2}$	-15.62
Pb ₃ (VO ₄) ₂	$\text{Pb}_3(\text{VO}_4)_2 + 8\text{H}^+ = 3\text{Pb}^{+2} + 2\text{VO}_2^{+} + 4\text{H}_2\text{O}$	6.14
Cr(OH) ₃ (am)	$\text{Cr(OH)}_3 + \text{H}^+ = \text{Cr(OH)}_2^{+} + \text{H}_2\text{O}$	-0.75

*Added from WATEQ4F thermodynamic database.

In addition, excess oxygen is assumed, meaning that Fe is assumed to be in the Fe^{3+} state and may precipitate as an iron hydroxide. Only phases that were at some point saturated in the WRS scenario are assumed to be in equilibrium, with initial amounts set to zero, allowing only precipitation to occur.

CO_2 equilibrium (fugacity) is set to -2.5, which is one order of magnitude higher than atmospheric conditions. This assumption is based on the expectation that the dissolution of carbonates, such as dolomite, enriches the waste rock pores with CO_2 , leading to higher alkalinity concentrations.

Analogue empirical data for seepage from the Devils WRS at Globe Progress, where the waste rock was present under sub-oxic conditions, indicated elevated concentrations of As and Fe (Hayton et al., 2022). Therefore, these concentrations are used as constant outputs for ELF seepage. To represent the sub-oxic conditions of the ELF, Fe and As concentrations are set at 7.6 mg/L and 0.2 mg/L, respectively based on the Globe Progress waste rocks drains concentrations (Hayton et al., 2022). There is some uncertainty in these data, but any issues can be resolved by active and passive treatment processes that are proposed for the BOGP in the active and post closure phases (MWM, 2025e).

4.3 Summary of Model Inputs and Other Considerations

A process diagram is shown in Figure 30 and summarises the process to derive water quality estimates for the proposed BOGP ELFs. Summary inputs for model are shown in Table 16.

Table 16. Summary for ELF modelling inputs

PARAMETER	VALUE	UNIT
SULFUR RESERVOIR		
TZ3-S (%)	0.088	%
TZ4-S (%)	0.236	%
TZ3 (SO4-S)/S (%)	2.19223	%
TZ4 (SO4-S)/S (%)	0.72973	%
SULFATE RELEASE RATES		
Short-term rates	0.4	%/month
Long-term rate TZ3	0.118904	%/month
Long-term rate TZ4	0.196745	%/month
ADJUSTMENT FACTORS		
non-reactive fraction	0.1	
long-term rates factor	0.8575	
MATERIAL QUANTITIES		
SHEP-TZ3	179,886	kt
SHEP-TZ4	18,089	kt
SRX-TZ3	4,377	kt
SRX-TZ3	606	kt
CIT-TZ3	2,550	kt
CIT-TZ3	850	kt
WELF-TZ3	10,732	kt
SCK Fill-TZ3	2,264	kt
EXPECTED YEAR FOR PEAK CONCENTRATION		
SHEPHERDS	27	year
SRX	5	year
CIT	4	year
WELF	10	year
SCK Fill	3	year

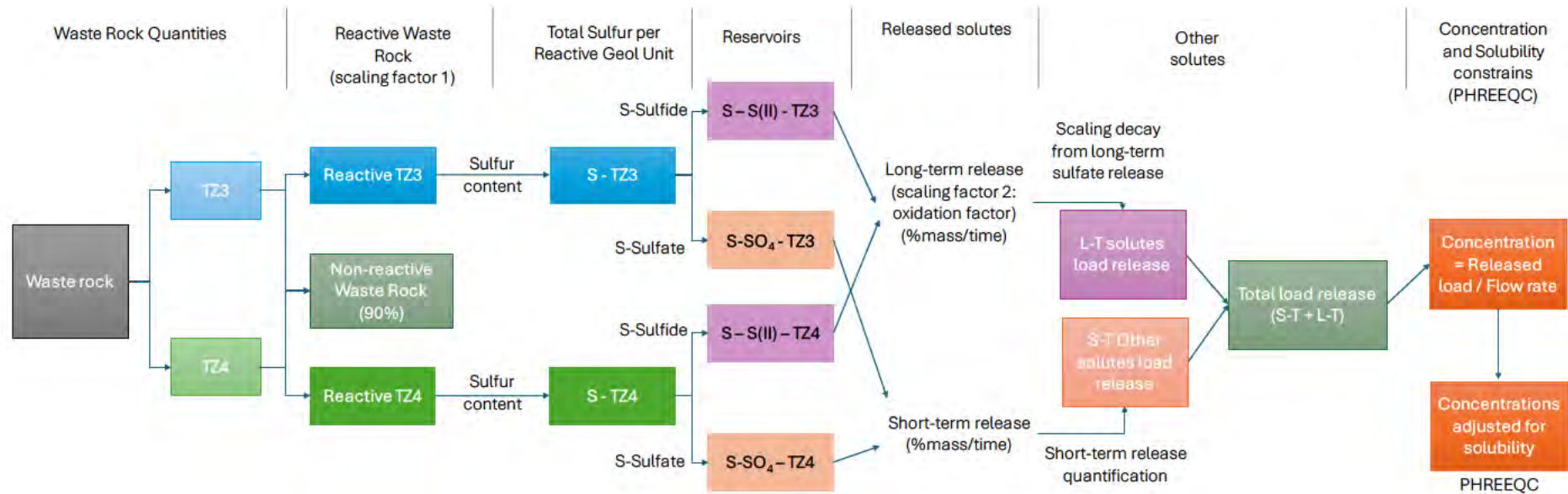


Figure 30. Process diagram for estimating the water quality seepage of the ELF.

4.4 Model Limitations

The model has the following limitations:

- It is not possible to model the dynamics of nitrogen speciation accurately, as they are governed by sites-specific biochemical reactions and oxygen availability. It can be assumed that the majority of nitrogen will be speciated as nitrate, however, there could be a minor part as nitrite or ammoniacal nitrogen. The results are presented as nitrogen (total nitrogen).
- The estimated release rates for some elements may be overly conservative, as they are based on sulfide decay rates. Consequently, solute generation could be overestimated thereby maintaining high solute generation rates over time.
- The time lag to peak concentrations is influenced by the ELF's geometry, therefore the applied time lag to peak sulfate concentration is an approximate estimate based on analogue empirical data, and simplistic assumptions. However, the time frame is likely to be reasonable to estimate potential environmental risks for the BOGP.
- In-situ precipitation of ferric hydroxides is anticipated. Consequently, certain metals (e.g., As, Cu, Zn)) may be sorbed and captured by these minerals, particularly at neutral to alkaline pH where sorption capacities are elevated. While PHREEQC modelling can model this, significant uncertainty exists around the amount of available iron. Therefore, a conservative approach is adopted, and sorption is not modelled. Sorption may be higher in the outer oxidising zone of the ELF and lower in the core where oxygen is limited. Fixed Fe and As concentrations are provided to identify the risk to receiving waters and the need for management.

5 MODEL RESULTS AND ANALYSIS

This section presents the model results for Shepherds ELF, SRX ELF, WELF, CIT Backfill, and the SCK Fill.

5.1 Water Quality Reference Criteria

Model results are compared to the proposed compliance water quality limits for the BOGP (Ryder, 2025) for surface and groundwater to understand what PCOC may be elevated from these mine domains (Table 17).

- Sulfate limit is set at 500 mg/L as a guide to understand MIW with no modifications for SW (Ryder, 2025 recommends a variable limit between 500 and 1,000 mg/L based on hardness and chloride modifications)
- No modifications (e.g., hardness) were applied to the limits.
- Boron limit (ANZG, 2018 limits for 90% of freshwater level of protection) was used for reference purposes at 1.5 mg/L.

Table 17. Reference concentration limits for surface water and groundwater (mg/L).

PARAMETER	SURFACE WATER REFERENCE LIMIT	GROUNDWATER REFERENCE LIMIT
Al	0.08	1
Co	0.001	1
Cu	0.0018	0.5
Mn	-	0.4
Mo	0.034	0.01
NO ₃ -N	2.4	11.3
Pb		0.01
Sb	0.074	0.02
Se	-	0.02
SO ₄	500	250
Sr	-	4
U	-	0.03
Zn	0.015	1.5
Cr	0.0033	0.05

Source: Ryder (2025); Units in mg/L

Results are displayed in time-series plots together with the GW and SW limits and a summary table of results.

5.2 General Observations

The following general observations are provided for the results:

- Water quality is expected to be circum-neutral pH with low acidity. This is due to the abundance of carbonate minerals and a low sulfide content.

- Peak sulfate concentrations, a function of average ELF height, were determined for Shepherds ELF (~27 years), SRX ELF (~5 years), CIT ELF (~4 years), WELF (~10 years), and SCK Fill (~3 years).
- When the results for the two scenarios overlap (e.g., 10 m and 20 m oxygen exclusion zones), it indicates that the solutes originate from short-term release, where oxidation has no impact on the results, and therefore, results are the same.
- The first 50 years are strongly influenced by the short-term release of SOP. This is particularly evident for nitrate-nitrogen (NO₃-N), boron (B), cobalt (Co), and zinc (Zn), which are generally elevated and are associated with SOP (see Table 14). Reducing water ingress would reduce the rate that these PCOC are mobilised.
- Sulfate concentrations are > 500 mg/L for the Shepherds ELF, SRX ELF, and WELF. Sulfate concentrations are < 500 mg/L in the CIT backfill and the SCK Fill.
- Nitrate-N concentrations are > 2.4 mg/L in seepage from all waste rock disposal areas. Duration of elevated nitrate in seepage is expected to range from 25 – 100 years but may be shorter due to biogeochemical processes that would remove the nitrate.
- Results indicate that the following trace metals: Sb, Co, Mo, Mn, Se, Sr, U, and Zn, are generally over the respective water quality reference limits.
- Results indicate that Al, B, Cd, Cr, Cu, Hg, and Pb, are below the respective water quality reference limits in all cases. These PCOC are not considered an issue for this mine domain.
- Constant concentrations are assumed for As (0.2 mg/L) and Fe (7.6 mg/L) based on empirical data for sub-oxic conditions (e.g., Globe Progress Waste Rock Stack, Hayton et al., 2022). These concentrations are above the proposed water quality reference limit (Ryder, 2025) and will require management. The SCK Fill assumes full oxidation, which results in low Fe concentrations.
- Zn is overall below both limits, however peak concentrations are slightly above the SW reference limit (0.0155 > 0.015 mg/L) for Shepherds ELF.

The following subsections present specific results and observations for each ELF.

5.3 Shepherds ELF

Results for the model scenarios for the Shepherds ELF are shown in Figure 31 and Figure 32 with selected outputs shown in Table 17.

The following observations are provided:

- In general, the highest concentrations of PCOC (especially SOP), can be found in Shepherds ELF, due to its higher material volume and higher height.
- Sulfate concentrations are similar across both scenarios (10 and 20 m oxygen exclusion) where oxygen is restricted to the outer rim of the ELF, peaking at approximately 1,100 mg/L. After year 50, sulfate concentrations declined to below 750 mg/L for both the 10 m and 20 m oxygen exclusion scenarios.

- $\text{NO}_3\text{-N}$ concentration peaks at ~ 80 mg/L.
- Sb, U, and Mn behave similarly to sulfate, likely associated with oxidation of sulfides.

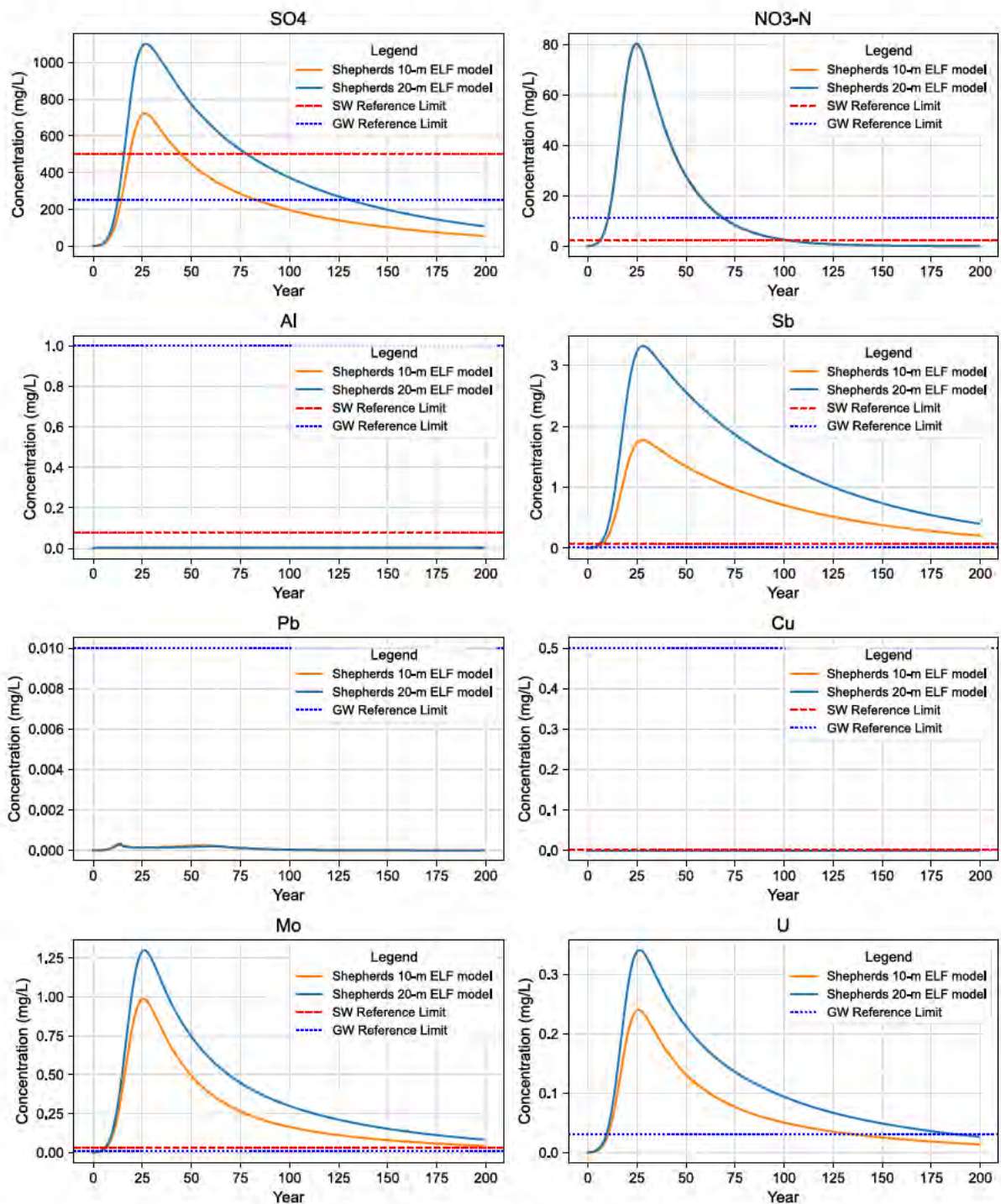


Figure 31. Model results part 1 for the Shepherds ELF.

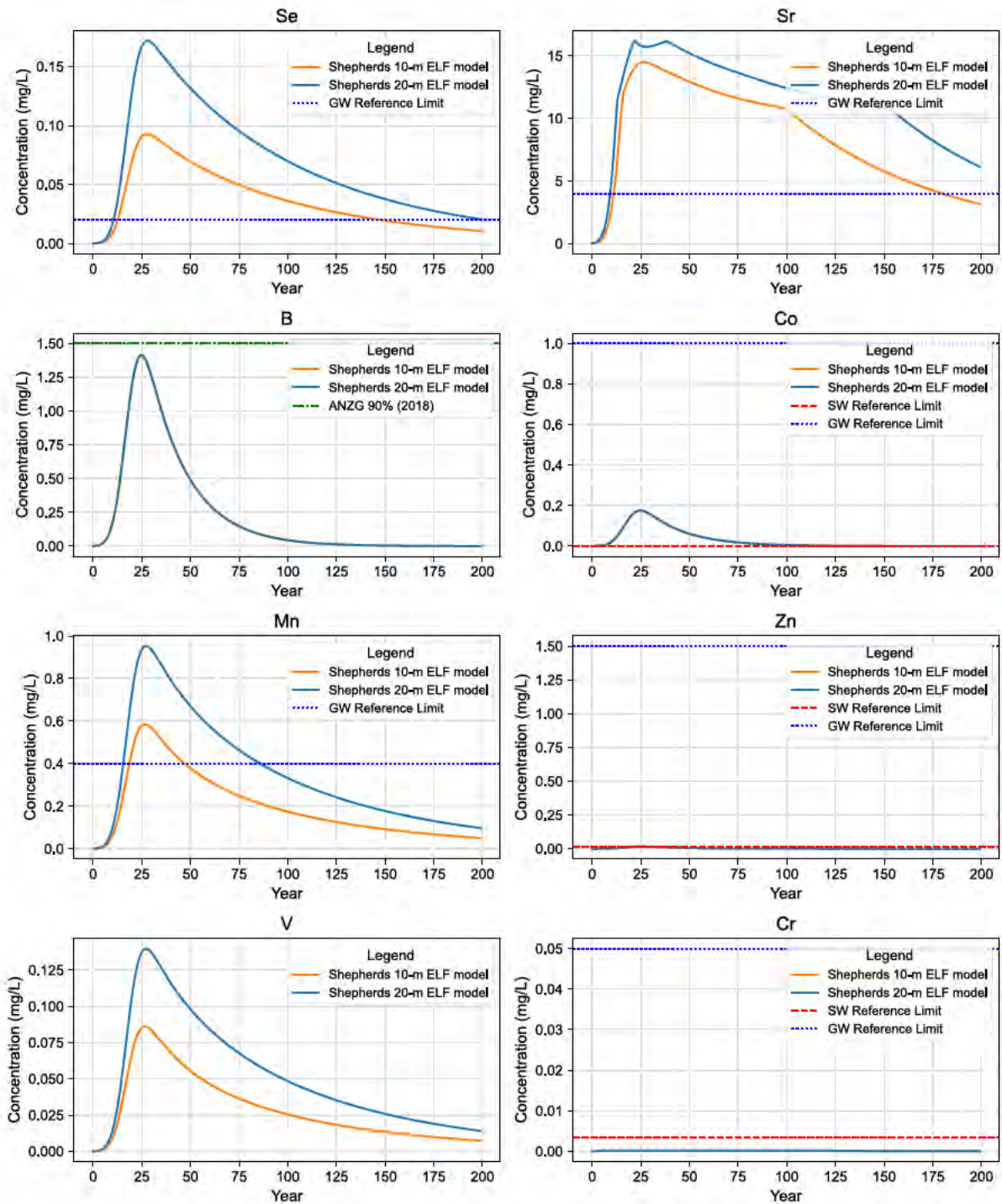


Figure 32. Model results part 2 for the Shepherds ELF.

Table 18. Selected model results for the Shepherds ELF Scenarios

SCENARIO	PARAMETER	Al	B	Co	Mn	Mo	NO3-N	Sb	Se	SO4	Sr	U	Zn	V	Cr
	SW REF LIMIT	0.08	-	0.001 ^a	-	0.034	2.4 ^b	0.074 ^a	-	500	-	-	0.015		0.0033 ^c
	GW REF LIMIT	1	-	1	0.4	0.01	11.3	0.02	0.02	250	4	0.03	1.5		0.05
YEAR															
ELF - 20 m model	1	0.0028	0.001	0.0002	0.0008	0.0012	0.08	0.0026	0.0001	1	0.04	0.000	0.0000	0.0001	0.00002
ELF - 20 m model	5	0.0028	0.023	0.0029	0.0129	0.0191	1.32	0.0426	0.0022	16	0.67	0.005	0.0003	0.0019	0.00017
ELF - 20 m model	10	0.0030	0.175	0.0218	0.0997	0.1464	9.96	0.3315	0.0172	120	5.18	0.037	0.0020	0.0147	0.00017
ELF - 20 m model	27	0.0035	1.378	0.1718	0.9529	1.2953	78.36	3.3105	0.1712	1102	15.73	0.341	0.0155	0.1398	0.00019
ELF - 20 m model	50	0.0033	0.490	0.0611	0.6704	0.7442	27.86	2.5623	0.1315	773	15.21	0.212	0.0055	0.0980	0.00019
ELF - 20 m model	100	0.0031	0.044	0.0055	0.3322	0.2996	2.51	1.3664	0.0697	373	12.41	0.094	0.0005	0.0484	0.00018
ELF - 20 m model	150	0.0030	0.004	0.0005	0.1772	0.1530	0.23	0.7386	0.0377	198	10.81	0.049	0.0000	0.0258	0.00004
ELF - 20 m model	199	0.0029	0.000	0.0000	0.0970	0.0831	0.02	0.4051	0.0206	108	6.14	0.027	0.0000	0.0141	0.00000
ELF - 10 m model	1	0.0028	0.001	0.0002	0.0005	0.0010	0.08	0.0014	0.0001	1	0.02	0.000	0.0000	0.0001	0.00002
ELF - 10 m model	5	0.0028	0.023	0.0029	0.0082	0.0151	1.32	0.0231	0.0012	10	0.37	0.004	0.0003	0.0012	0.00017
ELF - 10 m model	10	0.0029	0.175	0.0218	0.0633	0.1152	9.96	0.1791	0.0094	80	2.87	0.027	0.0020	0.0093	0.00017
ELF - 10 m model	27	0.0034	1.377	0.1716	0.5840	0.9791	78.27	1.7697	0.0927	722	14.51	0.239	0.0155	0.0861	0.00019
ELF - 10 m model	50	0.0032	0.490	0.0610	0.3785	0.4944	27.84	1.3431	0.0693	447	12.94	0.132	0.0055	0.0555	0.00018
ELF - 10 m model	100	0.0030	0.044	0.0055	0.1742	0.1644	2.51	0.7063	0.0361	197	10.74	0.050	0.0005	0.0254	0.00017
ELF - 10 m model	150	0.0029	0.004	0.0005	0.0916	0.0798	0.23	0.3810	0.0194	102	5.77	0.025	0.0000	0.0133	0.00004
ELF - 10 m model	199	0.0029	0.000	0.0000	0.0500	0.0429	0.02	0.2089	0.0106	56	3.16	0.014	0.0000	0.0073	0.00000

Units in mg/L

a: Chronic value is used for reference.

b: Annual median used for NO₃-N

c: Cr(III) recommended compliance limit is used.

Bold red text indicates values greater than the GW and SW reference limit.

Bold orange text indicates values greater than the SW reference limit.

Bold purple text indicates values greater than the GW reference limit.

5.4 SRX ELF

Selected results for the model scenarios for the SRX ELF are shown in Figure 33 and Figure 34 and selected outputs for key years shown in Table 18.

The following observations are provided:

- Sulfate concentrations peak at 646 mg/L for the ELF (20 m oxygen exclusion model) and at 402 mg/L for the ELF (10 m oxygen exclusion model).

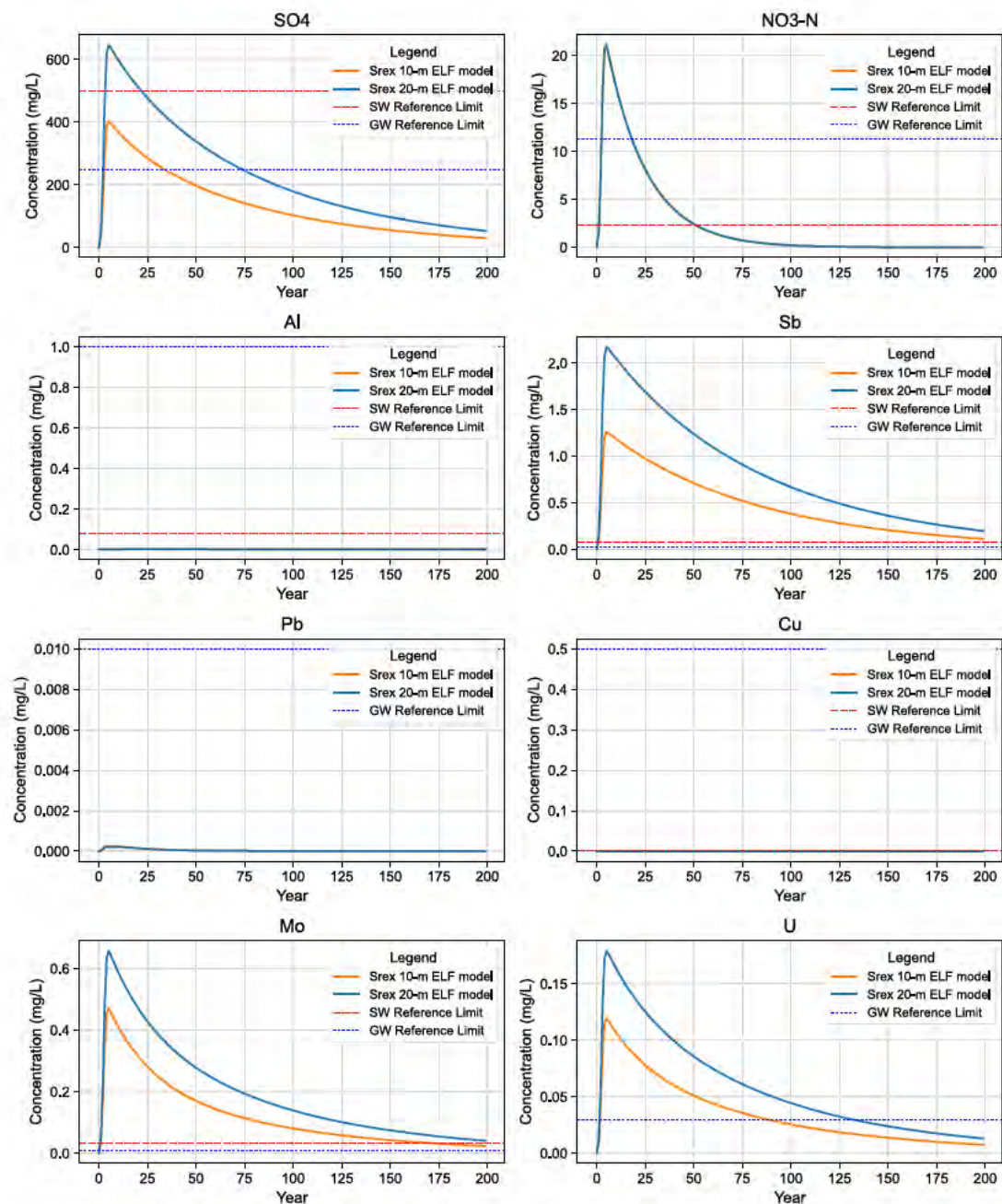


Figure 33. Model results part 1 for the SRX ELF.

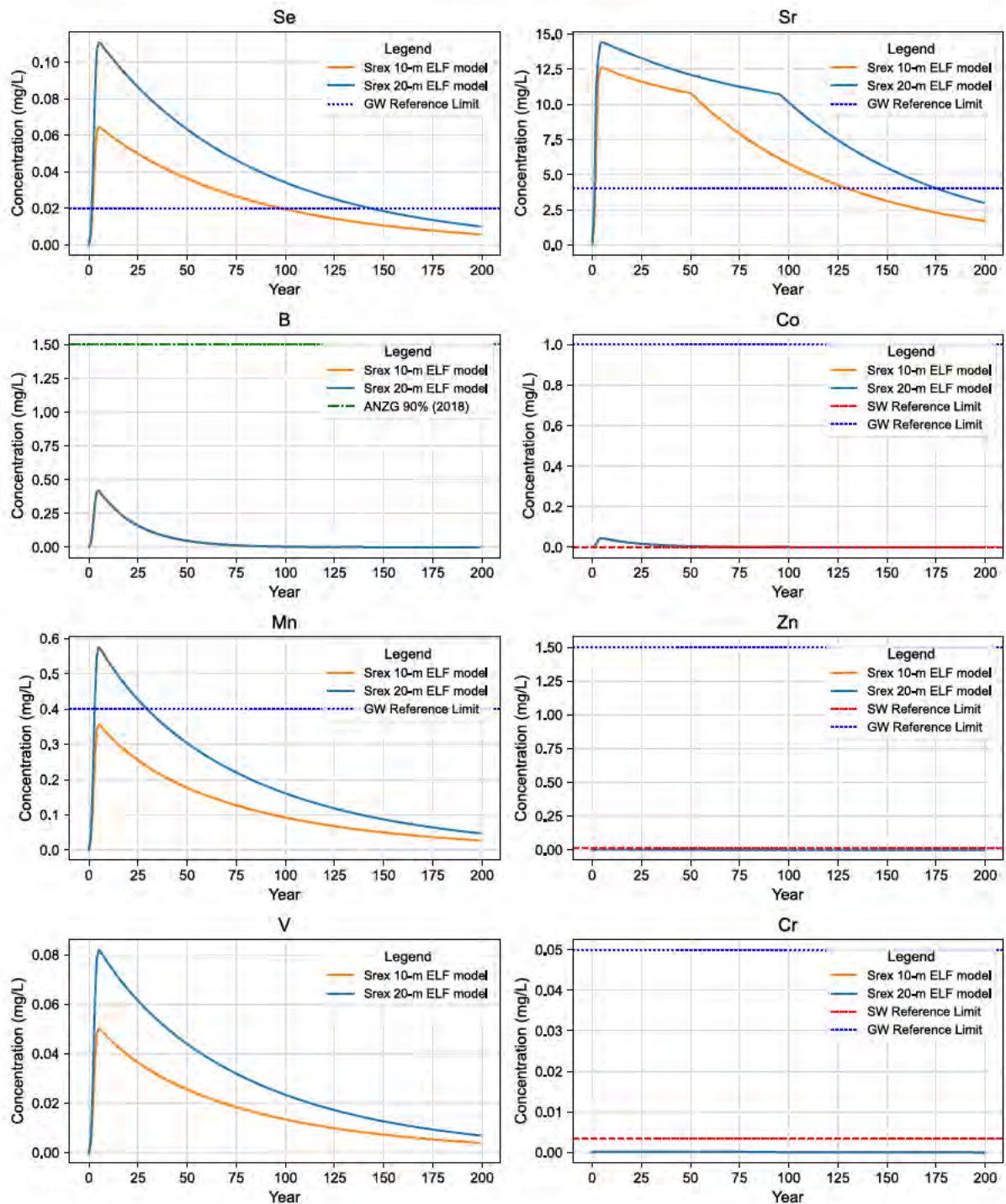


Figure 34. Model results part 2 for the SRX ELF.

Table 19. Selected model results for the SRX ELF Scenarios

SCENARIO	PARAMETER	Al	B	Co	Mn	Mo	NO3-N	Sb	Se	SO4	Sr	U	Zn	V	Cr
	SW REF LIMIT	0.08	-	0.001 ^a	-	0.034	2.4 ^b	0.074 ^a	-	500	-	-	0.015	0	0.0033 ^c
	GW REF LIMIT	1	-	1	0.4	0.01	11.3	0.02	0.02	250	4	0.03	1.5	0	0.05
YEAR															
ELF - 20 m model	1	0.0028	0.031	0.0034	0.0402	0.0468	1.58	0.151	0.0077	45	2.32	0.013	0.0003	0.0057	0.00017
ELF - 20 m model	5	0.0033	0.418	0.0449	0.5755	0.6579	21.11	2.173	0.1111	646	14.44	0.179	0.0040	0.0820	0.00019
ELF - 20 m model	10	0.0032	0.331	0.0355	0.5343	0.5880	16.70	2.049	0.1047	599	14.14	0.164	0.0032	0.0764	0.00019
ELF - 20 m model	27	0.0032	0.146	0.0157	0.4146	0.4125	7.37	1.651	0.0843	464	13.19	0.121	0.0014	0.0597	0.00018
ELF - 20 m model	50	0.0031	0.048	0.0052	0.3031	0.2784	2.44	1.239	0.0632	339	12.12	0.086	0.0005	0.0439	0.00018
ELF - 20 m model	100	0.0030	0.004	0.0005	0.1609	0.1393	0.22	0.669	0.0341	180	10.15	0.044	0.0000	0.0234	0.00005
ELF - 20 m model	150	0.0029	0.000	0.0000	0.0869	0.0745	0.02	0.363	0.0185	97	5.50	0.024	0.0000	0.0126	0.00000
ELF - 20 m model	199	0.0029	0.000	0.0000	0.0477	0.0408	0.00	0.199	0.0101	53	3.02	0.013	0.0000	0.0069	0.00000
ELF - 10 m model	1	0.0028	0.031	0.0034	0.0251	0.0339	1.58	0.088	0.0045	28	1.36	0.008	0.0003	0.0035	0.00017
ELF - 10 m model	5	0.0032	0.418	0.0448	0.3572	0.4710	21.09	1.261	0.0646	402	12.64	0.119	0.0040	0.0503	0.00018
ELF - 10 m model	10	0.0032	0.330	0.0355	0.3278	0.4113	16.69	1.186	0.0607	369	12.36	0.107	0.0032	0.0463	0.00018
ELF - 10 m model	27	0.0031	0.146	0.0157	0.2470	0.2691	7.36	0.951	0.0486	277	11.55	0.075	0.0014	0.0353	0.00018
ELF - 10 m model	50	0.0030	0.048	0.0052	0.1767	0.1702	2.44	0.712	0.0363	198	10.81	0.051	0.0005	0.0255	0.00017
ELF - 10 m model	100	0.0029	0.004	0.0005	0.0924	0.0807	0.22	0.384	0.0196	103	5.81	0.026	0.0000	0.0134	0.00005
ELF - 10 m model	150	0.0029	0.000	0.0000	0.0498	0.0427	0.02	0.208	0.0106	56	3.15	0.014	0.0000	0.0072	0.00000
ELF - 10 m model	199	0.0028	0.000	0.0000	0.0273	0.0234	0.00	0.114	0.0058	30	1.73	0.008	0.0000	0.0040	0.00000

Units in mg/L

a: Chronic value is used for reference.

b: Annual median used for NO₃-N

c: Cr(III) recommended compliance limit is used.

Bold red text indicates values greater than the GW and SW reference limit.

Bold orange text indicates values greater than the SW reference limit.

Bold purple text indicates values greater than the GW reference limit.

5.5 West ELF

Results for the model scenarios for the West ELF are shown in Figure 35 and Figure 36, and selected outputs for key years are shown in Table 19.

The following observations are provided:

- Sulfate concentrations are peaking at around 1,300 mg/L in the 20 m oxygen exclusion model, which is higher than those estimated for Shepherds. This is primarily because a greater proportion of material is expected to be located in the outer rim (e.g., large surface area), which reduces the relative impact of short-lift construction compared to Shepherds. In addition, the peak at Shepherds is broader (due to its 79 m average height), meaning the load is distributed over several years, whereas the peak at WELF is sharper and more concentrated.

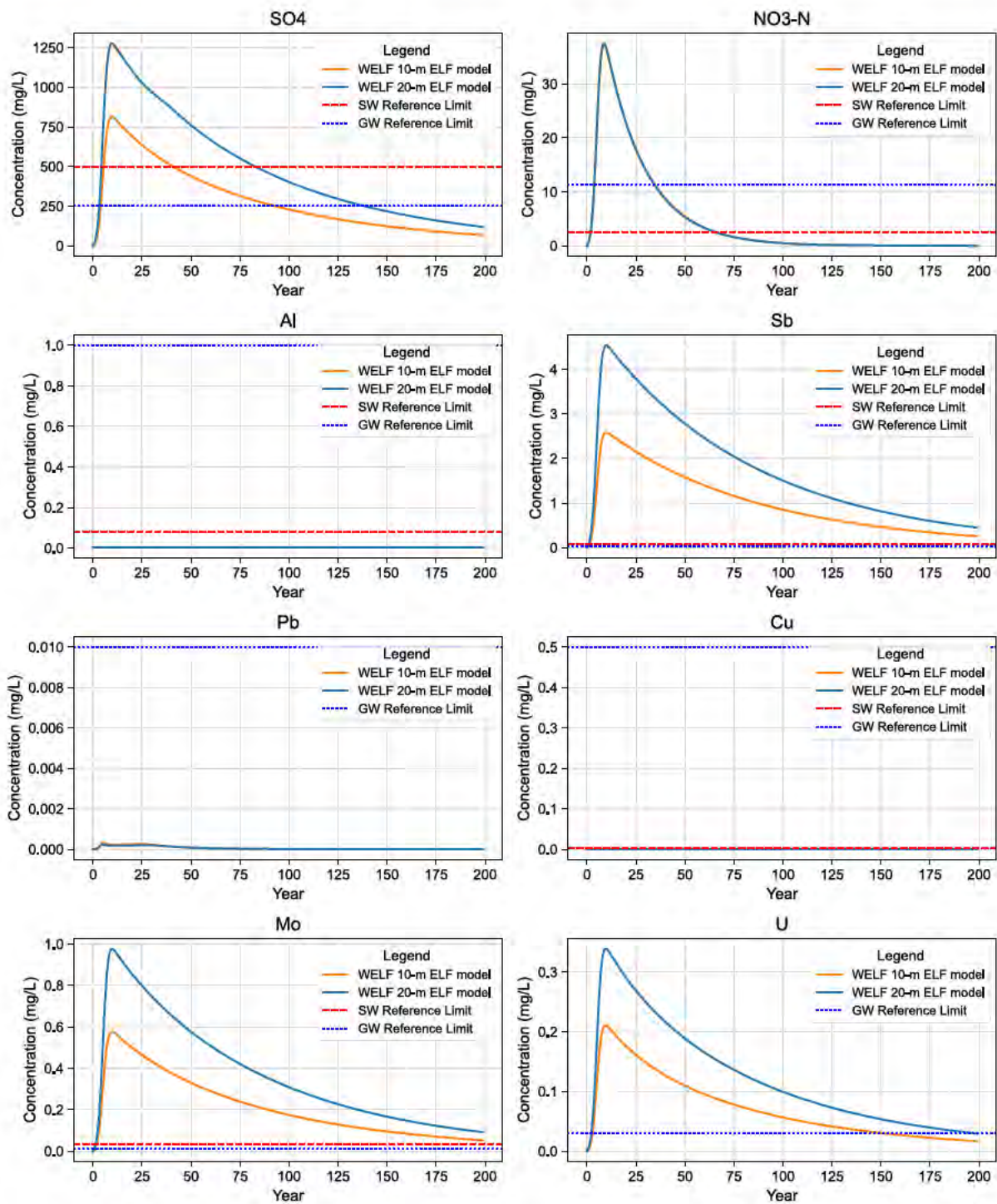


Figure 35. Model results part 1 for the West ELF.

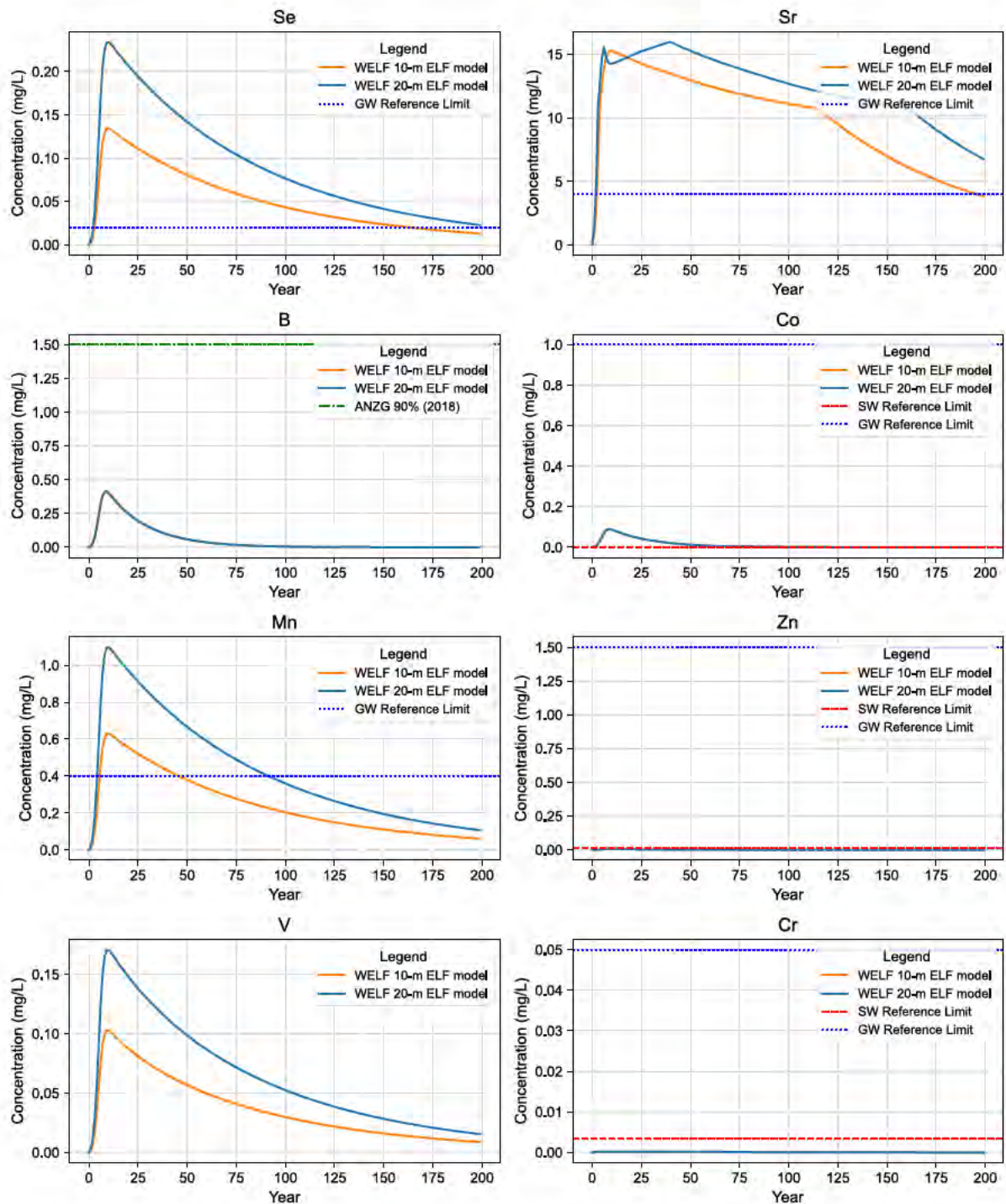


Figure 36. Model results part 2 for the West ELF.

Table 20. Selected model results for the WELF scenarios

SCENARIO	PARAMETER	Al	B	Co	Mn	Mo	NO3-N	Sb	Se	SO4	Sr	U	Zn	V	Cr
	SW REF LIMIT	0.08	-	0.001 ^a	-	0.034	2.4 ^b	0.074 ^a	-	500	-	-	0.015	0	0.0033 ^c
	GW REF LIMIT	1	-	1	0.4	0.01	11.3	0.02	0.02	250	4	0.03	1.5	0	0.05
YEAR															
ELF - 20 m model	1	0.0028	0.009	0.0020	0.0212	0.0190	0.82	0.087	0.0045	26	1.32	0.007	0.0002	0.0033	0.00005
ELF - 20 m model	5	0.0033	0.240	0.0521	0.5828	0.5208	21.81	2.404	0.1243	716	14.78	0.182	0.0047	0.0914	0.00019
ELF - 20 m model	10	0.0036	0.401	0.0871	1.0979	0.9763	36.45	4.536	0.2342	1275	14.26	0.339	0.0079	0.1708	0.00019
ELF - 20 m model	27	0.0034	0.178	0.0387	0.8889	0.7770	16.20	3.692	0.1895	1003	15.34	0.261	0.0035	0.1343	0.00019
ELF - 20 m model	50	0.0033	0.059	0.0128	0.6664	0.5756	5.36	2.777	0.1420	760	15.27	0.189	0.0012	0.0986	0.00019
ELF - 20 m model	100	0.0031	0.005	0.0012	0.3597	0.3082	0.48	1.502	0.0766	403	12.68	0.099	0.0001	0.0525	0.00003
ELF - 20 m model	150	0.0030	0.000	0.0001	0.1948	0.1667	0.04	0.819	0.0415	217	11.00	0.054	0.0000	0.0284	0.00000
ELF - 20 m model	199	0.0029	0.000	0.0000	0.1069	0.0914	0.00	0.447	0.0228	119	6.76	0.029	0.0000	0.0156	0.00000
ELF - 10 m model	1	0.0028	0.009	0.0020	0.0122	0.0113	0.82	0.049	0.0026	16	0.75	0.004	0.0002	0.0020	0.00005
ELF - 10 m model	5	0.0032	0.240	0.0521	0.3356	0.3094	21.79	1.372	0.0717	440	12.77	0.114	0.0047	0.0554	0.00018
ELF - 10 m model	10	0.0033	0.400	0.0869	0.6306	0.5766	36.40	2.584	0.1346	813	15.26	0.210	0.0078	0.1027	0.00019
ELF - 10 m model	27	0.0032	0.178	0.0387	0.5075	0.4507	16.19	2.098	0.1082	615	14.15	0.156	0.0035	0.0787	0.00019
ELF - 10 m model	50	0.0032	0.059	0.0128	0.3790	0.3297	5.35	1.576	0.0808	439	12.94	0.110	0.0012	0.0568	0.00018
ELF - 10 m model	100	0.0030	0.005	0.0012	0.2040	0.1750	0.48	0.852	0.0434	229	11.11	0.057	0.0001	0.0298	0.00003
ELF - 10 m model	150	0.0029	0.000	0.0001	0.1105	0.0945	0.04	0.462	0.0235	123	6.99	0.030	0.0000	0.0161	0.00000
ELF - 10 m model	199	0.0029	0.000	0.0000	0.0606	0.0519	0.00	0.253	0.0129	68	3.83	0.017	0.0000	0.0088	0.00000

Units in mg/L

a: Chronic value is used for reference.

b: Annual median used for NO₃-N

c: Cr(III) recommended compliance limit is used.

Bold red text indicates values greater than the GW and SW reference limit.

Bold orange text indicates values greater than the SW reference limit.

Bold purple text indicates values greater than the GW reference limit.

5.6 CIT Backfill ELF

Results for the model scenarios for the CIT backfill ELF are shown in Figure 37 and Figure 38 with selected outputs for key years shown in Table 20.

The following observations are provided:

- Sulfate concentrations are similar across both scenarios where oxygen is restricted to the outer rim of the ELF, and in both scenarios remain below 500 mg/L.
- In general, the concentrations in the CIT backfill are low due to the following reasons:
 - o The ELF has the least amount of waste rock, resulting in lower initial loads.
 - o A significant portion of the ELF will be submerged during the first four years, preventing the material from undergoing ongoing oxidation.
 - o It is assumed that a portion of the available material will remain inaccessible for oxidation due to the low-lift construction method.

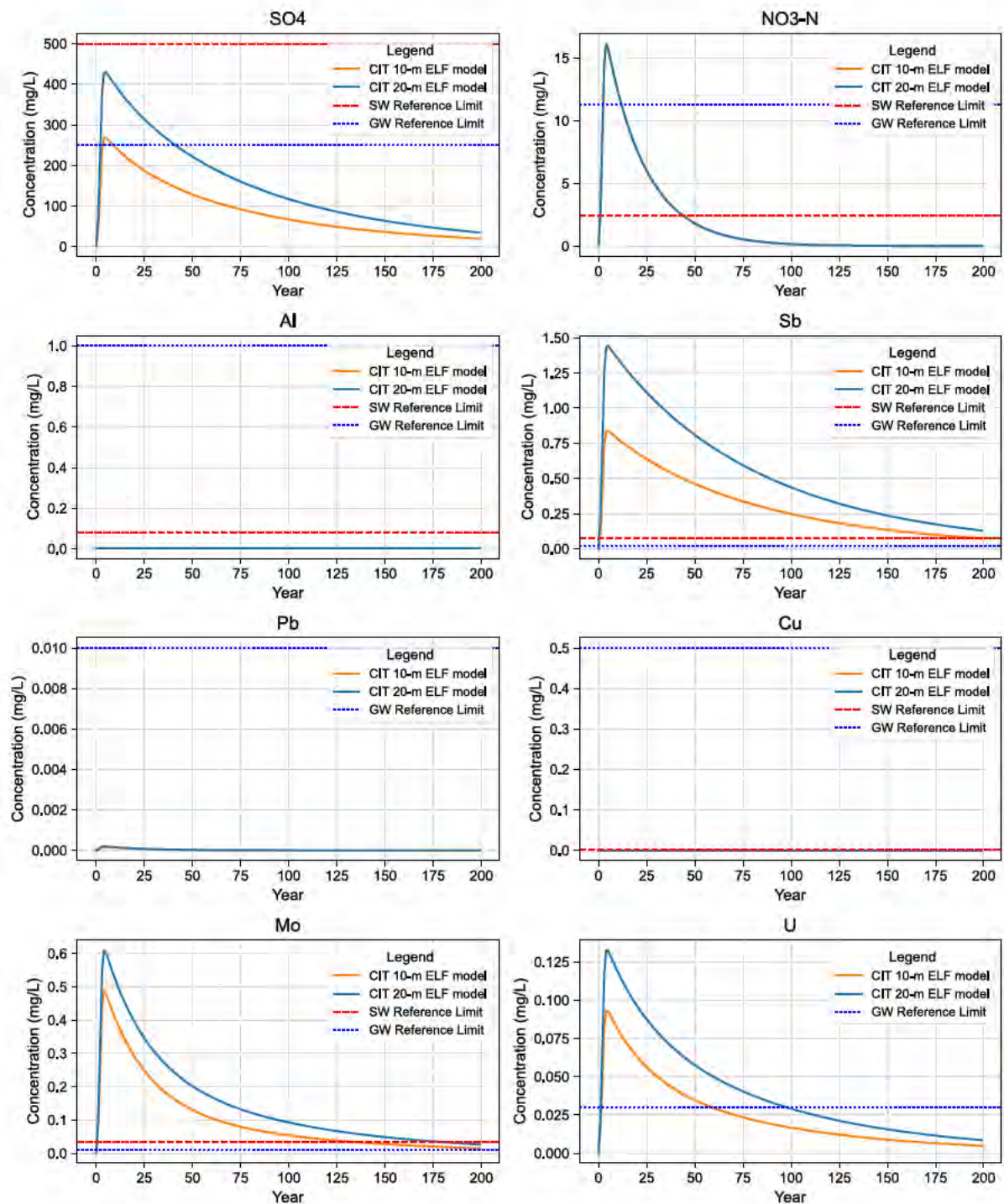


Figure 37. Model results part 1 for the CIT Backfilled ELF.

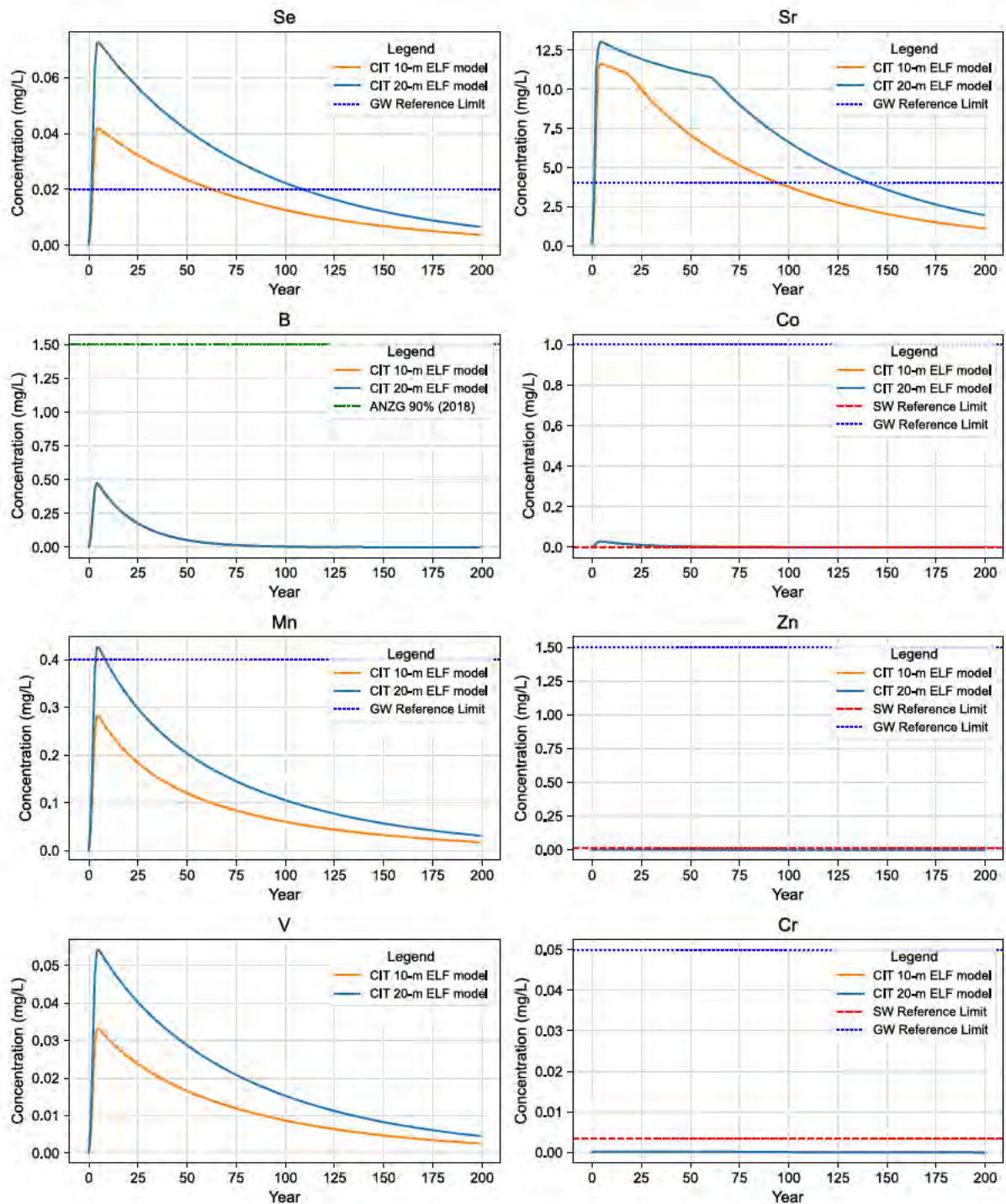


Figure 38. Model results part 2 for the CIT Backfilled ELF.

Table 21. Selected model results for the CIT Backfill scenarios.

SCENARIO	PARAMETER	Al	B	Co	Mn	Mo	NO ₃ -N	Sb	Se	SO ₄	Sr	U	Zn	V	Cr
	SW REF LIMIT	0.08	-	0.001 ^a	-	0.034	2.4 ^b	0.074 ^a	-	500	-	-	0.015	0	0.0033 ^c
	GW REF LIMIT	1	-	1	0.4	0.01	11.3	0.02	0.02	250	4	0.03	1.5	0	0.05
YEAR															
ELF - 20 m model	1	0.0029	0.079	0.0050	0.0680	0.0992	2.70	0.226	0.0114	68	3.57	0.021	0.0004	0.0086	0.00017
ELF - 20 m model	5	0.0032	0.462	0.0290	0.4259	0.6041	15.73	1.444	0.0727	430	13.03	0.132	0.0026	0.0542	0.00018
ELF - 20 m model	10	0.0032	0.364	0.0228	0.3869	0.5197	12.39	1.352	0.0682	396	12.72	0.118	0.0021	0.0502	0.00018
ELF - 20 m model	27	0.0031	0.160	0.0101	0.2873	0.3291	5.47	1.084	0.0549	305	11.86	0.084	0.0009	0.0391	0.00018
ELF - 20 m model	50	0.0030	0.053	0.0033	0.2032	0.2014	1.81	0.811	0.0412	222	11.06	0.058	0.0003	0.0287	0.00018
ELF - 20 m model	100	0.0029	0.005	0.0003	0.1054	0.0926	0.16	0.437	0.0223	117	6.62	0.029	0.0000	0.0153	0.00007
ELF - 20 m model	150	0.0029	0.000	0.0000	0.0567	0.0487	0.01	0.237	0.0121	63	3.58	0.016	0.0000	0.0082	0.00001
ELF - 20 m model	199	0.0028	0.000	0.0000	0.0311	0.0266	0.00	0.129	0.0066	35	1.97	0.009	0.0000	0.0045	0.00000
ELF - 10 m model	1	0.0029	0.079	0.0050	0.0454	0.0799	2.70	0.132	0.0066	43	2.14	0.015	0.0004	0.0053	0.00017
ELF - 10 m model	5	0.0031	0.462	0.0289	0.2812	0.4802	15.73	0.839	0.0419	268	11.63	0.093	0.0026	0.0331	0.00018
ELF - 10 m model	10	0.0031	0.363	0.0228	0.2506	0.4031	12.38	0.783	0.0392	244	11.37	0.081	0.0021	0.0303	0.00018
ELF - 10 m model	27	0.0030	0.160	0.0101	0.1767	0.2344	5.46	0.622	0.0314	181	9.70	0.054	0.0009	0.0230	0.00018
ELF - 10 m model	50	0.0030	0.053	0.0033	0.1198	0.1300	1.81	0.462	0.0234	128	7.09	0.035	0.0003	0.0165	0.00017
ELF - 10 m model	100	0.0029	0.005	0.0003	0.0602	0.0540	0.16	0.248	0.0126	67	3.76	0.017	0.0000	0.0087	0.00007
ELF - 10 m model	150	0.0028	0.000	0.0000	0.0322	0.0278	0.01	0.134	0.0068	36	2.03	0.009	0.0000	0.0047	0.00001
ELF - 10 m model	199	0.0028	0.000	0.0000	0.0176	0.0151	0.00	0.073	0.0038	20	1.12	0.005	0.0000	0.0026	0.00000

Units in mg/L

a: Chronic value is used for reference.

b: Annual median used for NO₃-N

c: Cr(III) recommended compliance limit is used.

Bold red text indicates values greater than the GW and SW reference limit.

Bold orange text indicates values greater than the SW reference limit.

Bold purple text indicates values greater than the GW reference limit.

5.7 SCK Fill

Results for the SCK Fill model are shown in Figure 39 and Figure 40 with selected outputs for key years shown in Table 21Figure 18.

The following observations are provided:

- Only the WRS scenario is presented, as it is assumed that all materials are oxidising.
- Sulfate concentrations peak at 327 mg/L.
- Arsenic concentrations are assumed to be 0.2 mg/L, consistent with the other waste rock facilities. Yet, as the system is assumed to be oxygenated, iron concentrations remain low according to PHREEQC modelling (due to precipitation as iron hydroxides). These hydroxides could potentially adsorb excess arsenic.

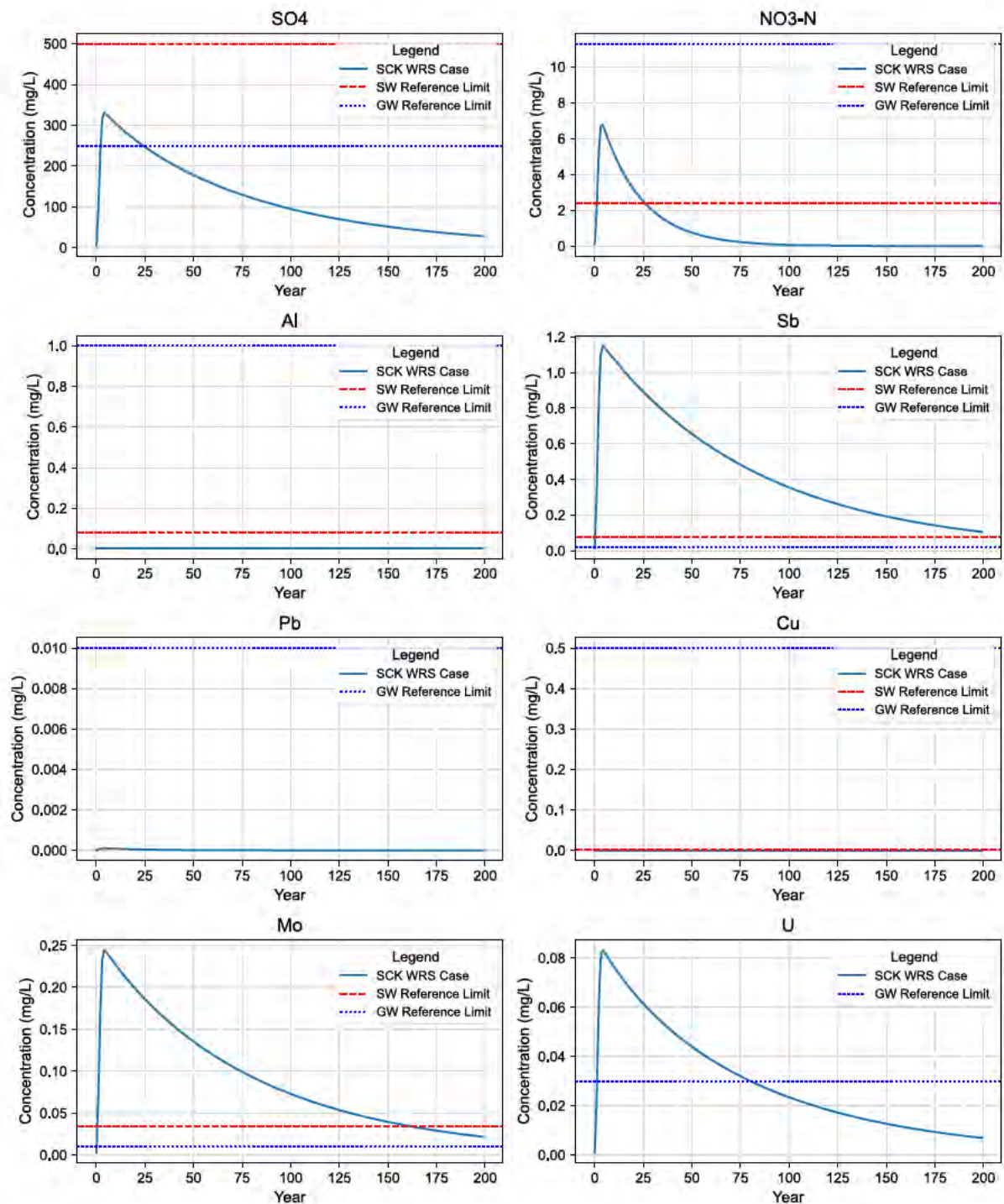


Figure 39. Model results part 1 for the SCK fill.

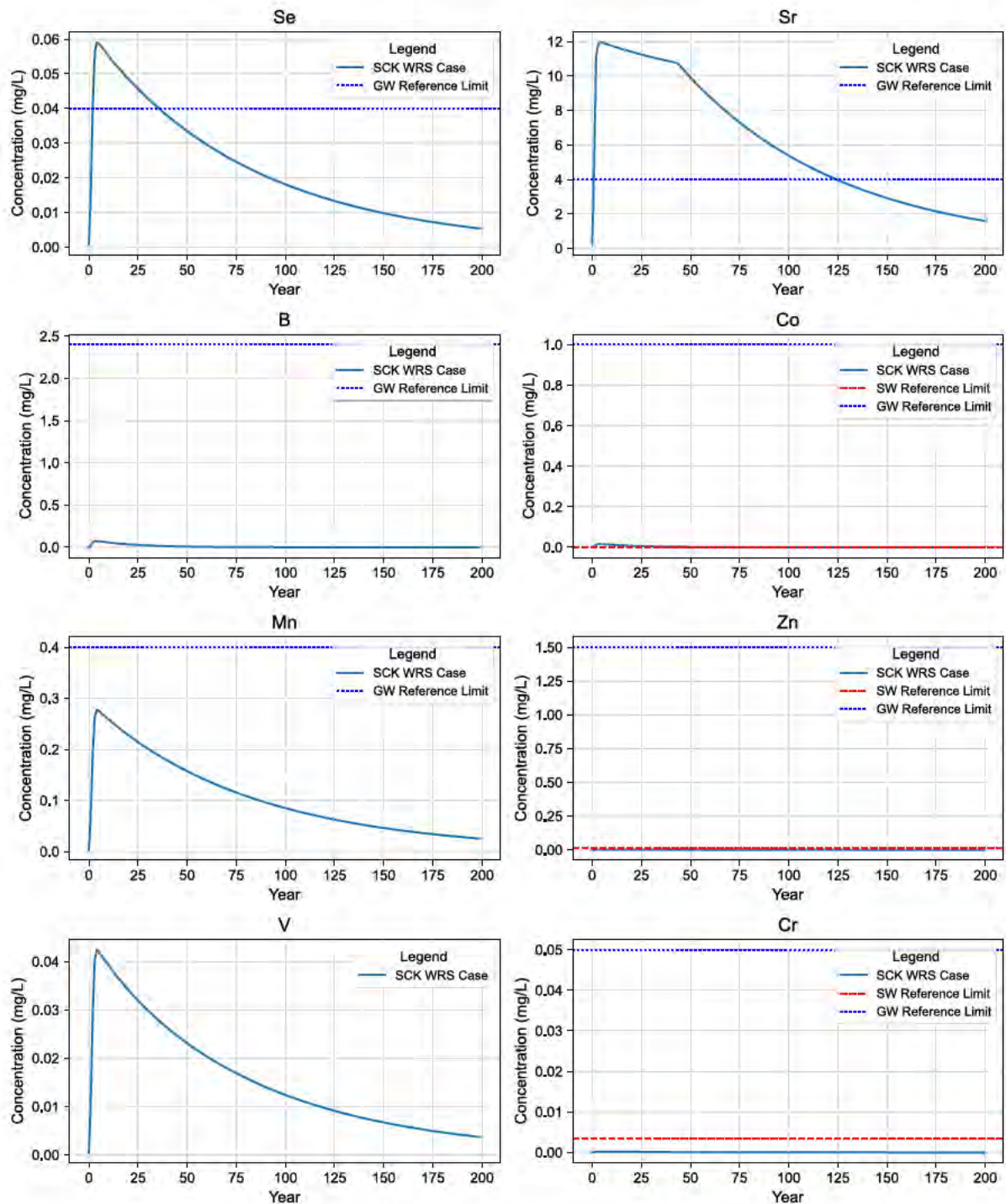


Figure 40. Model results part 2 for the SCK fill.

Table 22. Selected model results for the SCK Fill WRS scenario.

SCENARIO	PARAMETER	Al	B	Co	Mn	Mo	NO3-N	Sb	Se	SO4	Sr	U	Zn	V	Cr
	SW REF LIMIT	0.08	-	0.001	-	0.034	2.4	0.074 ^a	-	500	-	-	0.015	0	0.0033
	GW REF LIMIT	1	-	1	0.4	0.01	11.3	0.02	0.02	250	4	0.03	1.5	0	0.05
YEAR															
WRS	1	0.0029	0.023	0.0050	0.0798	0.0704	2.09	0.331	0.0170	95	5.00	0.024	0.0005	0.0122	0.00012
WRS	5	0.0031	0.072	0.0156	0.2757	0.2425	6.52	1.143	0.0588	327	11.95	0.082	0.0014	0.0421	0.00018
WRS	10	0.0031	0.056	0.0122	0.2588	0.2267	5.13	1.074	0.0552	304	11.76	0.076	0.0011	0.0392	0.00018
WRS	27	0.0031	0.025	0.0054	0.2091	0.1812	2.26	0.871	0.0445	240	11.19	0.060	0.0005	0.0311	0.00012
WRS	50	0.0030	0.008	0.0018	0.1572	0.1353	0.75	0.656	0.0335	178	9.93	0.044	0.0002	0.0231	0.00004
WRS	100	0.0029	0.001	0.0002	0.0850	0.0728	0.07	0.355	0.0181	95	5.38	0.023	0.0000	0.0124	0.00000
WRS	150	0.0029	0.000	0.0000	0.0461	0.0394	0.01	0.193	0.0098	51	2.92	0.013	0.0000	0.0067	0.00000
WRS	199	0.0028	0.000	0.0000	0.0253	0.0216	0.00	0.106	0.0054	28	1.60	0.007	0.0000	0.0037	0.00000

Units in mg/L

a: Chronic value is used for reference.

b: Annual median used for NO₃-N

c: Cr(III) recommended compliance limit is used.

Bold **red text** indicates values greater than the GW and SW reference limit.Bold **orange text** indicates values greater than the SW reference limit.Bold **purple text** indicates values greater than the GW reference limit.

6 SUMMARY

The following summary is provided to explain the modelling process, model outcomes, management requirements, and recommendations.

6.1 Overview

The geochemical modelling process for the proposed BOGP ELF's were designed to estimate mine-impacted water and evaluate best-practice construction methods to mitigate environmental risks. The study utilised site-specific data, predictive modelling, and analogue comparisons to develop an understanding of PCOC generation processes under varying conditions. Key components included

- **Quantifying sulfur reservoirs, oxidation rates, and contaminant release mechanisms**, as well as integrating field-based scaling factors.
- **Traditional WRS calibration modelling:** Representing a traditional WRS scenario with unrestricted oxygen ingress, leading to sulfide oxidation and relatively low arsenic and iron concentrations in seepage. Models were calibrated with analogue data.
- **ELF modelling:** Engineered scenarios incorporated reduced oxygen availability, resulting in lower PCOC concentrations yet higher arsenic and iron levels due to limited iron hydroxide formation (sub-oxic conditions).
- **Data Sources:** Laboratory testing (e.g., ABA, leachate, and kinetic tests) and empirical observations informed model parameters, with key sulfur contents and oxidation rates derived for TZ3 and TZ4 (RSSZ) lithological units.

6.2 Key Findings

The following key findings are presented:

- Sulfur content is a primary driver of poor water quality, with TZ4 and RSSZ materials presenting higher sulfur content, higher release rates, and AMD risks compared to TZ3.
- TZ4 was found to release sulfate at a rate six times higher than TZ3 due to its higher sulfur content and reactivity. Such data confirms the importance of placing these materials away from oxygen in the core of the ELF.
- Identified PCOCs are sulfate, As, Co, Fe, Nitrogen, Sr, Se, Sb, Mo, Mn, Se, Sr, and U.
- A traditional WRS construction process is likely to generate elevated PCOC and prolonged AMD generation. This should be avoided to reduce long-term reliance on water management activities by the construction of an ELF that minimises oxygen ingress.
- Engineered landforms provide notable improvements in water quality by limiting oxygen and water ingress, reducing sulfide oxidation rates, and capping high-sulfur material with non-reactive layers.
- Hydrogeochemical Processes: Short-term contaminant release from SOPs and long-term sulfide oxidation are critical considerations for modelling and management.

6.3 Recommendations

This study has identified and recommends the following management opportunities that will minimise the long-term risks to water quality for waste rock storage at the BOGP:

- Proceed with the proposed ELF design, ensuring TZ3 materials encapsulate high-sulfur materials (TZ4) to minimise oxygen ingress.
- Proceed with short lift heights at 5 m height and confirm that grainsize segregation is minimised and that oxygen is reduced to < 5% after 20 m horizontal distance into the ELF and that the oxygen profiles (from oxygen probe monitoring) demonstrate that oxygen ingress is diffusion controlled. Higher heights may be possible if advective oxygen ingress is prevented by engineering controls. Advective oxygen ingress is the driver for higher long term PCOC loads.
- Install cover systems to further mitigate risks as the final landform is created. Consider cover systems to minimise net percolation and oxygen flux as the key drivers of long term PCOC load.
- Establish a comprehensive monitoring program for water quality, oxidation rates, and cover system performance. Adapt management strategies based on observed trends and evolving conditions.
- Continue validating laboratory-to-field scaling factors using site-specific data, particularly for TZ3 and TZ4 materials, to refine long-term predictions.
- Confirm oxygen flux rates to further refine models.

By adopting these recommendations, the project can effectively manage geoenvironmental risks while aligning with best-practice approaches for sustainable waste rock management. As noted by INAP (2024): *“while it is true that designing and constructing a mine rock stockpile with a focus on source control can add upfront incremental costs to the project, a proactive approach allows for the ability to effectively understand, plan and reduce long term environmental risks and liabilities for a smaller range of anticipated outcomes”*.

6.4 Limitations

The model is based on the results of laboratory tests, and on assumptions from analogue data. Performance monitoring is recommended to confirm model expectations. The following assumptions are noted:

- A net percolation rate of 20% is a reasonable estimate. Further work is needed to confirm the reliability of this assumption as flow is a key driver of contaminant load. Site-specific trials should be undertaken to validate net percolation rates.
- It is assumed that ELF design and construction will limit diffusive oxygen ingress to a depth of 20 m horizontally once the ELF is constructed (and the cover system and rehabilitation is completed). This needs to be managed by MGL to ensure the models are valid. Such details are provided in the ELF Management Plan.
- It is assumed that the scaling approach using column data to forecast sulfate and other PCOC is appropriate to understand geochemical risks for the engineered landforms.

- It is assumed that ELF seepage waters will be elevated in nitrate for many decades (> 50 years) and that this would equate to a load of 16.6 mg/kg of nitrogen as (NH_4NO_3).
- It is not possible to model the dynamics of nitrogen speciation accurately, as they are governed by site-specific biochemical reactions and oxygen availability. It is assumed that the majority of nitrogen will be speciated as nitrate, however, there could be a minor part as nitrite or ammoniacal nitrogen.
- The time lag to peak concentrations is influenced by the ELF's geometry, therefore the applied time lag to peak sulfate concentration is an approximate estimate based on analogue empirical data, and simplistic assumptions. However, the time frame is likely to be reasonable to estimate potential environmental risks for the BOGP.
- In-situ precipitation of ferric hydroxides is anticipated. Consequently, certain metals may be sorbed (e.g., As, Cu, Zn) and captured by these minerals, particularly at neutral to alkaline pH where sorption capacities are elevated. While PHREEQC modelling could model this for this case, uncertainty exists around the amount of available iron. Therefore, a conservative approach is adopted, and sorption is not modelled. Sorption may be higher in the outer oxidising zone of the ELF and lower in the core where oxygen is limited.

6.5 Performance Monitoring

The following performance monitoring activities are required to validate model inputs and ensure the effectiveness of the ELFs:

- Confirm the sulfur content of materials placed in the ELF ensuring that lower sulfur TZ3 materials are placed on the outside of the ELF. Testing should include shake-flask testing to validate the quantity of sulfate and nitrogenous compounds present in blasted rock to validate model inputs.
- Confirm that advective oxygen ingress is excluded from the core of the ELF by the construction of oxygen probes into each lift during construction of the ELF.
- Confirm water quality for ELF seepage aligns with geochemical models including sulfate and nitrate. Update models where significant differences are observed.
- The geochemical model relies on laboratory data and analogue assumptions; field validation is required.
- If performance monitoring indicates unacceptable loads, then adaptive management actions should be considered including additional source control actions (e.g., engineered cover systems), reducing oxidation depth to 10 m into the ELF, a longer period of active treatment and/or the development of passive treatment systems to manage the PCOC concentrations and loads.

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8 LIMITATIONS

Attention is drawn to the document “Limitations”, which is included in Appendix B of this report. The statements presented in this document are intended to provide advice on what the realistic expectations of this report should be, and to present recommendations on how to minimise the risks associated with this project. The document is not intended to reduce the level of responsibility accepted by Mine Waste Management, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in doing so.

APPENDIX A ABBREVIATIONS

ABBREVIATION	DEFINITION
ABA	Acid base accounting
AMD	Acid and metalliferous drainage, which can also include low metal saline drainage
ANFO	Ammonium nitrate fuel oil (explosive)
ANC	Acid neutralisation capacity
BOGP	Bendigo-Ophir Gold Project
CIL	Carbon in Leach
CIT	Come in Time
CLT	Column Leach Test
CSM	Conceptual site model
DOC	Dissolved organic carbon
ELF	Engineered Landform
INAP	International Networks for Acid Prevention
LCM	Loose cubic metres
LOM	Life of mine
MIW	Mine impacted water
MPA	Maximum potential acidity
MGL	Matakanui Gold Limited
Mt	Million tonnes
MWM	Mine Waste Management Limited
NAF	Non-acid forming
NAPP	Net acid production potential
NP	Net percolation
PAF	Potentially acid forming
PCOC	Potential constituents of concern
PFS	Pre-feasibility study
QA/QC	Quality assurance and quality control
RAS	Rise and Shine
ROM	Run of mine
RSSZ	Rise and Shine Shear Zone
SCK Fill	Shepherds Creek Fill
SOP	Stored Oxidation Products
Srex	SRX
Srex East	SRE
TSF	Tailings storage facility

ABBREVIATION	DEFINITION
TSS	Total suspended solids
TZ3	Textural Zone 4 of the Otago Schist
TZ4	Textural Zone 4 of the Otago Schist
WELF	West ELF
WRS	Waste Rock Stack

APPENDIX B LIMITATIONS

This Document has been provided by Mine Waste Management Ltd (MWM) subject to the following limitations:

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The scope and the period of MWM's services are as described in MWM's proposal, and are subject to restrictions and limitations. MWM did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in this Document. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by MWM in regards to it.

Conditions may exist which were undetectable given the limited nature of the enquiry MWM was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Document. Accordingly, additional studies and actions may be required.

In addition, it is recognised that the passage of time affects the information and assessment provided in this Document. MWM's opinions are based upon information that existed at the time of the production of this Document. It is understood that the services provided allowed MWM to form no more than an opinion of the actual conditions of the site at the time the site was reviewed and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

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MINE WASTE MANAGEMENT

GREENROAD GROUP

APPENDIX M WATER TREATMENT STUDY

Water Treatment Study

Bendigo-Ophir Gold Project

9 October 2025

J-NZ0464-002-R-Rev2



MATAKANUI 
GOLD LIMITED

Water Treatment Study

Bendigo-Ophir Gold Project

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EXECUTIVE SUMMARY

Mine Waste Management Limited (MWM) has been engaged by Matakanui Gold Limited (MGL) to provide guidance on water treatment for Mine Impacted Water (MIW) for the proposed Bendigo-Ophir Gold Project (BOGP).

Objectives of this Study

The objectives of this report are to:

- Review the expected water treatment requirements during the Active Closure and Post Closure Phases of the BOGP when treated MIW will be released from site.
- Provide guidance on the Water Treatment Plant (WTP) that will be operational during the Active Closure Phase of the BOGP.
- Provide guidance on the Passive Treatment System(s) (PTS) that will be required during the Post Closure Phase of the BOGP.

Findings

The water and load balance model (WLBm) and other studies indicate that the BOGP needs to focus on the management and treatment of MIW that will contain potential constituents of concern (PCOC). Specifically:

- Water management to minimise the amount of water that requires treatment during the closure phases.
- Treatment of MIW by a WTP within the Shepherds Creek catchment during the active closure phase until PTS can be successfully established after a number of decades (~ 50 years).
- Partial passive treatment of the SRX Pit Lake overflow in the Rise and Shine catchment.
- PTS are likely to be operational for many decades once installed.

The following PCOC may require treatment by the WTP and PTS to achieve the proposed water quality limits for the BOGP (Ryder, 2025):

- Nitrogenous compounds (N) that include nitrate (NO_3) and ammoniacal-N (Amm-N).
- Sulfate (SO_4).
- Metals and metalloids that may include Aluminium (Al), arsenic (As), cadmium (Cd), cobalt (Co), copper (Cu), chromium (Cr), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), strontium (Sr), uranium (U), and zinc (Zn)
- Cyanide (CN) within the tailings water.

Management

Water management during the Operational Phase of the BOGP will involve discharge of only episodic runoff from haul roads and ELF surfaces. All other MIW (e.g., landform seepage) will be collected, used, and stored on site within the TSF. In the Active Closure Phase and Post Closure Phase, MIW will be treated and discharged to the receiving environment.

Order of magnitude (OoM) studies indicate that active and passive water treatment can achieve closure water quality objectives as defined by Ryder (2025), although further feasibility studies are required to confirm treatment performance and the ability to transfer from active to passive treatment.

Project Description

MGL is proposing to establish the BOGP, which comprises gold mining operations, processing operations, ancillary facilities and environmental mitigation measures on Bendigo and Ardgour Stations in the Dunstan Mountains of Central Otago. The project site is located approximately 20 km north of Cromwell and will have a maximum disturbance footprint of 550 hectares.

The total Mineral Resource Estimate for the BOGP using a 0.5 g/t cut-off for open pit and 1.5 g/t for underground is 34.3 Mt at 2.1 g/t for 2.34 M oz (MGL, 2025). The Bendigo-Ophir resources occur in four deposits: Come in Time (CIT), Rise and Shine (RAS), Srex (SRX), Srex East (SRE). The majority of identified mineral resources are located within the RAS deposit. Three primary geological units are recognised at site:

- RSSZ – Rise and Shine Shear Zone
- TZ3 – Lower Greenschist facies Textural Zone 3 rocks of the Otago Schist
- TZ4 – Upper Greenschist facies Textural Zone 4 rocks of the Otago Schist

The proposed BOGP will include the following components:

- Open pits targeting the RAS, SRX, SRE, and CIT deposits.
- An underground mine targeting the RAS deposit.
- Three ex-pit engineered landforms (ELFs) – Shepherds ELF, SRX ELF, and West ELF (WELF).
- Two in-pit landforms (backfill) – CIT and SRE¹.
- Plant and processing area, where CIL extraction technologies will be used as part of the ore recovery process. This includes the Shepherds Creek Fill (SCK Fill).
- A tailings storage facility (TSF) and TSF Embankment.
- Other ancillary support services / structures (e.g., roads, water management infrastructure, water treatment plants, etc).

¹ Note: SRE Pit is backfilled by the SRX ELF.

Water Treatment

During the Active Closure Phase, water treatment is required by a WTP once the project switches from a process of internal water management for MIW (during operations) to discharge of MIW from site after closure of the mine. WLBM results indicates that the WTP can be replaced by PTS within decades of mining cessation, which then defines the commencement of the Post Closure Phase.

Flow Rates

Flow rates that require treatment are presented in Table E1. Flow rates are based on a net percolation (NP) rate of 20% of rainfall. It is proposed that a NP rate of 20% may be achievable, with appropriate engineering controls (i.e., an engineered cover system).

Table E1: Estimated average water quantity per mine domain.

MINE DOMAIN	WTP DESIGN CRITERIA (L/s)	PTS (L/s)	COMMENTS
Shepherds ELF	4	4	20% Net percolation (MWM, 2025b)
SRX ELF ^{1,2}	-	1	20% Net percolation (MWM, 2025b)
West ELF ²	1	1	20% Net percolation (MWM, 2025b)
Shepherds TSF	13.4	3	Flow is expected to be ~13.4 L/s decreasing to 3 L/s after 5 years (MWM, 2025c).
RAS Underground Portal	6	6	Flow from the RAS Underground is not expected for 20-30 years after closure (MWM, 2025c).
CIT Pit Backfill	1.5	1.5	Further details are available in MWM (2025c).
SRX Pit	-	8	Further details are available in MWM (2025c). It is assumed this water will not require active treatment. Passive treatment is required.
SCK Fill ²	1	1	20% Net percolation (MWM, 2025b)
Non-NMD impacted water	-	-	Managed for TSS separate to the active WTP. At closure rehabilitated surfaces are assumed to be suitable for discharge with TSS management.

1. Active treatment for SRX ELF and SRX Pit is not anticipated.

2. Flow rates rounded up to 1 L/s

Active Water Treatment

Active treatment is expected for a number of decades (~ 50 years). During this period, the BOGP processing plant would be disestablished and the passive treatment system established. Process Flow (2025) note that the WTP will include the following processes:

- Surge sump
- Pontoon mounted pumps for plant feed
- Metal hydroxide precipitation and settling
- Gypsum precipitation and settling

- Ettringite precipitation and settling
- Carbonation and pH trimming
- Treated water sump
- Sludge management

Other processes that will likely be needed in addition to the active WTP are:

- Cyanide destruct on the Shepherds TSF influent stream.
- Potential additional nitrate removal after WTP via biological processes.

Process Flow (2025) indicate that the proposed water quality objectives (Ryder, 2025) can be achieved, although further work is required to develop the OoM study to a feasibility study (FS) level. Further details are provided in Appendix B. The WTP will operate until passive treatment systems can be installed to successfully treat MIW.

Passive Treatment System

Based on the identified PCOC for the BOGP a multi-stage passive treatment system is expected. This would include:

- Sediment management to mitigate any residue sediment and prevent the PTS from being overwhelmed with sediment.
- Oxidation to encourage $\text{Fe}(\text{OH})_3$ precipitation and adsorption of metals such as As and V.
- Anaerobic treatment to remove nitrate, reduce sulfate concentrations, and precipitate metals as sulfides.
- A polishing pond to remove secondary contaminants generated in the anaerobic treatment stage (e.g., sulfide (HS^-), ammoniacal nitrogen, and low dissolved oxygen).

Preliminary treatment efficiencies for the PTS are provided in Table E2. These efficiencies will require validation once mining commences, and MIW is available for trials. Data highlighted in yellow have lower confidence and further work is needed to confirm the passive treatment systems will be appropriate.

Table E2: PTS Treatment Efficiencies

PARAMETER	REMOVAL EFFICIENCIES ¹
Calcium	-43.2%
Magnesium	8%
Aluminium	83.3%
Arsenic	99% ²
Iron	99.1%
Nickel	97.9%
Zinc	99.8%
Manganese	86.4%
Cadmium	85.2 ³

PARAMETER	REMOVAL EFFICIENCIES ¹
Cobalt	98.4%
Copper	85.6 ³
Uranium	74% ³
Vanadium	90% ⁸
Other metals	98% ⁴
Sulfate	30% ⁵
Nitrate nitrogen	99%
Ammoniacal nitrogen	99% ⁶
Cyanide	90% ⁷

1. – where data are taken from Table 9 for MSR and limestone is assumed to be part of the treatment media.

2. – where data are taken from Hayton et al. (2022) = 95% removal with additional Fe to increase As removal to 99% (e.g., Raven et al., 1998).

3. – where data are obtained from Trumm et al. (2024).

4. – where data are assumed to be comparable to other metals removed by a MSR (Table 9).

5. – Based on 30% removal as determined from literature (Figure 21).

6. – Assumed to be 99% to be in alignment with nitrate removal efficiencies. Further work is required.

7. – Based on studies by Álvarez et al. (2004).

8. – Zhang et al. (2022).

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1 INTRODUCTION

Mine Waste Management Limited (MWM) has been engaged by Matakanui Gold Limited (MGL) to provide guidance on water treatment for Mine Impacted Water (MIW) for the proposed Bendigo-Ophir Gold Project (BOGP).

The water and load balance model (WLBm) (MWM, 2025c) indicates that the BOGP needs to focus on the management and treatment of MIW that will contain potential constituents of concern (PCOC). Specifically:

- Water management to minimise the amount of water that requires treatment during the closure phases.
- Treatment of MIW by a WTP within the Shepherds Creek catchment during the active closure phase until PTS can be successfully established after a number of decades (~ 50 years).
- Partial passive treatment of the SRX Pit Lake overflow in the Rise and Shine catchment.
- PTS are likely to be operational for many decades once installed.

1.1 Background

MGL is proposing to establish the BOGP, which comprises gold mining operations, processing operations, ancillary facilities and environmental mitigation measures on Bendigo and Ardgour Stations in the Dunstan Mountains of Central Otago. The project site is located approximately 20 km north of Cromwell and will have a maximum disturbance footprint of 550 hectares.

The total Mineral Resource Estimate for the BOGP using a 0.5 g/t cut-off for open pit and 1.5 g/t for underground is 34.3 Mt at 2.1 g/t for 2.34 M oz (MGL, 2025). The Bendigo-Ophir resources occur in four deposits: Come in Time (CIT), Rise and Shine (RAS), Srex (SRX), Srex East (SRE). The majority of identified mineral resources are located within the RAS deposit. Three primary geological units are recognised at site:

- RSSZ – Rise and Shine Shear Zone
- TZ3 – Lower Greenschist facies Textural Zone 3 rocks of the Otago Schist
- TZ4 – Upper Greenschist facies Textural Zone 4 rocks of the Otago Schist

The proposed BOGP will include the following components:

- Open pits targeting the RAS, SRX, SRE, and CIT deposits.
- An underground mine targeting the RAS deposit.
- Three ex-pit engineered landforms (ELFs) – Shepherds ELF, SRX ELF, and West ELF (WELF).
- Two in-pit landforms (backfill) – CIT and SRE².
- Plant and processing area, where CIL extraction technologies will be used as part of the ore recovery process. This includes the Shepherds Creek Fill (SCK Fill).

² Note: SRE Pit is backfilled by the SRX ELF.

- A tailings storage facility (TSF) and TSF Embankment.
- Other ancillary support services / structures (e.g., roads, water management infrastructure, water treatment plants, etc).

1.2 Mine Plan

The proposed mine plan is shown in Table 1 as a schedule of activities. The transition from active treatment to passive treatment is expected to be in the order of decades and will require further studies during the operational phases of the proposed BOGP.

Table 1. BOGP Mine Plan

MONTH	YEAR	MINING PHASE	DESCRIPTION OF PHASE
Pre-startup			Detailed design phase
0 to 6	0 to 0.5	Startup	Pioneering / RAS Pre-Strip, Initial Jean Creek Silt Pond, earthworks at process plant.
6 to 24	0.5 to 2	Project Development	Construction of process plant, TSF, Shepherds Silt Pond, North Diversion Channel, Commissioning, mining RAS pre-strip (Pre-strip ends month 19).
Operations			
25 to 54	3 to 4.5	RAS pit mining on its own	Operations (pit ore production in month 20. UG Development begins month 54)
54 to 72	4.5 to 5	RAS pit with UG development	Operations (UG Ore production begins month 70)
72 to 132	6 to 11	RAS pit plus RAS UG	Operations (UG Ore production months 70 to 150)
		RAS Pit plus RAS UG plus CIT Pit	Operations (CIT Pit mined months 102 to 114)
		RAS Pit plus RAS UG, plus CIT backfilled, plus Srex	Operations (Srex Pit mined months 145 onwards)
120 - 160	10 to 13.3	RAS UG continues on its own with CIT and Srex open pit feeds	Operations (all mining halted month 160)
Closure			
160 - 372	11 to 31	Active Closure ¹	All mining halted. Active closure of pits, TSF, and wider site, plus setup of active water treatment plant (option).
372 -	31 onwards	Post-Closure	Passive treatment and maintenance

TSF = Tailings Storage Facility; UG = Underground

1. Presented as two decades as part of the Pre-feasibility Mine Plan

1.3 Report Objectives

The objectives of this report are to:

- Review the expected water treatment requirements during the Active Closure and Post Closure Phases of the BOGP when treated MIW will be released from site.

- Provide guidance on the Water Treatment Plant (WTP) that will be operational during the Active Closure Phase of the BOGP.
- Provide guidance on the Passive Treatment System(s) (PTS) that will be required during the Post Closure Phase of the BOGP.
- Provide recommendations to advance the current studies from an order of magnitude (OoM) desktop assessment to a feasibility Study (FS) stage.

2 PROJECT DESCRIPTION

This section provides an introduction to the BOGP.

2.1 Introduction

MGL is proposing to establish the BOGP (Figure 1), which comprises gold mining operations, processing operations, ancillary facilities and environmental mitigation measures on Bendigo and Ardgour Stations in the Dunstan Mountains of Central Otago. The project site is located approximately 20 km north of Cromwell and will have a maximum disturbance footprint of 550 hectares.

The total Mineral Resource Estimate for the BOGP using a 0.5 g/t cut-off for open pit and 1.5 g/t for underground is 34.3 Mt at 2.1 g/t for 2.34 M oz (MGL, 2025). The Bendigo-Ophir resources occur in four deposits: Come in Time (CIT), Rise and Shine (RAS), Srex (SRX), Srex East (SRE). The majority of identified mineral resources are located within the RAS deposit. Three primary geological units are recognised at site:

- RSSZ – Rise and Shine Shear Zone
- TZ3 – Lower Greenschist facies Textural Zone 3 rocks of the Otago Schist
- TZ4 – Upper Greenschist facies Textural Zone 4 rocks of the Otago Schist

The resources will be mined by open pit methods at each deposit within the project site, with underground mining methods also proposed to be utilised at RAS to access the deeper gold deposits. The majority of the mining activities, ancillary facilities and associated infrastructure will be located in the Shepherds Valley with non-operational infrastructure located on the adjoining Ardgour Terrace. The BOGP also involves the taking of groundwater from the Bendigo Aquifer for use in mining-related activities and the realignment of Thomson Gorge Road via Ardgour Station.

The following mine facilities are proposed (Figure 2):

- Open pits targeting the RAS, SRX, SRE, and CIT deposits.
- An underground mine targeting the RAS deposit.
- Three ex-pit engineered landforms (ELFs) – Shepherds ELF, SRX ELF, and West ELF (WELF).
- Two in-pit landforms (backfill) – CIT and SRE³.
- Plant and processing area, where CIL extraction technologies will be used as part of the ore recovery process.
- A tailings storage facility (TSF) and TSF Embankment.
- Other ancillary support services / structures (e.g., roads, water management infrastructure, water treatment plants, etc).

These facilities will be placed in the catchment of Shepherds and Bendigo creeks. Understanding baseline water quality (surface and groundwater) is important to enable the establishment of site-specific water quality compliance criteria for any resource consent that may be granted in the future.

³ Note: SRE Pit is backfilled by the SRX ELF.

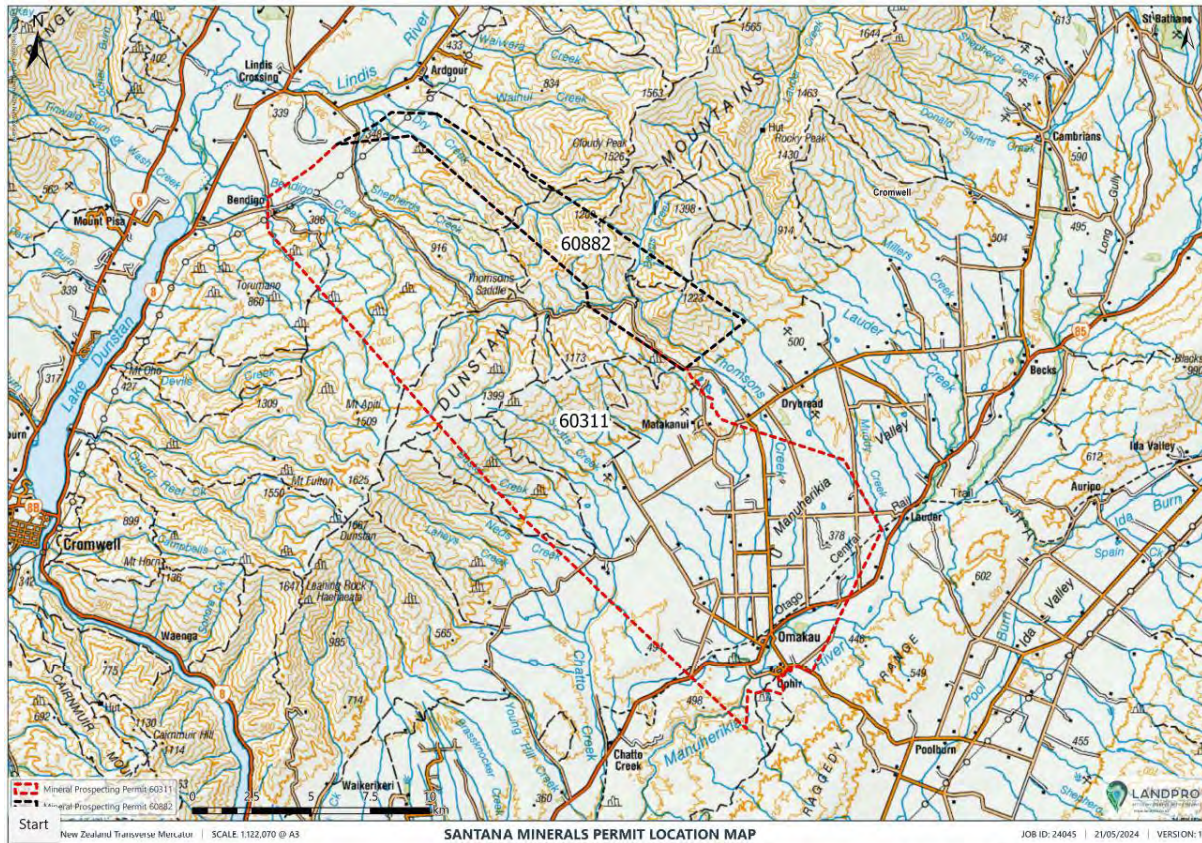


Figure 1. BOGP mineral permit boundaries showing MEP60311 and PEP60882.

2.2 Surface Water

The project area covers several catchments and sub-catchments (Figure 2), including:

- **Shepherds Creek:** This creek runs permanently through the project area and then intermittently from the Ardour Terrace towards the Lindis River. An irrigation water-take on Shepherds Creek (RM17.301.15) downstream of SC1 monitoring site takes all available surface water in normal flow conditions, which is supplied to an irrigation dam, so the creek does not flow past this point. There is potential for groundwater to flow past this point via a thin layer of alluvial gravels along the creek bed.
- **Jean Creek:** This creek is an intermittent tributary to Shepherds Creek.
- **Rise and Shine Creek:** This creek joins Clearwater Creek south-east of the Come in Time Battery and flows into Bendigo Creek.
- **Clearwater Creek:** Flows into Bendigo Creek.
- **Bendigo Creek:** Several irrigation water-takes are in place on this creek (RM20.079.01 and RM20.079.02).

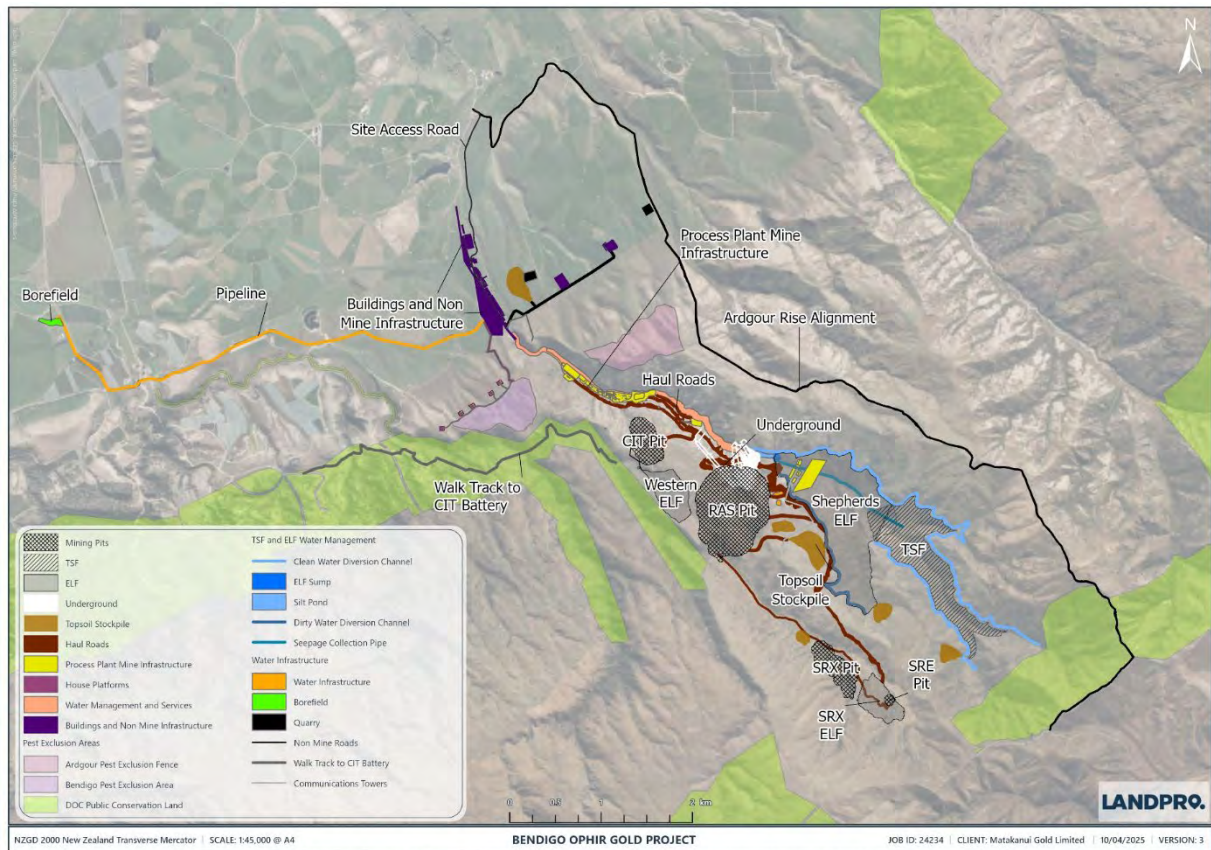


Figure 2. Bendigo-Ophir Gold Project area and water quality monitoring sites.

Baseline water quality data indicates that PCOC are elevated in the BOGP area due to historic mining activities and natural mineralisation (MWM, 2024a).

3 MINE IMPACTED WATER

The BOGP is located within the Otago Schist and is associated with the mineralised Rise and Shine Shear Zone (RSSZ) which juxtapose lower greenschist facies Textural Zone 3 (TZ3) and mid to upper greenschist facies Textural Zone 4 (TZ4) schists in their hanging walls and footwalls respectively. This mineralisation is dominated by sulfur (S) and arsenic (As) (e.g., the mineral arsenopyrite) with other trace metals also being potentially elevated but at much lower concentrations (e.g., cobalt, (Co), copper (Cu), chromium (Cr), antimony (Sb), and zinc (Zn)).

3.1 Baseline Studies

The proposed BOGP water quality compliance limits (Ryder, 2025) are used as a screening tool to determine whether baseline water quality is elevated. The assessment (MWM, 2025a) indicated that:

- Shepherds Creek is elevated in copper (Cu).
- Bendigo Creek is elevated in arsenic (As), cobalt (Co), Cu, and iron (Fe).
- Groundwater is elevated in As, Cu, Fe, zinc (Zn), and on occasion strontium (Sr) within the project area. Thallium (Tl) was elevated on one occasion (although this appears anomalous).

3.2 Geoenvironmental Hazards

All BOGP materials are classified as non-acid forming (NAF), with circum-neutral pH drainage expected from mine domains that contain the materials. However, neutral metalliferous drainage is likely to occur with elevated levels of arsenic (As), sulfate (SO₄), trace metal, and nitrogenous compounds. The most significant AMD source hazard for waste rock relates to the TZ4 and RSSZ materials, some of which will be waste rock, and some will be processed (to extract gold) producing tailings.

Data for waste rock indicates that the TZ4 and RSSZ lithologies contain ~95.3% of arsenic and 21.9% of sulfur yet represents only 9.3% of the waste rock that will be disturbed. Hence, appropriate management of TZ4 and RSSZ materials to reduce sulfide mineral oxidation is a critical step to minimise deleterious effects, i.e., manage 9.3% of the waste rock well to mitigate 95.3% of the arsenic risk in the engineered landforms (ELFs) that will contain the waste rock.

The key PCOC that are likely to be associated with MIW include: aluminium (Al), As, Co, Cu, chromium (Cr), Fe, manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), strontium (Sr), uranium (u), zinc, (Zn), cyanide (CN), ammoniacal nitrogen (Amm-N) and nitrate nitrogen (NO₃-N).

3.3 MIW Summary

It is expected that mining of the BOGP will affect waters within the project area including:

- Elevated total suspended solids (TSS).
- Neutral metalliferous drainage (NMD) with elevated sulfate (SO₄) and the certain PCOCs such as As, Fe, and potentially lesser amounts of trace metals.
- Nitrate-rich drainage due to the use of ANFO and cyanide.

Collectively these waters are referred to as MIW to acknowledge the different contributions to poor water quality within the project area.

4 PROPOSED COMPLIANCE MONITORING

This section summarises the proposed water quality limits for the BOGP.

4.1 Mine Impacted Water

Studies completed by MWM indicate that the following PCOC may be elevated and require treatment:

- Nitrogenous compounds (N) that include nitrate (NO₃) and ammoniacal-N (Amm-N).
- Sulfate (SO₄).
- Metals and metalloids that may include Aluminium (Al), arsenic (As), cadmium (Cd), cobalt (Co), copper (Cu), chromium (Cr), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), strontium (Sr), uranium (U), and zinc (Zn)
- Cyanide (CN) within the tailings water.

4.2 Proposed Water Quality Limits

PCOC that have been identified for the BOGP based on baseline water quality studies, environmental geochemistry studies, and proposed water quality compliance limits are shown in Table 3. Limits are based on:

- Ecotoxicity assessments developed by Ryder (2025) for the proposed surface water compliance sites
- Groundwater limits are based on New Zealand Drinking Water Standards (MoH, 2022).

The proposed compliance monitoring locations are shown in Figure 2 for surface waters and groundwaters.

For conceptual desk-top studies, it is proposed that the WTP and PTS design should be based on the more stringent water quality criteria (i.e., the lower compliance value) for surface and groundwaters to ensure that treated waters comply with both criteria.

These proposed water quality criteria for the BOGP (Ryder, 2025) are summarised in Table 2 for surface water and Table 3 for groundwater.

Table 2. Proposed surface water quality compliance limits for the BOGP.

PARAMETER (units are mg/l unless stated otherwise)	COMPLIANCE LIMIT
pH (unitless)	6.5 - 9.0
Turbidity (NTU)	5 (over a 5-year rolling period, 80% of samples, when flows are at or below median flow, are to meet the limit)
Ammoniacal-nitrogen (NH ₃ -N)	≤0.24 (annual median) <0.4 (annual 95 th percentile)
Nitrate-nitrogen (NO ₃ -N)	<2.4 (annual median) <3.5 (annual 95 th percentile)
Cyanide (CN)	0.011 (un-ionised HCN, measured as [CN], ANZG, 2018)

PARAMETER (units are mg/l unless stated otherwise)	COMPLIANCE LIMIT
Sulfate (SO ₄)	A. If hardness is <100 mg/L (CaCO₃), the sulfate compliance limit = 500 mg/L. B. If chloride is <5 mg/L, the sulfate compliance limit = 500 mg/L C. If the hardness is 100–500 mg/L AND if chloride is 5–<25 mg/L, the sulfate compliance limit is (in mg/L): $[-57.478 + 5.79 * (\text{hardness mg/L CaCO}_3) + 54.163 * (\text{chloride mg/L})] * 0.65$ D. If hardness is between 100 and 500 mg/L AND if chloride is between ≥25 and ≤500 mg/L, the sulfate limit is (in mg/L): $[1276.7 + 5.508 * (\text{hardness mg/L CaCO}_3) + 1.457 * (\text{chloride mg/L})] * 0.65$ A minimum of 12 samples must be collected over any rolling 12-month period. For compliance limits in A to D, no more than 20% of samples collected over a rolling 12-month period may exceed the relevant compliance limit. E. An acute compliance limit = 1,000 mg/L averaged over 4 days and not to be exceeded more than once in a one-year period, OR in more than 10% of samples over a one-year period.
Aluminium (Al) (dissolved)	≤0.08
Antimony (Sb) (total)	0.074 (chronic, the average of 5 (monthly) samples over a 5-month period) 0.250 (acute, not to be exceeded at any time)
Arsenic (As(V)) (dissolved)	≤0.042
Cadmium (Cd) (dissolved)	≤0.0004 See below for adjustment algorithm
Chromium (Cr) (dissolved)	≤0.0033 (CrIII) ≤0.006 (CrVI) See below for adjustment algorithm
Cobalt (Co) (dissolved)	0.001 (chronic) 0.11 (acute, not to exceed) See below for adjustment algorithm
Copper (Cu) (dissolved)	≤0.0018
Molybdenum (dissolved)	≤0.034
Zinc (Zn) (dissolved)	0.015 See below for adjustment algorithm
Adjustments	
Cd (dissolved)	HMTV = TV (H/30) ^{0.89} , where hardness-modified trigger value (HMTV) = (µg/L), trigger value (TV) (µg/L) at a hardness of 30 mg/L as CaCO ₃ ; H, measured hardness (mg/L as CaCO ₃) of a fresh surface water.
Cr (dissolved)	HMTV = TV (H/30) ^{0.82} , where hardness-modified trigger value (HMTV) = (µg/L), trigger value (TV) (µg/L) at a hardness of 30 mg/L as CaCO ₃ ; H, measured hardness (mg/L as CaCO ₃) of a fresh surface water.
Co (dissolved)	Cobalt (µg/L) = $\exp\{(0.414[\ln(\text{hardness CaCO}_3 \text{ mg/L})] - 1.887)\}$
Sb (total)	(chronic) the average of 5 (monthly) samples over a 5-month period (acute) not to be exceeded at any time
Zn (dissolved)	HMTV = TV (H/30) ^{0.85} , where hardness-modified trigger value (HMTV) = (µg/L), trigger value (TV) (µg/L) at a hardness of 30 mg/L as CaCO ₃ ; H, measured hardness (mg/L as CaCO ₃) of a fresh surface water.

Source: MGL (2025)

HMTV = hardness modified toxicity value.

TV = toxicity value.

H = hardness.

Table 3: Proposed groundwater quality compliance limits for the BOGP.

PARAMETER (units are mg/L unless stated otherwise)	COMPLIANCE LIMIT
Nitrate-nitrogen (NO ₃ -N)	11.3 (MAV)*
Cyanide (CN ⁻)	0.6 (MAV)
Sulfate (SO ₄)	≤250 (taste threshold)
Aluminium (Al)	1 (MAV)
Antimony (Sb)	0.02 (MAV)
Arsenic (As(V))	0.01 (MAV)
Cadmium (Cd)	0.004 (MAV)
Chromium (Cr)	≤0.05(MAV)
Cobalt (Co)	<1 (livestock drinking water)
Copper (Cu)	≤0.5
Iron (Fe)	≤0.3
Lead (Pb)	0.01 (MAV)
Manganese (Mn)	0.4 (MAV)
Molybdenum (Mo)	<0.01
Strontium (Sr)	4
Uranium (U)	0.03 (MAV)
Zinc (Zn)	≤1.5

Source: MGL (2025)

MAV = maximum acceptable value – from NZ drinking water standards

The PCOC presented in Table 2 and Table 3 were identified from the baseline studies, source hazard assessment, geochemical modelling, and the water and load balance modelling to understand potential effects of the BOGP.

5 FLOW RATES

This section summarises the long-term average flow rates for each mine domain that may require treatment during the Active Closure and Post Closure phases of the BOGP.

5.1 Average Flow Rates

Average flow rates are estimated from the Water and Load Balance Model (MWM, 2025c). It is assumed that the use of average flow rates is suitable for the WTP OoM Study and the PTS Concept Study. Peak flows may require either a larger capacity plant or a surge pond prior to any treatment. Further work is required to advance the designs to a FS level including understanding the treatment requirements for peak flow rates.

Table 4 provides a summary of flow rates for the various mine domains that require treatment. These flow rates are preliminary and are intended to provide guidance for the OoM study on the WTP design. For the OoM WTP Study it is recommended that the design include suitable contingency for variable flow rates. Active treatment is not required for SRX Pit - It is expected that the water quality from this mine domain will be acceptable for release to the receiving environment (e.g., Rise and Shine Creek / Bendigo Creek) with passive treatment.

Table 4: Estimated average water quantity per mine domain.

MINE DOMAIN	WTP DESIGN CRITERIA (L/s)	PTS (L/s)	COMMENTS
Shepherds ELF	4	4	20% Net percolation (MWM, 2025b)
SRX ELF ^{1, 2}	-	1	20% Net percolation (MWM, 2025b)
West ELF ²	1	1	20% Net percolation (MWM, 2025b)
Shepherds TSF	13.4	3	Flow is expected to be ~13.4 L/s decreasing to 3 L/s after 5 years (MWM, 2025c).
RAS Underground Portal	6	6	Flow from the RAS Underground is not expected for 20-30 years after closure (MWM, 2025c).
CIT Pit Backfill	1.5	1.5	Further details are available in MWM (2025c).
SRX Pit	-	8	Further details are available in MWM (2025c). It is assumed this water will not require active treatment. Passive treatment is required.
SCK Fill ²	1	1	20% Net percolation (MWM, 2025b)
Non-AMD impacted water	-	-	Managed for TSS separate to the active WTP. At closure rehabilitated surfaces are assumed to be suitable for discharge with TSS management.

1. Active treatment for SRX ELF and SRX Pit are not anticipated.

2. Flow rates rounded up to 1 L/s

Flow rates (Table 4) are based on a net percolation (NP) rate of 20% of rainfall. It is proposed that a NP rate of 20% may be achievable, with appropriate engineering controls (i.e., an engineered cover system), which would halve the flow rates (MWM, 2025c).

5.2 Model Flow Rates

The section summarises the flow rates for the mine domains presented in Table 4 to provide a visual guide to the flow variance.

5.2.1 ELF and TSF Flows

Model results for seepage flow rates from the ELFs and TSF are shown in Figure 3:

- Average flow rates for the Shepherds and other ELFs of approximately 4 and 1 L/s respectively.
- TSF seepage decays through the draindown period as the system equilibrates to lesser influent water (e.g., no process water, only rainfall), with average long term seepage flow rates of approximately 2 L/s. Flow rates typically vary between 1 and 3 L/s in the long term. Further details are provided in EGL (2025).

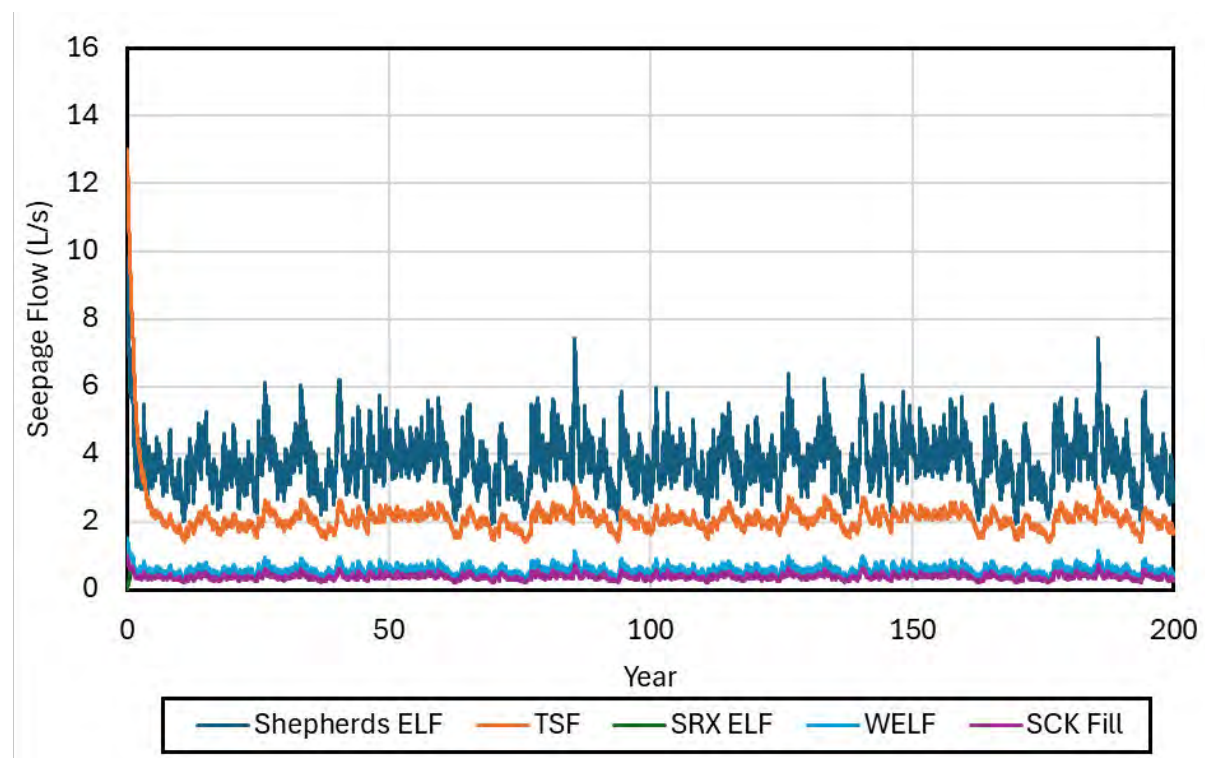


Figure 3: ELF and TSF seepage flow rates.

5.2.2 RAS Pit and RAS Underground

Model results for RAS Pit Void are shown in Figure 4 and Figure 5, and suggest:

- Stabilisation of the pit lake rebound in approximately 25 years, with a water level around 492 m asl (slightly above the adopted portal elevation of 490 m asl).
- Model results do not suggest the pit lake will spill over the pit crest low point (565 m asl).
- Discharge of pit lake water via the underground portal will start once the pit lake water level is above 490 m asl, and typically range between 4 to 7 L/s, with an average of about 6 L/s.

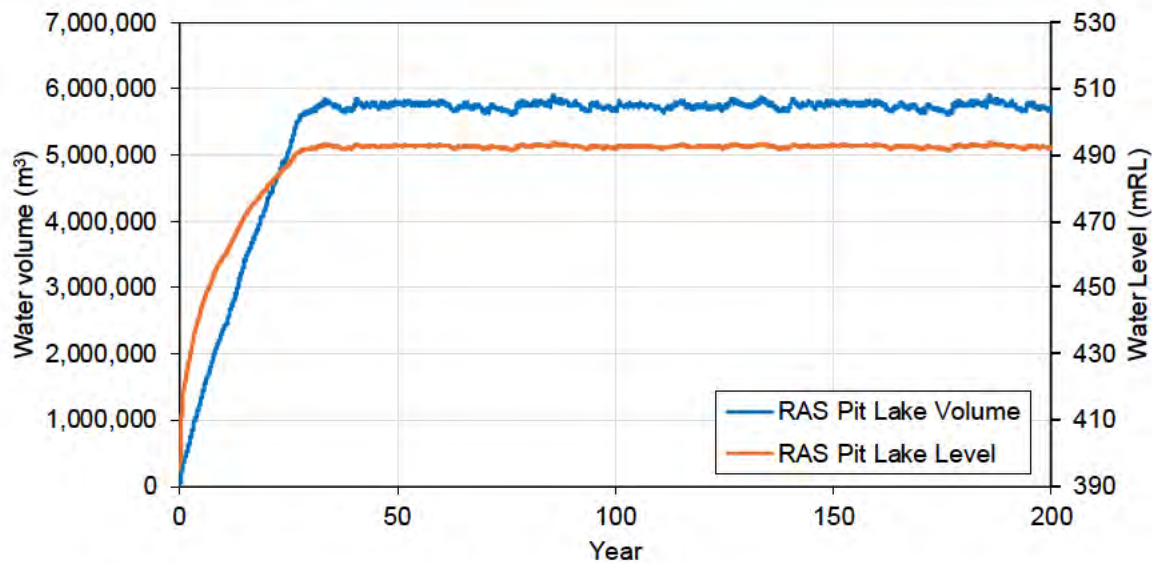


Figure 4: RAS Pit Void model results – water volume and level.

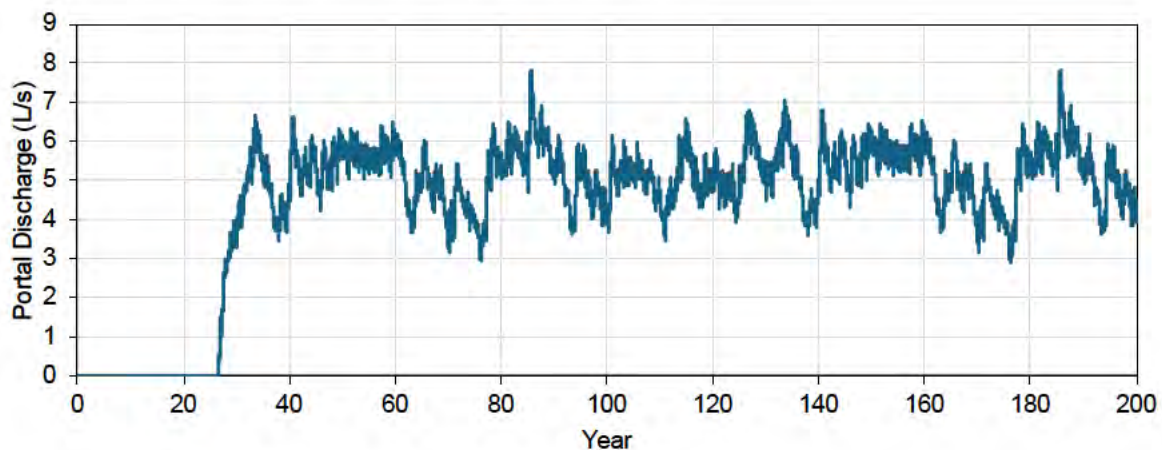


Figure 5: RAS Pit Void model results – underground portal discharge.

5.2.3 SRX Pit Void

Model results for SRX Pit Void are shown in Figure 6 and Figure 7, and suggest:

- The pit void will fill and spill quickly (~ 6 months) owing to the low pit crest elevation and high groundwater inflow rate.
- The variability in overflow rate from the pit lake is higher than other pit voids due to the contribution of runoff from undisturbed areas reporting to the pit. Periodic high outflow rates are predicted, 140 L/s or higher, but average outflow rate is approximately 8 L/s.

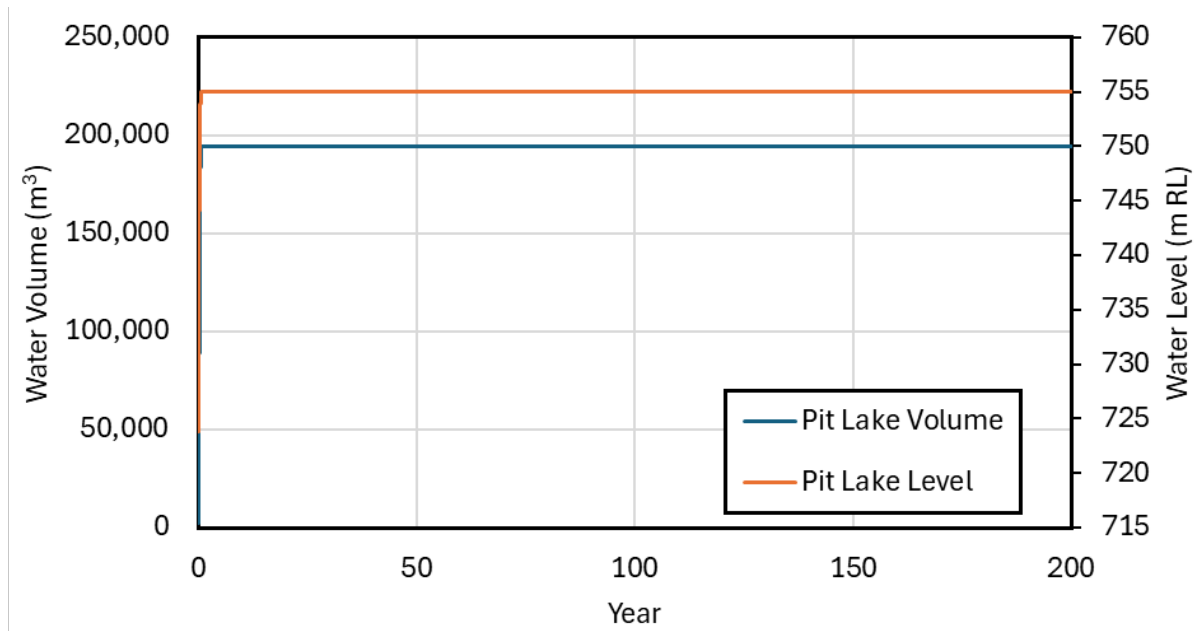


Figure 6: SRX Pit Void model results – water volume and level.

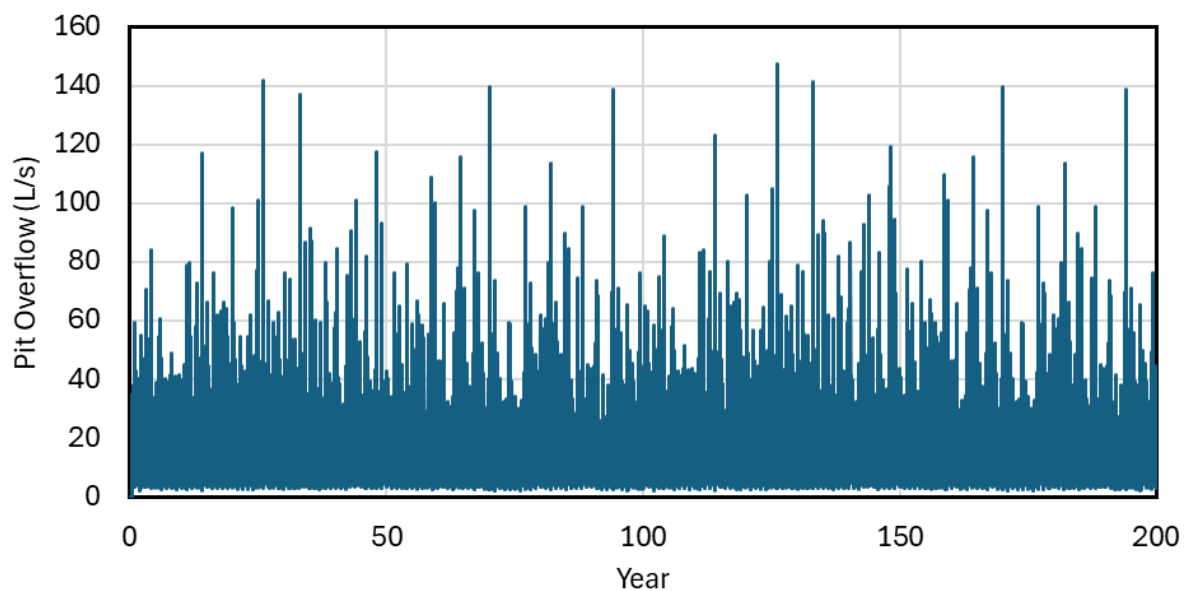


Figure 7: SRX Pit Void model results - overflow rate.

5.2.4 CIT Backfill Pit

Model results for CIT Pit Void are shown in Figure 8 and Figure 9, and suggest:

- The backfilled pit void will fill and spill at around 3.5 years.
- Outflow rates via groundwater pathways are low <0.1 L/s, with the majority of outflow via spilling at the pit crest at an average of approximately 1.5 L/s.

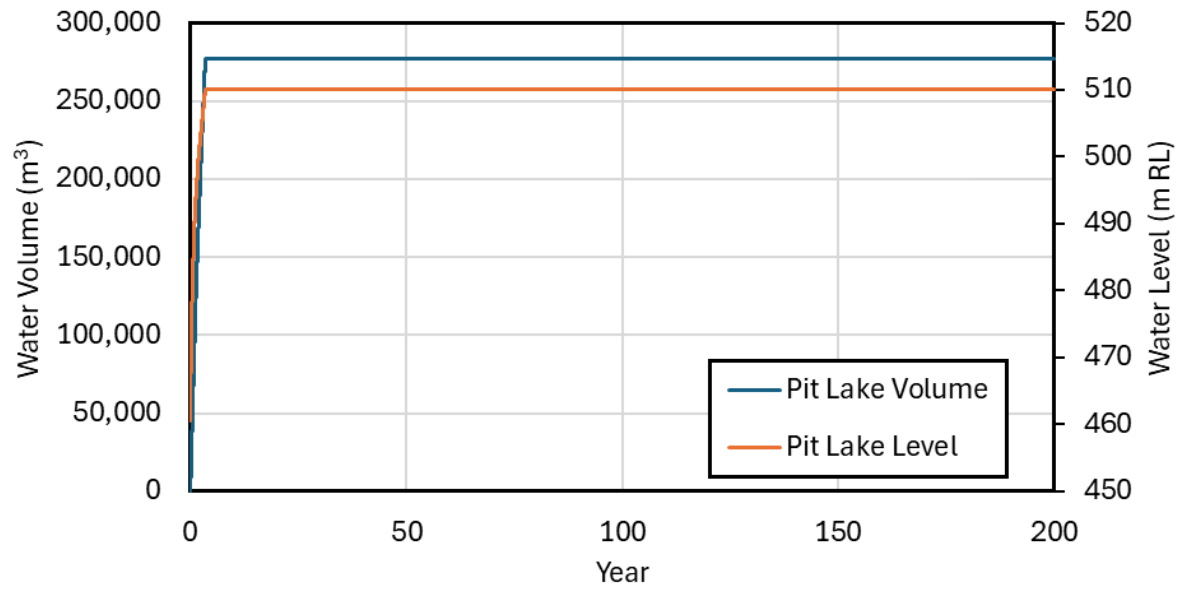


Figure 8: CIT Pit Void model results – water volume and level.

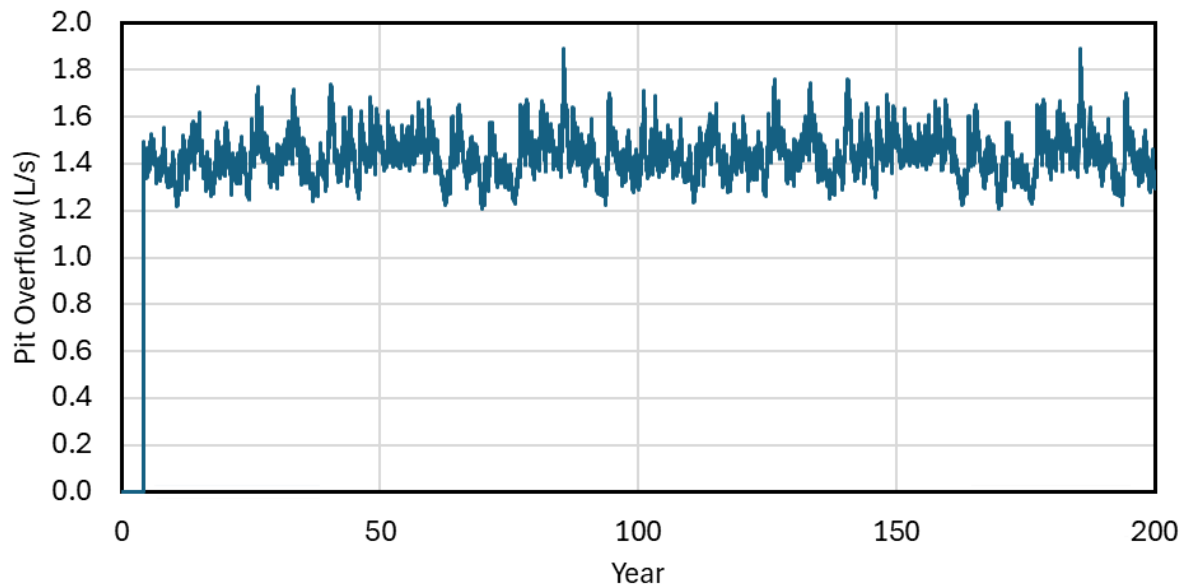


Figure 9: CIT Pit Void model results – outflow rates.

6 WATER QUALITY: ACTIVE WATER TREATMENT

This section summarises the water quality from the various mine domains that require treatment at closure of the BOGP by the active water treatment plant.

6.1 Shepherds TSF Water Quality

TSF seepage water quality at mine closure (Year 11) is presented in Table 5. Further details on how the water quality was derived are provided in MWM (2025e). Constant concentration is assumed.

Table 5: TSF seepage water quality (Closure).

PARAMETER	CLOSURE TSF SEEPAGE WATER QUALITY
Alkalinity (mg CaCO ₃ /L)	73.21
pH (pH units)	6.41
EC (µS/cm)	4,121
Ca	297
Cl	804
F	1.93
Mg	99
Na	847
K	50.8
TOC	-
Al	0.01
Ag	0.0068
As	2.05
B	0.825
Cd	0.0002
Co	0.053
Cr	0.0055
Cu	0.001
Fe	15.3
Mn	0.59
Mo	0.14
Ni	0.678
Pb	0.0275
Sb	0.18
Se	0.003
Sr	4.4
Tl	0.001
U	0.028
V	0.004
Zn	0.0296
Cyanide - WAD	0.35
Sulfate	954
Ammoniacal-N	2
Nitrate-N	0.005

Note: All units in mg/L unless otherwise stated. Green data are LOR

WAD – Weakly Acid Dissociable cyanide; If no data are provided these are identified by ‘-’.

6.2 ELF and CIT Backfill Water Quality

Water quality for the ELFs is provided in Table 6, which shows the water quality for Year 27, when maximum loads are being derived from the Shepherds ELF to provide peak concentration data for the design of the WTP.

Constant concentrations are assumed for As (0.2 mg/L) and Fe (7.6 mg/L) based on empirical data for sub-oxic conditions (e.g., Globe Progress Waste Rock Stack, Hayton et al., 2022). These concentrations are above the proposed water quality reference limit (Ryder, 2025) and will require management. The SCK Fill assumes full oxidation, which results in low Fe concentrations.

Table 6. Water Quality Data (Year 27) for WTP design – 20 m Oxygen Exclusion Model

STATION	TSF SEEPAGE	SHEPHERDS ELF SEEPAGE	WELF SEEPAGE	CIT PIT BACKFILL	SCK FILL SEEPAGE	MIW COMBINED ¹
Acidity	0.01	0	0	0	0	0.03
Al	0.011	0.003	0.003	0.005	0.003	0.013
Alkalinity	73	189	183	190	158	160
As	2.06	0.20	0.20	0.08	0.20	0.61
B	0.83	0.87	0.10	0.09	0.01	0.59
Ca	297	51	51	39	36	107
Cd	0.0002	0	0	0.0001	0	0.0001
Cl	806	63	37	12	8	223
Co	0.053	0.109	0.023	0.004	0.003	0.061
Cr	0.00636	0.00020	0.00019	0.00040	0.00007	0.00170
Cu	0.00100	0	0	0.00021	0	0.00049
DOC	0	0	0	0.206	0	0.038
F	1.94	6.30	6.12	1.39	2.37	3.90
Fe	15.3	7.6	7.6	2.4	7.6	8.7
Hg	0	0	0	0.00014	0.00000	0.00003
K	51	683	672	84	159	372
Mg	100	38	37	20	24	49
Mn	0.594	0.819	0.774	0.103	0.182	0.567
Mo	0.140	1.005	0.672	0.119	0.157	0.535
NO ₃ -N	2.01	49.64	9.54	0.73	1.33	22.89
Na	848	922	734	127	170	673
Ni	0.6784	0.0121	0.0010	0.0013	0.0001	0.1652
Pb	0.0276	0.0001	0.0001	0.0002	0.0000	0.0068
Sb	0.1802	2.9986	3.2208	0.3622	0.7601	1.6317
Se	0.0030	0.1544	0.1649	0.0196	0.0388	0.0826
SO ₄	954	957	888	110	208	730
Sr	4.40	16.15	15.91	3.77	10.89	10.12
Tl	0	0	0	0.00021	0.00000	0.00005
CN	0.35	0	0	0	0	0.08238724
U	0.0280	0.2751	0.2225	0.0299	0.0515	0.1468
V	0.0040	0.1200	0.1155	0.0135	0.0269	0.0633

STATION	TSF SEEPAGE	SHEPHERDS ELF SEEPAGE	WELF SEEPAGE	CIT PIT BACKFILL	SCK FILL SEEPAGE	MIW COMBINED ¹
Zn	0.0296	0.0098	0.0021	0.0014	0.0003	0.0117
pH (pH unit)	6.41	7.93	7.92	8.03	7.92	6.72
Hardness	1,151	285	280	179	190	469

Units in mg/L unless stated otherwise: DOC = dissolved organic carbon

1. weighted average

6.3 RAS Underground

As discussed in MWM (2025e) seepage from the RAS Underground will be comparable to the RAS Pit Lake. The RAS Underground is not expected to commence discharge until Year 26. Water Quality for Year 26 is provided in Table 7.

Table 7. RAS Underground water quality (Year 27)

PARAMETER	RAS UNDERGROUND
Acidity	0.44
Al	0.100
Alkalinity	182
As	0.09
B	0.05
Ca	59
Cd	0.0001
Cl	14
Co	0.000
Cr	0.00058
Cu	0.00302
DOC	0.090
F	0.23
Fe	7.9
Hg	0.00006
K	34
Mg	37
Mn	0.014
Mo	0.020
NO3-N	4.35
Na	42
Ni	0.0009
Pb	0.0035
Sb	0.0234
Se	0.0008
SO4	141
Sr	0.79

PARAMETER RAS UNDERGROUND	
TI	0.00031
CN	0
U	0.0094
V	0.0006
Zn	0.0022
pH (pH unit)	5.91
Hardness	299

Units in mg/L unless otherwise stated

7 PRINCIPLES OF WATER TREATMENT

This section discusses the principles of water treatment for the BOGP.

7.1 Overview

Water treatment should be the last option evaluated to manage mine water discharges (INAP, 2021) and a hierarchy of controls are proposed to minimise the requirements for water treatment (Figure 10). As noted by the Australian Commonwealth (DFAT, 2016) *“It makes good business sense, in addition to being leading practice, to avoid and minimise the production of acid mine drainage (AMD), and to treat AMD only as a last resort if other approaches have failed.”*

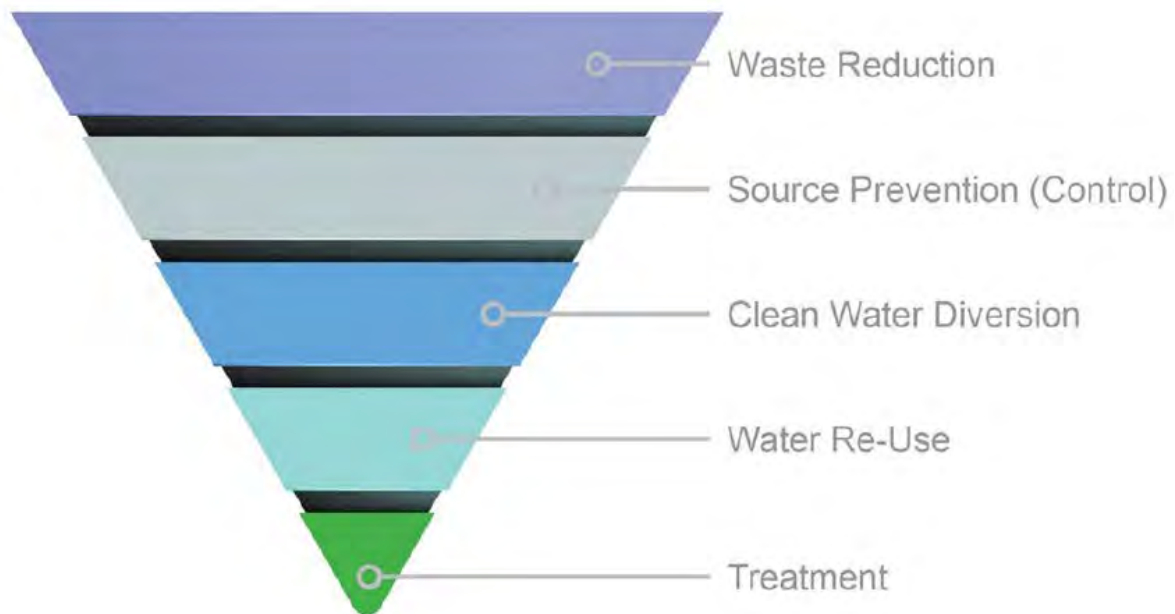


Figure 10. Hierarchy of MIW Treatment Controls

Source: INAP (2021).

Previous studies completed as part of an assessment of environmental effects for the BOGP have already considered these hierarchy of controls:

- Source control technologies for the proposed engineered landforms are proposed, which are expected to significantly reduce contaminant loads in the longer term (MWM, 2025d). Further discussion on source control is provided in Section 10 – Further Work that recommends additional studies to assess the options to reduce net percolation rates (which mobilises PCOC).
- Clean water diversion is part of the overall water management philosophy including minimising water ingress into the engineered landforms (MWM, 2025f).
- Water reuse is proposed during the operational phase where MIW is reused for process water and possibly dust suppression (MWM, 2025c).

This report discusses water treatment.

7.2 Treatment Technology Selection: Active Treatment versus Passive Treatment

Estimates of flow rates (Table 4) suggest that active treatment using a WTP is required for up to ~20 L/s during the Active Treatment Phase and up to 25 L/s for the PTS (split over two PTS) during the Post Closure Phase.

Passive systems, in general, can only handle relatively small flows (usually less than 50 L/s) unless a significant area is available for passive treatment to be successful (INAP, 2021). A common reference document (Taylor et al., 2005) provides general criteria for passive treatment (Table 9). However, INAP (2021) note that *'Under neutral to slightly acidic conditions, much higher flows can be treated through passive treatment, especially where sufficient real estate is available and where the concentrations of iron, which is often the largest problematic dissolved constituent, can be decreased through aeration.'* MIW at BOGP will be circum-neutral, hence PTS limitations on flow rates are unlikely given the flows proposed in Table 4.

INAP (2021) also note that *"most successful passive treatment projects are treating less than 1,000 m³ per day"*, however there are two examples where treatment of 6,500 m³ per day (~75 L/s) was maintained for up to 19 years.

Table 8. General Guidelines for Selection Active versus Passive Treatment

TREATMENT SYSTEM	AVERAGE ACIDITY RANGE (mg CaCO ₃ /L)	AVERAGE ACIDITY LOAD (kg CaCO ₃ /day)	AVERAGE FLOW RATE (L/s)	TYPICAL pH RANGE	MAX pH ATTAINABLE
Passive	1 - 800	1 – 150	< 50	>2	7.5 – 8.0
Active	1 – 10,000	1 – 50,000	No defined limit	No defined limit	14
BOGP	<50 ¹	~50 ²	~30	Circum-neutral	-

Source: Taylor et al. (2005).

1. Based on 7.6 mg/L as Fe(iii) converted to acidity mg CaCO₃/L).
2. Based on 30 L/s (see Table 4) – Active = 27 L/s; passive = 32 L/s.

Based on this review, it is anticipated that the flow rates expected for the BOGP in the Active Phase and Post Closure Phase can be managed by both active and passive treatment technologies.

7.3 MIW Redox Geochemical Characteristics

MIW can be summarised into three broad geochemical groups:

- Oxidic waters - waters that contain measurable dissolved oxygen.
- Suboxic waters - waters that lack measurable oxygen or sulfide but contain significant dissolved iron (> ~0.1 mg/L).
- Reducing waters (anoxic) - waters that contain both dissolved iron and sulfide.

Mine impacted water at BOGP are likely to have a number of different redox states:

- TSF seepage is likely to be suboxic or be reduced.
- ELF seepage is likely to be suboxic with elevated Fe.

- Pit lakes are likely to be oxic.
- RAS Underground is likely to be suboxic/oxic (e.g., may contain some elevated iron that has not hydrolysed by interaction with air as water seeps from the portal).

The various mine waters will be mixed prior to treatment through the WTP and PTS. The mixing will be optimised to encourage beneficial geochemical reactions that include, for instance, Fe hydrolysis with As and trace metal removal (via adsorption).

8 ACTIVE CLOSURE PHASE: WATER TREATMENT PLANT

The Active Closure Phase of the BOGP commences once mining is complete (i.e., no further ore processing) and the MIW management at site transitions from water retention to treat and release.

8.1 Introduction

Active closure of the site commences in Year 11 (Table 1) with final rehabilitation of mine domains and transition from water storage to water treatment by an active water treatment plant. An OoM design has been developed by Process Flow (2025) for active treatment of MIW. This is included as Appendix C.

As noted by INAP (2021) “*Surge ponds may be a valuable feature in the case of highly variable mine drainage flows and pollutant loads as this will afford some protection against surcharging the treatment system. It is typically not economically feasible to build very large raw water retention ponds nor is it economical to build small ponds and very large treatment plants*”. The surge pond capacity will be considered during the BOGP detailed design stage when peak flow rates will be considered. For this study, the average flow rates presented in Table 4 are used.

8.2 Location

The proposed location for the Active WTP is located within the Shepherds Creek catchment. Process Flow note the size and footprint requirements for the WTP and Surge and Treated water ponds is as follows.

- WTP Footprint – An area approximately 100 m x 60 m is recommended to be located near the surge and treated water ponds.
- WTP Surge Pond – 14,000 m³
- WTP Treated Water Pond – 2,000 m³

8.3 Technology Selection

Process Flow (2025) note that the selected process involves:

- Surge sump
- Pontoon mounted pumps for plant feed
- Metal hydroxide precipitation and settling
- Gypsum precipitation and settling
- Ettringite precipitation and settling
- Carbonation and pH trimming
- Treated water sump
- Sludge management

Other processes that will likely be needed in addition to the active WTP are:

- Cyanide destruct on the Shepherds TSF influent stream

- Potential additional nitrate removal after WTP via biological processes.

8.4 Summary

Process Flow indicate that the proposed water quality objectives (Ryder, 2025) can be achieved, although further work is required to develop the OoM study to a FS level. Further details are provided in Appendix B. The WTP will operate until passive treatment systems can be installed.

9 POST CLOSURE PHASE: PASSIVE TREATMENT SYSTEMS

The Post Closure Phase for the BOGP commences once MIW can be treated by passive treatment system technology. Based on the WLBM (MWM, 2025c) and expected sulfate concentrations at SC01, it is expected that transition from active to passive treatment can occur within a few decades depending on water management processes.

This section discusses passive treatment technologies. Passive treatment technologies for treatment of MIW are defined as biological and/or chemical processes that neutralise acidity and precipitate metals via oxidation or reduction using natural processes that do not require regular human intervention or maintenance (INAP, 2021). In general, a passive system should function for many years without a major retrofit to replenish materials and should operate with no or low electrical power.

9.1 Introduction

Based on the contaminants of concern identified at the BOGP a multi-stage passive treatment system is expected. This would include:

- Sediment management to mitigate any residue TSS and prevent the PTS from being overwhelmed with sediment.
- Oxidation to encourage $\text{Fe}(\text{OH})_3$ precipitation and adsorption of metals such as As.
- Aerobic treatment of tailings seepage waters for cyanide.
- Anaerobic treatment to remove nitrate, reduce sulfate concentrations, and precipitate metals as sulfides.
- A polishing pond to remove secondary contaminants generated in the anaerobic treatment stage (e.g., sulfide (HS^-), ammoniacal nitrogen, and low dissolved oxygen).

Gusek and Waples (2009) developed a periodic table of elements for passive treatment (Figure 11), which demonstrates the applicability of oxic and anaerobic treatment systems to PCOC identified at BOGP. Figure 11 provides useful context but does not cover all elements. For instance, Trumm et al (2024) noted that a mussel shell anaerobic bioreactor at Echo Mine, Reefton removed 96% of Cs; 82% of Rb, and 98% of La, which is not shown in Figure 11.

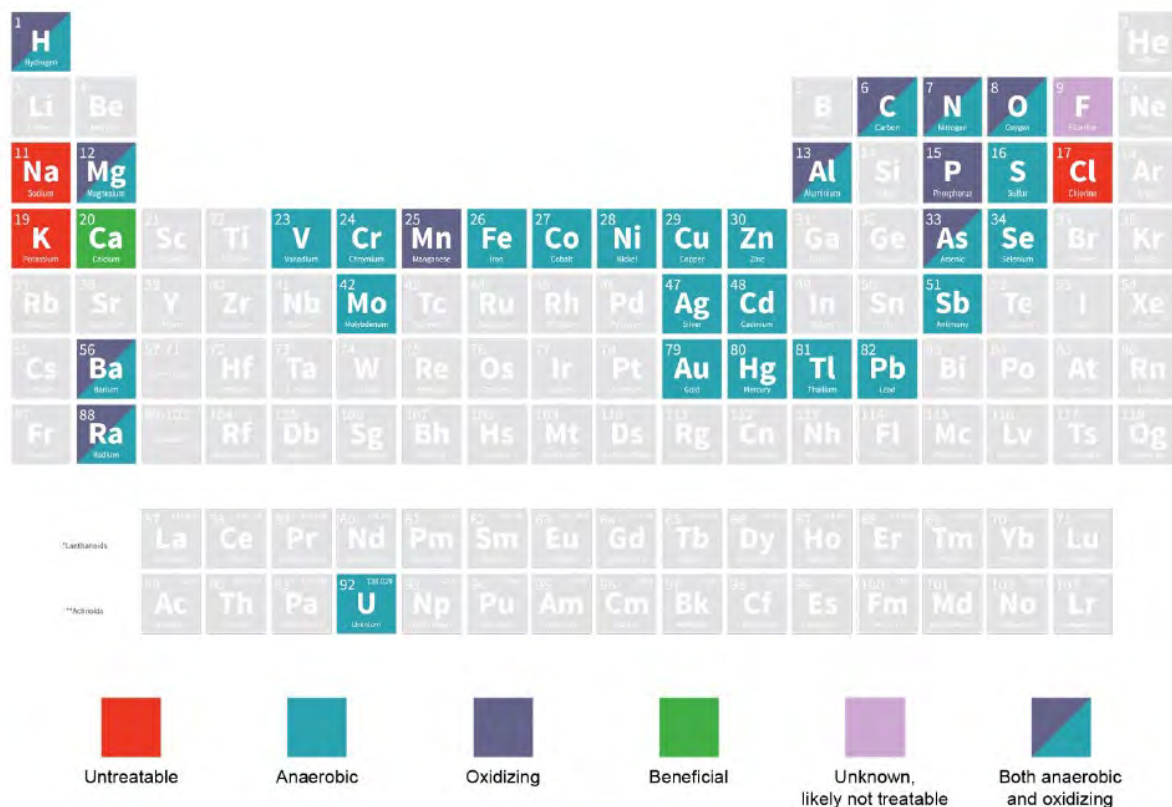


Figure 11. Periodic table for passive treatment.

Source: INAP (2021).

The following locations are potentially available for the construction of PTS at the BOGP after closure of the mine:

- Shepherds Sediment Pond footprint.
- SRX ELF toe seepage pond and/or SRX Pit.
- BOGP Infrastructure area to treat seepage from the Shepherds ELF, Shepherds TSF, RAS underground, WELF, and the CIT Backfill Pit.

Passive treatment during the operational phase of the mine is generally not viable due to the MIW being affected by significant sediment loads (TSS). However, the Operational Phase is an ideal time to test and confirm PTS technologies can achieve water quality objectives.

9.2 Oxidation of Suboxic Waters

Oxidation is a common approach for the treatment of waters discharging from suboxic / reduced environments (e.g., seepage from the ELF, underground workings, etc.) impacted by iron (Fe) and arsenic (As). The oxidation treatment process involves aerating water (to increase the dissolved oxygen content), which allows Fe^{2+} to oxidise to Fe^{3+} and form insoluble ferric hydroxide, $\text{Fe}(\text{OH})_3$ precipitates. Arsenic is removed through this process by co-precipitation / adsorption to the ferric hydroxide.

9.2.1 Aeration

Aeration is a common technology used to remove sulfide from water. This is demonstrated by the fact that hydrogen sulfide gas escapes (volatilizes) rapidly from water and can be identified by its distinct

odour⁴. Aeration can also be used to remove ammoniacal nitrogen and is common for wastewater treatment.

The following physical aeration systems are available to increase aeration of the PTS effluent to increase dissolved oxygen and remove ammoniacal N and un-ionised hydrogen sulfide.

9.2.1.1 Trompe

A trompe (Figure 12) utilises falling water to compress air, drawing air into a vertical downpipe as water flows through an airhead (Leavitt et al., 2015)⁵. The high velocity of the falling water carries entrained air down the pipe, which is then separated from the water in a chamber located below the discharge elevation. To generate air pressure, a drop of approximately four feet is required between the inlet head and discharge pipe, and the height of the discharge pipe controls the pressure generated (Leavitt and Danehy, 2011; Leavitt et al, 2015). Trompes can be installed in series for sites with multiple flow rates, and multiple airheads and downpipes.

The Curley passive treatment site in Pennsylvania installed a trompe to assist in the treatment of mine-impacted drainage. The mine drainage had Fe concentration of 23 mg/L (Dorman, 2019). The study found that the trompe added over 3 mg/L of dissolved oxygen, which was sufficient to oxidise 82 – 97% of the Fe present in the influent water (Dorman, 2019).

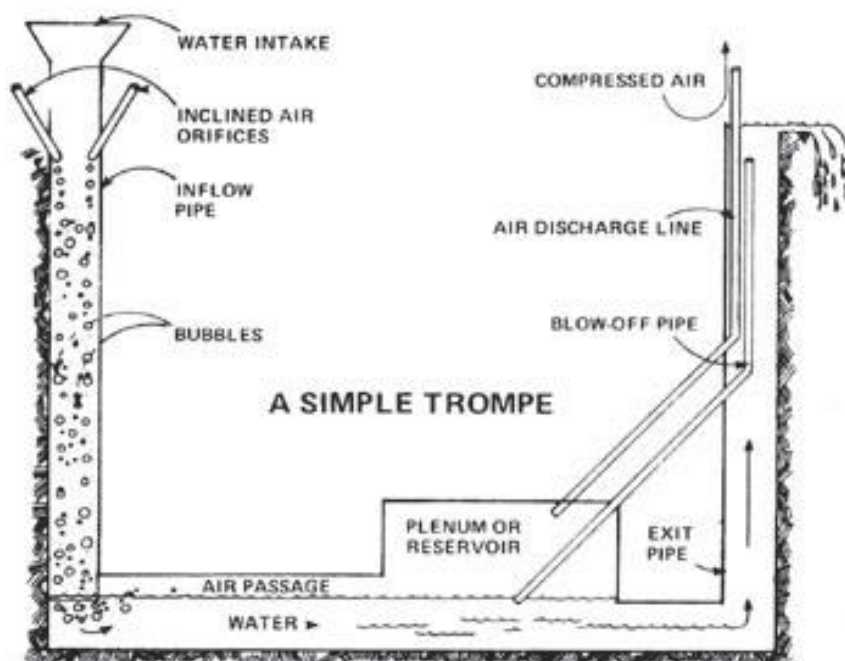


Figure 12. A simple trompe schematic

Air entrained in the water is compressed in the plenum, or reservoir, and delivered via pipeline

Source: Trumm 2013

9.2.1.2 Mechanical Aeration

Powered mechanical aeration systems are available for wastewater treatment systems (e.g., agitators), however, the electricity requirements are likely to be prohibitive once power is removed from the site in

⁴ Further details are available: <https://extension.uga.edu/publications/detail.html?number=C858-15>.

⁵ Further details are available from the U.S. Department of the Interior: <https://www.osmre.gov/node/794>.

the Post Closure Phase. Alternatively, solar options are available to generate compressed air (e.g., CWS, 2023).

9.2.1.3 Bubble Diffusers

Bubble diffusers or similar generate high surface area air particles to allow sufficient chemical oxidation of sulfide and ammoniacal nitrogen. Fine bubble diffusers create fine bubbles by pushing air through tiny holes in the diffuser plate, resulting in a large water-air interface and high oxygen transfer rate (Dorman, 2019).

Fine bubble diffusers may not be suitable for waters with high suspended solids like a mine drainage oxidation pond due to fouling from metal hydroxides or biofilm layers (Dorman, 2019; Schmidt 2004). However, the proposed polishing pond will have low dissolved metal content. Trials during the detailed design phase will confirm if fouling is a problem.

9.2.2 Ferric Treatment of High Arsenic MIW

Where waters are aerated but retain elevated As concentrations the addition of Fe to trigger further ferric hydroxide formation and remove As by co-precipitation / adsorption is a common treatment approach, and is used in many active treatment systems. Passive treatment systems can also use FeCl_3 addition. For instance, OceanaGold treated the Globe Pit Lake with FeCl_3 to reduce elevated arsenic concentrations (Navarro et al., 2022). This is shown in Figure 13 which demonstrates significant decreases in As following the addition of Fe.

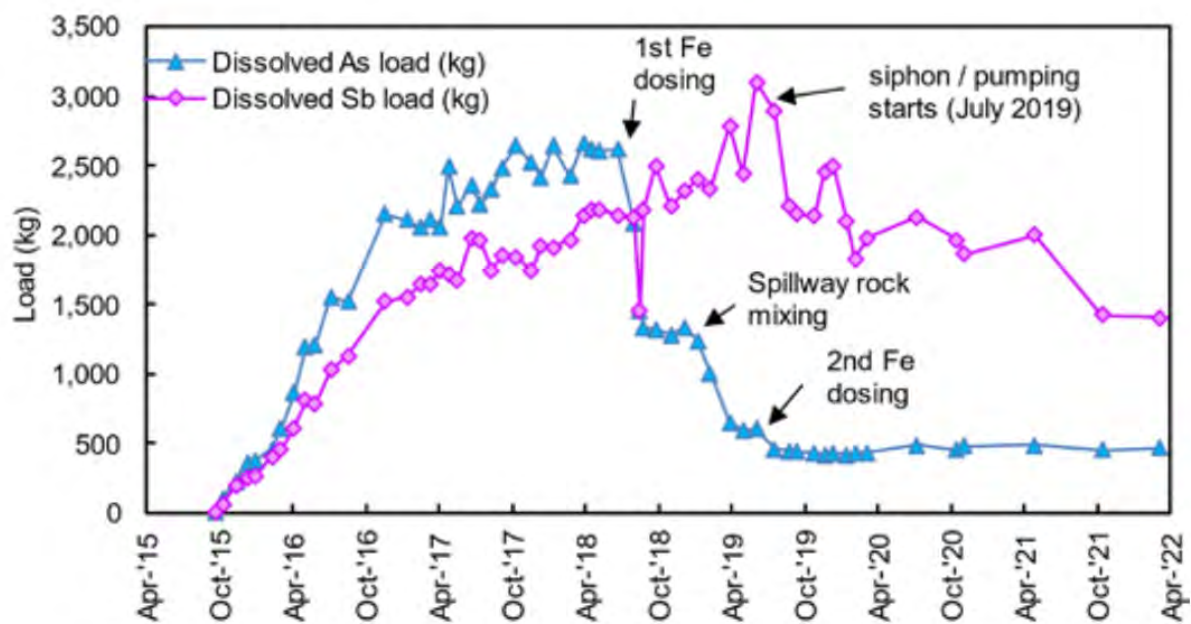


Figure 13. Arsenic and antimony loads – Globe Pit Lake, Reefton.

Source: Navarro et al. (2022)

9.2.3 Vertical Flow Reactor Technologies

Work completed by Hayton (2022) demonstrated that one option to treat arsenic and iron was a vertical flow reactor (VFR). A full-scale VFR has subsequently been constructed at the Globe-Progress Mine. The following link provides further information on the system:

- <https://oceanagold.com/2021/01/27/delivering-innovative-passive-water-treatment-at-reefton/>

The Globe-Progress Mine VFR aerates Fe- and As- rich waters from the waste rock stack seepage and tailings storage facility underdrains and then filters (downwards flow) the Fe-precipitates (with As adsorbed to the Fe-floc) through a gravel-bed. Treated waters are then discharged from site.

The use of Fe hydroxides to co-precipitate / adsorb and treat As-impacted mine waters is a proven technology for As treatment and could be applied at the BOGP where required. This could include seepage from the TSF, ELFs, and RAS Underground, etc. If Fe is limited in the influent water stream, this could be added by a simple FeCl_3 dosing system.

9.2.4 Summary

The precipitation of iron as hydroxide minerals may also assist in the removal of additional pollutants. Several ionic species, such as arsenic and molybdenum, coprecipitate or adsorb onto ferric hydroxide (INAP, 2021), which will help with these PCOC if they are elevated in MIW.

9.3 Aerobic Passive Treatment of TSF seepage: Cyanide

Aerobic passive treatment of TSF seepage may be required following active treatment for residual cyanide that may be present in concentrations up to 0.35 mg/L. This could be co-incidental with the passive oxidation and removal of Fe and As.

Studies state that that cyanide move only a short distance through soil before being biologically converted under aerobic conditions to nitrates via microbial attenuation to ammonia and then to nitrate (Mudder et al., 2001). It was also found that cyanides are immobilized after reacting with trace metals through chelation processes (Mudder et al., 2001). Álvarez et al (2004) indicated that passive treatment of cyanide is viable with 90.36% removal of Cyanide_{WAD}.

9.4 Anaerobic Passive Treatment of Mine Impacted Water

Anaerobic passive treatment can be used to mitigate the effects of poor water quality during the Post Closure Phase, which might be impacted by:

- Metals
- Nitrogenous compounds
- Sulfate

9.4.1 Anaerobic Treatment of MIW

There are numerous types of anaerobic treatment system for sulfate-rich waters, however all anaerobic PTS rely on Equation 1 to convert sulfate to sulfide, which can then be removed as either metal sulfides (e.g., pyrite that can also contain other trace elements, e.g., As, Zn, Ni, Pb, etc) or be converted to elemental sulfur. This process can only occur under anoxic conditions when there is a labile source of carbon to provide electrons and sulfate is available to receive the electrons (assuming microbes will naturally be present).

Equation 1: $\text{SO}_4^{2-} + 2\text{CH}_2\text{O} \xrightarrow{\text{SRB}} 2\text{HCO}_3^- + \text{H}_2\text{S}$ Where SRB = sulfate reducing bacteria.

H_2S is a common anaerobic degradation by-product where sulfate is present. H_2S can be found in natural sediments and is found in industrial wastes and landfill leachates (ANZECC, 2000). Mine-impacted waters can also be elevated in sulfate that can be converted to hydrogen sulfide under anoxic

conditions where labile organic carbon is available. This process is driven by microbes seeking energy to drive metabolic activity where energy is obtained from the transfer of electrons from electron-rich (reduced) substrates (e.g., organic matter) to electron-deficient (oxidised) species (e.g., nitrate, sulfate, etc). This is shown schematically in Figure 14 and an explanation of relative oxidation-reduction potential (Eh) for these reactions is shown in Figure 15.

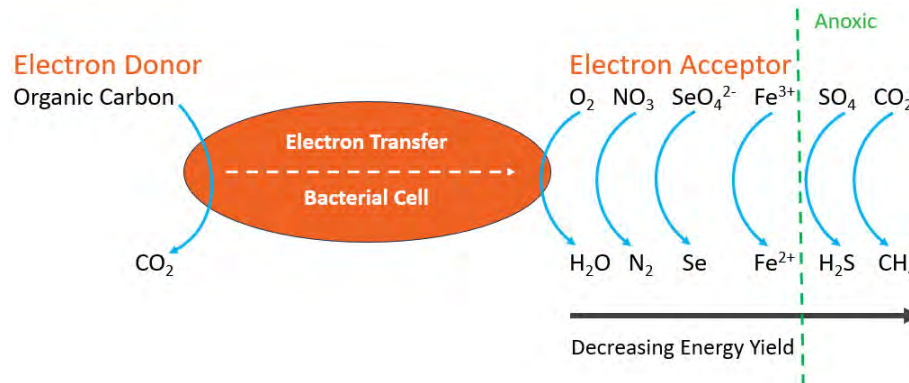


Figure 14. Energy yield and common oxidation-reduction (redox) sensitive species.

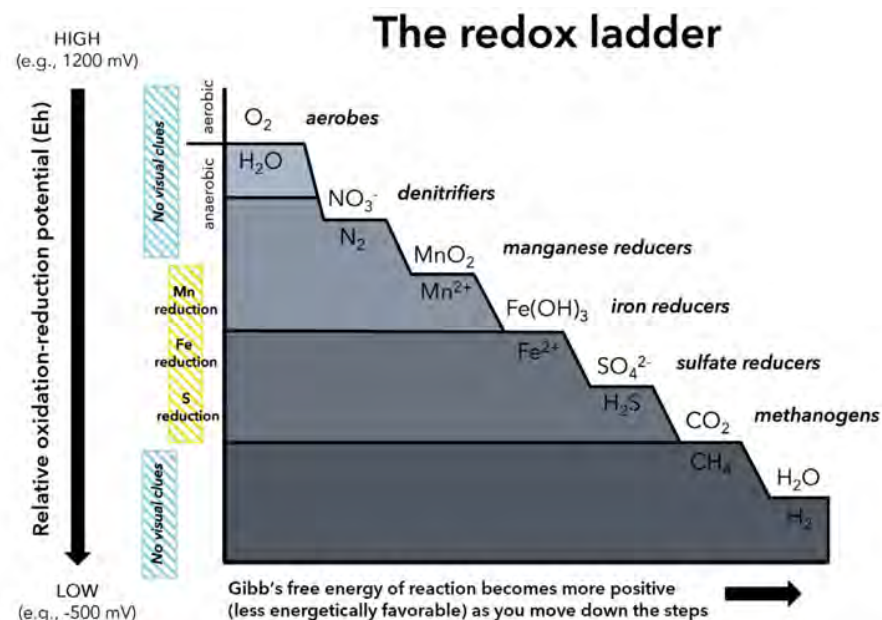


Figure 15. The Redox Ladder

Source: Sapkota et al. (2022)

As shown in Figure 14 and Figure 15, anaerobic passive treatment systems can also treat nitrate impacted waters.

A number of options for As-Fe-SO₄ impacted waters were assessed for OceanaGold's Globe Progress Mine (bioreactors and vertical flow reactors) (Hayton et al., 2022). The bioreactors included 4 different substrates:

- B-LC: Biosolids with less compost.
- M-LC: mussel shells with less compost.
- B-MC: biosolids with more compost.

- M-MC: mussel shells with more compost.

Data (Hayton et al., 2022) indicated that for a hydraulic residence time (HRT) of 50 hours there was a significant reduction in As in mine-impacted waters. The bioreactors were fed water from the sites combined underdrains (median chemistry: 28.5 mg Fe/L, 1.7 mg As/L and 425 mg SO₄/L). Results are shown graphically in Figure 16 and Figure 17.

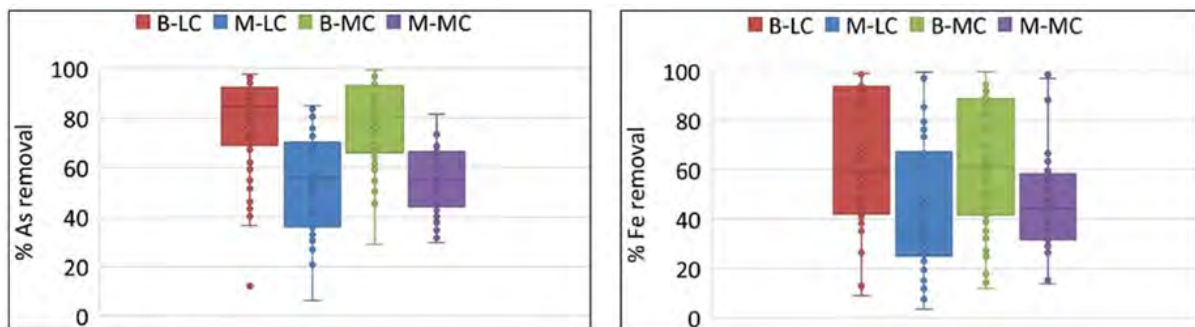


Figure 16. Globe Progress field trials

Percentage removal for As and Fe. B-LC: Biosolids with less compost, M-LC: mussel shells with less compost, B-MC: biosolids with more compost, and M-MC: mussel shells with more compost.

Sources: Hayton et al. (2022).

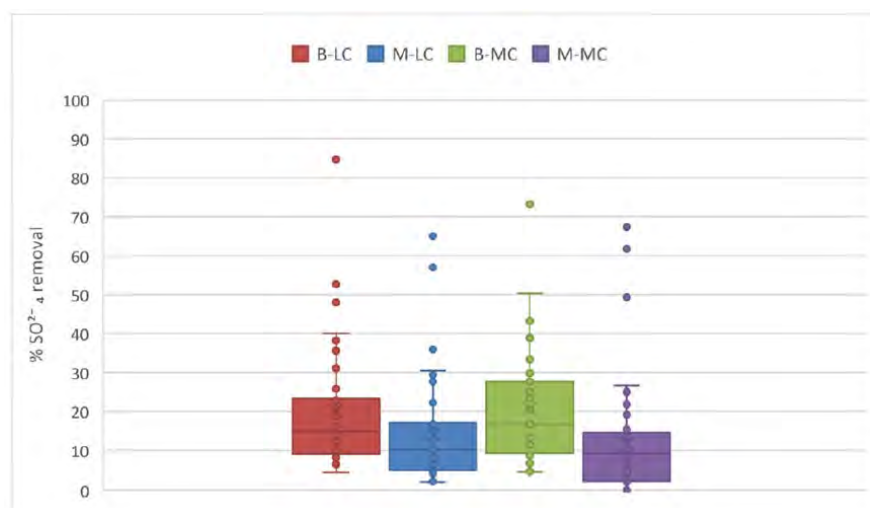


Figure 17. Globe Progress field trials

Percentage removal for sulfate. B-LC: Biosolids with less compost, M-LC: mussel shells with less compost, B-MC: biosolids with more compost, and M-MC: mussel shells with more compost. Source: Hayton (2020).

9.4.2 Enhanced Passive Treatment Systems of MIW

Enhanced passive treatment systems (E-PTS) are bioreactors that are enhanced by the addition of nutrients to passive bioreactors to increase the rates of water treatment (Christenson et al., 2022). Nutrient addition (e.g., liquid carbon) was undertaken on laboratory bioreactors, to test contaminant removal rates with varying substrates, temperatures, HRT and nutrient addition rates, in order to optimise parameter selection for field trials.

Trial results indicated that the SO₄ removal rates observed in the laboratory trials were more than 25 times higher than those of standard passive bioreactors, which typically remove 0.3 mol/m³/day of SO₄ from mine water (Figure 18). The highest SO₄ removal rates observed were 15 mol/m³/day and the SO₄

removal rates consistently exceeded 7 mol/m³/day (Christenson et al., 2022). It was noted that sulfide, dissolve organic carbon, and ammoniacal nitrogen could be elevated.

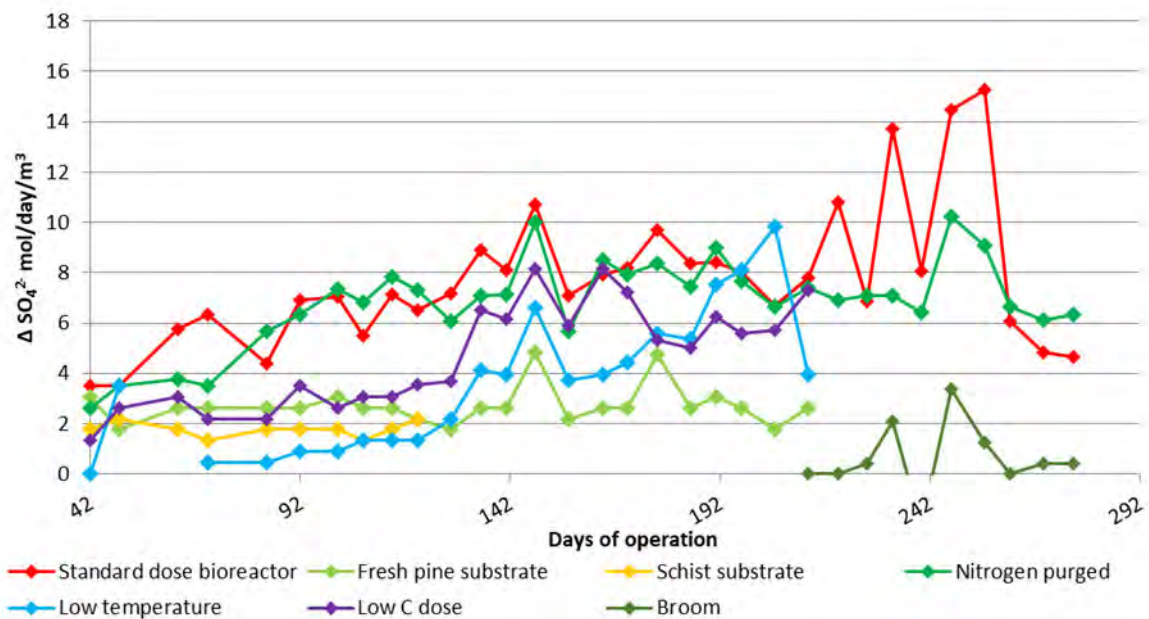
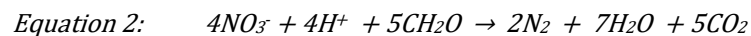


Figure 18. E-PTS bioreactor effluent sulfate concentrations.

Source: Christenson et al. (2022).

E-PTS have also been investigated as an option to treat nitrate-rich waters (e.g., Christenson et al., 2018) using nitrate-reducing bacteria (NRB) and water-soluble carbon compounds:



NRB have been used in woodchip bioreactors to successfully reduce nitrate concentrations in agricultural and other enriched waters (Christianson et al., 2017). Similar systems could also be applied to nitrate rich MIW resulting from the use of nitrogen-based explosives. Results demonstrated a significant decrease in nitrate concentrations compared to the influent water quality (Figure 19).

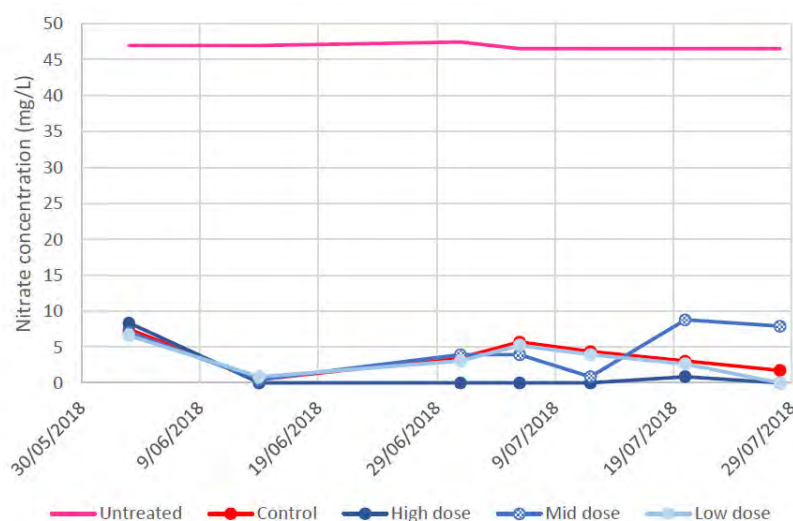


Figure 19. Nitrate treatment concentrations in the laboratory reactor effluent.

Source: Christenson et al. (2018).

9.5 Secondary Contaminants

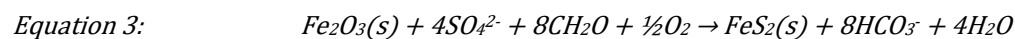
A polishing pond is required to remove secondary contaminants generated in the anaerobic treatment stage. This is likely to include low oxygen waters elevated in secondary contaminants such as sulfide (HS^-) and ammoniacal nitrogen. Sulfide and ammoniacal nitrogen have been identified in passive treatment systems by odour for hydrogen sulfide and by water measurement for ammoniacal nitrogen (e.g., Crombie et al., 2011). The generation of HS^- can also potentially generate health and safety issues due to H_2S gas. Several options are discussed to explain how these secondary contaminants can be removed.

9.5.1 Chemical Oxidation

Chemical oxidation is often used when mechanical aeration or passive technologies are not possible or practical. Chemical oxidants include, for instance: chlorine, hydrogen peroxide (H_2O_2), sodium hypochlorite (NaClO : e.g., household bleach), calcium hypochlorite ($\text{Ca}(\text{ClO})_2$), and potassium permanganate (KMnO_4).

9.5.2 Zero Valent Iron

Elevated sulfide can create ecotoxicity issues in waters affected by MIW. However, the sulfide readily combines with metals (often Fe) to form acid volatile sulfides, precursors to the formation of pyrite / marcasite, which can remove the sulfide from solution:



Iron-based compounds have been used previously for the removal of sulfide by precipitation, which can include zero valent iron (ZVI) materials such as scrap iron. Robinson et al. (2022) used sulfide scrubber (SCR) technology that involved the use of magnetite, hematite, and iron filings:



Results (Robinson et al., 2022) indicated that the effluent from the SCR systems contained concentrations of sulfide that were lower than the other passive treatment systems using organic matter and limestone by orders of magnitude (Figure 20).

Other research has noted that the use of ZVI led to minimal levels of toxic hydrogen sulfide in the treated effluent due to its efficient precipitation of sulfide as metal sulfides, which included Fe-sulfides generated by the anoxic corrosion of ZVI (Ayala-Parra et al., 2016).

Liao et al. (2022) notes that metal sulfide precipitation is a common method to treat sulfide-containing wastewater that allows rapid precipitation of the sulfide salt and selective precipitation of heavy metals, and that zinc is commonly chosen as precipitation agent to recover sulfide due to its higher chemical stability compared to other transition metals.

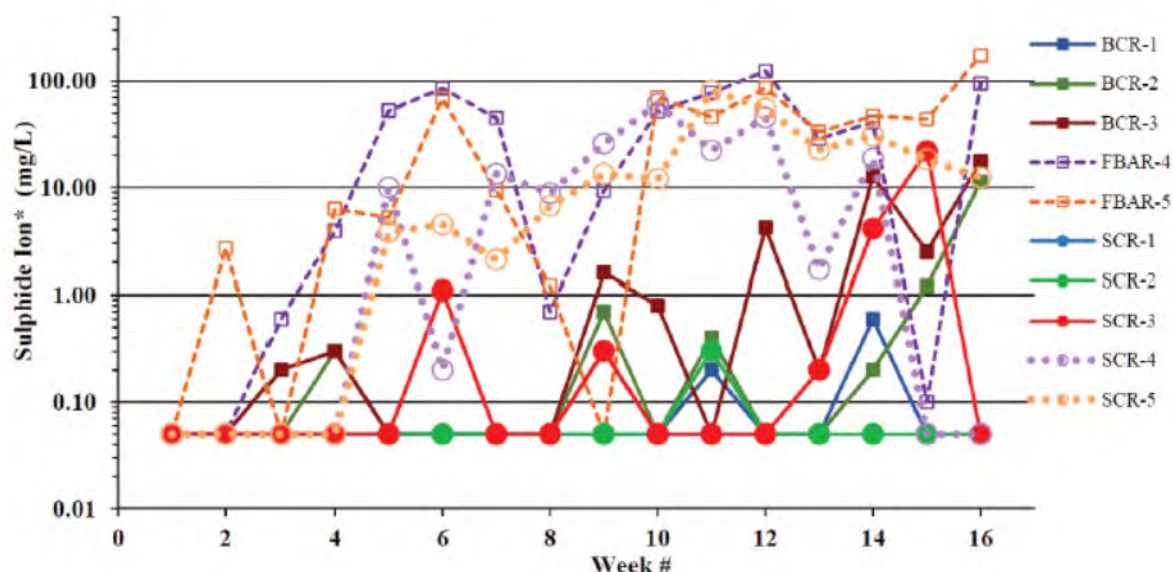


Figure 20. Sulfide concentrations following treatment.

Biochemical reactors (BCR); fixed-bed anaerobic bioreactors (FBAR) and Sulfide Scrubber (SCR) systems.

Source: Robinson et al (2022).

This sulfide precipitation approach could be applied to the effluent of a bioreactor. Ideally this would be undertaken prior to any oxidation step to encourage Fe-sulfide precipitation under reducing conditions. This could be incorporated as multi-step treatment approach whereby a scrubber system is used after an anaerobic treatment process. Materials could include iron fillings, waste galvanised steel, and possible Fe-rich sludge mixed with gravel to provide suitable permeability.

9.5.3 Adsorbents

There are various materials that are frequently employed as adsorbents to treat waters impacted by contaminants, including zeolites, clay minerals, activated carbon, and polymers (e.g., hydrogels). Zeolite was selected for this review as a suitable adsorbent material that may be suitable for the BOGP PTS.

Zeolite is a naturally occurring hydrated aluminosilicate mineral with a negative charge. The negative charge allows for the adsorption of certain positively charged ions. In aqueous solution, the negative charge is generally neutralized by Na^+ , however, NH_4^+ is preferentially adsorbed to the zeolite matrix. Zeolite has been used for decades to decrease the concentrations of ammonium in municipal effluents and, more recently, in freshwater environments (Burgess et al., 2004). Removal mechanisms include ion exchange and adsorption (Guida et al., 2020).

Zeolite materials are available in New Zealand (e.g., Blue Pacific Minerals) and are commonly used as kitty litter.

9.6 Passive Treatment System Efficiencies

This section reviews the treatment efficiency of passive treatment systems. The efficiencies are included in the WLBM to determine estimated water quality after PTS.

9.6.1 Arsenic and Iron Treatment Efficiency

Hayton et al. (2022) reports that a vertical flow reactor removed 95% of arsenic and 99% of iron, although when the hydraulic residence time (HRT) was lower the removal efficiency decreased to 75% and 84% respectively.

Other studies (Raven et al., 1998) indicate that Adsorption maxima of approximately 0.60 (0.58) and 0.25 (0.16) molAs.molFe⁻¹ were achieved for arsenite and arsenate, respectively, at pH 4.6 (pH 9.2 in parentheses). For passive treatment purposes a removal efficiency of 99% is used.

Zhang et al. (2022) indicates that Fe oxyhydroxides can also be used to remove vanadium with studies indicating removal efficiencies of 84 – 92%. A nominal value of 90% has been used as the treatment efficiency within the WLBM.

9.6.2 Sulfate Treatment Efficiency

It is proposed that a sulfate treatment efficiency of 30% is applied to mine-impacted waters treated by passive anaerobic treatment systems. This efficiency is in alignment with recent literature reviews of field-scale bioremediation systems. For instance, Zak et al. (2021) noted that bioremediation systems (BIOS) can achieve a variable range of sulfate removal efficiencies (Figure 21). Analysis of these data indicate that the average treatment removal efficiency is 30.7% for sulfate influent concentrations that range from 2.5 to 8,000 mg/L. Such sulfate ranges are within the bounds expected at BOGP.

The efficiency proposed will require validation through large scale field trials. The efficiency is applied to passive treatment systems in the WLBM.

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Table 2

Performance of field-scale bioremediation systems. CS=Composite System. CW=Constructed Wetland. SF=Surface Flow. SSF=Sub-Surface Flow. PRB=Permeable Reactive Barrier. *—refers to the cell of CS performing under anaerobic conditions. **=Water temperature reported in the studies. References: 1. Barton and Karathanasis (1999); 2. Hedin (2008); 3. Ji et al. (2008); 4. Di Luca et al. (2011); 5. Mitsch and Wise (1998); 6. Morrison and Aplin (2009); 7. Wieder (1993); 8. Wouids and Ngwenya (2004); 9. Wu et al. (2011); 10. Wu et al. (2012); 11. Benner et al. (2002); 12. Gibert et al. (2013); 13. Herbert et al. (2000); 14. Benner et al. (1999); 15. Caraballo et al. (2011); 16. Song et al. (2012); 17. Behum et al. (2011); 18. Matthies et al. (2012).

Reference	Type	Area/Volume (m ² /m ³)	Duration (y)	Plants	pH	T ^a (°C)/Climate	Substrate	SO ₄ ²⁻ inflow (mg L ⁻¹)	SO ₄ ²⁻ removal (%)
1	CS/SSF*	1,022/705	1.5	Yes*	3.4	Temperate, USA	Limestone/ Organic*	3034	53.5
2	CS/SF*	49,000/—	2		6.2	Temperate, USA		1085	5.6
3	CS	—/—			2.1–7.7	Temperate/South Korea		2.5–3046	0–62
4	CW/SF	2,000/900	1	Yes	9–10	12.8–27**		270–1649	24–66
5	CW/SF/ SSF	3,869/3,757	1	Yes	3	Temperate, USA	Limestone/ Organic	1672	29
6	CW/SF	440/132	3	Yes	5.6–6.7	5.9–15.8**	Organic	355–969	15–25
7	CW/SF	180/54	2	Yes	2.9	Temperate, USA	Limestone/Peat	3132	0–14
8	CW/SF	—/—	0.5	Yes	2.6	Temperate, Scotland	Limestone/ Organic	900	17–18
9	CW/SSF	6/3	0.7	Yes		Temperate, Germany	Sand/Gravel	283.1	7
10	CW/SSF	6/3	6	Yes	6.7	Temperate, Germany	Sand/Gravel	790–995	32–54
10	CW/SSF	6/3	6	No	6.7	Temperate, Germany	Sand/Gravel	790–995	12–0
11	PRB	60/216	4	No	5–6	Continental, Canada	Gravel/Organic	2304–2880	13–50
12	PRB	154/580	3	No	3.5–4.5	Temperate, Spain	Calcite/Organic/ Fe	1000	2–43
13	PRB	60/216	2	No	4.6	Continental, Canada	Gravel/Organic	2400–8000	70
14	PRB	60/216	2	No	4–6	Continental, Canada	Gravel/Organic	1000–5000	74
15	Bioreactor	120/—	1.8	No	2.6	16.8–22.2**	Limestone/ Organic	900	20–40
16	Bioreactor	—/0.0035	0.5	No	3–4	Temperate, South Korea	Organic	1277	20–48
17	Bioreactor	/5,887	3	No	2–3	Temperate, USA	Limestone/ Organic	up to 4100	30
18	Bioreactor	1,511;1,124/ 1,209;899	6	No	5.8; 5.0	Temperate, UK	Limestone/ Organic	369/1074	13–40

Figure 21. Performance of field-scale bioremediation systems for sulfate removal.

Source: Zak et al., 2021.

Note: where a range is provided, half the range is used to determine treatment efficiency

9.6.3 Nitrogen Treatment Efficiency

Nitrogenous compounds (e.g., nitrate) will be treated through the anaerobic passive treatment system. It is removed in preference to sulfate due to the higher energy yield (Figure 14) and nitrate is expected to be low after anaerobic treatment (although ammoniacal nitrogen is expected to increase and will be treated as a secondary contaminant. Christensen (2022) using enhanced PTS technologies (e.g., the addition of water soluble carbon) reports that near-complete nitrate removal occurred in all bioreactors (17 mg/L influent to <0.5 mg/L effluent $\text{NO}_3\text{-N}$) yet ammoniacal nitrogen was elevated in some trials and above proposed water quality limits for the BOGP (Table 3). These data are provided in Figure 22 and Figure 23.

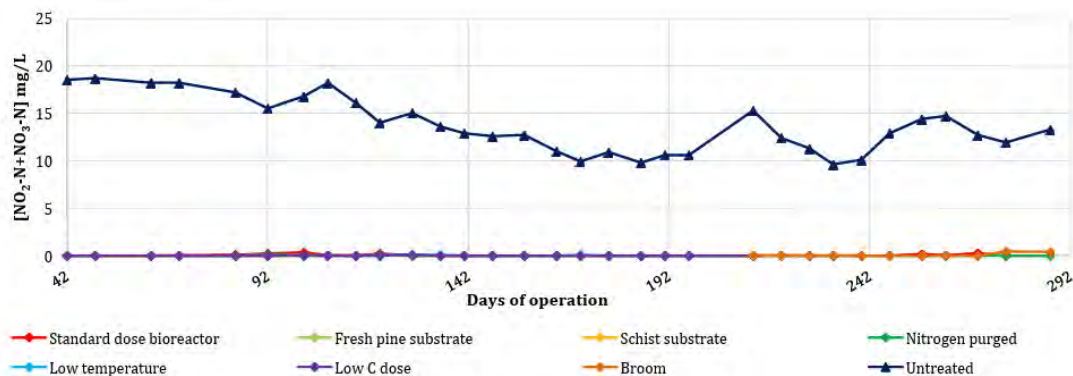


Figure 22. Nitrate + nitrite nitrogen concentration in the bioreactor effluents.

Source: Christensen et al. (2022)

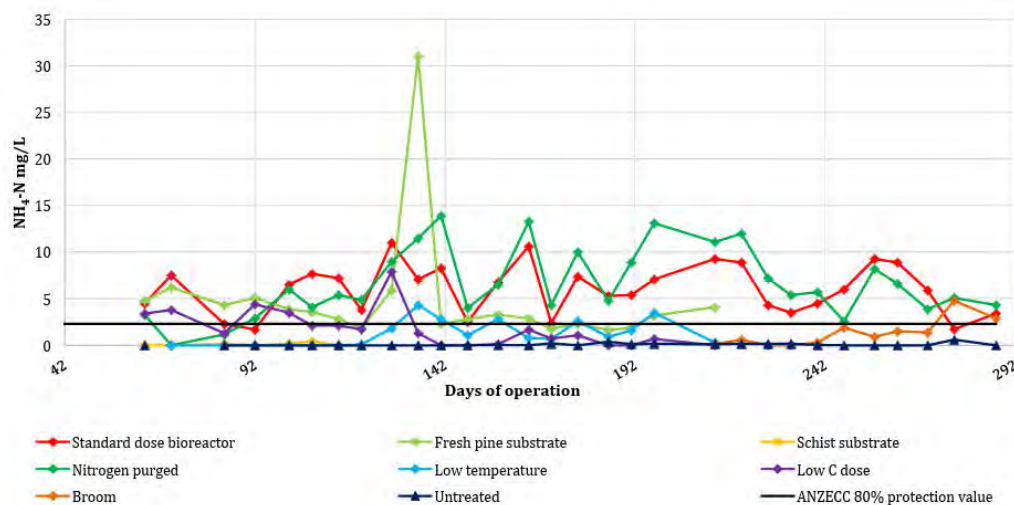


Figure 23. Ammoniacal nitrogen concentration in bioreactor effluents.

Source: Christensen et al. (2022)

For this review, it is assumed that nitrate nitrogen will be totally removed by passive treatment and that 50% of the influent is converted to ammoniacal nitrogen. Ammoniacal nitrogen will be treated by aeration and biological conversion to N_2 gas.

9.6.4 Metals

Various passive treatment systems have been installed in New Zealand, some of which use waste mussel shells (e.g., Weber et al., 2015). Trumm et al. (2022) reports that the removal efficiencies of a

mussel shell bioreactor (MSR) for acid rock drainage were 91.4% (Fe), 97.6% (Al), 83.3% (Zn), 85.6% (Cd), 85.2% (Co), 85.6% (Cu), and 87.0% (Ni). This is comparable to other studies for the treatment of acid rock drainage where Crombie et al. (2011) reports the removal of 96-99% of Al, Fe, Ni, and Zn with mean Ni decreasing from 0.27 mg/L to 0.0028 mg/L and mean Zn decreasing from 1.18 mg/L to 0.008 mg/L. Sinclair and Weber (2022) note that within a MSR treating circum-neutral MIW that (based on median data) 99% of the Fe; 98% of the Ni, and 99.8% of the Zn was removed. However, only 40% of the Al was removed (from 0.005 to 0.003 mg/L), but this is likely to be a function of the very low Al concentration.

Generally, these systems work well for metals that can be reprecipitated as sulfides or hydrolyse as the pH increases through the treatment system. The dataset provided by Sinclair and Weber (2002) was selected to derive metal removal efficiencies for the WLBM. This dataset was selected for the following reasons:

- Circum-neutral drainage that will be comparable to the BOGP MIW.
- Low metal loads, although iron is moderately elevated (as is expected at BOGP).
- A robust dataset provided over many months of operation.

Where the metal removal efficiencies could not be determined from Sinclair and Weber (2022) as the contaminants were below the limit of reporting (e.g., Cd, Cr, Cu, Pb) it is assumed they would be removed by similar mechanisms. As shown in Figure 11, these metals are also removed by anaerobic passive treatment systems and removal efficiency of 99% was applied. This will require validation by lab and field trials.

Table 9. MSR Treatment Efficiencies

PARAMETER	REMOVAL EFFICIENCIES (%)
Calcium ¹	-43.2 ¹
Magnesium	8
Aluminium	83.3 ²
Iron	99.1
Nickel	97.9
Zinc	99.8
Manganese	86.4
Cadmium	85.2 ³
Cobalt	98.4
Copper	85.6 ³
Uranium	74 ³
Vanadium	90 ⁴
Other metals	98 ⁵

1. - Negative numbers indicate an increase (e.g., an increase in Ca indicates minor dissolution of the shells).

2. - Data taken from Trumm et al. (2022). This is considered to be more reasonable due to the very low Al concentrations in the treated water assessed by Sinclair and Weber (2022).

3. - Data from Trumm et al. (2024).

4. - Zhang et al. (2022).

5. - Assumed to be comparable to other metals. Further laboratory and field work is required.

10 FURTHER WORK

Further work is required to advance the WTP and PTS studies towards a FS level to confirm technology suitability, costs, and management requirements prior to the systems being installed. Further work should be undertaken once MIW is available from the project area as this will help with water treatability trials. The following section summarises the work that needs to be undertaken.

10.1 Transition to the Post Closure Phase

Modelling (MWM, 2025c) indicates that the transition from active to passive treatment in the Shepherds Creek catchment could occur within 50 years of the cessation of mining. The transition point is a function of:

- Cover system performance (e.g., NP being 20% of rainfall).
- Flow rate and quality.
- PTS treatment efficiency.
- Dilution within Shepherds Creek and Bendigo Creek catchments
- Dilution within the downgradient alluvial aquifers.

Active treatment is not required in the Rise and Shine Creek catchment with partial treatment of the SRX Pit Lake overflow being required. Modelling was based on treatment of the average flow (8 L/s).

10.2 Active Water Treatment Plant

Process Flow indicate that the proposed water quality objectives (Ryder, 2025) can be achieved, although further work is required to develop the OoM study to a feasibility study level. Further details are provided in Appendix B. The WTP will operate until passive treatment systems can be installed.

The WLBM (MWM, 2025c) assumes the water is treated and meets the proposed water quality objectives.

10.3 Passive Treatment System

Trials should be undertaken using BOGP site specific MIW, prior to the site transitioning from active to passive treatment, to assess the treatability of waters by:

- Oxidation to encourage $\text{Fe}(\text{OH})_3$ precipitation and adsorption of metals such as As, V, and other trace metals.
- Anaerobic treatment to remove nitrate, reduce sulfate concentrations, and precipitate metals as sulfides.
- A polishing pond to remove secondary contaminants generated in the anaerobic treatment stage (e.g., hydrogen sulfide (HS^-), ammoniacal nitrogen, and low dissolved oxygen).

The technology development pathway should include:

- Bench-scale trials to validate OoM study assumptions.

- Site-based pilot trials (PFS⁶).
- Operational trials (FS).

For the WLBM the following efficiencies (Table 11) are proposed to understand effects to the receiving environment. These will require validation once mining commences, and MIW is available for trials. Data highlighted in Yellow have lower confidence and further work is needed to confirm the passive treatment systems will be appropriate.

Table 10. PTS Treatment Efficiencies

PARAMETER	REMOVAL EFFICIENCIES ¹
Calcium ¹	-43.2%
Magnesium ¹	8%
Aluminium	83.3%
Arsenic	99% ²
Iron	99.1%
Nickel	97.9%
Zinc	99.8%
Manganese	86.4%
Cobalt	98.4%
Uranium	74% ³
Vanadium	90% ⁸
Other metals	98% ⁴
Sulfate	30% ⁵
Nitrate nitrogen	99% ⁶
Ammoniacal nitrogen	99% ⁶
Cyanide	90% ⁷

1. – where data are taken from Table 10 for MSR and limestone of some form is assumed to be part of the treatment media.

2. – where data are taken from Hayton et al. (2022) = 95% removal with additional Fe to increase As removal to 99% (e.g., Raven et al., 1998).

3. – where data are obtained from Trumm et al. (2024).

4. – where data are assumed to be comparable to other metals removed by a MSR (Table 10).

5. – Based on 30% removal as determined from literature (Figure 21).

6. – Assumed to be 99% to be in alignment with nitrate removal efficiencies. Further work is required.

7. – Based on studies by Álvarez et al. (2004). Further work is required.

8. – Zhang et al. (2022).

⁶ Prefeasibility Study

11 REFERENCES

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12 LIMITATIONS

Attention is drawn to the document “Limitations”, which is included in Appendix C of this report. The statements presented in this document are intended to provide advice on what the realistic expectations of this report should be, and to present recommendations on how to minimise the risks associated with this project. The document is not intended to reduce the level of responsibility accepted by Mine Waste Management, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in doing so.

APPENDIX A ABBREVIATIONS

ABBREVIATION	DEFINITION
AMD	Acid and metalliferous drainage, which can also include low metal saline drainage
BIOS	Bioremediation systems
BOGP	Bendigo-Ophir Gold Project
CIT	Come in Time deposit
Eh	Oxidation-reduction potential
E-PTS	Enhanced passive treatment system
ELF	Engineered landform
FS	Feasibility study
HRT	Hydraulic residence time
MGL	Matakanui Gold Limited
MIW	Mine impacted water
MSR	Mussel shell reactor
MWM	Mine Waste Management Ltd
NAF	Non-acid forming
NMD	Neutral and metalliferous drainage
NP	Net percolation
NRB	Nitrate-reducing bacteria
OoM	Order of magnitude
PCOC	Potential constituents of concern
PTS	Passive treatment system
RAS	Rise and Shine deposit
RSSZ	Rise and Shine Shear Zone
SCR	Sulfide scrubber
SCK Fill	Shepherds Creek fill
SRE	Srex East deposit
SRX	Srex deposit
TSS	Total suspended solids
TSF	Tailings storage facility
TZ3	Lower Greenschist facies Textural Zone 3 rocks of the Otago Schist
TZ4	Upper Greenschist facies Textural Zone 4 rocks of the Otago Schist
VFR	Vertical flow reactor
WELM	West engineered landform
WLBM	Water and Load Balance Model

ABBREVIATION	DEFINITION
WTP	Water treatment plant
ZVI	Zero valent iron

APPENDIX B WTP OoM DESIGN REPORT

BOGP Post Closure Active Water Treatment Plant (WTP)

Order of Magnitude (Oom) Study

Prepared For:	Matakanui Gold Limited
Prepared By:	Process Flow
Date:	9/10/2025
Document Number:	PFL-2426-PRJ-RPT-00001



Revision Control

Revision	Status	Description	Author	Checked	Approved	Date
A	Draft	Issued for Client Comment	G Smith	E Manhart		12/05/2025
B	Draft Client Review	Issued for Client Review	E Manhart	G Smith		26/05/2025
0	Use	Issued for Use	E Manhart	G Smith	G Smith	16/06/2025
1	Use	Revised Flow Rates	E Manhart	G Smith	G Smith	28/09/2025
2	Use	Revised Tables	G Smith	G Smith		2/10/2025
3	Use	Revised following client comments	E Manhart	G Smith	G Smith	9/10/2025

EXECUTIVE SUMMARY

This report provides an order of magnitude assessment of the water treatment requirements following BOGP mine closure. During the mine closure phase, water treatment will be required by an active Water Treatment Plant (WTP) for years eleven to thirty-one. There are three water management stages during the project.

- Internal water management during the operations phase
- Active water treatment post closure (Summarised in this report)
- Passive water treatment within decades of the mining cessation

This report details the recommended process requirements for an active WTP with the capacity to treat an average flow of 26.9 l/sec.

Potential constituents of concern (PCOC) have been identified for the BOGP based on baseline water quality studies, environmental geochemistry studies, and proposed water quality compliance limits: It is expected that mining of the BOGP will affect waters within the project area, and these effects will include:

- Elevated total suspended solids (TSS) in surface waters.
- Neutral metalliferous drainage (NMD) that may have elevated PCOC such as arsenic (As), Sulphate (SO₄), and trace metals.
- Nitrate-rich drainage due to the use of ANFO.

Following a review of predicted water quality and a literature review of available treatment processes, and the suitability of these processes to remove the PCOCs, an Ettringite precipitation process is recommended.

Known commercial chemical precipitation sulphate removal processes include the SAVMIN process, the CESR (Cost effective Sulphate removal Process) and the Outotec (now Metso) Ettringite process.

The available treatment processes for Ettringite precipitation have been developed for Sulphate concentrations above 2000mg/l, which indicate performance removal of sulphate to 200-100mg/l. (Within the proposed consent limits for surface and ground waters).

Ettringite formation can also provide a polishing effect, allowing precipitation of metals, Ni, Cd, Cu, Zn, Cr, As and Se, often below their compliance limits and laboratory detection limits. Boron, fluoride and up to 30% of chloride and nitrate-nitrite in wastewater have also been removed (Reinsel 1999)

During the operations phase of the project and prior to detailed design of the active WTP it is highly recommended that detailed testing of the actual BOGP water quality take place. This testing should simulate each of the required precipitation steps which would give real data to present and reference for final water quality. This would also give certainty about the effectiveness of the treatment process on the BOGP proposed mine water quality and assurance that the water treatment system will achieve the final water quality and cater for final flow rates.

From the water quality and literature review, the proposed sulphate and metals removal processes will have several sludge management streams with different product outputs, some which will need disposal either on site or off site and some that could be recycled or form a product for export off site.

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1 INTRODUCTION

Process Flow Limited (PFL) has been engaged by Matakanui Gold Limited (MGL) to provide guidance on water treatment for Mine Impacted Water (MIW) for the proposed Bendigo-Ophir Gold Project (BOGP).

Input water quality data used in this study has been referenced from J-NZ0464-002-R-Rev1 Report on Water Treatment requirements by Mine Waste Management, dated 7 October 2025.

The MWM water and load balance model (WLBm) indicates that the BOGP needs to focus on the management and treatment of MIW that will contain potential constituents of concern (PCOC).

The following PCOC may require treatment by the WTP and PTS to achieve the proposed water quality limits for the BOGP (Ryder, 2025):

- Nitrogenous compounds (N) that include nitrate (NO₃) and ammoniacal-N (Amm-N).
- Sulfate (SO₄).
- Metals and metalloids that may include Aluminium (Al), arsenic (As), cadmium (Cd), cobalt (Co), copper (Cu), chromium (Cr), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), strontium (Sr), uranium (U), and zinc (Zn)
- Cyanide (CN) within the tailings water.

Our work specifically involves carrying out an order of magnitude (OoM) study for:

- Treatment of MIW by a WTP during the active closure phase, until the PTS can be successfully established (~ 50 years after closure).

1.1 Project Description

This section provides an introduction to the BOGP.

1.2 Introduction

MGL is proposing to establish the BOGP (Figure 1), which comprises gold mining operations, processing operations, ancillary facilities and environmental mitigation measures on Bendigo and Ardour Stations in the Dunstan Mountains of Central Otago. The project site is located approximately 20 km north of Cromwell and will have a maximum disturbance footprint of 550 hectares.

The total Mineral Resource Estimate for the BOGP using a 0.5 g/t cut-off for open pit and 1.5 g/t for underground is 34.3 Mt at 2.1 g/t for 2.34 M oz (MGL, 2025). The Bendigo-Ophir resources occur in four deposits: Come in Time (CIT), Rise and Shine (RAS), Srex (SRX), Srex East (SRE). The majority of identified mineral resources are located within the RAS deposit. Three primary geological units are recognised at site:

- RSSZ – Rise and Shine Shear Zone
- TZ3 – Lower Greenschist facies Textural Zone 3 rocks of the Otago Schist
- TZ4 – Upper Greenschist facies Textural Zone 4 rocks of the Otago Schist

The resources will be mined by open pit methods at each deposit within the project site, with underground mining methods also proposed to be utilised at RAS to access the deeper gold deposits. The majority of the mining activities, ancillary facilities and associated infrastructure will be located in the Shepherds Valley with non-operational infrastructure located on the adjoining Ardgour Terrace. The BOGP also involves the taking of groundwater from the Bendigo Aquifer for use in mining-related activities and the realignment of Thomson Gorge Road via Ardgour Station.

The following mine facilities are proposed (Figure 2):

- Open pits targeting the RAS, SRX, SRE, and CIT deposits.
- An underground mine targeting the RAS deposit.
- Three ex-pit engineered landforms (ELFs) – Shepherds ELF, SRX ELF, and West ELF (WELF).
- Two in-pit landforms (backfill) – CIT and SRE¹.
- Plant and processing area, where CIL extraction technologies will be used as part of the ore recovery process.
- A tailings storage facility (TSF) and TSF Embankment.
- Other ancillary support services / structures (e.g., roads, water management infrastructure, water treatment plants, etc).

These facilities will be placed in the catchment of Shepherds and Bendigo creeks. Understanding baseline water quality (surface and groundwater) is important to enable the establishment of site-specific water quality compliance criteria for any resource consent that may be granted in the future.

¹ Note: SRE Pit is backfilled by the SRX ELF.

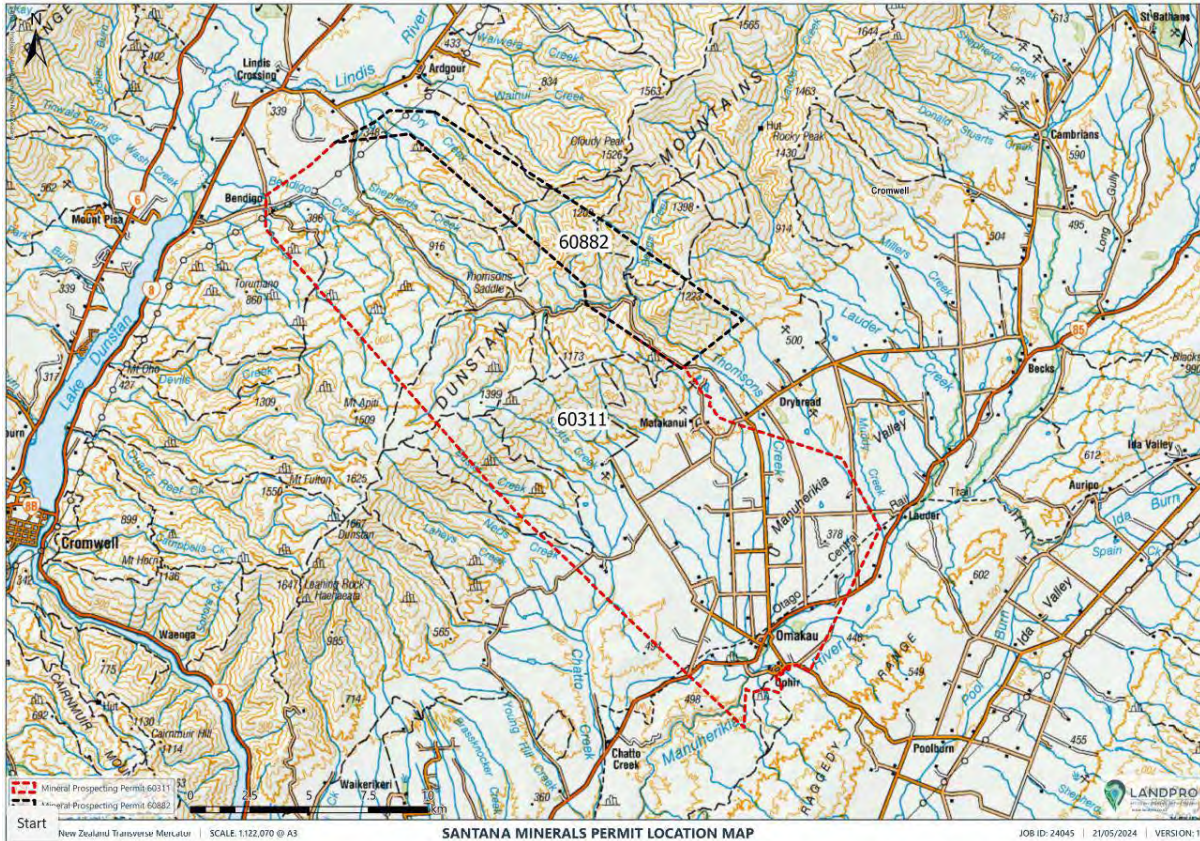


Figure 1. BOGP mineral permit boundaries showing MEP60311 and PEP60882.

1.3 Surface Water

The project area covers several catchments and sub-catchments (Figure 2), including:

- **Shepherds Creek:** This creek runs permanently through the project area and then intermittently from the Ardour Terrace towards the Lindis River. An irrigation water-take on Shepherds Creek (RM17.301.15) downstream of SC01 monitoring site takes all available surface water in normal flow conditions, which is supplied to an irrigation dam, so the creek does not flow past this point. There is potential for groundwater to flow past this point via a thin layer of alluvial gravels along the creek bed.
- **Jean Creek:** This creek is an intermittent tributary to Shepherds Creek.
- **Rise and Shine Creek:** This creek joins Clearwater Creek south-east of the Come in Time Battery and flows into Bendigo Creek.
- **Clearwater Creek:** Flows into Bendigo Creek.
- **Bendigo Creek:** Several irrigation water-takes are in place on this creek (RM20.079.01 and RM20.079.02).

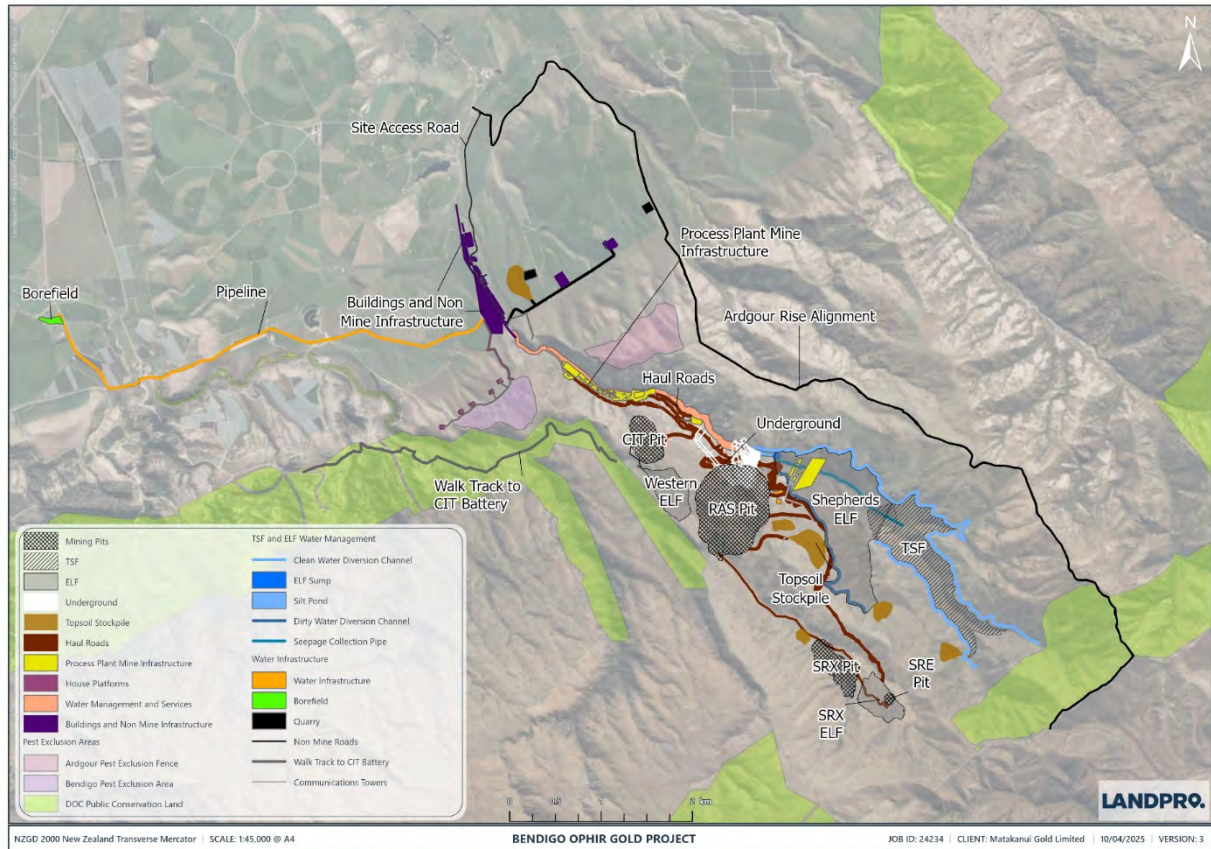


Figure 2. Bendigo-Ophir Gold Project area and water quality monitoring sites.

Baseline water quality data indicates that PCOC are elevated in the BOGP area due to historic mining activities and natural mineralisation. (MWM J-NZ0464-002-R-Rev1)

2 DISCLAIMER

This report provides information that is preliminary in nature and has been prepared to provide the client with water treatment information suitable for an “Order of Magnitude” assessment for the overall project. The information provided is not suitable for detailed design or construction purposes and the information should not be used as a specification for tendering or any other construction related purpose.

This report has been prepared solely for the benefit of Matakanaui Gold Limited. No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other person/parties.

This disclaimer shall apply notwithstanding that the memo may be made available to other persons for an application for permission or approval or to fulfil a legal requirement.

This report has been prepared for the particular purpose outlined in the Process Flow Proposal and no responsibility is accepted for the use of this Document, in whole or in part, in other contexts or for any other purpose.

Any assessments made in this report are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this memo.

Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Process Flow Limited for incomplete or inaccurate data supplied by others.

Process Flow acknowledges that this report will be relied on by a Panel appointed under the Fast Track Approvals Act 2024 and these disclaimers do not prevent that reliance.

The information presented in this report is based on a literature review of known water treatment process technologies for primarily sulphate and metals removal. The information presented is preliminary, and test-work should be carried during the mining phase of the project (prior to active closure) to confirm design assumptions and prove final water qualities can be achieved for the flows required.

3 PROCESS OBJECTIVES AND ASSUMPTIONS

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3.2 Process Objectives

During the Active Closure Phase, water treatment is required by a water treatment plant (WTP) once the project switches from a process of internal water management for MIW (during operations) to discharge of MIW from site after closure of the mine. Model results indicate that the WTP can be replaced by a passive treatment system (PTS) within decades of mining cessation, which then defines the commencement of the Post Closure Phase.

3.3 Definition of Plant Flow Rates

This section summarises the long-term average flow rates for each mine domain that may require treatment during the Active Closure and Post Closure phases of the BOGP.

3.3.1 Average Flow Rates

Average flow rates are estimated from the Water and Load Balance Model. It is assumed that the use of average flow rates is suitable for the WTP OoM Study and the PTS Concept Study. Peak flows may require either a larger capacity plant or a surge pond prior to any treatment. Further work is required to advance the designs to a feasibility Study (FS) level including understanding the treatment requirements for peak flow rates.

Table 1 provides a summary of flow rates for the various mine domains that require treatment. These flow rates are preliminary and are intended to provide guidance for the OoM study on the WTP design. For the OoM WTP Study it is recommended that the design include suitable contingency for variable flow rates. Active treatment is not required for SRX Pit - It is expected that the water quality from this mine domain will be acceptable for release to the receiving environment (e.g., Rise and Shine Creek / Bendigo Creek) with passive treatment.

Table 1: Estimated average water quantity per mine domain.

MINE DOMAIN	WTP DESIGN CRITERIA (L/s)	PTS (L/s)	COMMENTS
Shepherds ELF	4	4	• 20% Net percolation
SRX ELF ^{1, 2}	-	1	• 20% Net percolation
West ELF ²	1	1	• 20% Net percolation
Shepherds TSF	13.4	3	• Flow is expected to be ~13.4 L/s decreasing to 3 L/s after 5 years
RAS Underground Portal	6	6	• Flow from the RAS Underground is not expected for 20-30 years after closure
CIT Pit Backfill	1.5	1.5	• Further details are available in MWM J-NZ0464-002-R-Rev1
SRX Pit	-	8	• Further details are available in MWM J-NZ0464-002-R-Rev1. It is assumed this water will not require active

MINE DOMAIN	WTP DESIGN CRITERIA (L/s)	PTS (L/s)	COMMENTS
			treatment. Passive treatment is required.
SCK Fill ²	1	1	20% Net percolation
Non-AMD impacted water	-	-	Managed for TSS separate to the active WTP. At closure rehabilitated surfaces are assumed to be suitable for discharge with TSS management.

1. Active treatment for SRX ELF and SRX Pit are not anticipated.

2. Flow rates rounded up to 1 L/s

Table sourced from MWM J-NZ0464-002-R-Rev1

This results in an active water treatment plant with the capacity to treat an average flow of 26.9 l/sec.

3.4 Definition of Mine Water Quality (Plant Feed Envelope)

This section summarises the water quality from the various mine domains that require treatment at closure of the BOGP by the active water treatment plant. Peak concentrations are provided for the following streams

- Shepherds ELF
- West ELF
- Shepherds TSF
- RAS Underground Portal
- CIT Pit Backfill
- SCK Fill

3.4.1 Shepherds TSF Water Quality

TSF seepage water quality at mine closure (Year 11) is presented in Table 2. Further details on how the water quality was derived are provided in MWM J-NZ0464-002-R-Rev1

Constant concentration is assumed.

Table 2: TSF seepage water quality (Closure).

PARAMETER	CLOSURE TSF SEEPAGE WATER QUALITY
Alkalinity (mg CaCO ₃ /L)	73.21
pH (pH units)	6.41
EC (µS/cm)	4,121
Ca	297
Cl	804
F	1.93
Mg	99
Na	847
K	50.8
TOC	-

PARAMETER	CLOSURE TSF SEEPAGE WATER QUALITY
Al	0.01
Ag	0.0068
As	2.05
B	0.825
Cd	0.0002
Co	0.053
Cr	0.0055
Cu	0.001
Fe	15.3
Mn	0.59
Mo	0.14
Ni	0.678
Pb	0.0275
Sb	0.18
Se	0.003
Sr	4.4
Tl	0.001
U	0.028
V	0.004
Zn	0.0296
Cyanide - WAD	0.35
Sulfate	954
Ammoniacal-N	2
Nitrate-N	0.005

Note: All units in mg/L unless otherwise stated. **Green data** are LOR and are included in the source term as '0' WAD – Weakly Acid Dissociable cyanide; If no data are provided these are identified by '- '.

3.4.2 ELF and CIT Backfill Water Quality

Water quality for the ELFs is provided in Table 3, (Table sourced from MWM J-NZ0464-002-R-Rev1) which shows the water quality for Year 27, when maximum loads are being derived from the Shepherds ELF to provide peak concentration data for the design of the WTP.

Constant concentrations are assumed for As (0.2 mg/L) and Fe (7.6 mg/L) based on empirical data for sub-oxic conditions (e.g., Globe Progress Waste Rock Stack, Hayton et al., 2022). These concentrations are above the proposed water quality reference limit (Ryder, 2025) and will require management. The SCK Fill assumes full oxidation, which results in low Fe concentrations.

Table 3. Water Quality Data (Year 27) for WTP design – 20 m Oxygen Exclusion Model

STATION	TSF SEEPAGE	SHEPHERDS ELF SEEPAGE	WELF SEEPAGE	CIT PIT BACKFILL	SCK FILL SEEPAGE	MIW COMBINED*
Acidity	0.01	0	0	0	0	0.03
Al	0.011	0.003	0.003	0.005	0.003	0.013
Alkalinity	73	189	183	190	158	160
As	2.06	0.20	0.20	0.08	0.20	0.61

STATION	TSF SEEPAGE	SHEPHERDS ELF SEEPAGE	WELF SEEPAGE	CIT PIT BACKFILL	SCK FILL SEEPAGE	MIW COMBINED*
B	0.83	0.87	0.10	0.09	0.01	0.59
Ca	297	51	51	39	36	107
Cd	0.0002	0	0	0.0001	0	0.0001
Cl	806	63	37	12	8	223
Co	0.053	0.109	0.023	0.004	0.003	0.061
Cr	0.00636	0.00020	0.00019	0.00040	0.00007	0.00170
Cu	0.00100	0	0	0.00021	0	0.00049
DOC	0	0	0	0.206	0	0.038
F	1.94	6.30	6.12	1.39	2.37	3.90
Fe	15.3	7.6	7.6	2.4	7.6	8.7
Hg	0	0	0	0.00014	0.00000	0.00003
K	51	683	672	84	159	372
Mg	100	38	37	20	24	49
Mn	0.594	0.819	0.774	0.103	0.182	0.567
Mo	0.140	1.005	0.672	0.119	0.157	0.535
NO3-N	2.01	49.64	9.54	0.73	1.33	22.89
Na	848	922	734	127	170	673
Ni	0.6784	0.0121	0.0010	0.0013	0.0001	0.1652
Pb	0.0276	0.0001	0.0001	0.0002	0.0000	0.0068
Sb	0.1802	2.9986	3.2208	0.3622	0.7601	1.6317
Se	0.0030	0.1544	0.1649	0.0196	0.0388	0.0826
SO4	954	957	888	110	208	730
Sr	4.40	16.15	15.91	3.77	10.89	10.12
Tl	0	0	0	0.00021	0.00000	0.00005
CN	0.35	0	0	0	0	0.08238724
U	0.0280	0.2751	0.2225	0.0299	0.0515	0.1468
V	0.0040	0.1200	0.1155	0.0135	0.0269	0.0633
Zn	0.0296	0.0098	0.0021	0.0014	0.0003	0.0117
pH (pH unit)	6.41	7.93	7.92	8.03	7.92	6.72
Hardness	1,151	285	280	179	190	469

Units in mg/L *MIW Combined - This is a weighted average

3.4.3 RAS Underground Water Quality

As discussed in MWM J-NZ0464-002-R-Rev1 seepage from the RAS Underground will be comparable to the RAS Pit Lake. The RAS Underground is not expected to commence discharge until Year 26. Water Quality for Year 26 is provided in Table 4.

Table 4 RAS Underground water quality (Year 27)

PARAMETER	RAS UNDERGROUND
Acidity	0.44
Al	0.100
Alkalinity	182
As	0.09
B	0.05
Ca	59
Cd	0.0001
Cl	14
Co	0.000
Cr	0.00058
Cu	0.00302
DOC	0.090
F	0.23
Fe	7.9
Hg	0.00006
K	34
Mg	37
Mn	0.014
Mo	0.020
NO ₃ -N	4.35
Na	42
Ni	0.0009
Pb	0.0035
Sb	0.0234
Se	0.0008
SO ₄	141
Sr	0.79
Tl	0.00031
CN	0
U	0.0094
V	0.0006
Zn	0.0022
pH (pH unit)	5.91
Hardness	299

Units in mg/L

3.5 Discharge Water Requirements

PCOC that have been identified for the BOGP based on baseline water quality studies, environmental geochemistry studies, and proposed water quality compliance limits are shown in Table 3. Limits are based on:

- Ecotoxicity assessments developed by Ryder (2025) for the proposed surface water compliance sites
- Groundwater limits are based on New Zealand Drinking Water Standards (MoH, 2022).

The proposed compliance monitoring locations are shown in Figure 2 for surface waters and groundwaters.

For conceptual desk-top studies, it is proposed that the WTP and PTS design should be based on the more stringent water quality criteria (i.e., the lower compliance value) for surface and groundwaters to ensure that treated waters comply with both criteria.

These proposed water quality criteria for the BOGP (Ryder, 2025) are summarised in Table 5.

Table 5. Proposed Water Quality Compliance Limits for the BOGP

PARAMETER (UNITS ARE mg/L UNLESS STATED OTHERWISE)	SURFACE WATER RECOMMENDED COMPLIANCE LIMIT(S)	GROUNDWATER RECOMMENDED COMPLIANCE LIMIT(S)
pH (unitless)	6.5 - 9.0	-
Turbidity (NTU)	5 (over a 5-year rolling period, 80% of samples, when flows are at or below median flow, are to meet the limit)	-
Ammoniacal-nitrogen (NH ₃ -N)	≤0.24 (annual median) <0.4 (annual 95 th %) ¹	-
Nitrate-nitrogen (NO ₃ -N)	<2.4 (annual median) <3.5 (annual 95 th %)	11.3 (MAV) ²
Cyanide (CN ⁻)	0.011 (un-ionised HCN, measured as [CN], ANZG 2018) ¹	0.6 (MAV)
Sulfate (SO ₄ ²⁻)	• If hardness is <100 mg/L (CaCO₃), the sulfate compliance limit = 500 mg/L. • If chloride is <5 mg/L, the sulfate compliance limit = 500 mg/L. • If the hardness is 100–500 mg/L AND if chloride is 5–<25 mg/L, the sulfate compliance limit is (in mg/L): $[-57.478 + 5.79 * (\text{hardness mg/L CaCO}_3) + 54.163 * (\text{chloride mg/L})] * 0.65$ • If hardness is between 100 and 500 mg/L AND if chloride is between ≥25 and ≤500 mg/L, the sulfate limit is (in mg/L): $[1276.7 + 5.508 * (\text{hardness mg/L CaCO}_3) + 1.457 * (\text{chloride mg/L})] * 0.65$ A minimum of 12 samples must be collected over any rolling 12-month period.	≤250 (taste threshold)

PARAMETER (UNITS ARE mg/L UNLESS STATED OTHERWISE)	SURFACE WATER RECOMMENDED COMPLIANCE LIMIT(S)	GROUNDWATER RECOMMENDED COMPLIANCE LIMIT(S)
For compliance limits in the points above, no more than 20% of samples collected over a rolling 12-month period may exceed the relevant compliance limit. An acute compliance limit = 1,000 mg/L averaged over 4 days and not to be exceeded more than once in a one-year period, OR in more than 10% of samples over a one-year period.		
Aluminium (Al)	≤0.08	1 (MAV)
Antimony (Sb) (total)	0.074 (chronic) 0.250 (acute)	0.02 (MAV)
Arsenic (As(V))	≤0.042	0.01 (MAV)
Cadmium (Cd)	≤0.0004 ³	0.004 (MAV)
Chromium (Cr)	≤0.0033 (Cr(III)) ⁴ ≤0.006 (Cr(VI)) ⁴	≤0.05(MAV, Total Cr)
Cobalt (Co)	0.001 (chronic) ⁵ 0.11 (acute, not to exceed) ⁵	<1 (livestock drinking water)
Copper (Cu)	≤0.0018	≤0.5
Iron (Fe) (total)	-	≤0.3
Lead (Pb)	-	0.01 (MAV)
Manganese (Mn)	-	0.4 (MAV)
Molybdenum (Mo)	≤0.034	<0.01
Selenium (Se)	-	0.02
Strontium (Sr) (total)	-	4
Uranium (U)	-	0.03 (MAV)
Zinc (Zn)	≤0.015 ⁶	≤1.5

All limits are dissolved unless noted as total

"-" = no limit recommended.

¹ = refer to Ryder (2025), for concentration adjustments.

² MAV = Maximum acceptable value – From the NZ drinking water standards.

³ Cd (dissolved) is adjusted by the following algorithm: $HMTV = TV * (H/30) * 0.89$, where hardness-modified trigger value (HMTV) = (µg/L), trigger value (TV) (µg/L) at a hardness of 30 mg/L as CaCO₃; H, measured hardness (mg/L as CaCO₃) of a fresh surface water.

⁴ = Cr (dissolved) is adjusted by the following algorithm: Chromium (mg/L) = Toxicity value (mg/L) * $(H (mg/L)/30)^{0.82}$

⁵ = Co (dissolved) is adjusted by the following algorithm: Cobalt (µg/L) = $\exp \{ \{ 0.414 [\ln(\text{hardness CaCO}_3 \text{ mg/L})] - 1.887 \} \}$

⁶ = Zn (dissolved) is adjusted by the following algorithm: Zinc (mg/L) = Toxicity value (mg/L) * $(H (mg/L)/30)^{0.85}$

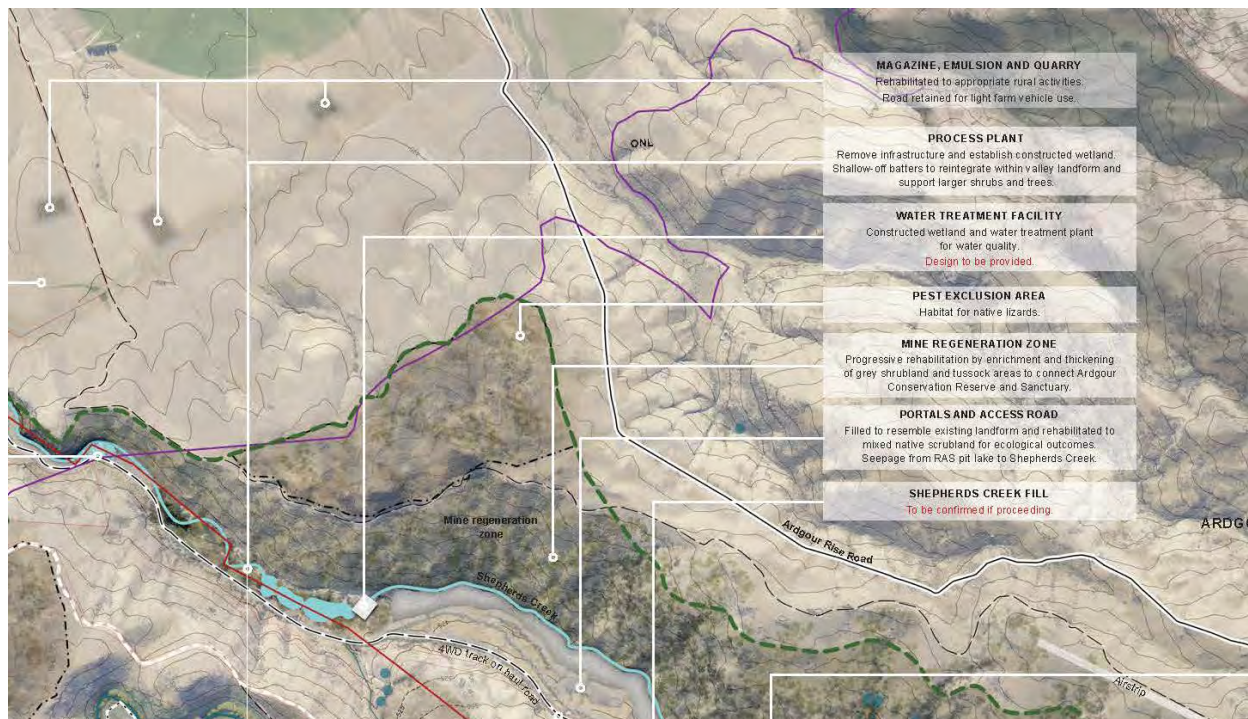
The PCOC presented in section 3.4 were identified from the baseline studies, source hazard assessment, geochemical modelling, and the water and load balance modelling to understand potential effects of the BOGP.

3.6 Plant Location and Footprint

The proposed location for the Active WTP is located on Shepherds creek near the mine regeneration zone (area labelled “Water Treatment Plant” on the image shown below).

The size and footprint requirements for the WTP and Surge and Treated water ponds is as follows.

- WTP Footprint – An area approximately 100 m x 60 m TBA is recommended to be located near the surge and treated water ponds.
- WTP Surge Pond – 14,000 m³ (see section 4.4 for detail and sizing philosophy)
- WTP Treated Water Pond – 2,000 m³ (see section 4.6 for detail and sizing philosophy)



4 PRELIMINARY PROCESS DESIGN

The following is a description of the preliminary level process design which has been developed for the purpose of selecting plant options. This description should be read in conjunction with the preliminary design process flow diagrams PFL-2426-PRO-PFD-00001 to 00003 (Sheets 1 to 3) included in Appendix A of this report.

The selected process is based on known water treatment process technologies for primarily sulphate and metals removal as described in the following sections. It should be noted that the design selection is preliminary, and test-work should be carried during the mining phase of the project (prior to active closure) to confirm design assumptions and prove final water qualities can be achieved.

The process selected involves the following unit processes.

- Surge Sump
- Pontoon mounted pumps for plant feed
- Metal hydroxide precipitation and settling
- Gypsum precipitation and settling
- Ettringite precipitation and settling
- Carbonation and pH trimming
- Treated Water Sump
- Sludge Management

Other processes that will likely be needed in addition to the active WTP are:

- Cyanide Destruct on the Shepherds TSF influent stream
- Potential additional nitrate removal after the WTP via biological processes

4.1 Treatment Literature Review

A range of Active Treatment technologies for sulphate and metals removal exist, including Ettringite Precipitation, Biological Sulphate Removal, Ion Exchange, Reverse Osmosis, Electrocoagulation, Treatment and Extraction of Rare Earth Metals. This section is a review of the processes currently available at bench and pilot trial and full plant scale for sulphate and metals removal.

4.1.1 Active Treatment Processes reviewed

The following active treatment processes were reviewed for suitability for sulphate and metals removal:

- Biological processes
- Membrane treatment including Reverse Osmosis
- Ion exchange
- Electrocoagulation
- Treatment and extraction of rare earth elements
- Chemical Treatment and Mineral Precipitation (Lime addition, Barium Salts addition, CESR, Savmin, Outotec/Metso, (GARD, 2021; Lorax, 2023))

The processes that are still only under bench scale and research and development stage are:

- Electrocoagulation (developed to bench scale)
- Treatment and extraction of rare earth elements (This is under research and development only (GARD, 2021))

With the passage of time, these treatment options may become viable however at this stage they are not considered a proven technology suitable for full scale plant application for this BOGP project.

Reverse Osmosis, Ion exchange and Biological Processes have been discounted for this project as active treatment options.

Reverse Osmosis may be appropriate if sulphate concentration was lower than the sum of all metals and chloride (if operational and capital consideration allowed).

Reverse Osmosis and membrane processes generally produce large quantities of membrane reject waters (brine) which requires reprocessing and disposal. Capital and operating costs for membranes are high, with RO operating pressures high, and chemical use for fouling removal has potential to be high (Lorax, 2023). Operational issues associated with RO and Membranes include high fouling and cleaning rates with membrane longevity is shown to be reduced in these applications (Lorax, 2023).

Ion exchange processes do not have long track record for this application at full plant size, although information about trials at pilot scale are available (Lorax, 2023). Ion exchange processes produce quantities of gypsum sludges, and high amounts of brine which need further processing. They are not widespread in use for this application (Bratty et al, 2014). One ion exchange technology, the GYP-CIX process is suitable for treated mine waters with high levels of TDS, sulphate and calcium (up to 2000mg/l). It uses calcium hydroxide and sulphuric acid to regenerate the ion exchange resins. Costing of resins would have to be done to compare lime and other chemical costs to see if this process would be viable. For this BOGP project it has been discounted due to insufficient information on its long-term use at full scale for this application.

Biological Processes can be limited by sufficient organic carbon and nutrients in mine influence waters and the presence of heavy metals limiting growth. (Lorax 2023, Bratty et al, 2014)

Biological treatment with sulphate-reducing bacteria is suitable to low or moderate sulphate loadings (Qian et al., 2015; Silva et al., 2012), but its application is usually hindered by the shortage of organics, the inhibition of high salinity and metal ions in the wastewater (Mothe et al., 2017), and the generation of hydrogen sulphide (Runtti et al., 2016). (Dou, W, 2017)

There has been limited application of Biological Treatment in Active Water Treatment systems and is more successful used in Passive Treatment systems. (Bratty et al, 2014)

Sulphate removal using chemical precipitation include processes of lime addition, barium salts addition and proprietary processes such as the CESR (Cost Effective Sulphate Removal process), Savmin, Oututec/(Metso) processes (GARD, 2021; Lorax, 2023).

(It is noted in literature that Barium Sulphate is highly insoluble and as an alternative to Calcium Hydroxide, the addition of Barium Hydroxide is extremely effective at removing sulphate. Barium Hydroxide is however, an expensive, corrosive and toxic treatment chemical and this rarely represents a cost-effective treatment option to use this as a hydroxide for this stage of the process. (Gard, 2021).)

For mine water that is net acidic, where low residual metal and sulphate concentrations are needed in the treated discharge water, and the sulphate concentration is higher than the sum of metals and chloride, where carbon sources (crude or refined) are not available or are expensive, then the Savmin process is recommended as an appropriate technology (Younger et al 2002).

Ettringite Precipitation (addition of Lime and $\text{Al}(\text{OH})_3$ can be used to remove sulphate and heavy metals. Ettringite ($3\text{CaO} \cdot 2\text{CaSO}_4 \cdot \text{Al}_2\text{O}_3 \cdot 31\text{H}_2\text{O}$) has very low solubility and therefore sulphate concentrations are low in treated water after precipitation and settling.

The Main unit operations for known processes for sulphate removal with Ettringite precipitation involve:

1. Metals Precipitation - pH lift with Lime to the range of 11.5 to 12 (Calcium Hydroxide, rather than barium), this enables Al dissolution
2. Gypsum Precipitation
3. Ettringite Precipitation - Al^{3+} addition to remove sulphate as precipitated ettringite
4. pH reduction of the treated water with CO_2 to meet effluent discharge criteria and precipitate CaCO_3

Ettringite sludge must be separated by gravitation separation and or filtration (Reinsel 1999, Lorax Environmental 2003, Outotec 2014).

Known commercial chemical precipitation sulphate removal processes include the SAVMIN process, the CESR (Cost effective Sulphate removal Process) and the Outotec (now Metso) Ettringite process. All commercial processes follow similar principles:

SAVMIN uses aluminium oxide (aluminium trihydroxide in amorphous or gibbsite form) to create ettringite, with recovery. CESR uses a proprieter Al containing chemical from cement production, without recovery of aluminium source. The Outotec process does not contain a separate lime addition step. (Lorax Environmental 2003, Outotec 2014).

The processes have been developed for Sulphate concentrations above 2000mg/l, with performance levels providing removal of sulphate to 200-100mg/l. Ettringite formation can also provide a polishing effect, allowing precipitation of metals, Ni, Cd, Cu, Zn, Cr, As, Se, Cd, Boron, fluoride and chlorite and nitrate, in waste up to 30% have been removed (Reinsel 1999, Outotec 2014)

4.1.2 Design Considerations

Operating costs for the SAVMIN process depend on reagent use which depends on levels of sulphate and univalent cations (Na, K, NH_4 etc present in the feed water (Smit, 1999)).

Typically, there are low settling rates for the liquid/solid separation phases (Smit 1999). For this reason, conventional high-flow thickeners are preferred for the solid-liquid separation phases in the treatment process (Lorax, 2023). Mixing times for each phase varies from 30-60 minutes but will depend on site specific water quality.

Magnesium ions can interfere with sulphate removal by inhibiting the formation of ettringite (Zahedi et al, 2022).

It is reported that Mg^{2+} has adverse effects on the formation of ettringite in cement paste (De Weerd et al., 2014), and prevents sulphate removal as gypsum (Tolonen et al., 2015). However, the effects of Mg^{2+} on ettringite, precipitation are scarcely reported, and it should be essential for process design and very useful for understanding the precipitation behaviour in real wastewater rich in Mg^{2+} and sulphate. (Dou. W, 2017), also

The study by Dou. W, et al shows that Mg^{2+} has a significant inhibitory effect on sulphate removal by ettringite precipitation and that an additional precipitation step prior to ettringite precipitation is needed to remove magnesium hydroxide as a settled precipitate (as well as metal hydroxides). Dou.W, 2017 et al found in their study that High Caustic alkalinity (using Sodium Hydroxide) and low Mg are the most suitable conditions to precipitate ettringite.

Others have found that using calcium hydroxide as the initial step is effective in reducing magnesium concentration by conversion to insoluble magnesium hydroxide precipitate at pH 12. (Zahedi et al, 2022, Smit, 1999 and Lorax, 2023)

The operating parameters such as molar ratios of SO_4^{2-}/Ca^{2+} and SO_4^{2-}/Al^{3+} , and pH value have a significant effect on the sulphate removal process efficiency (Aygun et al. 2018, as cited in Zahedi 2022).

4.1.3 Treatment Process Site Specific Testing

The sulphate removal process is not commonly used in New Zealand and elsewhere there are limited full size treatment plant sites with available design data to reference.

The ability to test the on-site mine influenced water, or a laboratory formed mimic water, similar to the BOGP proposed water quality and then simulate each of these precipitation steps would give real data to present and reference for final water quality. This would also give more certainty about the effectiveness of the treatment process on the BOGP proposed mine water quality and assurance that the water treatment system will achieve the final water quality. It is proposed that during the detailed design phase that this level of bench scale and pilot scale testing be performed.

4.2 Treatment Plant Process

Of the chemical precipitation processes, a process like the SAVMIN process is proposed for this project.

4.2.1 Savmin Process Summary

The Savmin process uses precipitation reactions to remove sulphates from minewater. This process also removes heavy metals and calcium. The first stage is addition of lime to raise pH and precipitate out metals and magnesium as hydroxides.

After separating out the hydroxides, the resulting supersaturated calcium sulphate solution is contacted with gypsum crystals, which catalyse the precipitation of calcium sulphate (gypsum). Due to the slow settling rate of the precipitates, the most cost-effective equipment for the solid-liquid separation stages of the process are parallel-plate cone clarifiers.

In the third stage of the process, aluminium hydroxide is added to the solution which causes formation of the insoluble salt ettringite, which removes calcium and sulphate from solution.

The solution is then treated with carbon dioxide to lower the pH (process pH values in the first and third stages of the process need to be maintained at 11.6 to 12). The lower pH causes the precipitation of pure calcium carbonate which is separated from the water by filtration.

The final stage of the process is the recycling of ettringite, in which the ettringite slurry is which is treated with sulphuric acid to regenerate aluminium hydroxide.

Reported removal rates are: Heavy metals removed to below drinking water levels; 99% of calcium; 100% of magnesium and 98% of Sulphate. Sodium, chloride, potassium and fluoride are not removed. (Brown. et al, 2002)

4.2.2 Metal Hydroxide precipitation and settling

The metal hydroxide precipitation step is part of both the Savmin and CESR (Cost Effective Sulphate removal process) and generally consists of addition of Hydrated lime (Calcium Hydroxide) to a pH of 10.5-11, mixing from 30- 60 minutes (Reinsel.M,1999). Levels of pH of up to 12-12.5 have been documented and mixing time up to 3 hours.

Settling of the precipitated metals and magnesium as hydroxides occurs and this sludge will need further processing via thickening, dewatering and disposal.

With respect to the BOGP project, during the closure phase in the 50 years when the active treatment system will be used, if Chemical precipitation processes are chosen, large volumes of sludge will be produced (as a byproduct of water treatment) will be created.

Further studies need to be completed to determine the quantity and quality of the water treatment residues (including sludge) for both active and passive treatment systems and identify appropriate disposal options and locations. The sludge should be disposed of at a suitable facility or studies should be undertaken to confirm onsite management options.

4.2.3 Gypsum precipitation and settling

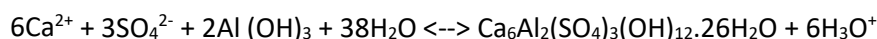
Following removal of the settled metal hydroxides, the liquid is contacted with gypsum to provide active surfaces and catalyse the precipitation of the supersaturated gypsum (Smit, 1999). This precipitated gypsum is then thickened and filtered with some leaving the process and some recycled to the mixing tank as the seed gypsum. It is noted that the sulphate content of the water leaving this stage is dependent on the pH. Higher pH will result in lower sulphate concentrations. The pH in this stage is determined by the settling of the metal hydroxides from the previous stage (at high pH, poor settling occurs).

As gypsum interferes with the precipitation reaction of ettringite, it is important that all gypsum is removed from the feed water before the ettringite formation process steps. (Lorax, 2023).

4.2.4 Ettringite precipitation and settling

Following the precipitation and removal of gypsum, Aluminium Hydroxide is added to the liquid phase. This allows the insoluble salt ettringite to precipitate which results in the removal of both sulphate and calcium from the solution (Smit, 1999).

The stoichiometry of the formation of ettringite with the addition of aluminium is:



The optimal pH range for the formation of ettringite is 11.6-12.0. The pH is maintained in this range by the addition of lime. Literature suggests that for efficient sulphate removal, a multistage reactor is required to produce an ettringite product with good liquid solid separation characteristics (Smit 1999). The ettringite is removed from the process using thickening, filtration.

Long mixing phases for the aluminium hydroxide/ettringite formation were reported in some instances, up to 61h mixing (Zahedi et al, 2022).

4.2.5 Carbonation and pH trimming

At this stage the waste water stream, with a pH 11-12 and dissolved $\text{SO}_4 < 200\text{mg/L}$ is treated with carbon dioxide gas to lower the pH and to prevent scaling. The reduction of pH is prior to discharge to the receiving environment such as surface water or to the nitrate removal system. Relatively pure CaCO_3 is precipitated and removed by filtration or settling. Alternatively, pH can be adjusted to precipitate $\text{Ca}(\text{HCO}_3)_2$. (Lorax, 2023)

If treated water will be used again in the process, as service water, (for mixing, dosing chemical makeup water and washing), then reduction of pH and stabilisation to prevent deposition of hard carbonate scale on filters and distribution piping is required.

4.2.6 Recycling of Aluminium Hydroxide

Aluminium hydroxide is recovered by thickening and filtration and reused in the third stage as the ettringite formation catalyst (Lorax, 2023).

This recovery is achieved by taking the ettringite slurry from the Ettringite Precipitation phase, adding sulphuric acid to lower the pH and decompose the ettringite. This decomposition takes place in gypsum saturated water at a liquid to solid ratio that allows the calcium and sulphate ions to remain in solution as supersaturated calcium sulphate (Smit 1999). The stoichiometry is the reverse of the ettringite formation reaction.

Instead of sulphuric acid, CO_2 can be used, however it converts half of the calcium from the ettringite forms solid calcium carbonate. Some of the regenerated aluminium hydroxide then has to be removed from the circuit as a bleed to control the buildup of calcium carbonate (Smit 1999).

4.3 Treatment Process Equipment

The SAVMIN process contains precipitation reactions in conventional stirred reactors at ambient pressure and temperature. The reactors will be mixing tanks, with mechanical agitators, and settling/clarification vessels in the most part and associated slurry and sludge pumps.

During settling phases of this treatment, settling rates potentially will be lower than conventional thickeners, but sludge volumes may be high, so allowance should be made on site for tall deep cone settlers. The Wren Parallel Cone clarifiers are mentioned in literature. These either have no moving parts for the settling phase or have rotating flocculator in the centre cylinder. Parallel settlers are also mentioned in literature, as an option for a smaller site footprint, but scale removal provisions for maintenance in design would have to be paramount and a less restricted settling vessel may be preferable if site space allows.

Most of the vessels will contain water to pH 12 or thereabouts. There will also be chemical dosing of strong acids such as sulphuric acid and acid coagulants (Aluminium Sulphate and Aluminium Hydroxide). Durability of vessels, piping and pumps will be paramount in design, as will chemical safety during maintenance.

Most of the pipelines and pumping and vessels will involve materials in liquid, slurry or sludge form with the propensity for scale formation from calcium carbonate, gypsum and ettringite, so allowance should be made for scale removal maintenance and redundancy for all equipment in case of blockage and scale removal maintenance downtime.

EQUIPMENT DESCRIPTION	PROCESSES USED
Mixing Vessels	Stage 1, 2 and 3 plus lime saturation and Ettringite decomposition
Settling Clarifiers	Stage 1, 2 and 3
Chemical Dosing systems	Lime, Aluminium Hydroxide, Aluminium Sulphate, Carbon Dioxide Sulphuric Acid
Sludge Handling, Dewatering and disposal systems	Metal Hydroxide, Gypsum, Ettringite, Calcium Carbonate

4.4 Surge Sump

A surge sump located adjacent to plant has been included in the design. Primarily this is to allow a pumped (fixed speed) feed to the plant. Recommended sump/pond sizing is based seven days storage at average flow.

PLANT FEED RATE	DURATION/RETENTION	RECOMMENDED SUMP VOLUME
Average Flow Rate (26.9 l/sec) 96.84 m ³ /hr	7 Days	16,269 m ³

4.5 Pontoon Mounted Pumps

A pontoon mounted pump system with duty/standby pumps is recommended to reclaim MIW from the surge sump for plant feed. Therefore, two centrifugal pumps are recommended (each capable of feeding the plant at full flow. The required pump specification is as follows.

PUMP DETAILS	TECHNICAL DATA
Actual Calculated Flow	(30 l/sec) 108 m ³ /hr each (VSD Driven)

4.6 Treated Water Sump

A treated water surge sump located adjacent to plant has been included in the design. Primarily this is to allow retention time on treated water prior to discharge. Additional residence time post treatment is recommended as a polishing pond to allow for any carry over of final impurities to settle before discharge. Recommended sump/pond sizing is based on 24 hours storage at maximum flow.

PLANT FEED RATE	DURATION/RETENTION	RECOMMENDED SUMP VOLUME
Average Flow Rate (26.9 l/sec) 96.84 m ³ /hr	24 Hours	2,324 m ³

4.7 Sludge Management

From the water quality and literature review, the proposed sulphate and metals removal processes will have several sludge management streams with different product outputs, some which will need disposal either on site or off site and some that could be recycled or form a product for export off site.

1. Metal hydroxide sludge will need to be thickened and dewatered prior to transport to disposal in an appropriate landfill off site. There may be potential to process this further to recover certain metal if this was desired.
2. Gypsum sludge will be collected, processed and mainly be recycled on site, but there may be the need to export some gypsum product off site or to on-site disposal.
3. Ettringite sludge will partially be recycled and again disposal will be required in an appropriate landfill off site.
4. Calcium Carbonate Sludge, which may contain impurities will also have to be thickened, dewatered and disposed in an appropriate landfill off site.

Theoretical maximum TSS and metals quantities predicted will give a total precipitated solids amount of in g/m³ (% solids w/v) of influent to the WTP. Preliminary theoretical design suggests that a range of 5-10% of the total flows from the various processes will be required to report to the settlement column underflow. Further design will require test work on mimic waters to confirm proposed sludge volumes and dry weight percentages expected.

Preliminary theoretical sludge volumes based on 5-10% range of total underflows, with dry weight percentage of 0.5-1% would give the following sludge qualities. Note that not all the total underflows need disposal as some will be recycled, but this represents the total sludge processing capacity needed, not total disposal.

4.7.1 Total Sludge Processing Capacity – Theoretical

DESCRIPTION	DATA
Total Underflow 5-15% Plant flow	4.8 -15 m ³ /hr
Solids in Total Underflow (assume 0.5-1%)	5-10 kg/m ³
Dry Weight Solids (kg/Hr at average flow rate)	24-150 kg/hr

DESCRIPTION	DATA
Dry Weight Solids (T/Year at average flow rate)	210.2-1,314.0 kg/year (Assuming 24 WTP hour continuous operation)
Wet solids at spadable consistency 20% solids T/year	1051.2 T/yr – 6570.0 T/yr

There are number of methods/technologies for available for dewatering of the settler underflow sludge, these include.

- Mechanical dewatering – centrifuge, belt press filters etc
- Wet/dry stacking of tailings (tailings dam)
- Bag dewatering technologies – vertical bag, geo bags etc

4.8 Other Treatment Processes

Other processes that will likely be needed in addition to the active WTP are:

- Cyanide Destruct on the Shepherds TSF influent stream
- Potential additional nitrate removal after WTP via biological processes

4.8.1 Cyanide Destruct – Shepherds TSF Influent Stream

As part of baseline water quality studies and environmental geochemistry studies, (MWM, 2025). It is reported that the influent stream from Shepherds TSF will have low concentrations of Cyanide present. Modelling indicates that this could be approximately 0.35mg/L. Compliance limits allow 0.6 mg/L in ground water and 0.011 mg/L in surface water (Ryder, 2025). Therefore, treatment may be required for this influent stream. Cyanide is highly toxic even in very low concentrations.

Cyanide removal is required for the waste flows coming from the Shepherds TSF area. This is estimated to contain Cyanide at around 0.35 mg/L. The recommended compliance limits for Cyanide are: 0.011mg/L (Surface Water) and 0.6mg/l (MAV Groundwater).

To provide more efficient treatment, it is anticipated the cyanide treatment would be carried out on the Shepherds TSF Stream only, prior to combining this with flows from other areas of the mine. Information from BOGP PFS document for the Bendigo Mine states that an Air/SO₂ circuit has been chosen as the preferred form of Cyanide treatment for the process due to the amenability of the ore to this type of process and this is expected “to reduce the weakly acid dissociable cyanide to less than 30ppm at discharge” (30ppm=30mg/L).

Various forms of Cyanide treatment have been used in gold mines worldwide, including Alkaline Chlorination, Hydrogen Peroxide, SO₂/Air, Ferrous Sulphate Complexation, Ozonation, Caro’s Acid, Biological Treatment, Thermal destruction (SGS 2005, Palmer et al 1987) and UV Oxidation. Copper is used as a catalyst in some of these processes.

Of the cyanide removal processes, there are various advantages and disadvantages for each. A brief comment on some of the technologies is offered below.

Alkaline Chlorination is a very common process for cyanide removal and is reported to be inexpensive and effective. However, it has the potential to generate hazardous by-products and more recently is

considered to be undesirable due the potential for negative environmental effects including high discharge of chloride and hypochlorite anions (Young and Jordan, 1995). It is also unable to remove some cyanide metal complexes known as SADs (Strong Acid Dissociable Complexes).

In terms of performance, it was shown that the Ozonation process at a San Diego plating plant reduced cyanide from 1.02mg/L in the Influent to 0.08mg/L in the effluent (Palmer et al, 1987). Ozonation was reported to have high operating costs.

More recently, UV oxidation has also been shown to be effective.

Wet Air Oxidation was reported to remove 99% of cyanide at a waste treatment facility in California from influent concentrations of 110mg/L to 0.035mg/L in the effluent (Palmer et al, 1987). This technology is more commonly used in domestic wastewater applications but is also used in industrial waste treatment to lesser extent.

The SO₂/Air processes include a range of technologies. One such process called the INCO Process used at a Gold Mill site has been shown to reduce cyanide concentrations from around 40mg/L to 0.07mg/L in industrial applications (Palmer et al, 1987) however we have not established if this technology can achieve concentrations lower than this.

During the mining phase of the project, it is recommended that detailed testing of the BOGP water quality from Shepherds TSF take place to determine actual levels of Cyanide present prior to detailed design of a cyanide destruct process.

4.8.2 Nitrate Removal

Nitrate removal may be required but again this will need to be confirmed by test work.

Ettringite formation can also provide a polishing effect, allowing precipitation of metals, Ni, Cd, Cu, Zn, Cr, As and Se, often below their compliance and laboratory detection limits. Boron, fluoride and up to 30% of chloride and nitrate-nitrite in wastewater have also been removed (Reinsel 1999).

If required following test work, additional nitrate treatment systems can be added as a bolt on to the back end of the plant, depending on the amount of removal required. Options include the following.

- Fluidised bed reactors (FBR)
- Ion exchange
- Wetland (if polishing required)

Note that biological processes can be limited by sufficient organic carbon and nutrients in mine influence waters and the presence of heavy metals limiting growth. (Lorax 2023, Bratty et al, 2014)

4.8.2.1 Fluidised Bed Reactor

Fluidised bed reactors can be effective in removing nitrates from mine wastewater. They use a biological process where the wastewater flows upwards through a bed of granular materials, such as sand or activated carbon. This allows the growth of biofilm within the FBR using the denitrification process, converting nitrate to nitrogen gas in anoxic conditions. (Metcalf and Eddy, 2003).

Design would include the sizing appropriately of the following:

- Upflow velocities
- Bed depth
- Specific surface area
- Hydraulic retention times

A pilot size trial with similar water would provide more accurate sizing for a full-size plant.

4.8.2.2 Ion Exchange

As mentioned earlier in this document, any ion exchange processes will generate a brine waste stream which will have to be disposed of off-site.

4.8.2.3 Wetlands

There are three types of wetlands that differ in form, function and applicability:

- Aerobic wetlands (reed beds)
- Compost wetlands
- Reducing and Alkalinity Producing Systems (RAPS)

Aerobic wetlands can legitimately be regarded as proven technology when applied to ferruginous net alkaline waters. (Brown Barley and Wood, (2007)).

The two principle aims of mine water treatment in wetlands are.

1. To neutralise acidity and
2. To precipitate out metals.

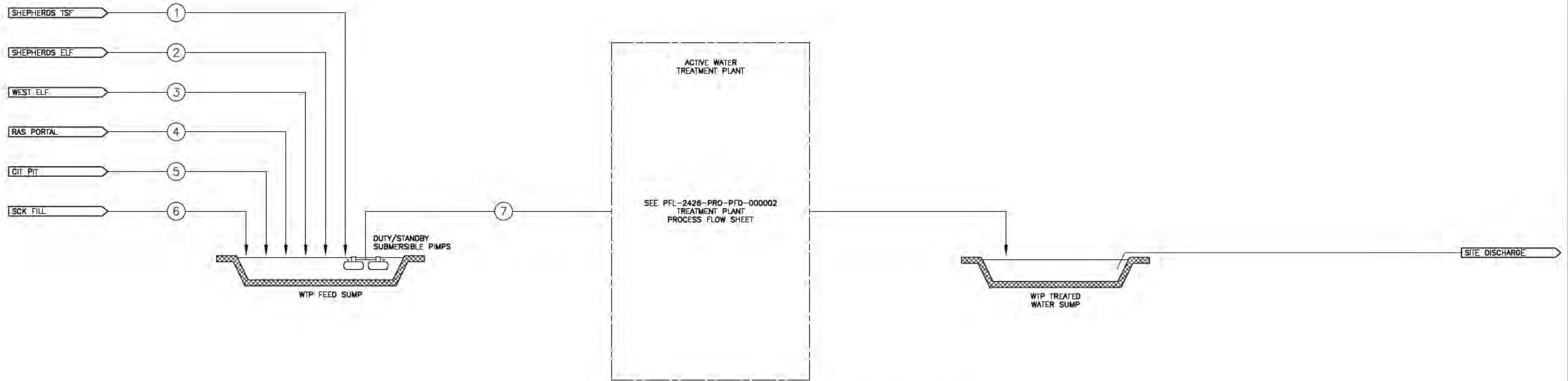
Constructed wetlands need to comprise the following five components:

1. Substrates (which may have widely varying rates of hydraulic conductivity)
2. Plants adapt to water saturated anaerobic conditions
3. Water column (water flowing in or above the substrate)
4. Vertebrates and invertebrates
5. Aerobic and microorganisms

Natural wetlands are biologically complex and cover large land areas. When designing constructed wetlands, care must be taken when reducing them to minimal components and treatment areas for minewater processing purposes. Such loss of biological complexity may prevent the achievement of a balanced self-sustaining ecosystem which is the aim of passive treatment. (Brown Barley and Wood, (2007))

At this stage it is not possible to quantify the amount of nitrate that would be removed by a wetland system prior to detailed design.

APPENDIX A - PROCESS FLOW SHEETS



Parameter	Units	Stream 1 TSF Seepage	Stream 2 Shepherds ELF Seepage	Stream 3 WELF Seepage	Stream 4 RAS Portal	Stream 5 CIT Pit Backfill	Stream 6 SCK Fill Seepage	Stream 7 MIW combined
Flow Rate	l/sec	13.4	4	1	6	1.5	1	26.9
Acidity	mg/L	0.01	0	0	0.44	0	0	0.03
Al	mg/L	0.011	0.003	0.003	0.1	0.005	0.003	0.013
Alkalinity	mg/L	73	189	183	182	190	158	160
As	mg/L	2.06	0.2	0.2	0.09	0.08	0.2	0.61
B	mg/L	0.83	0.87	0.1	0.05	0.09	0.01	0.59
Ca	mg/L	297	51	51	59	39	36	107
Cd	mg/L	0.0002	0	0	0.0001	0.0001	0	0.0001
Cl	mg/L	806	63	37	14	12	8	223
Co	mg/L	0.053	0.109	0.023	0	0.004	0.003	0.061
Cr	mg/L	0.00636	0.0002	0.00019	0.00058	0.0004	0.00007	0.0017
Cu	mg/L	0.001	0	0	0.00302	0.00021	0	0.00049
DOC	mg/L	0	0	0	0.09	0.206	0	0.038
F	mg/L	1.94	6.3	6.12	0.23	1.39	2.37	3.9
Fe	mg/L	15.3	7.6	7.6	7.9	2.4	7.6	8.7
Hg	mg/L	0	0	0	0.00006	0.00014	0	0.00003
K	mg/L	51	683	672	34	84	159	372
Mg	mg/L	100	38	37	37	20	24	49
Mn	mg/L	0.594	0.819	0.774	0.014	0.103	0.182	0.567
Mo	mg/L	0.14	1.005	0.672	0.02	0.119	0.157	0.535
NO3-N	mg/L	2.01	49.64	9.54	4.35	0.73	1.33	22.89
Na	mg/L	848	922	734	42	127	170	673
Ni	mg/L	0.6784	0.0121	0.001	0.0009	0.0013	0.0001	0.1652
Pb	mg/L	0.0276	0.0001	0.0001	0.0035	0.0002	0	0.0068
Sb	mg/L	0.1802	2.9986	3.2208	0.0234	0.3622	0.7601	1.6317
Se	mg/L	0.003	0.1544	0.1649	0.0008	0.0196	0.0388	0.0826
SO4	mg/L	954	957	888	141	110	208	730
Sr	mg/L	4.4	16.15	15.91	0.79	3.77	10.89	10.12
Tl	mg/L	0	0	0	0.00031	0.00021	0	0.00005
CN	mg/L	0.35	0	0	0	0	0	0.082
U	mg/L	0.028	0.2751	0.2225	0.0094	0.0299	0.0515	0.1468
V	mg/L	0.004	0.12	0.1155	0.0006	0.0135	0.0269	0.0633
Zn	mg/L	0.0296	0.0098	0.0021	0.0022	0.0014	0.0003	0.0117
pH	mg/L	6.41	7.93	7.92	5.91	8.03	7.92	6.72
Hardness	mg/L	1151	285	280	299	179	190	469

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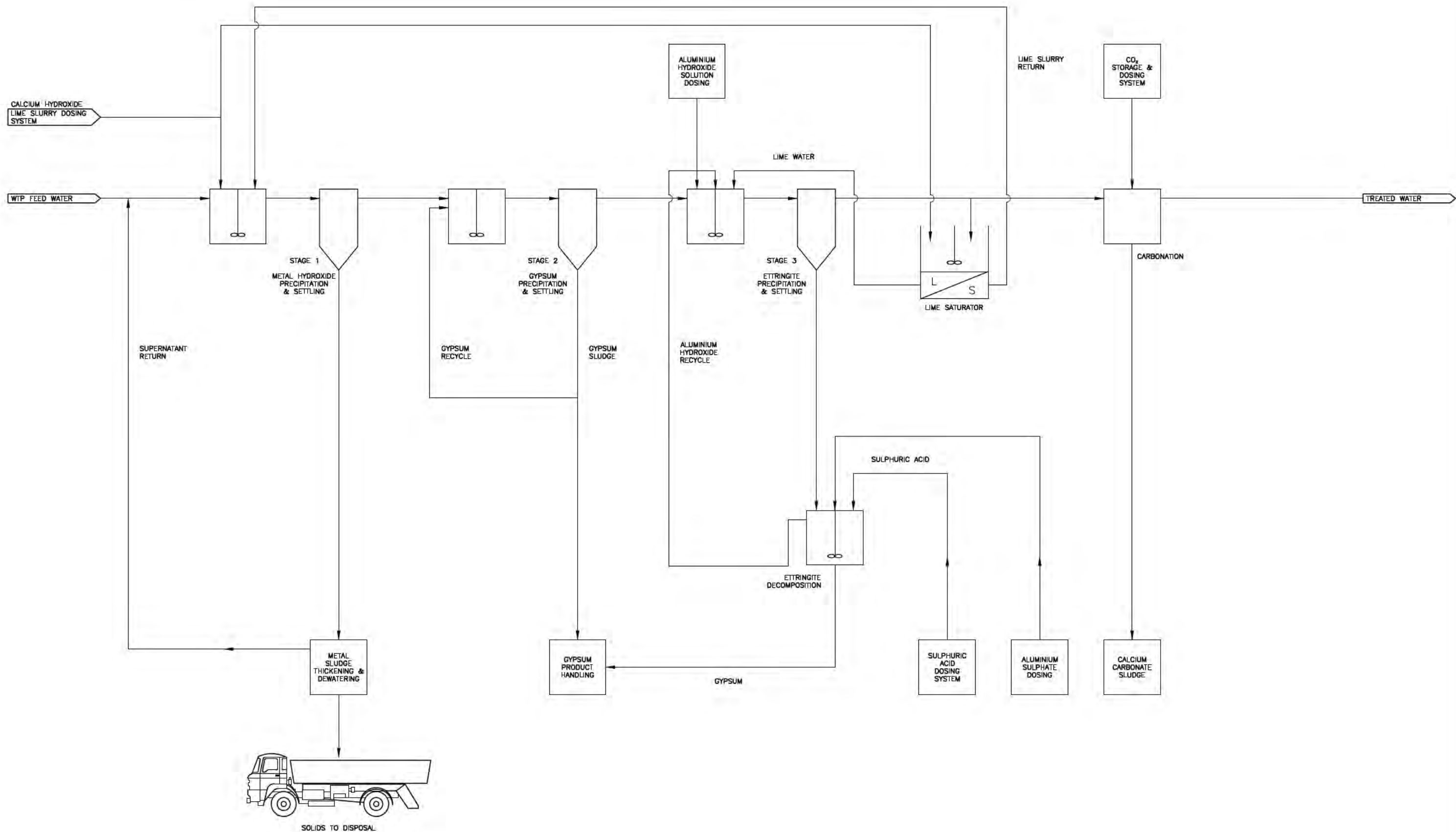
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ACTIVE WATER TREATMENT PLANT
PLANT FEED ENVELOPE
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MINE WASTE MANAGEMENT

GREENROAD GROUP

APPENDIX N WATER LOAD BALANCE MODEL

Water and Load Balance Model Report

Bendigo-Ophir Gold Project

10 October 2025

J-NZ0233-016-R-Rev1



MATAKANUI
GOLD LIMITED 

Water and Load Balance Model Report

Bendigo-Ophir Gold Project

Document Number: J-NZ0233-016-R-Rev1

Document Date: 10 October 2025

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Rev0	25/09/2025	RB	PW
Rev1	10/10/2025	PW/RB	PW

EXECUTIVE SUMMARY

This report describes the development of a site-wide water and load balance model (WLBm), which will support the Assessment of Environmental Effects (AEE) for the Bendigo-Ophir Gold Project (BOGP) for Matakanui Gold Limited (MGL).

Objectives of this Study

The primary objectives of the modelling exercise were as follows:

- Forecast operational and closure phase water balance conditions for the BOGP.
- Forecast instream water quality at the proposed resource consent compliance locations as compared to proposed water quality limits for the operational and closure phases.
- Forecast changes in stream flows as a result of the BOGP for the operational and closure phases.

Findings

The BOGP operational and post-closure assessment findings are summarised below.

Operational Phase

The Operational Phase calculations suggest the following:

- Water balance calculations suggest that the site will be in a water deficit condition up to Year 8. After this point, dewatering from satellite pits (i.e., SRX¹ and to a lesser extent CIT²) may push the site to a water surplus condition for the last few years of mine life without additional controls. Engineering controls (e.g., construct the water treatment plant prior to closure) are available to manage potential water surpluses, and can be evaluated during detailed design phases. Ongoing site water balance reconciliation for the BOGP will be required to confirm water balance conditions remain in a water deficit condition.
- Based on mine features that will retain water on site and not be discharged to the receiving environment during operations, mean flows at SC01 and RS03 are estimated to be reduced by approximately 17% and 13% respectively, at the full life of mine project footprint. Low flow conditions will also increase, showing the seven day mean annual low flow decreasing by approximately 27% and 15%, for SC01 and RS03 respectively.
- Interpretation of the mixing model results suggests surface water quality at SC01 and RS03 will remain below the proposed compliance limits for both surface and groundwater if groundwater is used for dust suppression.

¹ Srex Pit

² Come in Time Pit

Post-Closure Phase

The Post-Closure WLBM results suggest the following:

- Pit voids will fill with water and discharge mine-impacted water (MIW) at average rates of approximately 6 L/s, 8 L/s and 1.5 L/s, from the RAS³ Pit (via the RAS underground workings), SRX Pit, and CIT Pit, respectively. RAS Pit Lake will reach a stable condition at ~25 years, and SRX and CIT pits will do so in <5 years.
- Of the mine waste storage facilities (MWSFs), using a net percolation rate of 20%, Shepherds engineered landform (ELF) will have the highest average seepage rate of MIW of approximately 4 L/s, followed by the TSF⁴ seepage rate of approximately 2 L/s on average. SRX ELF, WELF⁵, and SCK Fill⁶ all had seepage rates of approximately 1 L/s or less.
- In the post closure phase, creek flows will increase, with average flows increasing by approximately 60% at Shepherds Creek (at SC01) and 50% at Rise and Shine Creek (at RS03). Low flow conditions will also increase, with the seven day mean annual low flow increasing by approximately 530% and 280%, for SC01 and RS03 respectively.
- Model results suggest that active water treatment within the Shepherds Creek catchment will be needed for 50 years, when concentrations of SO₄, Mo, and Sb after passive treatment are below the surface water and groundwater limits, for the base case model scenario.
- Water quality findings for the base case model at RS03 indicate:
 - o No limits are exceeded after partial passive treatment of the average flow (8 L/s) from SRX Pit.
 - o Active treatment of MIW from SRX Pit and SRX ELF is not required.

Operational Management Recommendations

The following management recommendations are proposed for the Operations Phase:

- Back to back wet years and changes of water balance assumptions (e.g., dust suppression water sources) may move the site into a water surplus condition. As such, detailed water balance modelling by mine stage and that includes rainfall variability is recommended to support detailed mine design and improve confidence in a water deficit being maintained. Development of an adaptive management process related to the site water balance would also support proactive management of identified risks.

³ Rise and Shine Pit

⁴ Tailings Storage Facility

⁵ West ELF

⁶ Shepherds Creek

- A site water balance reconciliation should be completed regularly (e.g., annually or more frequent) to confirm water balance model results are appropriate, and/or make model updates to improve confidence in model results projected into the future.
- Clean water sources (i.e., bore water) should be used for dust suppression.
- Pit sump water could potentially be used for dust suppression early on in mine life. Adaptive management processes should be developed to proactively manage and respond if performance and/or compliance monitoring data suggests use of pit sump water may begin to provide a risk of non-compliance (i.e., potential to cause exceedance of water quality limits at SC01 and RS03).
- Other water management options include the early construction, during operations, of the water treatment plant if prolonged water surplus conditions eventuate.

Closure Management Recommendations

The following management recommendations are proposed for the active- and post- closure phases:

- Active water treatment in the Shepherds Creek catchment through a water treatment plant (WTP) is required until passive treatment systems can achieve the proposed water quality compliance limits.
- Passive treatment of the SRX Pit Lake is required to achieve water quality limits at RS03. Noting that passive treatment is modelled at 8 L/s (average SRX Pit flow rate) with higher flows being untreated.
- Active and passive water treatment systems need to be developed to a detailed design level:
 - o For the WTP, these studies need to be completed within the first few years of the mine commencing so that the technology is ready for operations and closure. Early design of the WTP would mean it is ready as part of any adaptive management process for water management.
 - o Passive water treatment systems should be designed once the project is operational using actual water quality from the project mine domains to confirm the proposed approach is appropriate.
- The majority of PCOC loads originate from Shepherds ELF and the TSF; therefore, performance monitoring of both flow rates and water quality is recommended at these locations.
- Model results suggest that active water treatment within the Shepherds Creek catchment will be needed for 50 years, when concentrations of SO₄, Mo, and Sb after passive treatment are below the surface water and groundwater limits, for the base case model scenario.
- Diverting Shepherds ELF and TSF seepage to the RAS Pit Lake for dilution was also assessed as a management option. Results indicate that at closure of the BOGP, the proposed water quality limits can be achieved without active treatment. The exception to this is molybdenum.

Active treatment is required until Mo decreases to a concentration that can be managed by passive treatment technologies.

- Performance monitoring is necessary to assess whether treatment is required using these management mechanisms.

Forward Works

The following forward works are proposed:

- A transient operational site wide water and load balance model needs to be developed prior to mine commencing to improve confidence in water accumulation or losses over time and water quality, particularly for seasonal dynamics. Such a model will support detailed design of the TSF.
- Additional ground investigations, groundwater monitoring, and detailed modelling will be required at the detailed design to confirm mine waste storage facility seepage collection systems will achieve anticipated collection requirements.
- The collection of performance monitoring data to improve model input data reliability is required, including:
 - o Water quantity and quality data from mine domains and water movement around the site.
 - o Water quantity and quality data as compliance locations.
 - o Records of pit lake filling levels over time.
- Once the mine is operational, collection of water quantity and quality data (obtained as part of performance monitoring) should be compared to the developed operational site wide water balance model periodically to confirm model results remain reasonable. Model revisions and/or re-calibration may be required if material differences are apparent.
- A cover system trial should be established early on in mine life to demonstrate that a NP of 20% of mean annual rainfall can be achieved. Such a study would provide confidence that water quality closure objectives can be achieved and support closure planning.

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1 INTRODUCTION

This report describes the development of a site-wide water and load balance model (WLBM), which will support the Assessment of Environmental Effects (AEE) for the Bendigo-Ophir Gold Project (BOGP) for Matakaniui Gold Limited (MGL).

1.1 Objectives and Scope

1.1.1 Objectives

The primary objectives of the modelling exercise were as follows:

- Forecast operational and closure water balance conditions for the BOGP.
- Forecast stream water quality at the proposed resource consent compliance locations as compared to proposed water quality limits for the operational and closure phases.
- Forecast changes in stream flows as a result of the BOGP.

1.1.2 Scope of Work

Mine impacted water (MIW) management during the operational phase of mining will involve discharge of only episodic runoff from haul roads and engineered landforms (ELFs) via sediment control structures. All other MIW (e.g., landform seepage from the ELFs and the tailings storage facility (TSF)) will be collected and stored for re-use on site (e.g., processing plant water) or be returned to the TSF impoundment. MIW management in the closure/post-closure phase, will require some seepages to be treated and discharged to the receiving environment. In this analysis, we partition the operational phase and closure/post-closure phase separately as follows:

- Operational phase - spreadsheet based models and associated calculations used to describe average annual water balance and runoff event discharges of MIW (Section 4).
- Closure/post-closure phase – GoldSim models and associated calculations, used to describe the evolution of water-quality over time, that results from the discharge of treated MIW (Section 5).

It is noted that during mine operations there will be the opportunity for proactive management of potential water-quality impacts. This will contrast with long term post-closure water management, where on-site presence is typically limited. The increased model complexity and effort required to describe closure/post-closure conditions is therefore appropriate. It is recommended that future updates to the modelling should expand the GoldSim model to include the operational phase to support mine water management planning.

2 PROJECT DESCRIPTION

MGL is proposing to establish the BOGP, which comprises gold mining operations, processing operations, ancillary facilities and environmental mitigation measures on Bendigo and Ardour Stations in the Dunstan Mountains of Central Otago. The project site is located approximately 20 km north of Cromwell and will have a maximum disturbance footprint of 610 hectares.

2.1 Project Background

The total Mineral Resource Estimate for the BOGP using a 0.5 g/t cut-off for open pit and 1.5 g/t for underground is 34.3 Mt at 2.1 g/t for 2.34 M oz (MGL, 2025). The Bendigo-Ophir resources occur in four deposits: Come in Time (CIT), Rise and Shine (RAS), Srex (SRX), Srex East (SRE). The majority of identified mineral resources are located within the RAS deposit. Three primary geological units are recognised at site:

- RSSZ – Rise and Shine Shear Zone.
- TZ3 – Lower Greenschist facies Textural Zone 3 rocks of the Otago Schist.
- TZ4 – Upper Greenschist facies Textural Zone 4 rocks of the Otago Schist.

The resources will be mined by open pit methods at each deposit within the project site, with underground mining methods also proposed to be utilised at RAS to access the deeper gold deposits. The majority of the mining activities, ancillary facilities and associated infrastructure will be located in the Shepherds Valley with non-operational infrastructure located on the adjoining Ardour Terrace. The BOGP also involves the taking of groundwater from the Bendigo Aquifer for use in mining-related activities and the realignment of Thomson Gorge Road via Ardour Station.

The following mine facilities are proposed (Figure 1):

- Open pits targeting the RAS, SRX, SRE, and CIT deposits.
- An underground mine targeting the RAS deposit.
- Three ex-pit ELF's – Shepherds ELF, SRX ELF, and West ELF (WELF).
- Two in-pit landforms (backfill) – CIT and SRE⁷.
- Plant and processing area, where CIL extraction technologies will be used as part of the ore recovery process. This includes the Shepherds Creek Fill (SCK Fill).
- A TSF and TSF Embankment.
- Other ancillary support services / structures (e.g., roads, water management infrastructure, water treatment plants, etc).

These facilities will be placed in the catchment of Shepherds and Rise and Shine creeks.

⁷ Note: SRE Pit is backfilled by the SRX ELF.

2.2 Mine Plan

The mine plan for the Bendigo-Ophir site is outlined in Table 1. The schedule describes the timing of construction of different mine-site infrastructure and water-management components (illustrated in Figure 1), and subsequent mining operations. The schedule is also used to inform development of operational phase and closure phase water-management plans.

Table 1: BOGP Mine plan schedule.

MONTH	YEAR	MINING PHASE	DESCRIPTION OF PHASE
Pre-startup			Detailed design phase
0 to 6	0 to 0.5	Startup	Pioneering / RAS Pre-Strip, Initial Jean Creek Silt Pond, earthworks at process plant.
6 to 24	0.5 to 2	Project Development	Construction of process plant, TSF, Shepherds Silt Pond, North Diversion Channel, Commissioning, mining RAS pre-strip (Pre-strip ends month 19). Construction of the WELF begins.
Operations			
25 to 54	2 to 4.5	RAS pit mining on its own	Operations (pit ore production in month 20. UG Development begins month 54). WELF construction complete.
54 to 72	4.5 to 5	RAS pit with UG development	Operations (UG Ore production begins month 70)
72 to 132	6 to 11	RAS pit plus RAS UG	Operations (UG Ore production months 70 to 150)
		RAS Pit plus RAS UG plus CIT Pit	Operations (CIT Pit mined months 102 to 114)
		RAS Pit plus RAS UG, plus CIT backfilled, plus SRX	Operations (SRX Pit mined months 145 onwards)
120 - 160	10 to 13.3	RAS UG continues on its own with CIT and SRX open pit feeds	Operations (all mining halted month 160)
Closure			
160 - 372	11 to 31	Active Closure ¹	All mining halted. Active closure of pits, TSF, and wider site, plus setup of active water treatment plant (option).
372 -	31 onwards	Post-Closure	Passive treatment and maintenance

UG = Underground

1. Presented as two decades as part of the Pre-feasibility Mine Plan.

Source: BOGP_high_level_schedule_PFSconsent.xlsx (Santana, 2025)

Key BOGP domains and their footprint area are summarised in Table 2.

Table 2: Key mine domain footprints.

MINE DOMAIN	CATCHMENT	AREA	NOTES
TSF	SC01	608,338 m ²	Maximum TSF footprint.
Shepherds ELF	RS03	1.11 km ²	Maximum ELF footprint.
SRX ELF	RS03	0.15 km ²	Maximum ELF footprint.
WELF	RS03	0.17 km ²	Maximum ELF footprint.
SCK Fill	SC01	0.11 km ²	Maximum footprint.
RAS Pit	SC01/RS03	0.64 km ²	72% in SC01 catchment 28% in RS03 catchment.
CIT Pit	SC01/RS03	0.14 km ²	87% in SC01 catchment 13% in RS03 catchment.
SRX Pit	RS03	0.15 km ²	Maximum footprint.
SRE Pit	RS03	0.10 km ²	Maximum footprint.
Infrastructure Area	SC01	0.05 km ²	Includes Mill and ROM.
Haul Roads	SC01/RS03	0.39 km ²	82% in SC01 catchment 8% in RS03 catchment.

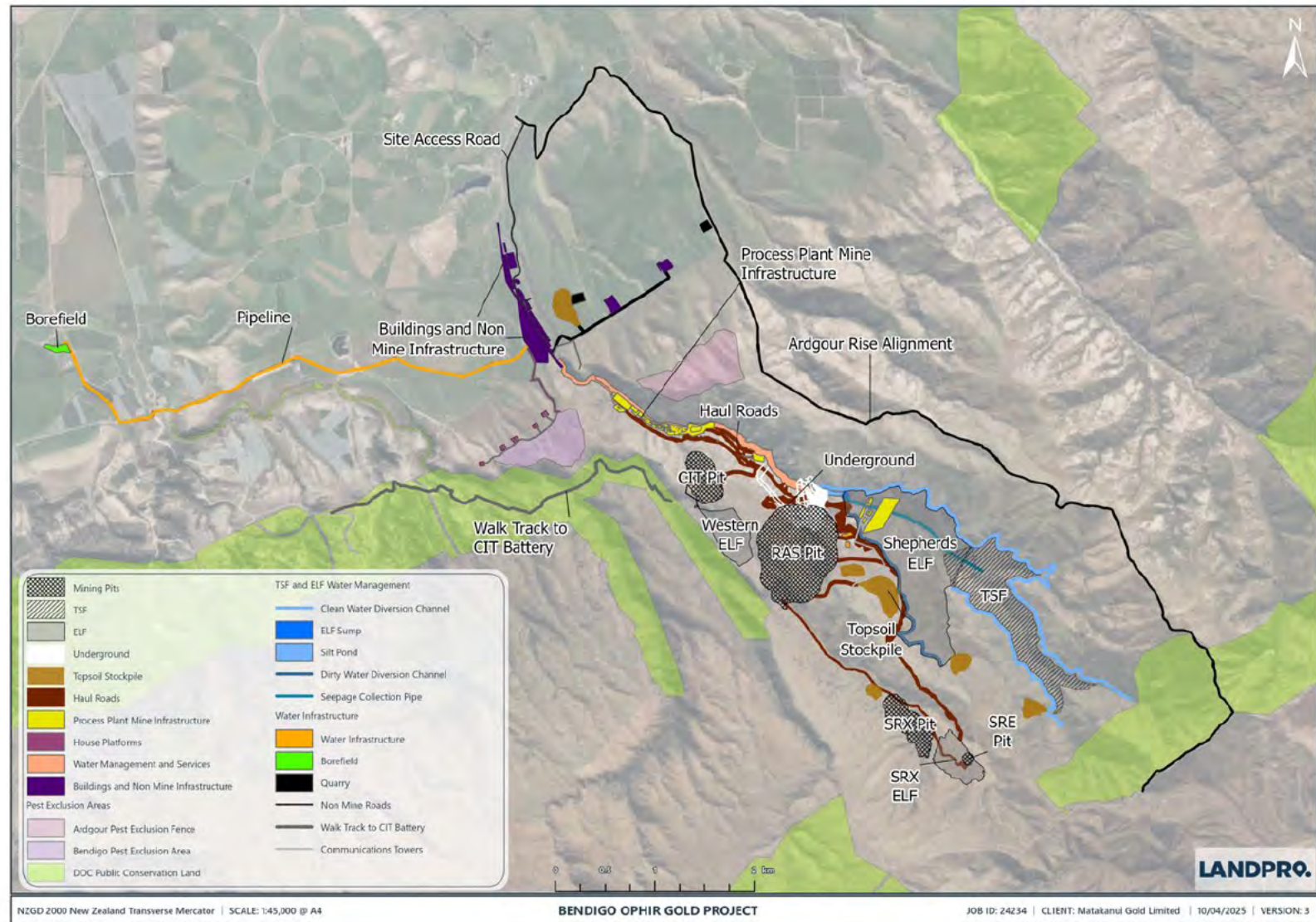


Figure 1: BOGP mine domains.

2.3 Water Management

To help understand the origin and quantity of rainfall and runoff being derived from different infrastructure areas and domains, the site is divided into surface water monitoring locations and their upstream catchment areas (Figure 2). Surface water quantity and quality are referenced with respect to the proposed downstream resource consent compliance monitoring locations at SC01 and RS03. These catchments are shown in Figure 2.

The water management strategy for the BOGP is also divided into operational and closure/post-closure phases:

- **Operational Phase:** most MIW will be retained on site for use (e.g., for process water, dust suppression, etc.), with the only discharge from disturbed areas being surface runoff from haul roads, the infrastructure area, and ELF's via sediment control structures. Seepage from landforms will not be discharged off site.
- **Active Closure and Post Closure phases (Closure Phase):** seepage from ELF's, the TSF, and pit void water will be collected and treated, initially with an active water treatment plant (Shepherds Creek catchment) until loads have reduced such that passive treatment can be utilised to meet water quality objectives.

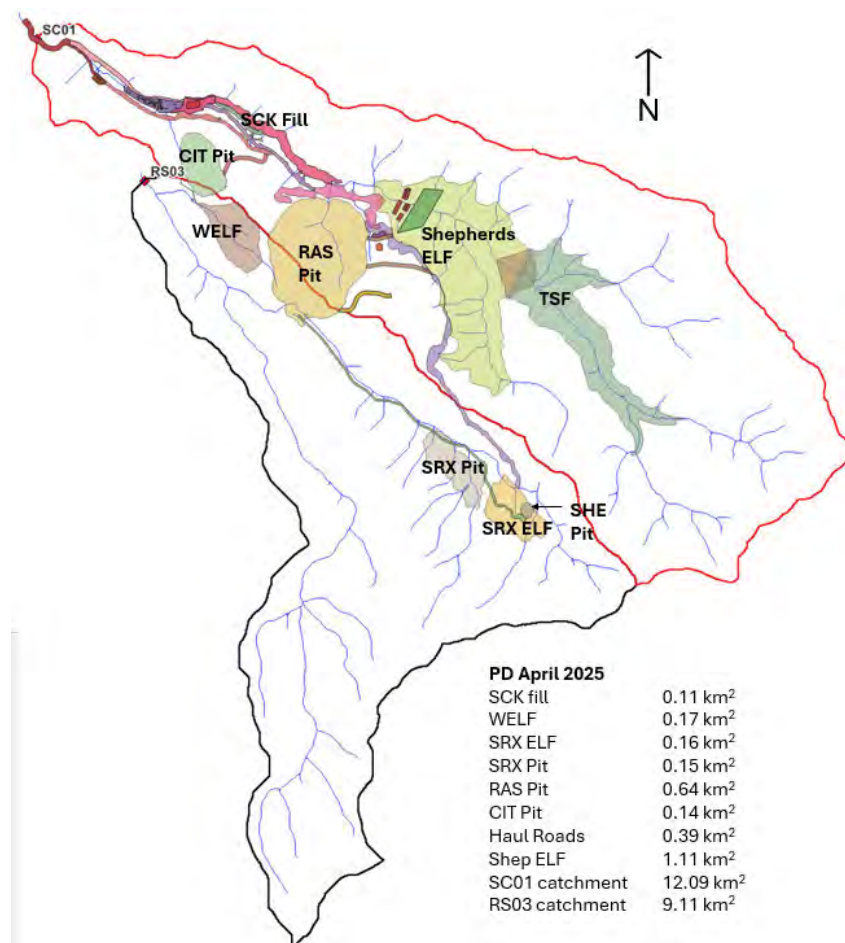


Figure 2: Location and areas of key mine domains within SC01 and RS03 catchments.

The water management approach for each key mine domain element (that has potential to produce MIW) are summarised for operational and closure phases in Table 3. These descriptions form the basis of the water quality and water balance calculations in subsequent sections of this report.

Table 3: MIW management approach for operational and closure phases.

MINE DOMAIN	DESCRIPTION	OPERATIONAL PHASE	CLOSURE PHASE
TSF	Condition	Active tailings deposition.	Rehabilitated.
	Surface Runoff	Runoff retained within facility. Diversion channels established to minimise run-on.	Runoff assumed to be clean and discharges to Shepherds Creek.
	Seepage	TSF seepage collected and conveyed to TSF or used for process water.	TSF seepage collected and conveyed for treatment.
Shepherds ELF	Condition	Active mine rock placement.	Rehabilitated.
	Surface Runoff	Runoff sheeted to sediment pond and then discharged to Shepherds Creek (if water quality is suitable). Otherwise pumped to the mine water circuit for reuse. Diversion channels established to minimise run-on.	Runoff assumed clean and discharged to Shepherds Creek. Diversion channels maintained to minimise run-on (i.e., to reduce seepage flows).
	Seepage	ELF seepage collected and conveyed to TSF or used for process water.	ELF seepage collected and conveyed for treatment.
RAS Pit Void	Condition	Active dewatering of pit.	Dewatering ceases and pit lake development.
	Surface Runoff	Rise and Shine Creek diverted around pit extent. Collected in pit sumps and used for dust suppression if suitable and/or process water	Reports to pit lake.
	Seepage	None.	Pit lake discharges via RAS underground workings portal and conveyed for treatment.
Underground Workings	Condition	Workings actively dewatered. Paste backfilling of stopes.	Workings flooded and provide discharge pathway for RAS pit lake water discharge.
	Surface Runoff	None.	None.
	Seepage	Dewatering used for processing or conveyed to TSF.	Portal discharge collected and conveyed for treatment.
CIT Pit Void	Condition	Pit void actively dewatered.	Void backfilled, rehabilitated and filled with water.
	Surface Runoff	Collected in pit sumps and used for dust suppression.	Runoff assumed clean and discharges to Shepherds Creek.
	Seepage	Collected in pit sumps and used for dust suppression if suitable and/or process water	Backfill seepage collected and conveyed for treatment.

MINE DOMAIN	DESCRIPTION	OPERATIONAL PHASE	CLOSURE PHASE
WELF	Condition	Active mine rock placement.	Rehabilitated.
	Surface Runoff	Runoff sheeted to local sediment pond. Discharged to Rise and Shine Creek (RS03) if water quality is suitable, otherwise conveyed to TSF.	Runoff assumed clean and discharges to Rise and Shine Creek (RS03). Diversion channels maintained to minimise run-on where practicable.
	Seepage	Collected in pit sumps and used for dust suppression if suitable and/or process water	Reports to SC01 via treatment.
Process Plant/Infrastructure Area	Condition	Area operational.	Rehabilitated.
	Surface Runoff	Diversion in place to limit run-on. Runoff sheeted to local sediment ponds and discharged to receiving environment if suitable. Otherwise, conveyed to mine water circuit.	Runoff assumed clean and discharged to Shepherds Creek.
	Seepage	No significant seepage expected.	No significant seepage expected.
Shepherds Creek Valley Fill	Condition	Lower gorge has to be filled, to create sufficient width for services (e.g., infrastructure). Shepherd channel designed to take a 1% AEP event	Valley infill to remain. Channel continues to support 1% annual exceedance probability (AEP). Non-channel area assumed rehabilitated.
	Surface Runoff	Clean water diversions that bypass the TSF and ELF drop into new channel in Shepherds Creek valley until past the mine infrastructure.	Runoff assumed clean and discharged to Shepherds Creek.
	Seepage	Any seepage that expresses at surface to downstream extent of fill will be collected and conveyed to TSF or used for process water.	If water quality is not suitable for discharge, collected and treated. If suitable, then discharged to Shepherds Creek.
SRE Pit Void	Condition	Pit void actively dewatered.	Dewatering stops. Pit void backfilled with SRX ELF overtop and floods.
	Surface Runoff	Collected in pit sumps and used for dust suppression if suitable and/or process water. Diversions in place to minimise run-on.	Reports to SRX Pit Lake.
	Seepage	None.	Reports to SRX Pit Lake.
SRX Pit Void	Condition	Pit void actively dewatered.	Dewatering stops. Pit void floods to develop pit lake and spills to Rise and Shine Creek.
	Surface Runoff	Collected in pit sumps and used for dust suppression if suitable and/or process water Diversions in place to minimise run-on.	Reports to SRX Pit Lake. Partial passive treatment of SRX Pit Lake overflow (8 L/s) is required to achieve the proposed water quality compliance limits at RS03.
	Seepage	None.	Reports to SRX Pit Lake. Partial passive treatment of SRX Pit Lake overflow (8 L/s) is required to achieve the proposed water quality compliance limits at RS03.

MINE DOMAIN	DESCRIPTION	OPERATIONAL PHASE	CLOSURE PHASE
SRX ELF	Condition	Active mine rock placement.	Rehabilitated.
	Surface Runoff	Runoff sheeted to local sediment pond. Discharged to Rise and Shine Creek is water quality if suitable, otherwise conveyed to TSF. Diversions channels established minimise run-on where practicable.	Runoff assumed clean and discharges to Rise and Shine Creek. Diversions channels maintained to minimise run-on where practicable.
	Seepage	Seepage collected at local sump and conveyed to TSF or used for process water.	Reports to SRX Pit Lake. Pit lake spill partially treated (8 L/s).
Haul Roads	Condition	Haul roads operational.	Rehabilitated.
	Surface Runoff	Diversions in place to limit run-on. Runoff sheeted to local sediment ponds and discharged to receiving environment if suitable. Otherwise, conveyed to TSF or used for process water.	Runoff assumed clean and discharged to Shepherds Creek and Rise and Shine Creek.
	Seepage	No significant seepage expected.	No significant seepage expected.

2.4 Proposed Compliance Limits

Proposed compliance limits are described in the BOGP Water Management Plan (MGL, 2025) and tabulated below for surface water (Table 4) and groundwater (Table 5). These limits were used to screen model results against in Sections 4 and 5.

Table 4: Proposed surface water compliance limits.

PARAMETER (units are mg/l unless stated otherwise)	COMPLIANCE LIMIT
pH (unitless)	6.5 - 9.0
Turbidity (NTU)	5 (over a 5-year rolling period, 80% of samples, when flows are at or below median flow, are to meet the limit)
Ammoniacal-nitrogen (NH ₃ -N)	≤0.24 (annual median) <0.4 (annual 95 th percentile)
Nitrate-nitrogen (NO ₃ -N)	<2.4 (annual median) <3.5 (annual 95 th percentile)
Cyanide (CN)	0.011 (un-ionised HCN, measured as [CN], ANZG, 2018)
Sulfate (SO ₄)	A. If hardness is <100 mg/L (CaCO₃), the sulfate compliance limit = 500 mg/L. B. If chloride is <5 mg/L, the sulfate compliance limit = 500 mg/L C. If the hardness is 100–500 mg/L AND if chloride is 5–<25 mg/L, the sulfate compliance limit is (in mg/L): $[-57.478 + 5.79 \times (\text{hardness mg/L CaCO}_3) + 54.163 \times (\text{chloride mg/L})] \times 0.65$ D. If hardness is between 100 and 500 mg/L AND if chloride is between ≥25 and ≤500 mg/L, the sulfate limit is (in mg/L): $[1276.7 + 5.508 \times (\text{hardness mg/L CaCO}_3) + 1.457 \times (\text{chloride mg/L})] \times 0.65$ A minimum of 12 samples must be collected over any rolling 12-month period. For compliance limits in A to D, no more than 20% of samples collected over a rolling 12-month period may exceed the relevant compliance limit.

	E. An acute compliance limit = 1,000 mg/L averaged over 4 days and not to be exceeded more than once in a one-year period, OR in more than 10% of samples over a one-year period.
Aluminium (Al) (dissolved)	≤0.08
Antimony (Sb) (total)	0.074 (chronic, the average of 5 (monthly) samples over a 5-month period) 0.250 (acute, not to be exceeded at any time)
Arsenic (As(V)) (dissolved)	≤0.042
Cadmium (Cd) (dissolved)	≤0.0004 See below for adjustment algorithm
Chromium (Cr) (dissolved)	≤0.0033 (CrIII) ≤0.006 (CrVI) See below for adjustment algorithm
Cobalt (Co) (dissolved)	0.001 (chronic) 0.11 (acute, not to exceed) See below for adjustment algorithm
Copper (Cu) (dissolved)	≤0.0018
Molybdenum (dissolved)	≤0.034
Zinc (Zn) (dissolved)	0.015 See below for adjustment algorithm
Adjustments	
Cd (dissolved)	HMTV = TV (H/30) ^{0.89} , where hardness-modified trigger value (HMTV) = (µg/L), trigger value (TV) (µg/L) at a hardness of 30 mg/L as CaCO ₃ ; H, measured hardness (mg/L as CaCO ₃) of a fresh surface water.
Cr (dissolved)	HMTV = TV (H/30) ^{0.82} , where hardness-modified trigger value (HMTV) = (µg/L), trigger value (TV) (µg/L) at a hardness of 30 mg/L as CaCO ₃ ; H, measured hardness (mg/L as CaCO ₃) of a fresh surface water.
Co (dissolved)	Cobalt (µg/L) = $\exp\{(0.414[\ln(\text{hardness CaCO}_3 \text{ mg/L})] - 1.887)\}$
Sb (total)	(chronic) the average of 5 (monthly) samples over a 5-month period (acute) not to be exceeded at any time
Zn (dissolved)	HMTV = TV (H/30) ^{0.85} , where hardness-modified trigger value (HMTV) = (µg/L), trigger value (TV) (µg/L) at a hardness of 30 mg/L as CaCO ₃ ; H, measured hardness (mg/L as CaCO ₃) of a fresh surface water.

Source: MGL (2025)

HMTV = hardness modified toxicity value.

TV = toxicity value.

H = hardness.

Table 5: Proposed groundwater compliance limits.

PARAMETER (units are mg/L unless stated otherwise)	COMPLIANCE LIMIT
Nitrate-nitrogen (NO ₃ -N)	11.3 (MAV)*
Cyanide (CN ⁻)	0.6 (MAV)
Sulfate (SO ₄)	≤250 (taste threshold)
Aluminium (Al)	1 (MAV)
Antimony (Sb)	0.02 (MAV)
Arsenic (As(V))	0.01 (MAV)
Cadmium (Cd)	0.004 (MAV)
Chromium (Cr)	≤0.05(MAV)

PARAMETER (units are mg/L unless stated otherwise)	COMPLIANCE LIMIT
Cobalt (Co)	<1 (livestock drinking water)
Copper (Cu)	≤0.5
Iron (Fe)	≤0.3
Lead (Pb)	0.01 (MAV)
Manganese (Mn)	0.4 (MAV)
Molybdenum (Mo)	<0.01
Strontium (Sr)	4
Uranium (U)	0.03 (MAV)
Zinc (Zn)	≤1.5

Source: MGL (2025)

MAV = maximum acceptable value – from NZ drinking water standards.

3 CLIMATIC SETTING

This section summarises the climatic data for the BOGP, which provides key inputs to the WLBM.

The site is situated within the Otago semi-alpine region. As a result, the climate is strongly seasonal, comprising of frosts and snow between Autumn and Spring, and dry and hot summer months (with temperatures frequently exceeding 30° C). Rainfall in the region varies spatially, typically decreasing with increasing distance from the Southern Alps (KSL, 2025a). At the BOGP, three meteorological stations have been installed since 2022:

- Lake Clearview (340 m above sea level, asl).
- Come in Time (475 m asl).
- Srex, formerly Shreks Met (753 m asl).

The location of these stations and regional stations is shown in Figure 3.

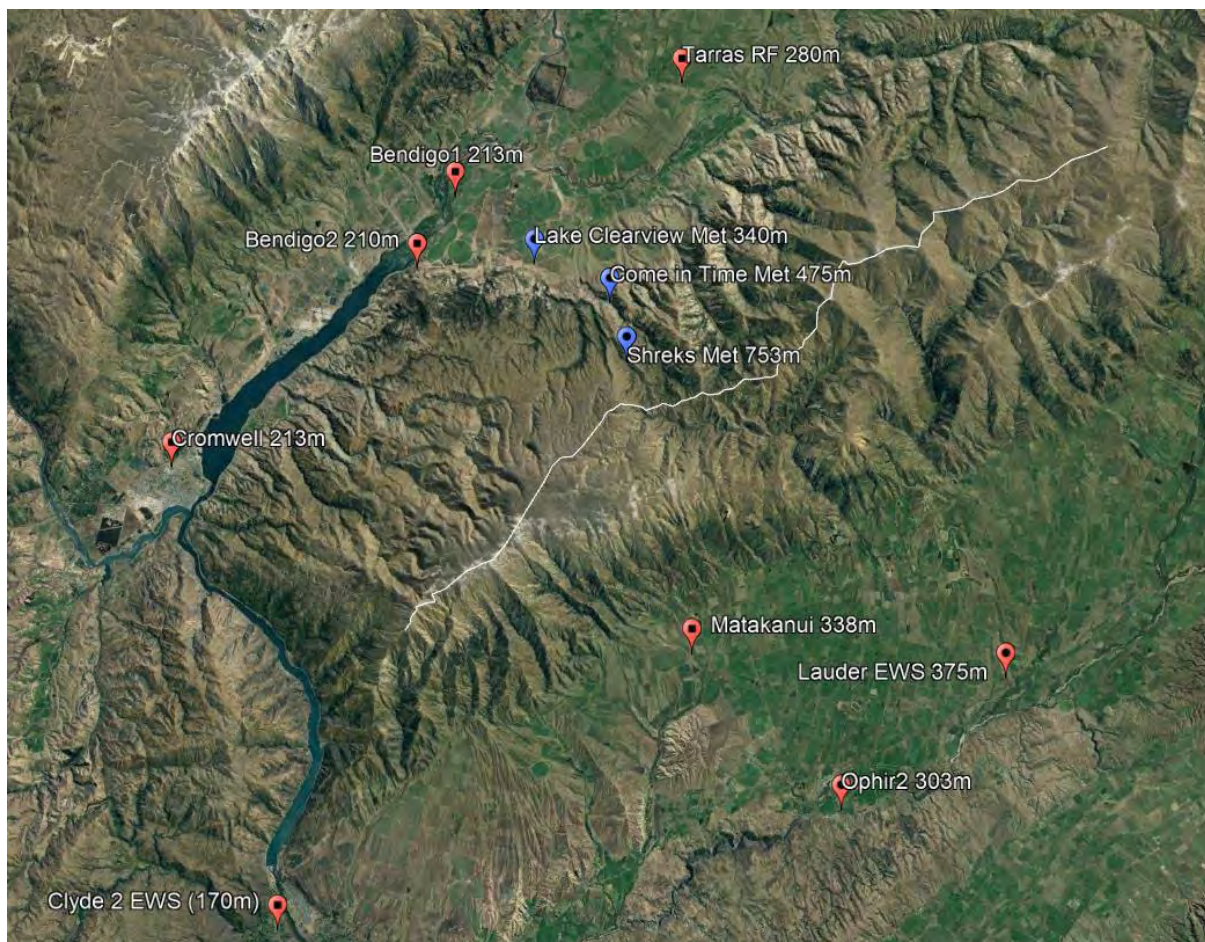


Figure 3 Location of meteorological stations.

Source: Chater (2024a).

Notes: BOGP stations shown in blue, regional stations shown in red. Shreks is now referred to as SRX.

3.1 BOGP Climatic Data

Site recorded data indicates a mean annual rainfall (between November 2022 through January 2025) that ranges from 442 to 506 mm depending on elevation for data collected between (KSL, 2025a), with

Lake Clearview being the lowest and Srex being the highest. An increasing rainfall-altitude relationship is observed. Rainfall remains broadly constant throughout the year ranging from 30 – 50 mm per month except for the months of July and August in which rainfall is notably lower. Dry spells of up to two weeks are also common in these months. Evapotranspiration is strongly seasonal with the reported long-term average ranging from approximately 6 mm in July to 136 mm in January. Due to evapotranspiration exceeding rainfall in the summer months, with the exception of storm events, runoff typically only occurs in the winter months (Santana, 2024).

3.2 BOGP Synthetic Climate Dataset

Synthetic climate datasets were developed to increase the length of climate records beyond the handful of years available from site meteorological stations:

- A synthetic daily rainfall dataset was developed by Chater (2024a). This was scaled to the Srex meteorological station (elevation: 753 m above sea level), based on a relationship between rainfall and elevation derived by Chater (2024b) that was representative of the Shepherds and Rise and Shine Creek catchments. The synthetic rainfall record was developed for the Lake Clearview meteorological station (elevation: 340 m asl) and spanned the period 03/06/1949 through to 16/02/2025 (~75 years). These reference works (Chater, 2024a, 2024b) are provided in Appendix B.
- A synthetic daily potential evapotranspiration (PET) record was developed by establishing a relationship between the Srex meteorological station and the Cromwell EWS (retrieved from <https://cliflo.niwa.co.nz/> October 2024) station potential evaporation data. The relationship was based on overlapping data between 2/12/2022 and 1/12/2024 (~2 years), the following linear regression equation: $\text{Srex PET} = 0.715 \times \text{Cromwell EWS PET} + 0.5078$ (Figure 4). The synthetic record established ranged between 7/04/2006 through to 12/12/2024 (~19 years).

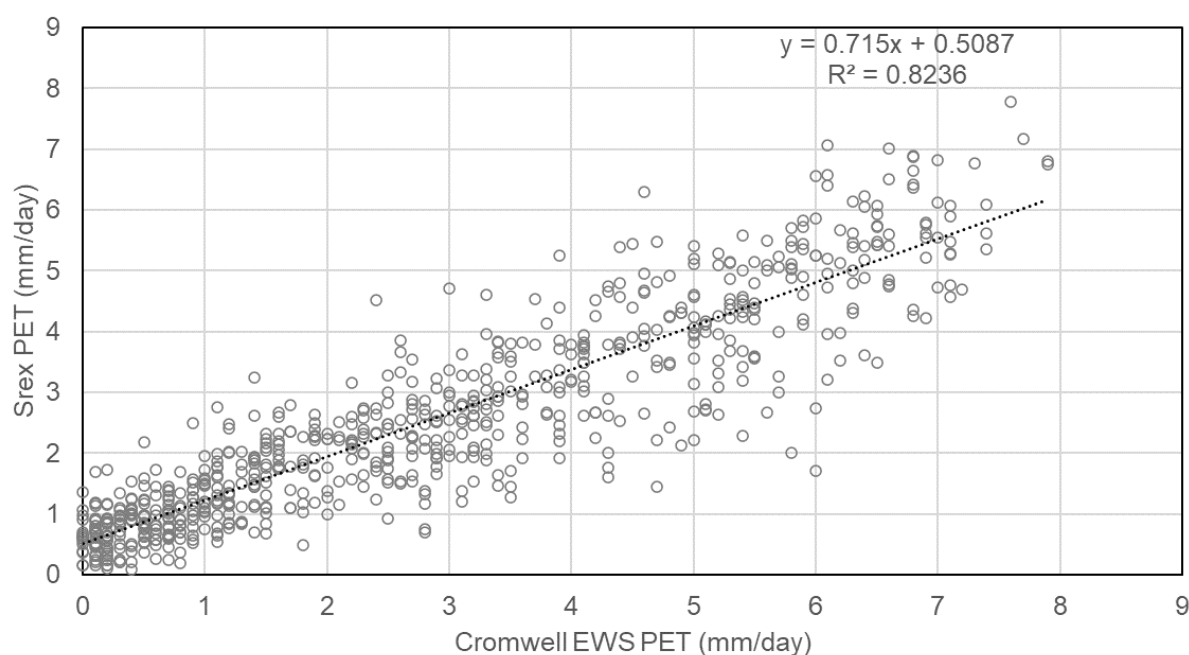


Figure 4: Srex Met vs Cromwell EWS PET.

Annual totals of the synthetic rainfall and PET datasets are shown in Figure 5 and Figure 6, respectively. On average, annual, PET (~930 mm/year) is close to twice that of rainfall (~500 mm/year). The wettest year was 1995, where ~760 mm of rain fell. The average annual synthetic PET compares well with evaporation pan data from NIWA climate stations Bendigo 2, Clyde Dam, and Cromwell 2, multiplied by a typically used conversion factor of 0.7 (average of ~1010 mm/year).

Figure 7 summarises the average monthly climate setting for the synthetic dataset, showing a strong water deficit in the summer months and a slight water surplus in the winter months.

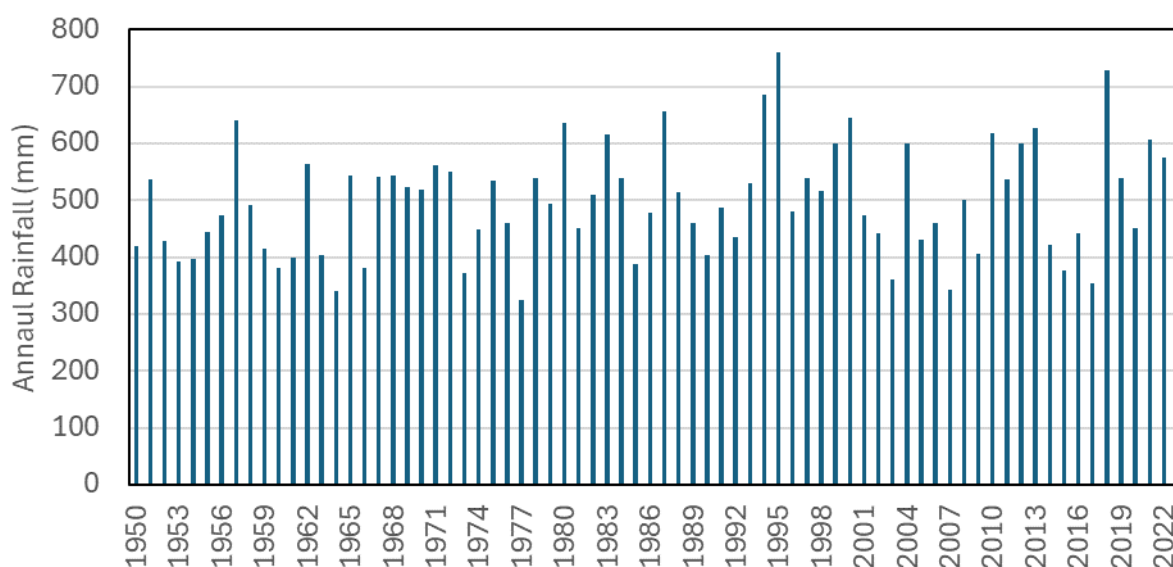


Figure 5: Annual rainfall totals of synthetic rainfall dataset.

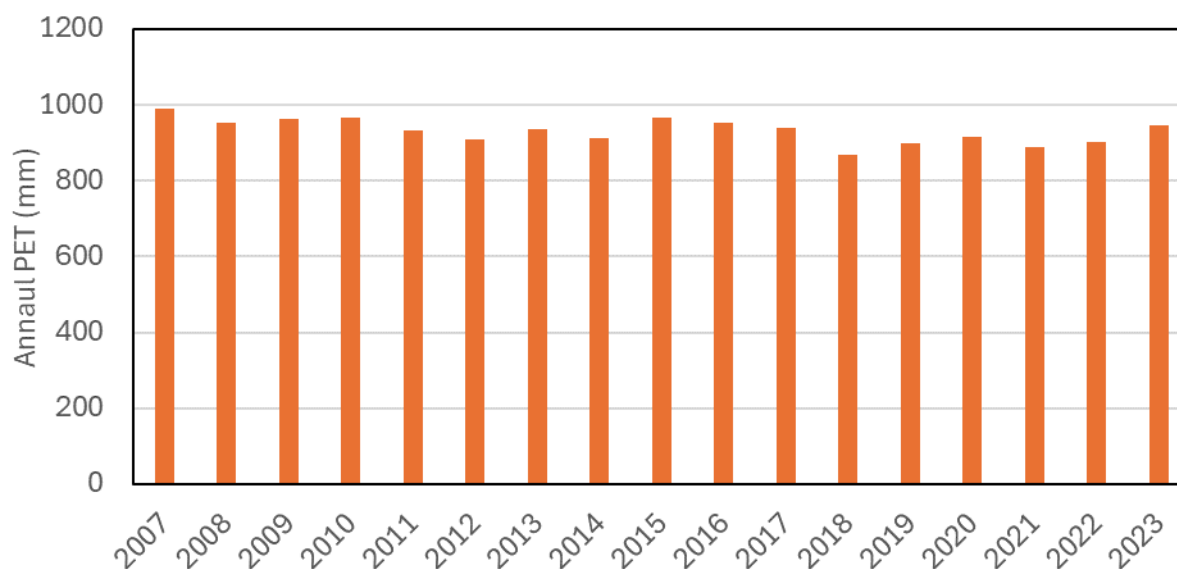


Figure 6: Annual PET totals of synthetic rainfall dataset.

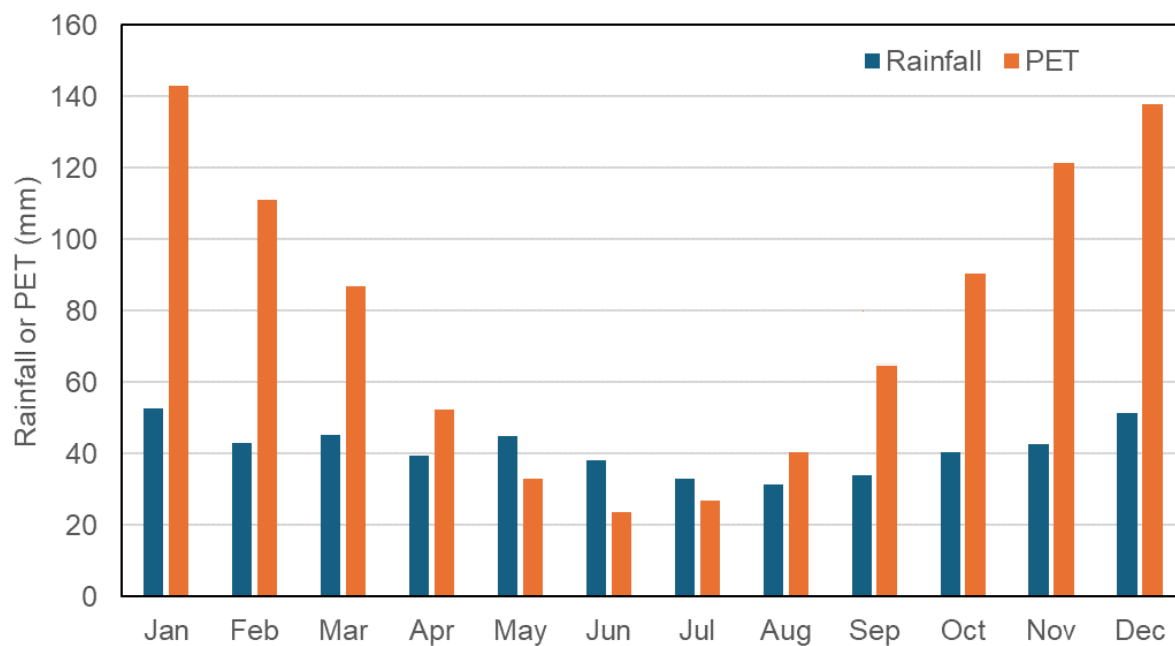


Figure 7: Average monthly synthetic climate data summary.

4 OPERATIONAL PHASE ASSESSMENT

This section assesses the potential effects to the receiving environment during the Operational Phase of the mine.

4.1 Introduction

There are two key water types that need to be managed as part of the BOGP water management strategy:

1. **Internal MIW:** Waters that will be managed internally and will not be discharged during the operational phase of the BOGP. This includes process water, seepage from ELF's, the TSF, water from pit voids, and the underground (Figure 8).
2. **Surficial MIW:** Waters that will be discharged during the operational phase of the BOGP. These waters are derived from routing of runoff from haul roads, infrastructure areas⁸, and ELF surfaces through sediment control structures (ponds and/or sumps) (Figure 8), and subsequent discharge to the receiving streams (Shepherds Creek and Rise and Shine Creek).

4.2 Operational Water Management Risks

As a result, the key MIW risks to downstream water quality for the Operational Phase are:

- **For Internal MIW:** A prolonged site water surplus conditions (under normal operating conditions) could exceed site water storage capacity and result in discharge of Internal MIW to the receiving environment. Additional controls may need to be engaged to prevent direct discharge. Further discussion on this issue is provided in Section 4.3.
- **For Surficial MIW:** Elevated sulfate, potential constituents of concern (PCOC) such as arsenic (As), and suspended sediments concentrations in runoff from haul roads, the infrastructure area, and the ELF surfaces. It is assumed that sediment will be managed by routing runoff from these sources through sediment control structures⁹. These structures are not anticipated to reduce sulfate or PCOC; therefore, non-compliance could potentially occur during and/or following runoff events. Further discussion on this issue is provided in Section 4.4.

⁸ Note: the infrastructure area excludes the process plant area, ore stockpiles, and other areas of impacted water, which will be used for processing, or will be diverted to the TSF.

⁹ This risk is managed by the erosion and sediment control management plan.

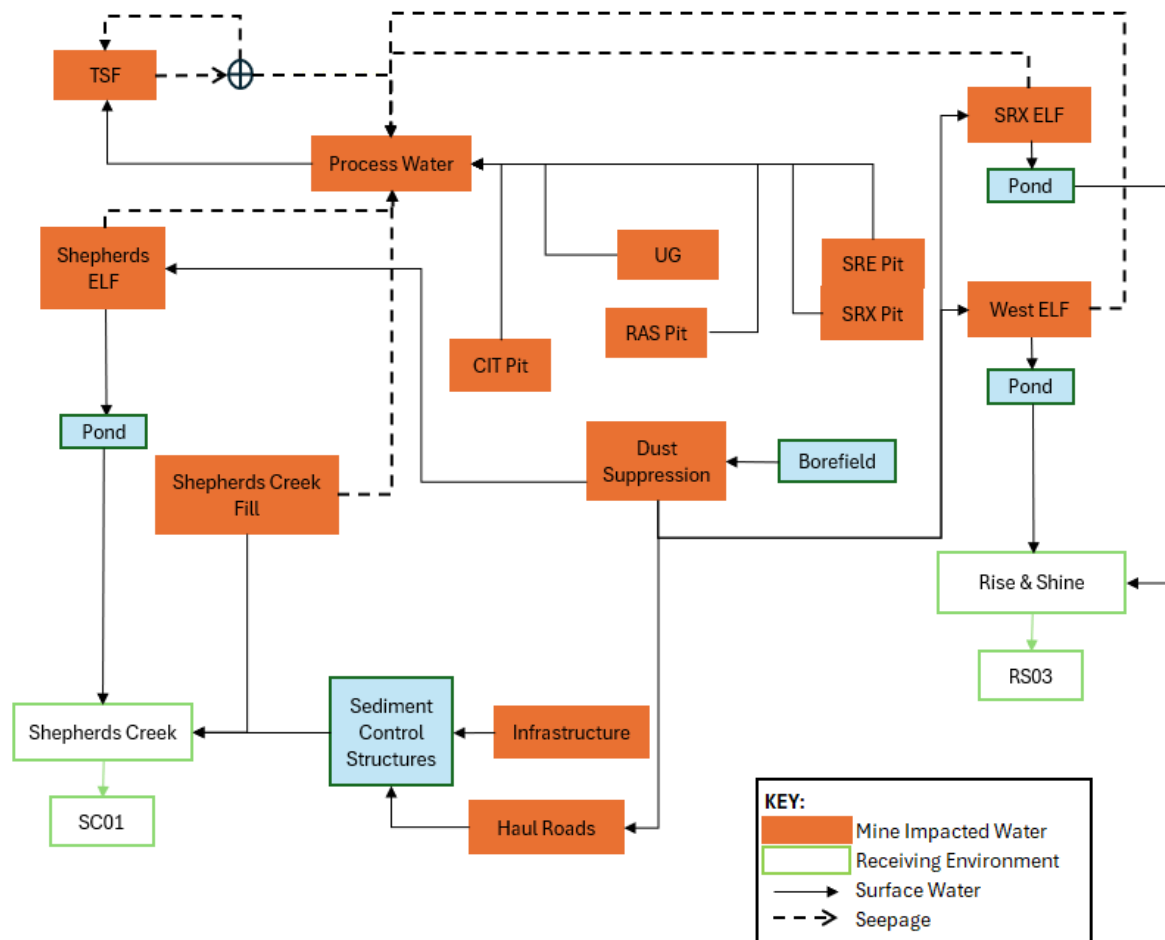


Figure 8: Separation of Internal and Surficial MIW during the operational phase at the BOGP site.

4.3 Internal MIW Water Balance

This section assesses the risks for an Internal MIW water surplus and then subsequent discharge to the receiving environment.

4.3.1 Internal MIW Water Sources and Water Loss

The BOGP Internal MIW water balance is calculated from the annual volumes of water sources and sinks. Sources include, for instance, raw water for processing, rainfall (and subsequent runoff) to the TSF, and pit dewatering, whereas sinks include, for instance, evapotranspiration and water locked up in tailings (Table 4).

Table 6: Internally managed MIW sources and sinks of water.

SOURCES	SINKS
Rainfall directly onto the TSF.	Evaporation from the TSF.
Rainfall runoff from undisturbed areas between diversion channels and the TSF.	Water retained in tailings.
Seepage from the ELFs.	Evaporation of water used for dust suppression.
Runoff from the plant area.	Water used for paste production.
Dewatering from active pits.	
Dewatering from underground workings.	
Raw water input to the processing plant.	

4.3.2 Annual Site Water Balance

A site water balance of the internally managed MIW source and sinks was developed on an annual basis over the operational mine phase from Year 2 through Year 13 (see Table 1 for mine plan schedule). Given the uncertainty in water quality and quantity for some sources, two scenarios were included in the water balance, a Low Case and High Case. These cases show the range in potential water balance conditions for the site. Components of the annual site water balance are described in Table 5. Annual average rainfall and potential evaporation from the synthetic climate dataset described in Section 3 was used. The implication of wetter years on the water balance is discussed alongside the water balance results.

Seepage from the TSF, and any water reclaimed from the TSF pond for ore processing, were not included in the water balance as they will be returned to the TSF and therefore do not contribute to a change in the water balance.

Table 7: Water balance input basis.

COMPONENT	DESCRIPTION	
	LOW CASE	HIGH CASE
WATER SOURCES		
TSF direct rainfall	Adopts maximum TSF footprint of 608,338 m ² .	No change from Low Case.
Runoff to TSF	Adopts an estimated footprint of 300,000 m ² (that represents the undisturbed area reporting to the TSF and not diverted by clean water channels) and a runoff coefficient of 10% (based on synthetic average flows developed for SC01 by KSL [2025a]).	No change from Low Case.
Shepherds ELF seepage	Assumes an ELF footprint of 1,107,928 m ² . Progressive rehabilitation of 5% of this area per year, which equates to 55% at the end of mine life was adopted. For non-rehabilitated areas, a net percolation rate of 60% of annual rainfall was adopted, and 20% for rehabilitated portions (based on MWM 2025a) ^(vii) .	As per Low Case, except net percolation was increased to 80%.
RAS Pit dewatering	The area of the open pit void was increased over time from Year 2, assuming the full footprint (643,390 m ²) was reached by Year 10. A pit wall runoff coefficient of 50% and groundwater inflow of 5 L/s (KSL, 2024) were adopted for the full pit footprint and reduced based on the reduced footprint over time.	As per Low Case, except runoff coefficient was increased to 70%.
Underground dewatering	KSL (2025b) estimated an inflow of 30 L/s that represented the full underground development using the Goodman et al. (1965) equation. However, many examples have shown that the Goodman equation tends to overestimate inflows to tunnels. For example, work by Moon and Fernandez (2009) suggest at depths of 150 m below the phreatic surface, inflows could be only 30% of that calculated by the Goodman equation once drawdown and effective stress around a tunnel is taken into account. Therefore, a groundwater inflow rate for the RAS underground workings 200 m below the phreatic surface would be in the region 9 L/s. Once ventilation losses (5 L/s adopted) are taken into account, the net water source equates to 4 L/s for the water balance assessment.	No change from Low Case.
Process Plant raw water	Estimate provided by MACA Interquip ⁽ⁱⁱⁱ⁾ . Does not vary with average vs wet year condition.	No change from Low Case.

COMPONENT	DESCRIPTION	
	LOW CASE	HIGH CASE
SCK Valley Fill	Assumes a footprint of 111,845 m ² and a net percolation of 20% (based on MWM 2025a) where the fill is rehabilitated from the start of mining.	No change from Low Case.
SRX ELF	Assumes a footprint of 200,799 m ² and a net percolation rate of 60% of annual rainfall (unrehabilitated). Active from Year 12.	No change from Low Case except net percolation increased to 80%.
Western ELF	Assumes a footprint of 200,799 m ² Active from Year 2, then rehabilitated from Year 4 onwards. Net percolation rate of 60% of annual rainfall adopted for unrehabilitated period, and this was reduced to 20% once rehabilitated.	No change from Low Case except net percolation increased to 80% for unrehabilitated period.
CIT Pit dewatering	Given the pit is only operating for ~12 months, it was assumed that water quality would not deteriorate significantly and be suitable for use as dust suppression.	Assumes a footprint of 135,357 m ² and a runoff coefficient of 70%, plus groundwater inflows of 3.5 L/s (KSL, 2024). Only active during Year 9, then backfilled and rehabilitated.
SRX Pit dewatering	Given the pit is only operating for ~24 months, it was assumed that water quality would not deteriorate significantly and be suitable for use as dust suppression.	Assumes a footprint of 135,934 m ² and a runoff coefficient of 70%, plus groundwater inflows of 23 L/s (KSL, 2024). Only active during from Year 12 onwards.
SRE Pit dewatering	Given the pit is only operating for <12 months, it was assumed that water quality would not deteriorate significantly and be suitable for use as dust suppression.	Assumes a footprint of 10,461 m ² and a runoff coefficient of 70%, plus groundwater inflows of 1 L/s (KSL, 2024). Only active during Year 12, then backfilled with SRX ELF.
Plant area runoff.	Adopts an estimated footprint of 300,000 m ² and a runoff coefficient of 10%.	No change from Low Case.
WATER SINKS		
TSF pond evaporation	Adopts a maximum TSF footprint of 608,338 m ² and an open water evaporation estimate of 1,000 mm/year ⁽ⁱⁱⁱ⁾ . Does not vary with average vs wet year condition.	No change from Low Case.
Water retained in tailings	Estimate provided by EGL ^(iv) for 1.5 mega tonne per day nominal processing rate. Does not vary with average vs wet year condition.	No change from Low Case.
Paste production	Estimate of 3 L/s from MGL ^(viii) .	No change from Low Case.

Table Notes:

i. Average annual rainfall (500 mm) was based on the 73-year synthetic rainfall record developed for the site, scaled to the elevation of the Srex meteorology station.

ii. C. Warden personal communication 25 November 2024.

iii. Open-water evaporation estimate based on Srex meteorology station PET (~930 mm/year) multiplied by 1.05 as per Allen et al. (1998).

iv. E. Torvelainen personal communication 18 November 2024.

v. R. Redden personal communication 21 November 2024.

vii. R. Redden personal communication 22 November 2024.

vii. MWM (2025a) has estimated a net percolation rate of 60-80% for exposed (unrehabilitated ELFs), and 20% for rehabilitated ELFs.

viii. R. Redden personal communication 22 November 2024.

Results from the water balance are presented graphically in Figure 9, and the total proportion over the mine life from each source and sink is tabulated in Table 6. Results suggest the following:

- For the Low Case, a water deficit condition is maintained, which reduced through time to ~10,000 m³/year from Year 12 onwards.
- The High Case results are similar, except for Year 9 and Year 12 onwards where CIT Pit and SRX Pit dewatering are managed within the MIW circuit.
- The largest water sources include rainfall on the TSF, Shepherds ELF seepage, RAS Pit dewatering, and the process plan raw water demand.

The dominant water-deficit condition for the Low Case is consistent with regional meteorological data which indicates a dry temperate climate (KSL, 2025a). This is characterised by an average annual PET nearly twice that of average annual rainfall.

Although only an annual average rainfall year is used, it is noted that following the wettest year on record (1995, with 760 mm falling), the subsequent three years had close to average annual rainfall (480 mm, 560 mm, and 520 mm), suggesting for the Low Case, that the site could 'recover' from a wet year except potentially towards the end of mine life when the deficit becomes smaller.

The High Case is less promising, where the CIT Pit and SRX Pit dewatering could drive the site into a water surplus condition without any additional controls in place. However, it is noted that the available estimate of groundwater inflow to SRX Pit of 23 L/s (KSL, 2024) is higher than the average creek flow in Rise and Shine Creek by a factor of approximate 3, and therefore highly conservative. The conservative nature of the estimate notwithstanding, if a lower groundwater inflow rate is applied to the High Case of say 3 L/s, a water surplus condition is still reached, but of much less magnitude.

If the site were to enter into a consistent water surplus condition, the following engineering controls could be considered to additional water:

- Use of evaporation cannons to increase evaporative losses.
- Increase water storage capacity on site for additional water storage prior to an active water treatment plant being commissioned.
- Commission the water treatment plant during operations rather than at closure to allow discharge of water surpluses.

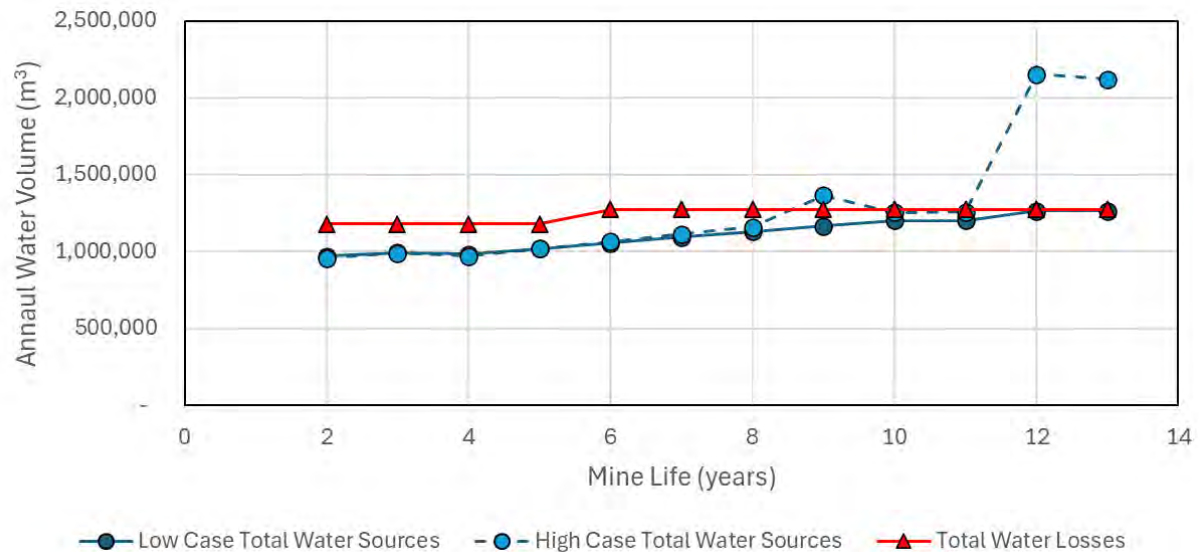


Figure 9: Annual water balance results.

Table 8: Total water balance proportion.

COMPONENT	LOW CASE	HIGH CASE
WATER SOURCES		
TSF direct rainfall	29%	26%
Runoff to TSF	1%	1%
Shepherds ELF seepage	23%	17%
RAS Pit dewatering	20%	21%
Underground dewatering	5%	4%
Process Plant raw water	17%	15%
SCK Valley Fill	1%	1%
SRX ELF	1%	1%
Western ELF	2%	2%
CIT Pit dewatering	0%	1%
SRX Pit dewatering	0%	10%
SRE Pit dewatering	0%	<1%
Plant area runoff.	1%	1%
WATER SINKS		
TSF pond evaporation	53%	As per Low Case.
Water retained in tailings	42%	As per Low Case.
Paste production	5%	As per Low Case.

Note: values are rounded so may not sum to 100% for all sources or sinks.

4.3.3 Internal MIW Water Quality

Internal MIW water quality is not assessed given it will not be discharged to the receiving environment under normal operating conditions.

4.3.4 Changes to Creek Flows

Changes to creek flows were calculated based on the runoff generation described in Section 4.4.2, and reflect the mine footprint at life of mine (i.e., maximum disturbance footprint). Calculation results are presented in Table 7, showing reductions to average flow of 17% and 13% for SC01 and RS03,

respectively. It is noted here that flow changes will be lower at the start of mine life and increase over time as the mine footprint expands.

Table 9: Calculated changes in creek flow summary statistics at end of the operation phase.

	MEAN FLOW (L/s)	MEDIAN FLOW (L/s)	7D MALF (L/s)
SC01 Simulated Baseline	19.2	13.2	4.42
SC01 Simulated LOM	15.9	10.2	3.24
SC01 difference between baseline and LOM	-3.3 (-17%)	-3 (-23%)	-1.18 (-27%)
RS03 Simulated Baseline	14.5	10	3.34
RS03 Simulated LOM	12.6	8.7	2.84
RS03 difference between baseline and LOM	-1.9 (-13%)	-1.3 (-13%)	-0.5 (-15%)

7D MALF = seven day mean annual low flow.

Note flow values are rounded to reflect inferred accuracy.

4.4 Surficial MIW Water Quality

This section assesses the risks for Surficial MIW discharge to the downstream receiving environment during and/or after high rainfall events.

4.4.1 Approach

This section describes the use of conservative solute mixing models (i.e., no geochemical reactions such as mineral precipitation) to assess water quality during the Operational Phase. The models include solute associated with runoff from haul road and infrastructure areas, ELF surfaces, mixed with runoff from the undisturbed parts of a given catchment. Separate models were developed for SC01 and RS03. Life-of-mine footprints were used within the analysis to provide a conservative assessment. The models were run at daily time steps using the 11-year period synthetic rainfall record period, to account for the influence of climatic variability.

Derivation of runoff rates and solute source terms are described in the following sections.

4.4.2 Runoff Generation

Runoff was estimated for each mine area/domain reporting to compliance locations SC01 and RS03. Areal footprints adopted for each mine domain are tabulated in Table 8. The domains are grouped into areas of similar runoff response type (i.e., haul roads, ELF's, infrastructure and undisturbed) but are not necessarily physically connected. All runoff is assumed to report to the relevant compliance location within the same daily timestep that rainfall occurs. Runoff was calculated differently for disturbed and undisturbed areas as follows:

- Daily runoff for undisturbed areas was estimated using an 11-year synthetic daily unit runoff dataset derived by KSL (2025a) for SC01. This approach was used rather than the Runoff Model described in Section 5.2.3 because the Runoff Model does not replicate high flow events well, and this is when runoff from disturbed mine surfaces will be highest. The synthetic daily runoff should represent these dynamics better.

- Runoff from ELF surfaces, haul roads, and the infrastructure area was estimated based on the different runoff coefficients for different daily rainfall totals and the synthetic rainfall dataset spanning the same 11-year period used for estimating runoff for undisturbed areas. The runoff coefficients were based on previous work at the Macraes Mine (Golder, 2011) and are shown in Table 9.

Silt ponds on the site (e.g., Shepherds Silt Pond) will be designed to detain peak flows from 1 in 10-year, storm events. Maximum outflow from such silt ponds will range from 134 to 278 L/s for the 1-hour and 24-hour storm events respectively (EGL personal communication, 2024). Based on the daily runoff coefficients in Table 9, and the synthetic rainfall record, runoff would pass through the silt pond within a day (for 95% of the time). As such, the influence of the silt pond is unlikely to be significant for average daily water quality at compliance locations and is therefore not accounted for in this assessment. The same assumption was made for sediment control structures related to the haul roads or infrastructure areas.

Table 10: Mine domain runoff source areas.

SOURCE TYPE	TOTAL AREA REPORTING TO SC01 (Ha)	TOTAL AREA REPORTING TO RS03 (Ha)	REMARK
Haul roads	32	7	
Infrastructure areas	11	-	All mine infrastructure is within the Shepherds Creek catchment.
ELF surfaces	136 (Shepherds ELF, CIT, and Shepherds Fill)	33 (SRX ELF and WELF)	All engineered landform surfaces assumed to be similar.
Undisturbed areas	871	769	Total SC01 and RS03 catchment area minus areas disturbed by mining.

Further details on mine domain areas are provided in Table 2.

Table 11: Runoff coefficients for different daily totals.

RAINFALL DEPTH (mm/day)	HAUL ROADS AND INFRASTRUCTURE AREAS	ELF SURFACES
0 to 10	0.05	0
10 to 50	0.2	0.05
50 to 90	0.4	0.15
90	0.7	0.4

Source: Golder (2011).

4.4.3 Source Terms

Water running off mine impacted surfaces can be elevated in PCOC. The source of water used for dust suppression on mine impacted surfaces (e.g., haul roads) can also affect the run-off water quality.

Source terms have been developed to represent mine impacted surfaces where aquifer bore water has been used for dust suppression (no additional PCOC load other than that mobilised by water-rock interaction).

Pit sump water is anticipated to increase in solute concentration (e.g., sulfate) over time as the pit wall exposure increases. Application of this water source for dust suppression would elevate dissolved concentrations of runoff from a given surface. By contrast, if groundwater from a dedicated water supply bore is used for dust suppression, then dissolved concentrations of runoff would tend to be lower.

Groundwater source terms for dust suppression scenarios are therefore used in the mixing model to provide a range of resulting surface water quality.

Source terms for baseline surface water and mine impacted surfaces are tabulated in Table 10 based on MWM (2025b).

The source terms for mine impacted surfaces with bore water dust suppression had elevated components such as iron, which are not generally mobile in neutral/alkaline oxidised conditions. This source term was therefore run through PHREEQC¹⁰ with equilibrium phases to provide a more realistic source term.

The TZ4/RSSZ bore water dust suppression source term had lower sulfate concentrations than the mine impacted surfaces dust suppression source term that used the pit water source term. This source term is considered to be conservative since hauls roads and most ELF surfaces will be TZ3, which is a lower geochemical risk material. See MWM (2025b) for further details.

Table 12: Source terms used for the solute mixing model.

PARAMETER	BASELINE SW SC01	BASELINE SW RS03	TZ4 / RSSZ MINE IMPACTED SURFACES -BORE DS ¹
Report reference	J-NZ0475-001-R-Rev0 Table 3	J-NZ0475-001-R-Rev0 Table 4	J-NZ0475-001-R-Rev0 Table 20 run with PHREEQC equilibrium phases.
Alkalinity (mg CaCO ₃ /L)	216	39.1	140.5
pH (pH units)	8.11	7.42	8.4
EC (µS/cm)	488.9	86.4	1,037
Ca	60.8	11.1	90.4
Cl	6.08	1.33	20
F	0.103	0.057	0.83
Mg	21.3	1.99	76.42
Na	20.3	39.5	59
K	2.01	0.578	7.1
TOC	2.08	1.75	-
Al	0.00454	0.00756	0.00016
As	0.00239	0.0085	0
B	0.03304	0	0.104
Cd	0	0.0001	0
Co	0.00026	0.00025	0
Cr	0.00056	0.00059	0
Cu	0.00055	0.00046	0
Fe	0.011	0.0375	0
Hg	0	0	-
Mn	0.00265	0.0095	0.039
Mo	0.00051	0	0.045

¹⁰ A computer program for speciation, batch-reaction, one-dimensional transport, and inverse geochemical calculations. US geological survey techniques and methods, 6(A43), 497 (Parkhurst, D. L., & Appelo, C. A. J., 2013).

PARAMETER	BASELINE SW SC01	BASELINE SW RS03	TZ4 / RSSZ MINE IMPACTED SURFACES -BORE DS ¹
Report reference	J-NZ0475-001-R-Rev0 Table 3	J-NZ0475-001-R-Rev0 Table 4	J-NZ0475-001-R-Rev0 Table 20 run with PHREEQC equilibrium phases.
Ni	0.00035	0.00035	0.003
Pb	0	0	0.003
Sb	0.00053	0	0.14
Se	0.0025	0	0
Sr	0.947	0.136	1.84
Tl	0.00023	0	0
U	0.0051	0.00012	0.016
V	0	0	0
Zn	0.0017	0.00229	0.007
Sulfate	40.5	1.57	320
Ammoniacal-N	0.0103	0.0092	0.012
Nitrate-N	0.083	0.0088	0.094

Note: All units in mg/L unless otherwise stated.

SW = surface water

Note: Green data were <LOR and are included in the source term as '0'.

Source: Orange cells are from OceanaGold (2020a) Blue cells from Golder 2011. Yellow cells reduced from original source term after running with PHREEQC equilibrium phases.

1. Where there is a relationship between sulfate and the constituent for the sulfate concentration of interest, then the TZ3 relationship is used.

4.4.4 Mixing Model Results

The mixing model results for SO₄ concentrations in SC01 for bore water used as dust suppression are presented in Figure 10 through Figure 12, while Figure 13 through Figure 15 presents results for RS03. The mixing model result graphs for analytes where the mine impacted source term is greater than 0 are provided in Appendix C.

Mixing model results where bore water is used for dust suppression are presented in Table 11, with model results presented as maximum daily, and 30-day rolling mean, concentrations. Fixed value proposed compliance limits were used to screen model results against. The percentage of simulated concentrations which exceed proposed compliance limits are also presented. Surface water compliance limits were compared to the daily model results (except for antimony due to the 5-month average compliance condition; 30 day rolling mean results were used instead), while the groundwater limits were compared to a 30-day rolling mean of the model results to account for mixing processes along groundwater flow paths.

The only parameter that showed any potential for exceedance of the proposed compliance limits is molybdenum (Mo), with exceedances up to 2% of the time for surface water, but none for groundwater. However, review of the model results revealed that exceedances only occurred when there was a mismatch between the synthetic flow record and the synthetic rainfall record. For example, when rainfall (and disturbed surface runoff) was high, but the synthetic flow record reported low flows (e.g., 4/02/2013, 21/03/2018, and 29/05/2021). These rare mismatches occurred because the source of each dataset differs in location, with the rainfall based on a relationship to Cromwell, and the flow record based on a relationship to Cluden (~40 km apart). One would expect daily rainfall patterns to differ slight

on occasion. As a result, the apparent Mo exceedance is interpreted to be an artifact of the mixing model limitations rather than pose a real risk of non-compliance.

Overall, interpretation of the mixing model results suggests surface water quality will remain below the proposed compliance results for both surface and groundwater.

Table 13: Mixing model results for bore water dust suppression scenario including the maximum and average concentrations for each analyte and percentage of generated readings which exceed proposed compliance limits.

	PROPOSED COMPLIANCE LIMITS		SC01 - BORE WATER DUST SUPPRESSION				RS03 - BORE WATER DUST SUPPRESSION			
	SW SC01, RS03	GW (MW-101, MW-103, MW-103)	MAXIMUM DAILY CONC. (mg/L)	% EXCEEDING SW COMPLIANCE	MAX 30 DAY MEAN CONC. (mg/L)	% EXCEEDING ^B GW COMPLIANCE	MAXIMUM DAILY CONC. (mg/L)	% EXCEEDING SW COMPLIANCE	MAX 30 DAY MEAN CONC (mg/L)	% EXCEEDING ^B GW COMPLIANCE
Alkalinity (mg CaCO ₃ /L)	–	–	216.0	–	216.0	–	17.52	–	1.7	–
Ca	–	–	90.29	–	65.7	–	89.5	–	12.88	–
Cl	–	–	19.97	–	8.4	–	19.80	–	1.75	–
F	–	–	0.83	–	0.2	–	0.822	–	0.074	–
Mg	–	–	76.25	–	30.4	–	75.59	–	3.66	–
Na	–	–	58.88	–	26.7	–	58.78	–	39.94	–
K	–	–	7.085	–	2.8	–	7.03	–	0.724	–
TOC	–	–	–	–	–	–	–	–	–	–
Al	0.08	1 (MAV)	0.00454	0%	0.0045	0%	0.00756	0%	0.0074	0%
As	0.042	0.01 (MAV)	0.039	0%	0.0085	0%	0.0085	0%	0.0084	0%
B	–	–	0.10	–	0.045	–	0.102	–	0.002	–
Cd ^A	0.0004	0.004 (MAV)	–	–	–	–	–	–	–	–
Co ^A	0.001	1	–	–	–	–	–	–	–	–
Cr (diss) ^A	0.0033 (Cr(III))	0.05 (MAV)	–	–	–	–	–	–	–	–
	0.006 (Cr(VI))		–	–	–	–	–	–	–	–
Cu ^A	0.0018	0.5	–	–	–	–	–	–	–	–
Fe ^A	–	0.3	–	–	–	–	–	–	–	–
Hg	–	–	–	–	–	–	–	–	–	–
Mn	–	0.4 (MAV)	0.0389	–	0.0086	0%	0.0387	–	0.0086	0%
Mo	0.034	0.01	0.045	2.3% ^C	0.0078	0%	0.0445	0.4% ^C	0.0048	0%
Ni	–	–	0.30	–	0.00079	–	0.30	–	0.00062	–

	PROPOSED COMPLIANCE LIMITS		SC01 - BORE WATER DUST SUPPRESSION				RS03 - BORE WATER DUST SUPPRESSION			
	SW SC01, RS03	GW (MW-101, MW-103, MW-103)	MAXIMUM DAILY CONC. (mg/L)	% EXCEEDING SW COMPLIANCE	MAX 30 DAY MEAN CONC. (mg/L)	% EXCEEDING ^B GW COMPLIANCE	MAXIMUM DAILY CONC. (mg/L)	% EXCEEDING SW COMPLIANCE	MAX 30 DAY MEAN CONC (mg/L)	% EXCEEDING ^B GW COMPLIANCE
Pb	–	0.01 (MAV)	0.0031		0.00052	0%	0.0031		0.00032	0%
Sb	0.074 ^B (chronic)	0.02 (MAV)	0.14	0%	0.024	0%	0.14	0%	0.014	0%
	0.250 (acute)			0%				0%		
Se ^A	–	–	–	–	–	–	–	–	–	–
Sr	–	4	1.84	0%	1.09	0%	1.82	0%	0.31	0%
Tl ^A	–	–	–	–	–	–	–	–	–	–
U	–	0.03	0.0161	–	0.0069	0%	0.016	–	0.0018	0%
V ^A	–	–	–	–	–	–	–	–	–	–
Zn	0.015	1.5	0.0070	0%	0.00195	0%	0.0069	0%	0.0023	0%
Sulfate	500	250	319.2	0.0%	86.6	0%	316.5	0.0%	34.3	0%
Amm-N	0.24 (median)	–	0.012	0.0%	0.011	–	0.012	0.0%	0.0095	–
	0.4 (95 th percentile)									
Nitrate-N	2.4 (median)	11.3	0.094	0.0%	0.085	0.0%	0.093	0.0%	0.018	0.0%
	3.5 (95 th percentile)									

Note: Values of 0 result from both surface water and mine impacted water source terms being <LOR. SW = surface water: GW = groundwater

^A mine impacted water source term has a value of 0 for these analytes. ^B based on 30-day rolling mean. ^C due to misalignment between rainfall and flow in mixing model, discussed further in text.

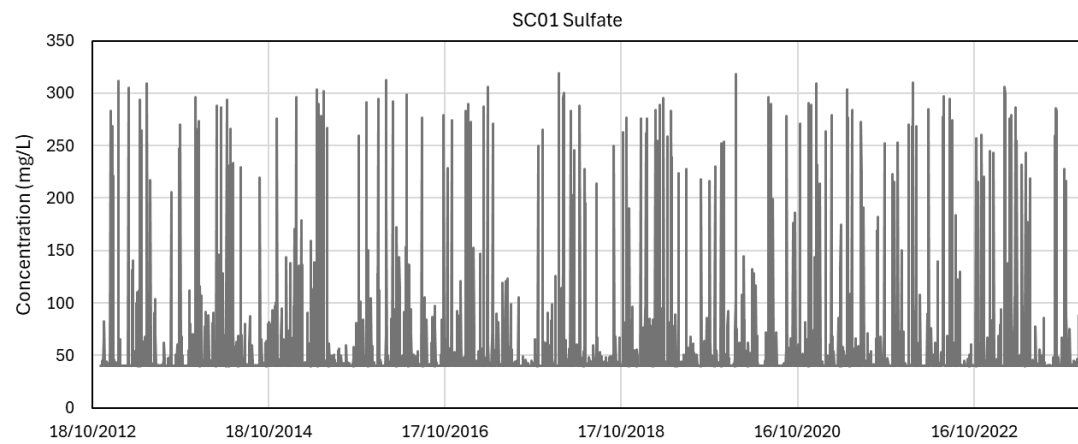


Figure 10: Modelled sulfate concentrations at SC01, where bore water is used for dust suppression.

Note: dates on graph are representative of the synthetic flow record, not mine life.

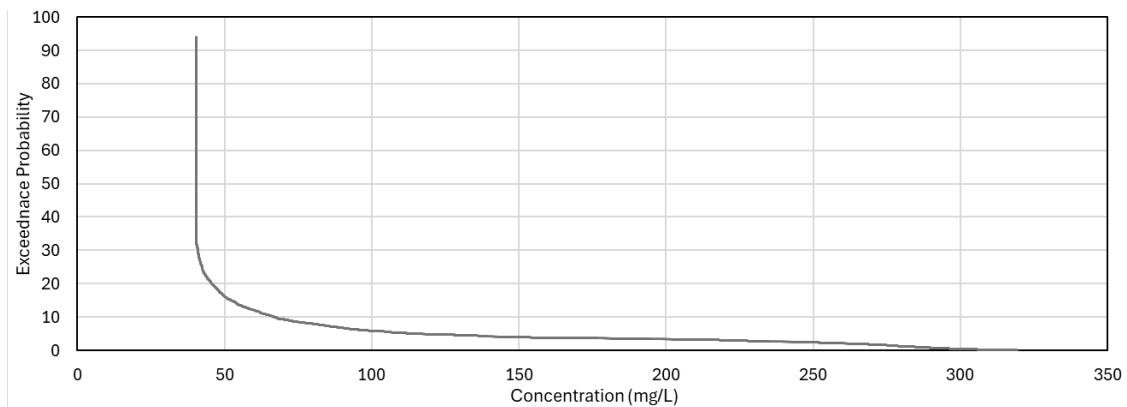


Figure 11: Sulfate exceedance probability in SC01 where bore water is used for dust suppression.

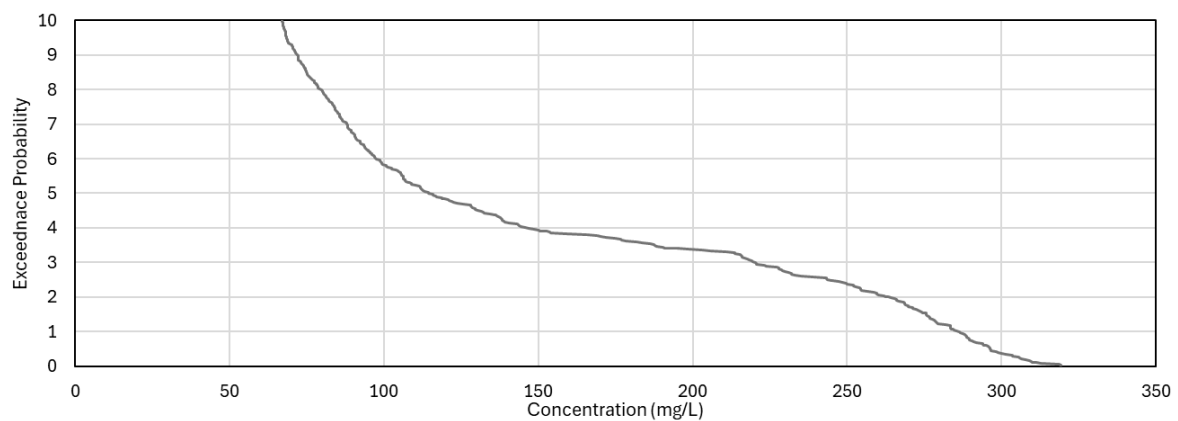


Figure 12: Bottom 10% exceedance probability for sulfate concentrations where bore water is used for dust suppression at SC01.

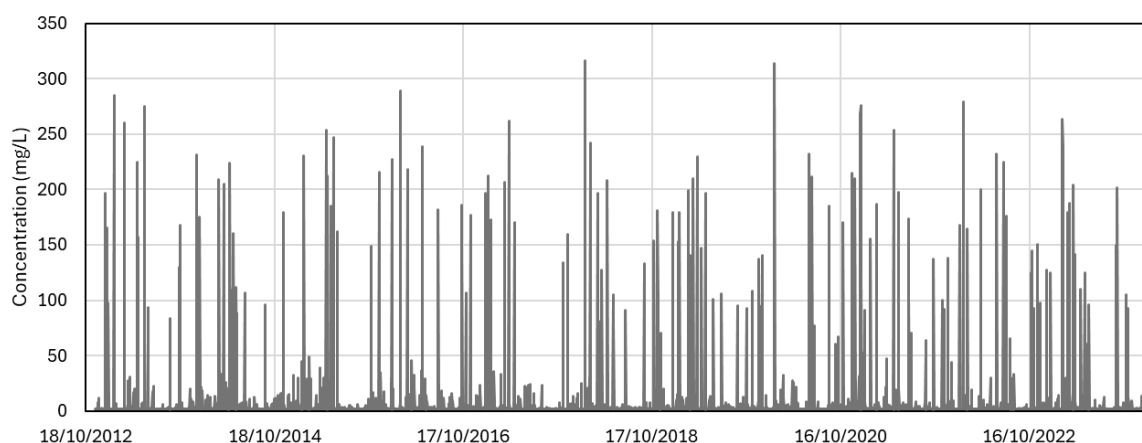


Figure 13: Modelled sulfate concentrations at RS03, where bore water is used for dust suppression.

Note: dates on graph are representative of the synthetic flow record, not mine life.

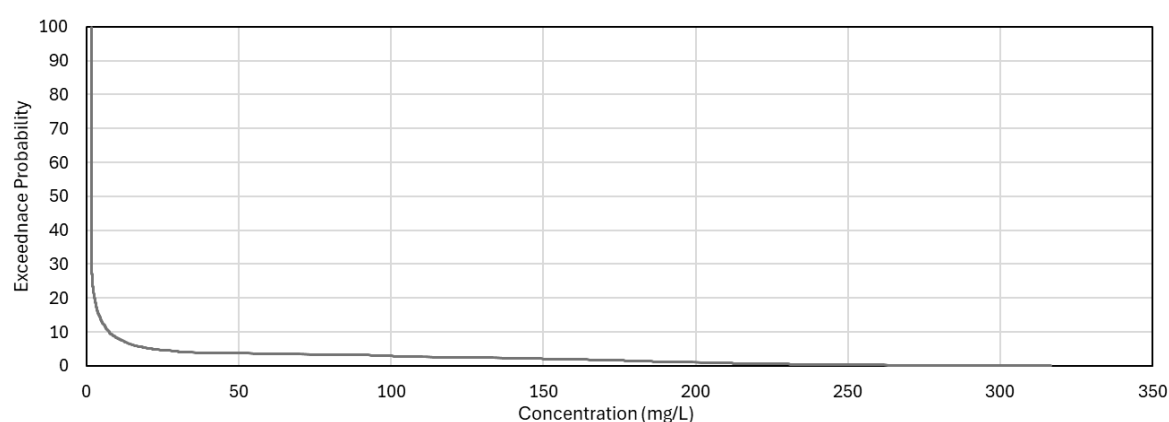


Figure 14: Sulfate exceedance probability at RS03 where bore water is used for dust suppression.

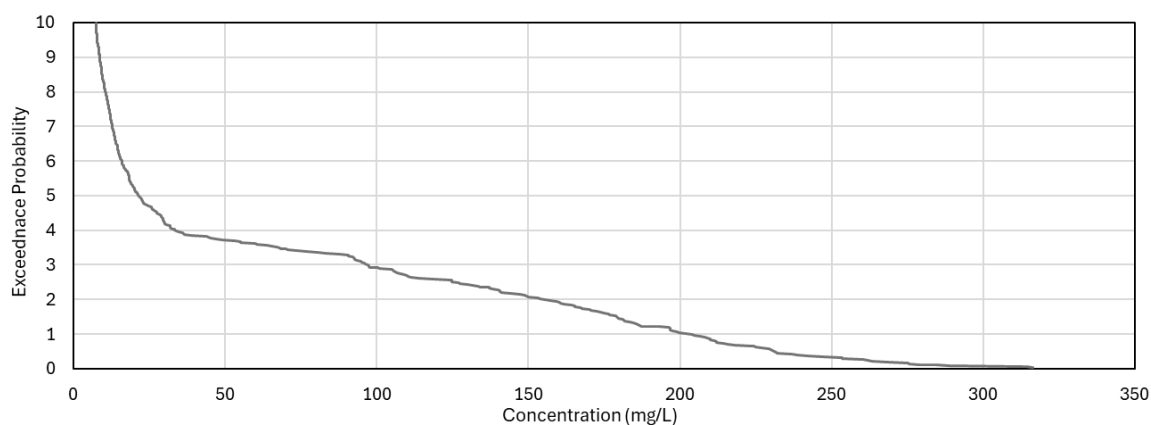


Figure 15: Bottom 10% exceedance probability for sulfate concentrations where bore water is used for dust suppression at RS03.

4.5 Summary

Water balance calculations suggest that the site will be in a water deficit condition up to Year 8. After this point, dewatering from satellite pits (i.e., SRX and to a lesser extent CIT) may push the site to a water surplus condition for the last few years of mine life without additional controls. Engineering controls (e.g., construct the water treatment plant prior to closure) are available to manage potential water surpluses, and can be evaluated during detailed design phases. Ongoing water balance

reconciliation of the site will be required to confirm water balance conditions remain in a water deficit condition.

Creek flows will be reduced by approximately 13 to 17% on average by the life of mine. Reduction would be lower earlier in mine life with a lower disturbance footprint.

Interpretation of the mixing model results suggests surface water quality at SC01 and RS03 will remain below the proposed compliance limits for both surface and groundwater if groundwater is used for dust suppression.

4.6 Recommendations

The following recommendations are provided:

- A transient operational site wide water balance model be developed prior to mine development to improve confidence in water accumulation or losses over time, particularly to understand seasonal dynamics. Such a model will likely be needed to support detailed design of the TSF.
- A site water balance reconciliation be completed regularly (e.g., annually or more frequent) to confirm water balance model results are appropriate, and/or make model updates to improve confidence in model results projected into the future.

Discharge of runoff will be monitored with contingencies in place. Adaptive management processes need to be developed to proactively manage and respond if performance and/or compliance monitoring suggests these discharges provide risk of non-compliance. Contingencies could include for example:

- Use fresh groundwater for dust suppression surfaces that will discharge runoff to the receiving environment. This will lower the sulfate load buildup at surface available for transport via runoff.
- Collect and contain runoff within the mine water circuit.
- Use of evaporation cannons to increase evaporative losses.
- Increase water storage capacity on site.
- Commission the water treatment plant during operations rather than at closure.
- Storage of water within pits or other purpose designed infrastructure.

5 ACTIVE AND POST CLOSURE PHASE ASSESSMENT

This section assesses the potential effects to the receiving environment during the active and post closure phases of the mine.

5.1 Model Description

The objective of the WLBM is to mechanistically model the water management system at the BOGP. Inputs to the model are based on reported or derived values; some inputs were derived empirically. Hydrological, geochemical, and operational processes that influence water quantity and quality on site are represented in the model and calibrated to existing monitoring data. The model is built to simulate future water management scenarios and predict factors and behaviours that will inform decision making for closure.

5.1.1 Overview

The BOGP WLBM was developed using GoldSim dynamic system modelling software used for simulation of mine water and load balances (Version 15). The water balance uses a daily precipitation timeseries generated with a stochastic climate generator based on statistics from long-term climate data series (as described in Section 3).

The model was divided into two surface water catchments: Shepherds Creek and Rise and Shine Creek. Daily precipitation rates were applied to each catchment area to estimate overland runoff flow volume. A runoff coefficient based on montane landcover and topography was then applied to this volume to account for a proportional loss of water to evapotranspiration and infiltration to groundwater.

The load balance is based on a mass balance approach. It calculates loading rates by assigning source term concentrations to the flows determined in the water balance and generates water quality projections for both onsite and downstream locations. Source terms are applied as constant concentration (where concentration is assumed to remain the same over time), or constant load (where concentration is estimated based on dividing a constant load), and the flow rate for that day. The later means that at low flow rates the concentration is higher, and at higher flows, there is more dilution, hence, less concentrated waters.

Mechanisms represented in the model include:

- Runoff from undisturbed catchments, including conveyance via water diversion structures.
- Filling and discharge of open pit voids, including RAS pit water discharging via the underground workings.
- ELF and TSF runoff and seepage.

The model is run on a daily time step. Results can be provided as monthly mean or median values to align with proposed water quality consent conditions. The selection of model output as monthly projections is therefore considered adequate to inform water management decisions. The model projects 200 years forward from closure. A schematic of model representation of mine site key domains and flow of water and sediment load is illustrated in Figure 16.

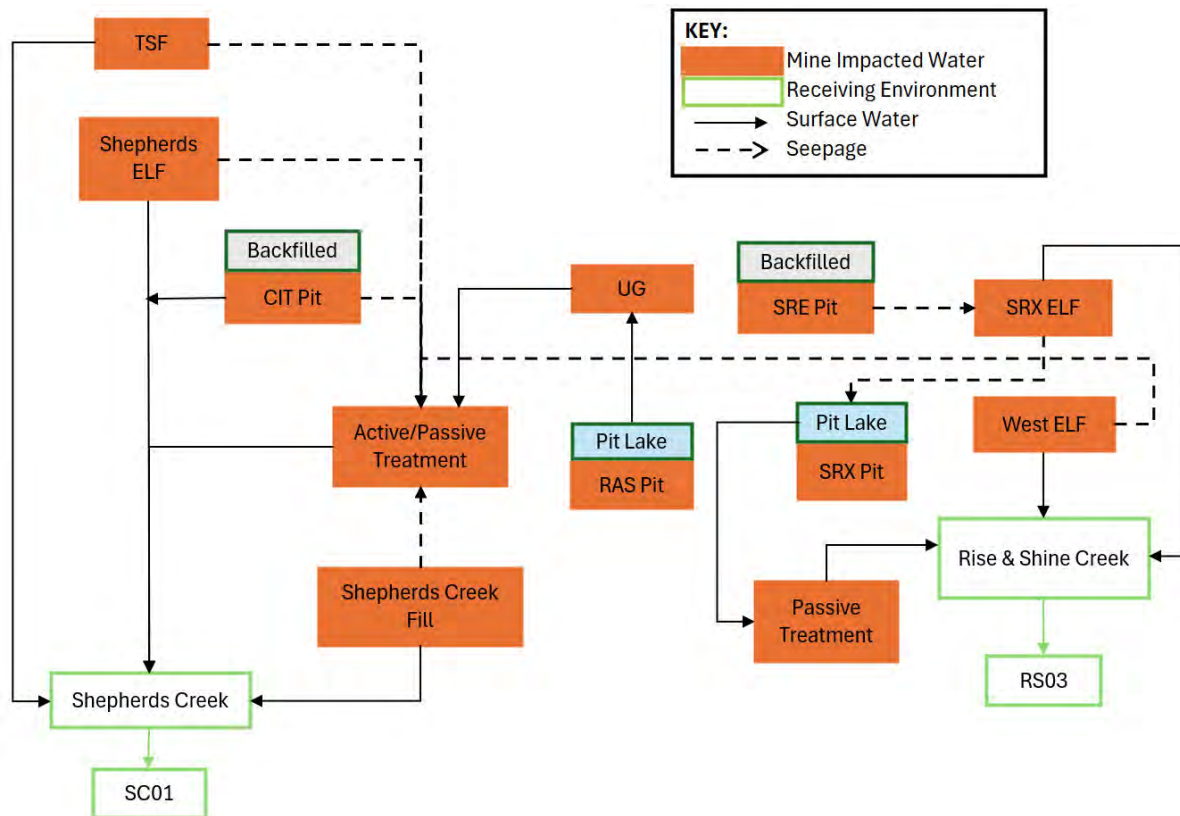


Figure 16: Schematic diagram of MIW and non-impacted rainfall and runoff for the closure phases at the BOGP site.

Note: An active water treatment plant (WTP) is proposed for the Active closure Phase. When PCOC loads decrease sufficiently the WTP will be replaced by passive water treatment systems, which defines the start of the Post Closure Phase (Table 1). Partial passive treatment of the SRX Pit Lake overflow is proposed (8 L/s) to ensure water quality limits are achieved at RS03.

5.2 Water Balance Model Inputs

5.2.1 Climate Inputs

The Stochastic Climate Library (v2.2.0) tool was used to generate future rainfall and PET timeseries using a first-order autoregressive multivariate model condition based on the rainfall state and nested in monthly and annual models. Input data for the model included:

- Synthetic daily rainfall data described in Section 3.
- Synthetic daily PET data described in Section 3.
- A synthetic daily maximum temperature record was developed in the same manner as for PET, following a linear regression equation: $S_{\text{rex Max Temp}} = 0.7554 \times \text{Cromwell EWS Max Temp} - 0.1099$ (Figure 17).

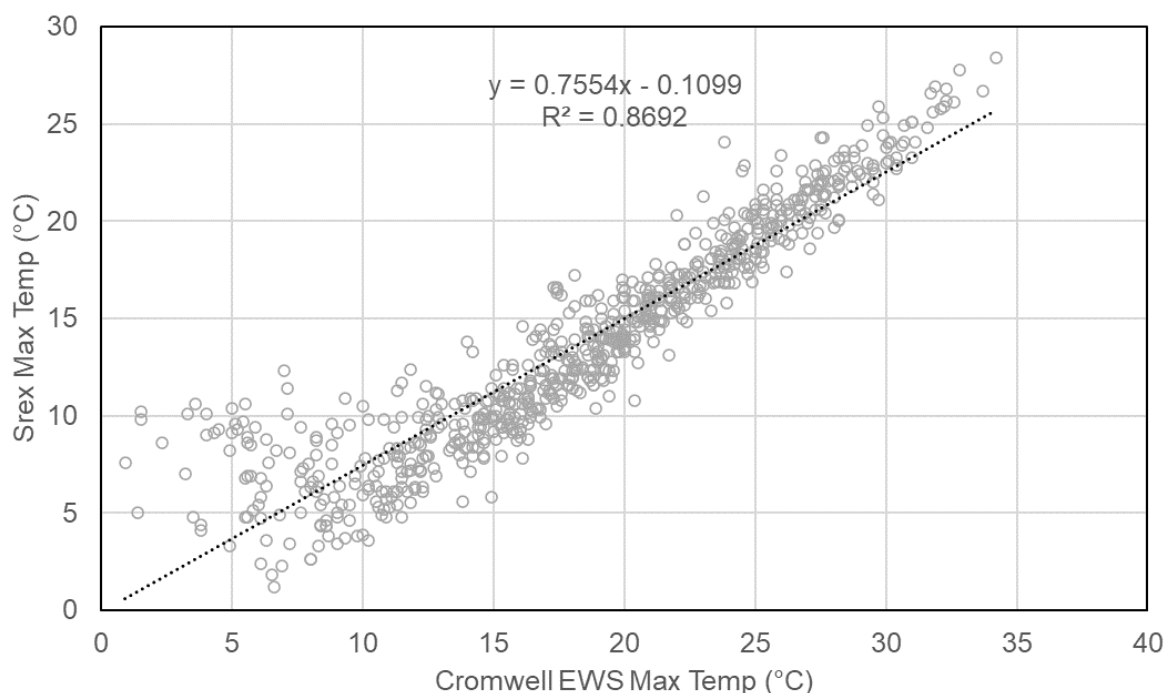


Figure 17: Srex Met vs Cromwell EWS maximum temperature.

Table 12 compares statistical summaries of the synthetic data series with the forward climate realisation, showing a close agreement between annual totals for rainfall and PET.

Table 14: Synthetic vs projected climate summaries.

STATICITICAL DESCRIPTOR	YEARLY RAINFALL (mm)		YEARLY PET (mm)	
	SYNTHETIC DATA SERIES	FORWARD PROJECTION	SYNTHETIC DATA SERIES	FORWARD PROJECTION
Mean	498	505	932	935
Median	493	508	938	933
Standard Deviation	96	108	33	29

Climate data was retrieved for the project for the SSP2-4.5 scenario, for the 1995-2014 base period and for projections for 2080-2099 (<https://map.climatedata.environment.govt.nz/>) (accessed 20/01/2025). Annual climate change factors were applied to the projected climate data to account for changes in future climate as follows:

- Rainfall factor 1.07 (+7% annual rainfall).
- PET factor 1.045 (+4.5% annual PET based on an annual daily average air temperature increase of 1.8 °C applied to the Penman [1946] method).

The factors were applied to increase linearly from 1 at the start of the model to fully reach the above defined factors after 65 years of simulation time, approximately representing 2080-2099. Beyond this period the factors remained the same.

5.2.2 Catchment Delineation

Catchment boundaries were derived based on the topographic watershed divides using QGIS open-source topographic maps (QGIS, 2025). Mine area footprints provided by MGL (such as pits, ELFs, and

TSF) were removed from the total catchment areas to derive the undisturbed surface areas. Areas of topsoil deposits were included within the undisturbed footprints. Surface areas were calculated based on areal footprints. The catchments and undisturbed surface area inputs used in the model are summarised in Table 13 below.

Table 15: Catchment delineations and undisturbed surface areas.

CATCHMENT DELINIATION	DESCRIPTION	MINE DOMAINS	UNDISTURBED SURFACE AREA (km ²)
Rise and Shine Creek Catchment	Rise and Shine Creek sources in the central and southeastern extent of the mine area and flows northeast. Includes Clearwater Creek.	SRX Pit SRX ELF RAS Pit (28% of footprint) CIT Pit (13% of footprint) WELF Monitoring location RS03 – this marks location of outflows from RS03 out of model.	7.60
Shepherds Creek Catchment	Extends across the northern half of the mine area. Shepherds Creek flows southeast across the catchment extent.	TSF Shepherds ELF RAS Pit (72% of footprint) CIT Pit (87% of footprint) Shepherds Creek Valley Fill Monitoring location SC01 – marks location of outflows from SC01 out of model.	9.79

5.2.3 Runoff Model

The Runoff Model utilised for generating flows from undisturbed surface water areas (Table 13) was based on modifications to the Snow Melt Runoff Model by Martinec et al. (2008). For the purpose of this model the influence of snow melt was assumed negligible. Daily discharge (runoff) is calculated by superimposing daily rainfall on calculated recession and baseflow using the following equation:

$$Q_{n+1} = C \times R \times A \times (1 - k_{n-1}) + Q_n \times k_{n-1}$$

Where:

- Q is the average daily discharge.
- C is the runoff coefficient.
- R is the rainfall contributing to runoff.
- k is the recession coefficient.
- A is the area of the catchment.

The input parameters used for each flow source are summarised in Table 14, with the runoff coefficient varying by month. Selection of parameters was based on professional judgment and attaining a reasonable fit with observed flows at SC01. See Section 5.4.2 for further description on undisturbed runoff model calibration.

Table 16: Runoff coefficients for the water balance model.

PARAMETER	VALUE
Runoff Coefficient (C)	January
	0.02
	February
	0.02
	March
	0.03
	April
	0.04
	May
	0.08
	June
	0.15
Recession Coefficient (k)	July
	0.3
	August
	0.3
	September
	0.12
	October
	0.06
	November
	0.06
	December
	0.03
Recession Coefficient (k)	
0.955	

5.2.4 Pit Voids

Pit voids were represented in the model as pool elements, accounting for inflows, outflows, and changes in water storage within the pit void. Model inputs are summarised in Table 15.

Table 17: Pit void model summary.

MODEL FEATURE	DESCRIPTION
Post-closure setting	- RAS Pit: Open void and pit lake develops. Connected to underground workings via fractured rock mass associated with crown pillar. - SRX Pit: Open void and pit lake develops. - CIT Pit: Backfilled void with both saturated and unsaturated mine rock.
Pit void dimensions, including volume/surface area stage relationship, and spill points elevation.	Provided by MGL in file RAS2503_FTA_ST5 volumes.xlsx. Spill points were defined by the pit crest low points as follows: - RAS Pit: 610 meters above sea level (m asl). - SRX Pit: 755 m asl. - CIT Pit: 510 m asl. For the RAS Pit, the volume of underground workings was assumed negligible compared to the pit void volume. For the backfilled CIT pit, a mine rock porosity value of 0.3 was adopted based on the expectation that the mine rock will be relatively coarse with little fines (MWM, 2025a).
Direct rainfall onto pit lake (when present)	Only relevant for RAS and SRX. Forward rainfall projection as described in Section 5.2.1 of this report. Pit lake surface area dynamically calculated based on provided stage-surface relationship.
Pit wall runoff	Only relevant for RAS and SRX. Daily climatic water balance (rainfall-PET) suggested 80% of rainfall was available to generate runoff, while at a monthly scale, only 45% was available. Given the pit walls of exposed rock are likely to have little capacity for infiltration or water storage that can be evaporated at a future time, a runoff coefficient of 60% of rainfall was adopted as the approximate mid-point between the daily and monthly available rainfall. This value was applied uniformly in time, with no differentiation between winter vs summer given insufficient data to define such seasonal variation. Exposed pit wall footprint dynamically calculated based on provided stage-surface relationship.
Groundwater inflow	Based on numerical groundwater model results reported in (KSL, 2024). Inflows rates were defined to decrease linearly as void water level increases over time and hydraulic gradient decreases.

MODEL FEATURE	DESCRIPTION																					
	• RAS Pit: 3 L/s when pit empty, dropping to 1 L/s when water level stabilised as higher level. • SRX Pit: 25 L/s when pit empty, dropping to 5 L/s when water level stabilised as higher level. • CIT Pit: 3.5 L/s when pit empty, dropping to 1 L/s when water level stabilised as higher level.																					
Run-on from undisturbed upstream sources	• RAS Pit: assumed negligible. • SRX Pit: defined based on Runoff Model described in Section 5.2.3. • CIT Pit: assumed negligible.																					
Backfill seepage	Only relevant for CIT. Described in Section 5.2.5																					
Pit lake evaporation	Only relevant of RAS and SRX. The forward PET projection as described in Section 5.2.1 of this report. Pit lake surface area dynamically calculated based on provided stage-surface relationship.																					
Groundwater outflow	Based on Darcy's law assuming horizontal outflow only. Not significant for SRX as lower hydraulic gradient to Rise and Shine Creek (spill point elevation close to creek level) than other pits.																					
	<table><tr><th>PARAMETER</th><th>CIT</th><th>RAS</th></tr><tr><td>Hydraulic conductivity</td><td>10⁻⁸ m/s, based on bulk rock mass.</td><td>10⁻⁵ m/s, based on zone of enhanced fracturing.</td></tr><tr><td>Discharge to discharge point</td><td>250 m, distance between outflow zone and Shepherds Creek.</td><td>50 m, based on approximate lateral thickness of zone of enhanced fracturing between pit wall and closest underground workings.</td></tr><tr><td>Discharge head</td><td>430 m asl, nearby Shepherds Creek elevation.</td><td>490 m asl, approximate underground portal elevation.</td></tr><tr><td>Pit lake head</td><td colspan="2">Calculated dynamically as pit void water level changes.</td></tr><tr><td>Outflow width</td><td>200 m, based on approximate lateral width of pit shell at discharge zone.</td><td>200 m, based on approximate lateral width underground workings at discharge zone.</td></tr><tr><td>Outflow thickness</td><td>Calculated dynamically as pit void water level changes.</td><td>50 m, based on approximate thickness of zone of enhanced fracturing.</td></tr></table>	PARAMETER	CIT	RAS	Hydraulic conductivity	10 ⁻⁸ m/s, based on bulk rock mass.	10 ⁻⁵ m/s, based on zone of enhanced fracturing.	Discharge to discharge point	250 m, distance between outflow zone and Shepherds Creek.	50 m, based on approximate lateral thickness of zone of enhanced fracturing between pit wall and closest underground workings.	Discharge head	430 m asl, nearby Shepherds Creek elevation.	490 m asl, approximate underground portal elevation.	Pit lake head	Calculated dynamically as pit void water level changes.		Outflow width	200 m, based on approximate lateral width of pit shell at discharge zone.	200 m, based on approximate lateral width underground workings at discharge zone.	Outflow thickness	Calculated dynamically as pit void water level changes.	50 m, based on approximate thickness of zone of enhanced fracturing.
PARAMETER	CIT	RAS																				
Hydraulic conductivity	10 ⁻⁸ m/s, based on bulk rock mass.	10 ⁻⁵ m/s, based on zone of enhanced fracturing.																				
Discharge to discharge point	250 m, distance between outflow zone and Shepherds Creek.	50 m, based on approximate lateral thickness of zone of enhanced fracturing between pit wall and closest underground workings.																				
Discharge head	430 m asl, nearby Shepherds Creek elevation.	490 m asl, approximate underground portal elevation.																				
Pit lake head	Calculated dynamically as pit void water level changes.																					
Outflow width	200 m, based on approximate lateral width of pit shell at discharge zone.	200 m, based on approximate lateral width underground workings at discharge zone.																				
Outflow thickness	Calculated dynamically as pit void water level changes.	50 m, based on approximate thickness of zone of enhanced fracturing.																				

5.2.5 Mine Waste Storage Facilities

Mine Waste Storage Facilities (MWSFs) represented in the model included the:

- Shepherds ELF.

- SRX ELF.
- Western ELF.
- CIT backfilled pit void.
- TSF.

The SCK Fill was also represented as a MWSF. From near the top of the valley, clean water diversions will be used to allow clean water to bypass the TSF and Shepherds ELF. The diversions will drop onto a constructed channel in the lower SCK Fill that will extend to the Run of Mine (ROM) at least (the natural creek may need to be lifted past the process area). Areas below the ROM where there is minimal ore exposure will be channelled via silt retention ponds to Shepherds channel (or possibly the natural creek). The lower gorge has to be filled to create sufficient width for services. The Shepherd channel shall be formed through this section to take a 1% AEP event (D. Stretch, MGL, personal communication, 16 April 2025).

Run off from the Shepherds ELF is directed to the Shepherds Silt Pond and then discharged through a decant to the Shepherds channel after settling. In a large storm event, the silt pond can discharge directly by spill way to the Shepherds channel. Run off from the valley below the silt pond shall also be captured in sediment treatment ponds and discharged into Shepherds channel.

Mechanistically, the MWSFs were represented in a similar manner, with runoff being calculated as a proportion of daily rainfall, net percolation into the facility also calculated as a proportion of daily rainfall, and seepage out of a facility calculated as a function of water storage within the facility with a reservoir element. Model inputs are summarised in Table 16.

Table 18: MWSF model input parameter summary.

MODEL FEATURE	DESCRIPTION												
Post-closure setting.	The cover system established at closure is anticipated to perform similarly across all MWSFs (MWM, 2025a).												
Runoff	Defined as a proportion of daily rainfall, with runoff coefficients increasing as rainfall depth increased, as follows: <table border="1"> <thead> <tr> <th>DAILY RAINFALL</th><th>RUNOFF COEFFICIENT</th></tr> </thead> <tbody> <tr> <td><5 mm</td><td>0</td></tr> <tr> <td>≥ 5 mm but < 10 mm</td><td>0.05</td></tr> <tr> <td>≥ 10 mm but < 50 mm</td><td>0.1</td></tr> <tr> <td>≥ 50 mm but < 90 mm</td><td>0.15</td></tr> <tr> <td>> 90 mm</td><td>0.2</td></tr> </tbody> </table> Modified from previous work at Macraes Mine (Golder, 2011) to achieve an average runoff yield similar, but slightly lower, than Shepherds Creek yield of ~10% of average rainfall. The values adopted achieved a yield of ~7% of average rainfall. Applies to all MWSFs.	DAILY RAINFALL	RUNOFF COEFFICIENT	<5 mm	0	≥ 5 mm but < 10 mm	0.05	≥ 10 mm but < 50 mm	0.1	≥ 50 mm but < 90 mm	0.15	> 90 mm	0.2
DAILY RAINFALL	RUNOFF COEFFICIENT												
<5 mm	0												
≥ 5 mm but < 10 mm	0.05												
≥ 10 mm but < 50 mm	0.1												
≥ 50 mm but < 90 mm	0.15												
> 90 mm	0.2												
Net percolation (NP)	20% of daily rainfall, as per MWM (2025a). Applies to all MWSFs.												
Initial condition	Varies by MWSF as follows: • Shepherds ELFs, SRX ELF, SCK Fill, CIT Backfill: mine rock assumed to be wetted up and at semi-stable seepage rates. • TSF: set to achieve an initial flow rate of approximately 13.4 L/s as per EGL (2025) and then stabilised at rate based on NP.												

Recession Coefficient (k, -)	Recession equation: MWSF Storage Volume x (1-k). Varies by MWSF as follows:
	- Shepherds ELFs, SRX ELF, SCK Fill, and CIT Backfill: set to 0.995 to achieve a relatively stable seepage rate. Translates to 5% of water stored in MWSF discharged as seepage. - TSF: set to 0.998 to achieve a relatively stable seepage rate after approximately 5 years of drain down as per EGL (2025).

5.2.6 Water Treatment

Active water treatment in the Shepherds Creek catchment is proposed during the Active Closure Phase and passive water treatment systems are proposed for BOGP in the Post Closure Phase (Table 1) for MIW in the Shepherds Creek catchment and for partial treatment of the SRX Pit Lake overflow (8 L/s being the average pit lake overflow rate). Active treatment will run until passive treatment systems can achieve compliance with water quality compliance limits. The model did not account for any hydrological influence of such systems (i.e., water passes through them within the daily timestep).

Further details on active and passive water treatment are provided in MWM (2025d). Passive treatment efficiencies are also provided in Table 25.

5.3 Load Balance Inputs

Each of the water balance components shown in Figure 16 are associated with the water quality source terms as presented in Table 17 and Table 18. The derivation of the data in these tables is described in detail in the *Source Term Definition Report* by MWM (2025b).

Table 19. Source Term Water Quality Part 1 of 2.

SOURCE TERM	ELF_RO_ST	PW_RO_ST	TSF_RO_ST	CC01_UND_ST
DESCRIPTION	Rehabilitated ELF Runoff Water Quality	Pit Walls Runoff	Rehabilitated TSF Runoff	Surface water quality for Clearwater Creek
MWM (2025b) REPORT SECTION	Section 8.3. Table 20 Source terms: Mine Impacted Surfaces and Rehabilitated Surfaces Brown Rock	Section 6.4.1. Table 16 BOGP Pit Wall Runoff Source Term	Section 8.3. Table 20 Source terms: Mine Impacted Surfaces and Rehabilitated Surfaces Brown Rock	Section 4.1.2 Table 4 Surface Water Quality Source Terms for Bendigo Creek (CC01)
UNITS / PARAMETER	mg/L	mg/L	mg/L	mg/L
Al	0.155	0.114	0.155	0.01231
Alkalinity	140.5	61.3	140.5	14.7
As	0.02	0.093	0.02	0.001
B	0.064	0.046	0.064	0.0175
Ca	15.68	55	15.68	3.88
Cd	0.0001	0.0001	0.0001	0.00009
Cl	3.1	13	3.1	0.794
Co	0.0005	0.0005	0.0005	0.00021
Cr	0.0005	0.0005	0.0005	0.00056

SOURCE TERM	ELF_RO_ST	PW_RO_ST	TSF_RO_ST	CC01_UND_ST
Cu	0.001	0.0034	0.001	0.00043
DOC	2.01	0	2.01	1.23
F	0.34	0.21	0.34	0.055
Fe	0.14	9.1	0.14	0.0293
Hg	-	-		0.00024
K	8.66	39	8.66	0.335
Mg	1.95	37	1.95	0.844
Mn	0.0115	0.014	0.0115	0.0009
Mo	0.147	0.023	0.147	0.00033
NO3-N + Amm-N	0.4	40	0.4	0.0096
Na	32.88	33	32.88	2.35
Ni	0.0005	0.0009	0.0005	0.00056
Pb	0.00019	0.004	0.00019	0.00022
Sb	0.049	0.027	0.049	0.00044
Se	0.00025	0.00025	0.00025	0.0022
SO ₄	470	160	470	0.843
Sr	0.67	0.91	0.67	0.042
Tl	0.00025	0.00025	0.00025	0.00019
TOC	2.01	0	2.01	1.23
CN	0	0	0	0
U	0.053	0.0106	0.053	0.00009
V	0.0005	0.0005	0.0005	0.0005
Zn	0.001	0.002	0.001	0.00161
pH	8.4	8.2	8.4	7.03

In addition, the seepage water quality forecast for five waste rock domains (Shepherds ELF, SRX ELF, WELF, CIT Backfill, and SCK Fill) were developed in detail in the *Engineered Landform Water Quality Forecast Model Report* (MWM, 2025c). Four of the five domains are assumed to start generating seepage 11 years before closure (assuming that BOGP takes 11 years to be completed). Therefore, peak concentrations for WELF, SCK Fill, and SRX ELF occur during operation. Peak concentration for Shepherds ELF occurs in Active Closure phase, same as CIT ELF Backfill, as it is assumed the latter will be backfilled at closure. These model outputs with time are presented in Figure 18 and Figure 19.

Table 20. Source Term Water Quality Part 2 of 2.

SOURCE TERM	RS03_UND_ST	RS04_UND_ST	SC03_UND_ST	GW_MDD015_ST	Rain_ST	TSF_Seepage_ST
MWM (2025b) REPORT SECTION	Section 4.1.2 Table 4 Surface Water Quality Source Terms for Bendigo Creek (RS03)	Section 4.1.2 Table 4 Surface Water Quality Source Terms for Bendigo Creek (RS04)	Section 4.1.1 Table 3 Surface Water Quality Source Terms for Shepherds Creek (RS04)	Section 4.2.1 Table 6 Water Quality Source Terms for Groundwater (MDD015)	Section 3.1.1. Table 2. Rainfall Quality Source Term Data.	Section 9.3.2. Table 23 Process Water Quality and Tailings Seepage Water
PARAMETER/UNITS	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Al	0.00756	0.00686	0.0064	0.0061	-	0.01
Alkalinity	39.1	72.8	136.2	201.6	0.81	73.21
As	0.0085	0.001	0.00079	0.024	-	2.05
B	0.0188	0.011	0.028	0.0331	-	0.825
Ca	11.1	23.3	40.9	38.9	0.11	297
Cd	0.0001	0.00003	0.00011	0.00008	-	0.0002
Cl	1.33	1.96	2.74	9.42	0.31	804
Co	0.00025	0.00013	0.00029	0.00019	-	0.053
Cr	0.00059	0.00026	0.00062	0.0005	-	0.0055
Cu	0.00046	0.00083	0.00055	0.0003	-	1.598
DOC	1.75	2.75	2.01	0.3	-	0
F	0.057	0.059	0.119	0.162	-	1.93
Fe	0.0375	0.068	0.0215	0.0147	-	15.3
Hg	0.00026	0.00011	0.0003	0.0002	-	0
K	0.578	1.18	1.43	1.44	0.88	50.8
Mg	1.99	3.74	10.2	16.2	0.09	99
Mn	0.0095	0.006	0.00357	0.0068	-	0.59
Mo	0.00033	0.00022	0.00044	0.0004	-	0.14
NO3-N + Amm-N	0.0088	0.0033	0.1507	0.0051	0.06	2.005
Na	39.5	5.15	36.2	43.6	0.32	848
Ni	0.00035	0.00049	0.00036	0.0003	-	0.678

SOURCE TERM	RS03_UND_ST	RS04_UND_ST	SC03_UND_ST	GW_MDD015_ST	Rain_ST	TSF_Seepage_ST
Pb	0.00025	0.00008	0.00029	0.0002	-	0.0275
Sb	0.0005	0.00017	0.00058	0.0004	-	0.18
Se	0.0025	0.0008	0.0029	0.0018	-	0.003
SO ₄	1.57	2.8	14.4	10.3	0.18	954
Sr	0.136	0.315	0.675		-	4.4
Tl	0.00023	0.00005	0.00027	0.0003	-	0
TOC	1.75	2.75	2.01	0.3	-	0
CN	0	0	0	0	0	0.35
U	0.00012	0.0003	0.0022	0.001	-	0.028
V	0.0005	0.0005	0.0005	0.0005	-	0.004
Zn	0.00229	0.00142	0.0015	0.0015	-	0.0296
pH	7.42	7.51	7.88	8.1	5.2	6.41

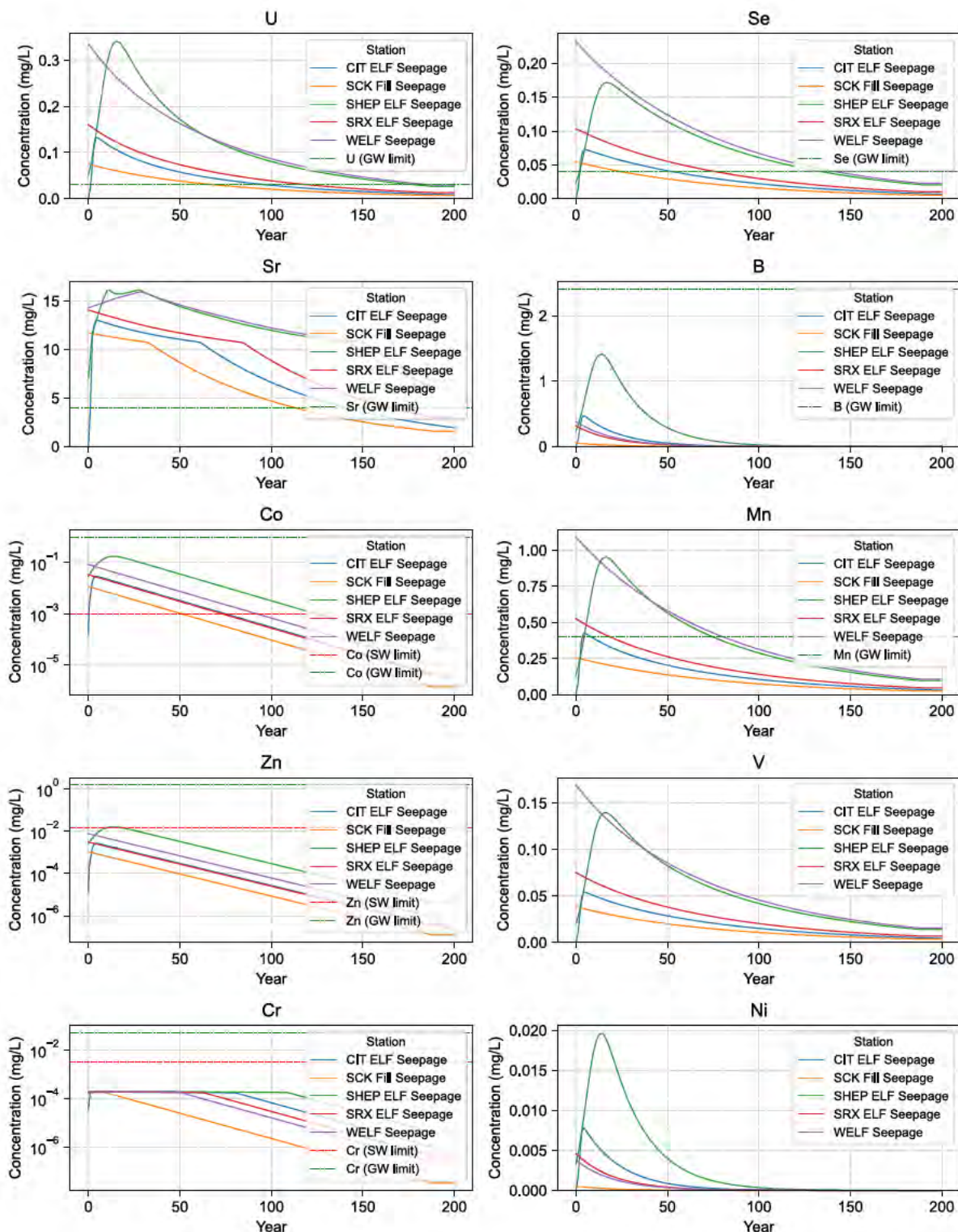


Figure 18. Seepage Water Quality for Waste Rock Domains at the BOGP. Part 1 of 2.

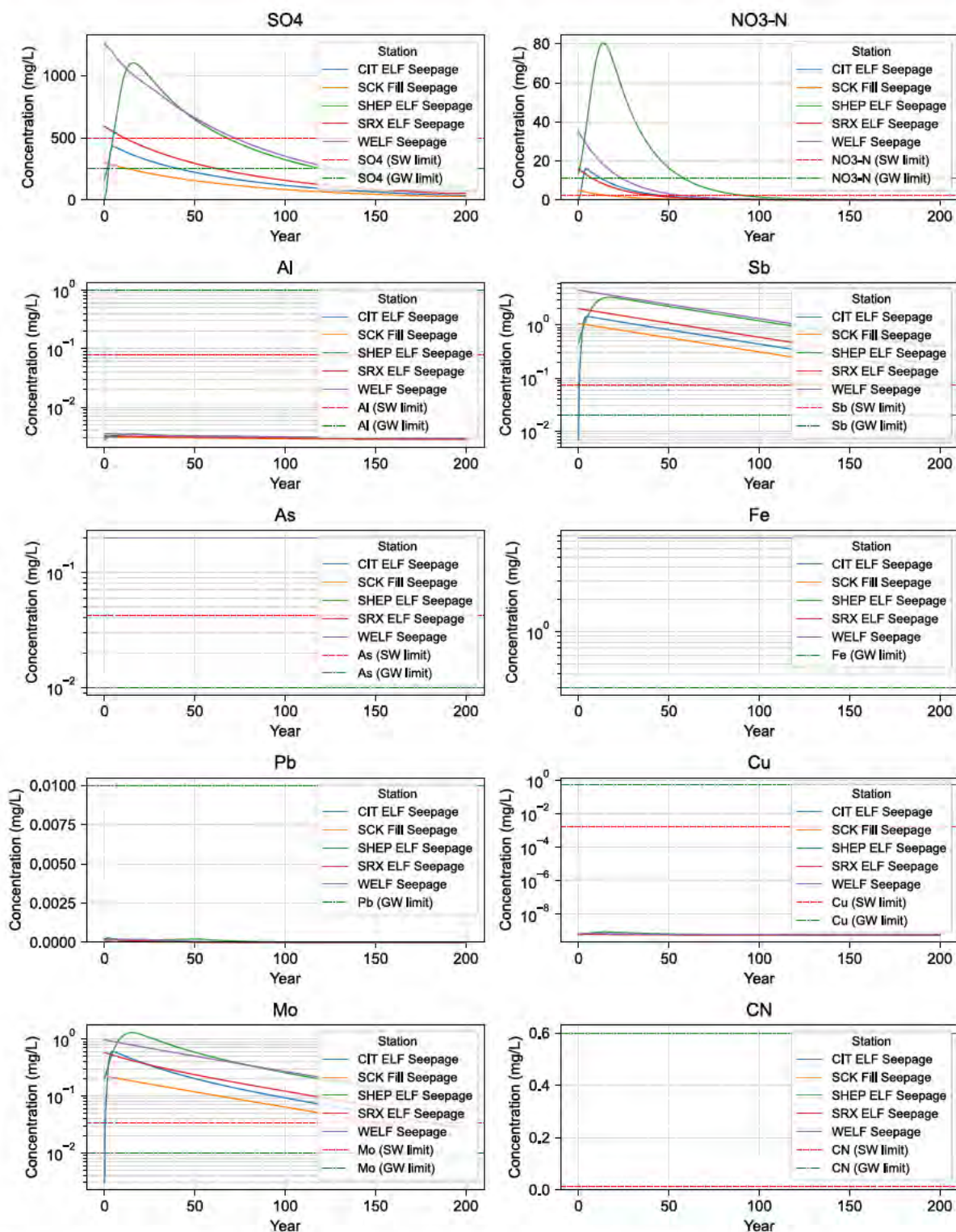


Figure 19. Seepage Water Quality for Waste Rock Domains at the BOGP. Part 2 of 2.

CN = Cyanide.

5.4 Model Evaluation

5.4.1 Model QA/QC¹¹.

The WLBM was reviewed as part of internal QA/QC and this included the following steps:

- Checking that data sources are documented.
- Verification that storages, inflows, and outflows are correctly located and allocated to the right source and sink.
- Cross checking of flows to ensure they are not duplicated or missed.
- Verification of model functions and expressions to ensure they are working as intended.
- For the calibration period, predictions were evaluated through comparison to monitoring data.
- Using professional judgement and experience to evaluate if results reflect the understanding of the project and model inputs.

5.4.2 Model Calibration

The Runoff Model was history matched against a synthetic flow record for SC01. The synthetic record was developed based on the relationship established between SC01 and Cluden Stream @ Stockyards (KSL, 2025a): $SC01 \text{ flow} = 0.03974838 \times \text{Cluden flow} - 0.25974622$. The synthetic flow record timespan covered 23/11/2012 through 31/01/2025 (~12 years). History matching to the Rise and Shine Creek data was considered not worthwhile due to water takes of unknown volume and timing from this creek for drilling purposes. The Runoff Model was driven by the synthetic rainfall record described in Section 5.2.1.

Initially, the Australian Water Balance Model was used in an attempt to reproduce the synthetic flow record, but model performance was found to be poor. Thus, the Runoff Model was utilised as described in Section 5.2.3. History matching with the Runoff Model was completed using a manual trial and error approach, with a focus on balancing the match between:

- Daily average simulated and observed stream flow rates (Figure 20 and Figure 21).
- Flow exceedance probability (Figure 22).
- Cumulative water volume (Figure 23).

Findings from the history matching were as follows:

- History matching was unable to achieve a satisfactory fit to both high and low flow conditions; a trade-off between fitting one or the other was apparent. One of the main causes behind this was the use of synthetic rainfall and flow records from two different physiographic locations, namely a low valley bottom setting for the Cromwell EWS station and a mountainous terrain catchment reporting to Cluden @ Stockyards. Although the synthetic records are reasonable approximations of average conditions at Bendigo, they are unlikely to represent well individual storm/rainfall events which drive high flow conditions. On balance, the fit to the lower flow

¹¹ Quality Assurance / Quality Control

conditions was prioritised as there is less dilutive capacity during these conditions, so the risk of exceeding in stream water quality objectives is higher (i.e., a conservative choice).

- Low flow conditions were slightly under predicted (e.g., Figure 21), which all else being equal, would conservatively result in higher modelled instream water quality concentrations.
- Average flow statistics were reasonably well matched (Table 19), while the 7 day mean annual low flow was under predicted.
- The overall fit to daily average flow data, flow exceedance probability, and cumulative water volume is considered reasonable for representing conditions at the spatial scale of the Project. Mismatch to observed data is typically a result of under predicting higher flow conditions.

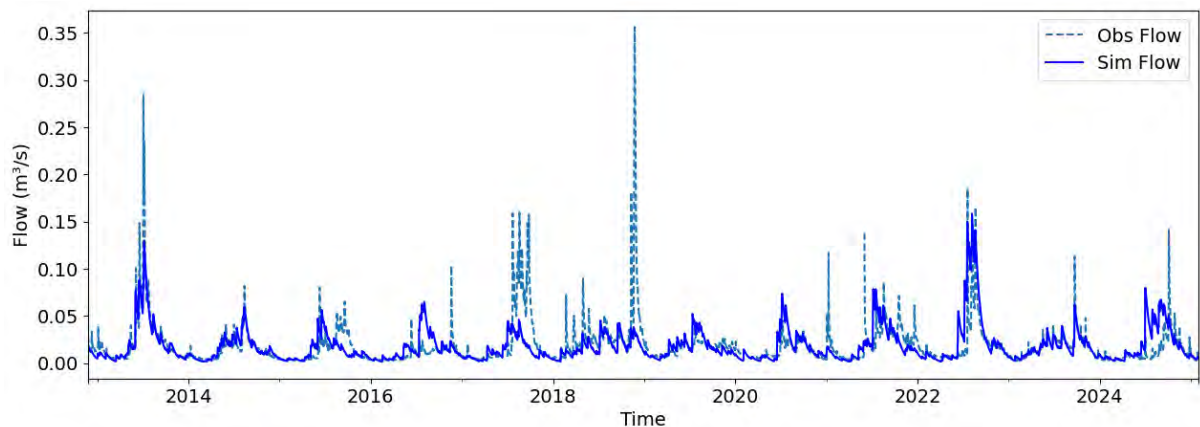


Figure 20: Daily flow rate comparison.

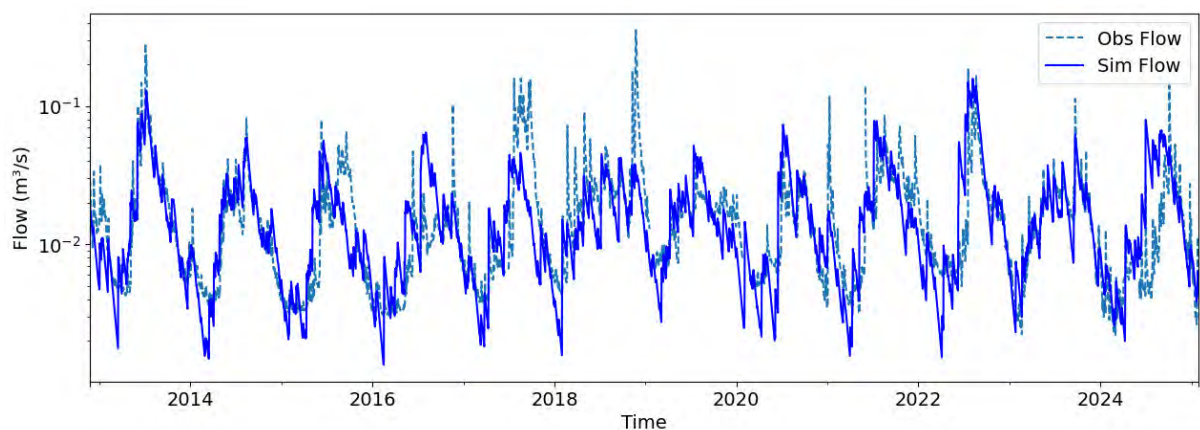


Figure 21: Daily flow rate comparison (log scale).

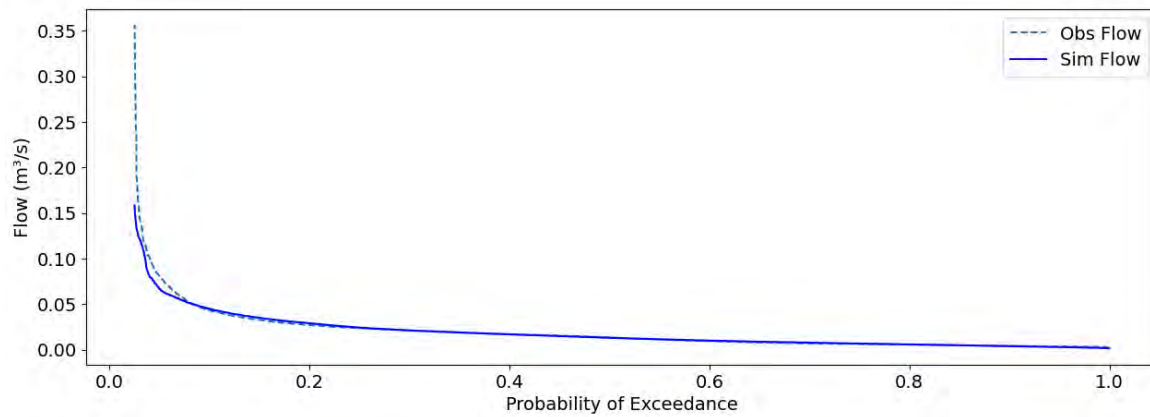


Figure 22: Flow exceedance comparison.

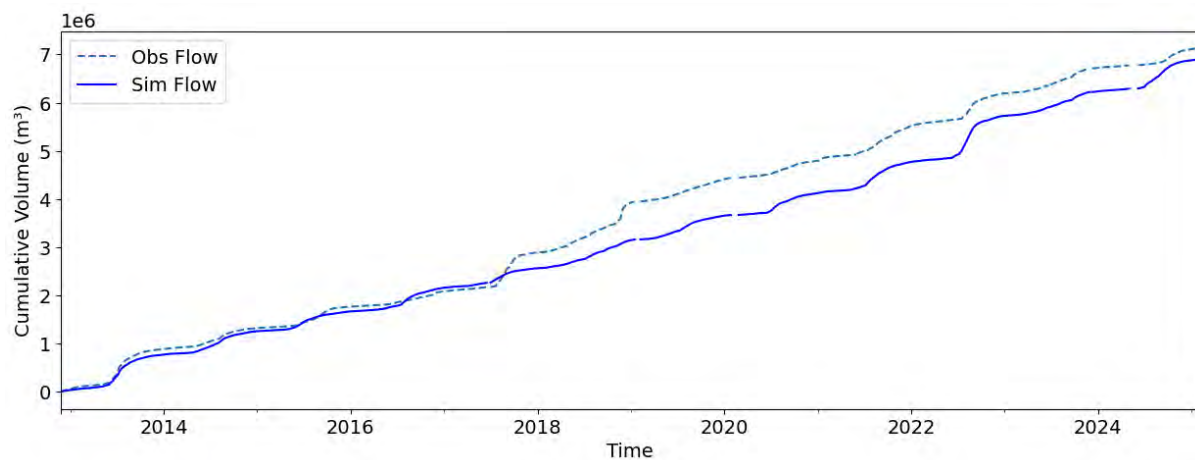


Figure 23: Cumulative water volume comparison.

Table 21: SC01 flow statistic comparison.

METRIC	SYNTHETIC RECORD	MODEL RESULTS
Mean flow (L/s)	19.0	18.1
Median flow (L/s)	12.7	12.3
7-day MALF (L/s)	4.5	2.40

MALF = mean annual low flow.

5.4.3 Model Limitations

5.4.3.1 Water Balance

As discussed in Section 5.4.2, the Runoff Model did not provide a strong match to high or (daily average) peak flow conditions. In addition, peak flows typically occur at a finer temporal scale than the modelled daily time step. As such, the Runoff Model, and by extension the wider Water Balance Model results are not appropriate to inform engineering design criteria that are sensitive peak flows.

The Runoff Model was history matched to SC01 flows, which spatially average flow generation over the entire catchment. However, higher elevation sub-catchments (e.g., area reporting to SC03) are known to have higher unit flow yields (KSL, 2025a). As such, the Runoff Model may not be reliable at forecasting flows at smaller, lower elevation portions of the Project area.

Pit lake evaporation was derived based on the SRX climate station record. It is known that deep lakes (e.g., >5 m) can display different patterns in lake evaporation than PET derived from land-based weather stations, where radiation energy can be stored within the in warmer months and released in colder months (Jenson and Allen, 2016). In addition, PET from land-based weather stations may not reflect well wind, water temperature, and pit wall shading effects specific to pit lake evaporation (McJannet et al., 2019). This is a noted uncertainty in the model, particularly for the pit voids, but no more uncertain than other model elements.

Model inputs and outputs to the mine domain components of the WLBM were not calibrated and typically informed by experience at mine sites in similar settings (e.g., Macraes Mine, etc.). Performance monitoring during operations and post-closure will be essential to confirm model results are reasonable.

Seepage collection systems are assumed to collect and recover 100% of load associated with mine waste storage facilities. Additional ground investigations, groundwater monitoring, and detailed modelling will be required at detailed design.

5.4.3.2 Load Balance

Load balance limitations are outlined below:

- **Conservative transport assumption:** The model assumes that all parameters are transported downstream without accounting for geochemical reactions. This means that processes such as precipitation (e.g., formation of hydroxy-sulfates) and adsorption are not represented. As a result, elements known to be removed from solution, such as Al, Fe, and As, are likely overestimated. Other trace metals (e.g., Co, Mo, V), may also be affected. These processes can occur within pit lakes or along flow pathways.
- **Nitrate decay in pit lakes:** A decay rate has been applied to nitrate to reflect biological denitrification processes, as observed in pit lakes at Macraes (Navarro-Valdivia et al., 2023). This accounts for partial natural attenuation of nitrate concentrations within the receiving water bodies.
- **Nitrogen:** Nitrogen speciation is not modelled (e.g., ammoniacal nitrogen, nitrite, nitrate). Total nitrogen concentrations are used in the model, however they are presented as Nitrate-N, as it is assumed that is the predominant nitrogen species in typical oxic MIW.
- **pH:** pH is expected to remain neutral to alkaline in this load balance. To account for “pH transport,” the hydrogen ion concentration (estimated from the source terms using the equation $\text{pH} = -\log_{10}[\text{H}^+]$) is used instead. It remains relatively stable, but this does not account for carbonate speciation, which is likely to control and buffer pH at neutral levels due to the high alkalinity expected from the dissolution of carbonate minerals in the schists.
- **Source terms assumptions:** The model applies average water quality conditions across the simulation period. This limits its ability to capture short-term water quality variability, such as the ones caused by storm events, seasonal dry periods, which can influence contaminant mobility and concentrations. As more information becomes available, additional processes, such as decaying concentrations of pit walls or load contributions from rehabilitated areas, can be incorporated.

- **Pit lake full mixing approach:** The model does not simulate physical processes such as density-driven stratification or mixing within pit lakes or water bodies. In reality, thermal stratification can influence redox conditions, nutrient cycling, and the timing and depth of contaminant release (e.g. from bottom layers). The current approach assumes full mixing of the pit lake. It is assumed that some stratification may occur, but annually this stratification would break down in winter.
- **No biogeochemical processes:** Whilst a nitrate decay rate is included for water bodies, other biologically mediated processes (e.g., sulfate reduction, organic matter degradation, iron reduction) are not explicitly represented. These processes can significantly influence redox-sensitive elements (e.g. Fe, Mn, U, As) and could result in either attenuation or remobilisation depending on conditions.

5.5 Model Results

Model results for water balance and load balance are described separately in this section.

5.5.1 Water Balance Results

Water balance model results are described separately for mine domains (e.g., RAS Pit water level) and creek flows (e.g., SC01) in the following subsections.

5.5.1.1 Mine Domains

Model results for RAS Pit Void are shown in Figure 24 and Figure 25, and suggest:

- Stabilisation of the pit lake rebound in approximately 25 years, with a water level around 492 m asl (slightly above the adopted portal elevation of 490 m asl).
- Model results do not suggest the pit lake will spill over the pit crest low point (565 m asl).
- Discharge of pit lake water via the underground portal will start once the pit lake water level is above 490 m asl, and typically range between 4 to 7 L/s, with an average of about 6 L/s.

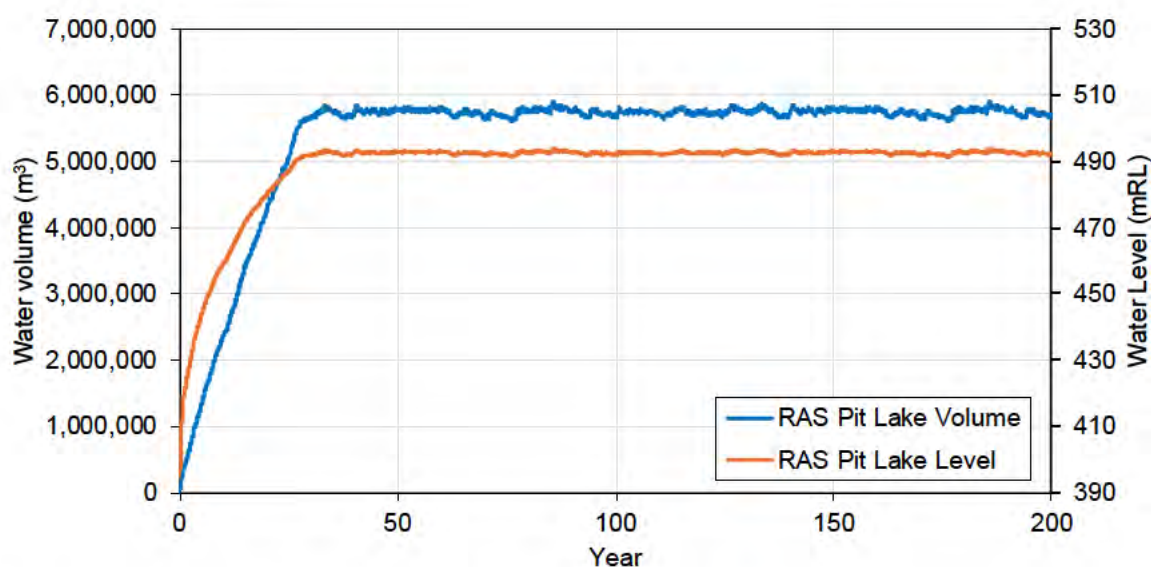


Figure 24: RAS Pit Void model results – water volume and level.

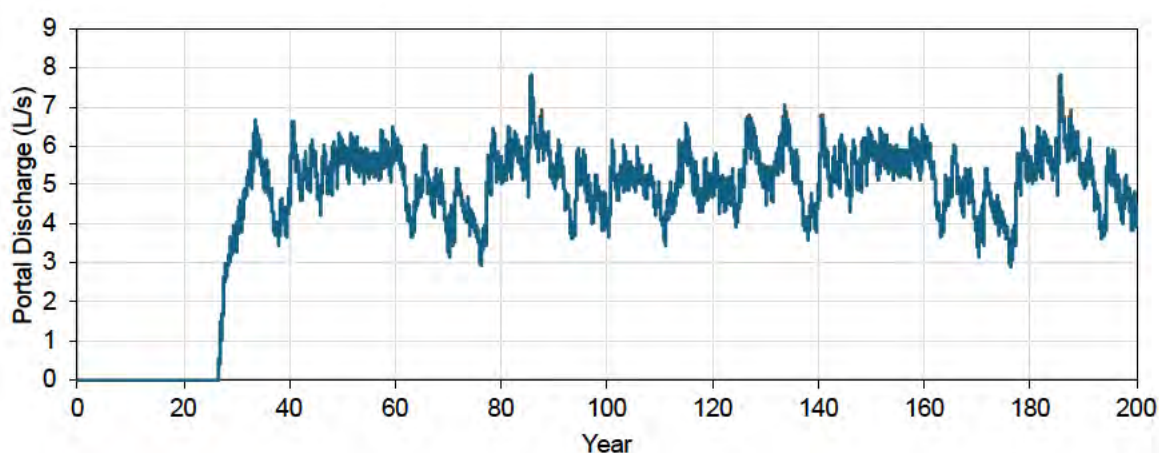


Figure 25: RAS Pit Void model results – underground portal discharge.

Model results for SRX Pit Void are shown in Figure 26 and Figure 27, and suggest:

- The pit void will fill and spill quickly (~ 6 months) owing to the low pit crest elevation and high groundwater inflow rate.
- The variability in overflow rate from the pit lake is higher than other pit voids due to the contribution of runoff from undisturbed areas reporting to the pit. Periodic high outflow rates are predicted, 120 L/s or higher, but average outflow rate is approximately 8 L/s.

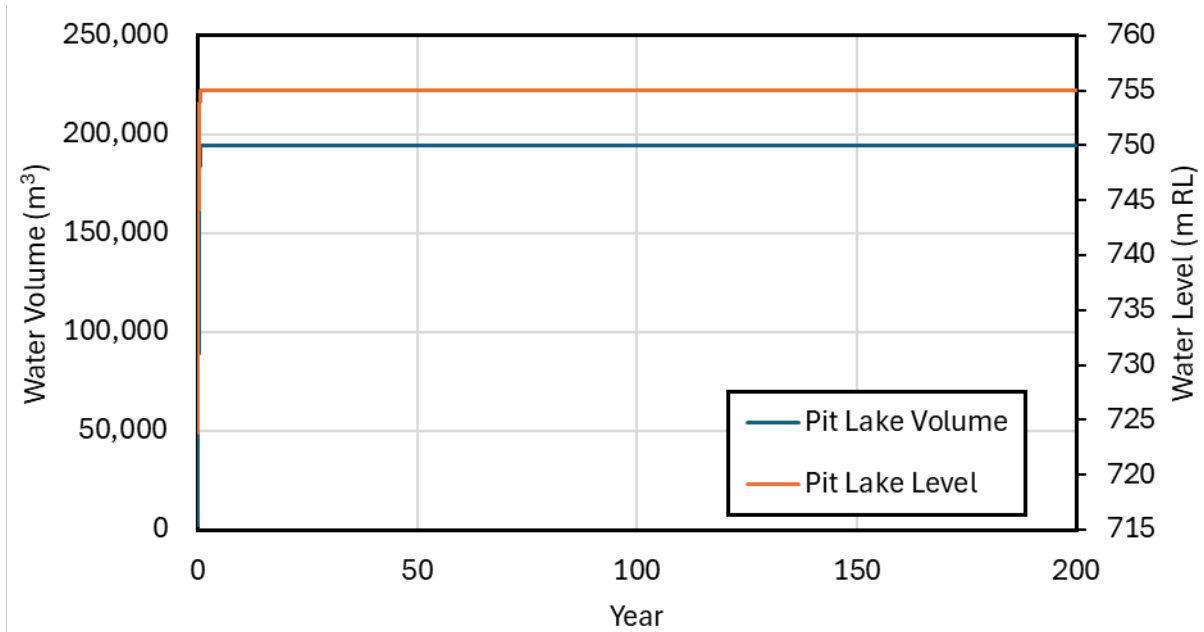


Figure 26: SRX Pit Void model results – water volume and level.

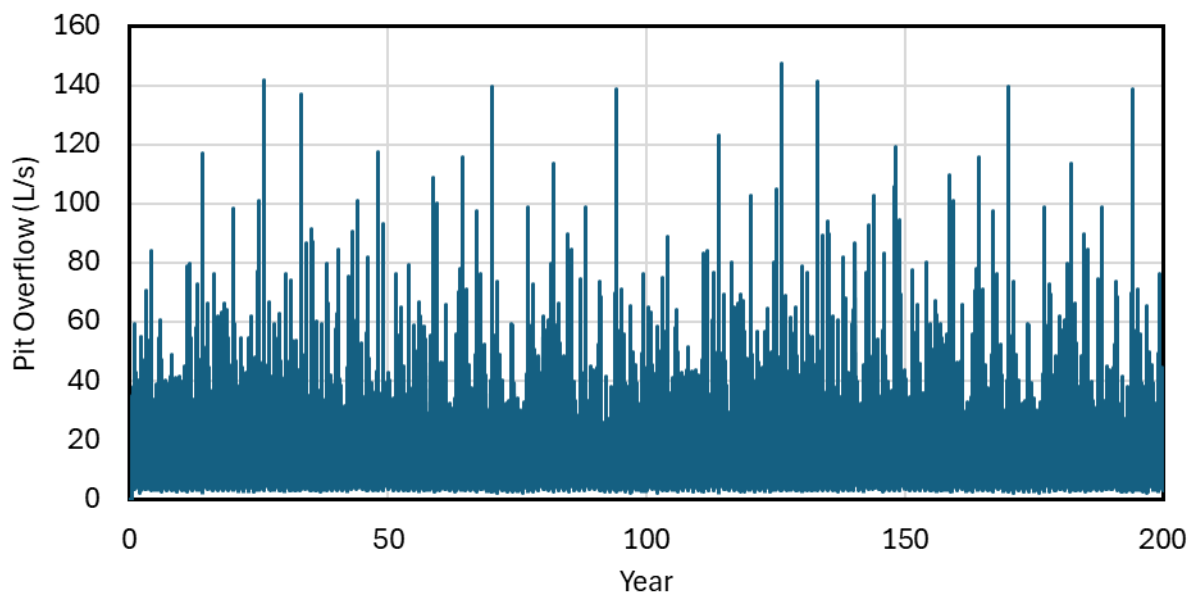


Figure 27: SRX Pit Void model results - overflow rate.

Model results for CIT Pit Void are shown in Figure 28 and Figure 29, and suggest:

- The backfilled pit void will fill and spill at around 3.5 years.
- Outflow rates via groundwater pathways are low <0.1 L/s, with the majority of outflow via spilling at the pit crest at an average of approximately 1.5 L/s.

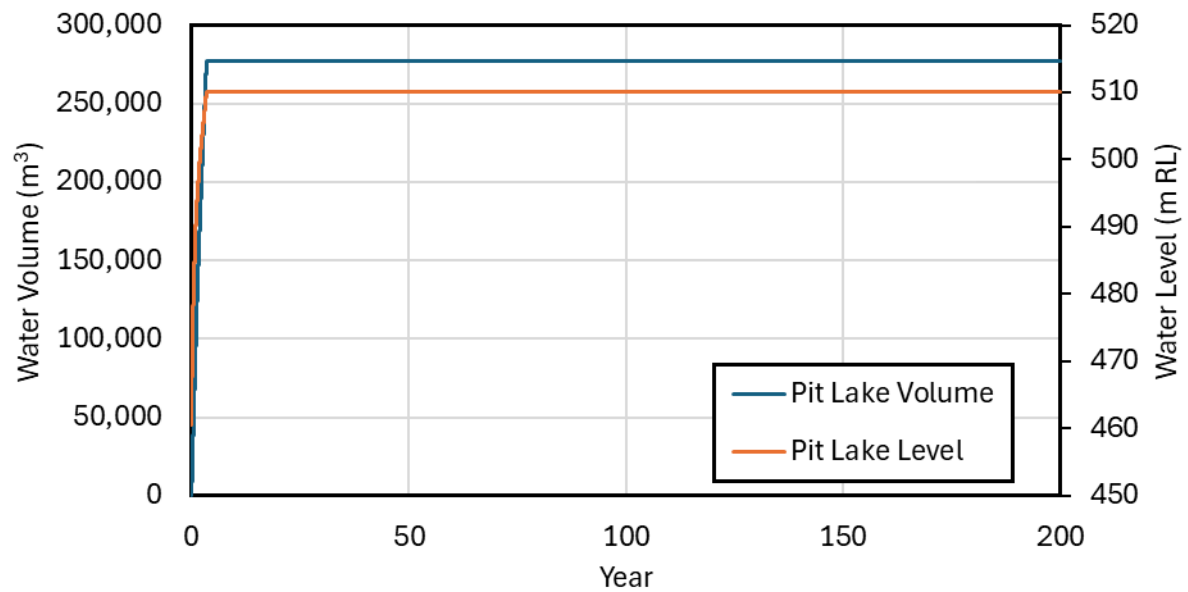


Figure 28: CIT Pit Void model results – water volume and level.

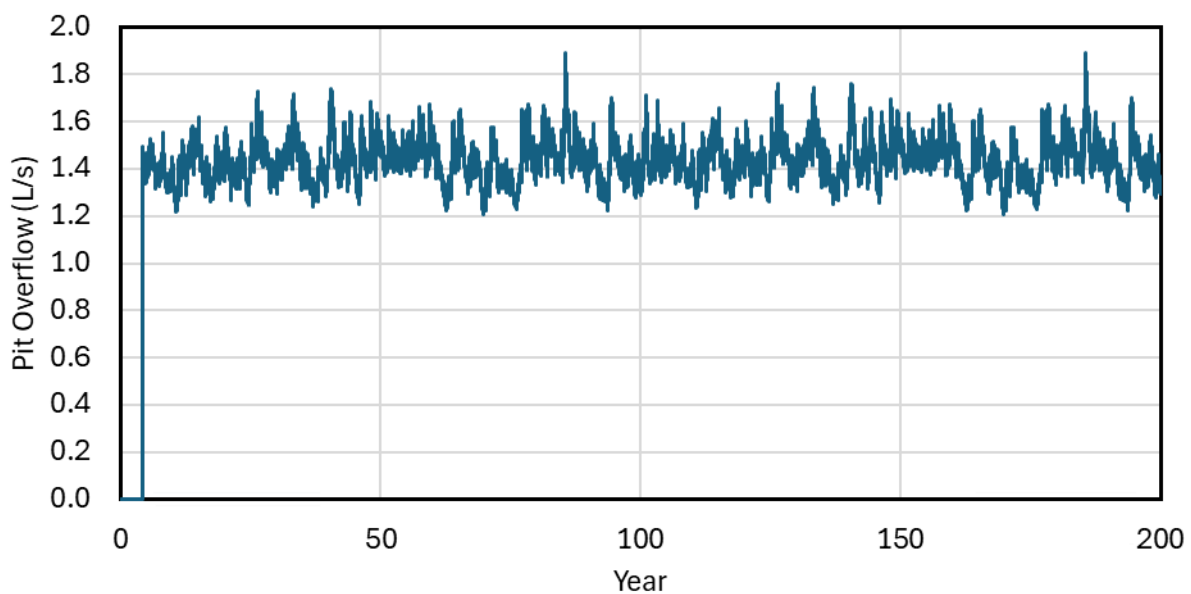


Figure 29: CIT Pit Void model results – outflow rates.

Model results for seepage flow rates from the ELF's and TSF are shown in Figure 30, and suggest:

- Average flow rates for the Shepherds ELF's of approximately 4 L/s, with flow rates typically varying between 2 and 6 L/s. Seepage flow rates from SRX ELF, WELF, and SCK Fill approximately 0.5 L/s or less on average.
- TSF seepage decays through the drain down period in accordance with input described in Section 5.2.5, with average long term seepage flow rates of approximately 2 L/s. Flow rates typically vary between 1 and 3 L/s in the long term.

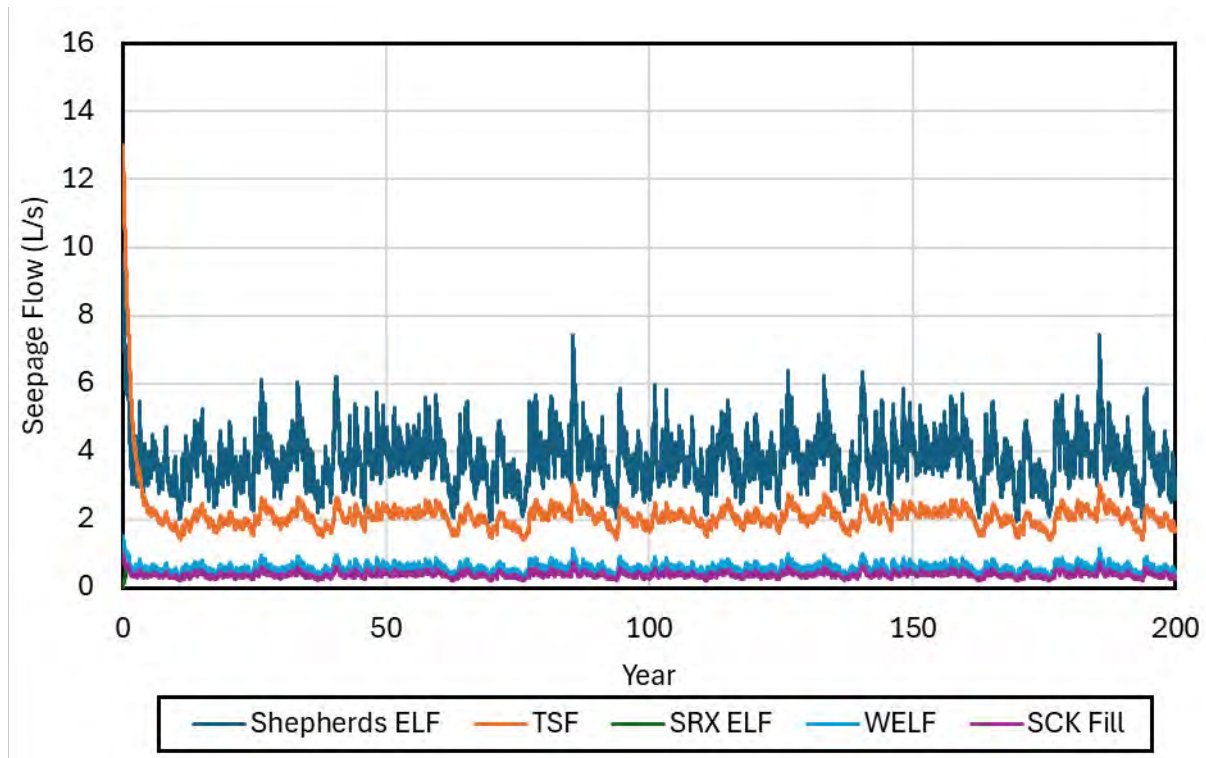


Figure 30: ELF and TSF seepage flow rates.

Note: SRX ELF seepage flow rate is similar to the WELF, so plots behind this trace.

5.5.1.2 Creek Flows

Forecasted changes to the Shepherds Creek flow regime (at SC01) are shown in Figure 31, while Clearwater Creek changes (at RS03) are shown in Figure 32. Summary statistics are presented in Table 20. Forecast baseline conditions, based off the Runoff Model (See Section 5.2.3), are shown for comparison.

Overall model results suggest the project will increase the water flow passing through the compliance points. Average and median flows increase between 50 and 60%, while low flows increase more significantly, ranging between increases of appropriately 280 to 530%. The main cause in flow increase, especially for lower flow conditions, is the increased seepage from ELFs and TSFs. The RAS pit lake storage and outflow dynamics are also a contributing factor, albeit less influential.

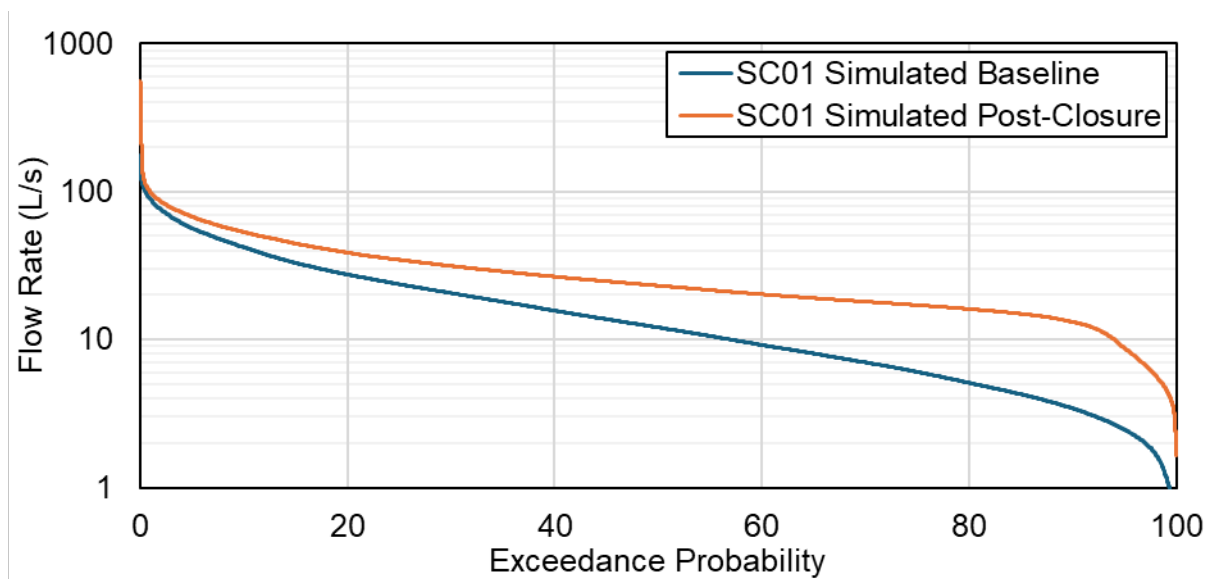


Figure 31: SC01 forecasted flows regime.

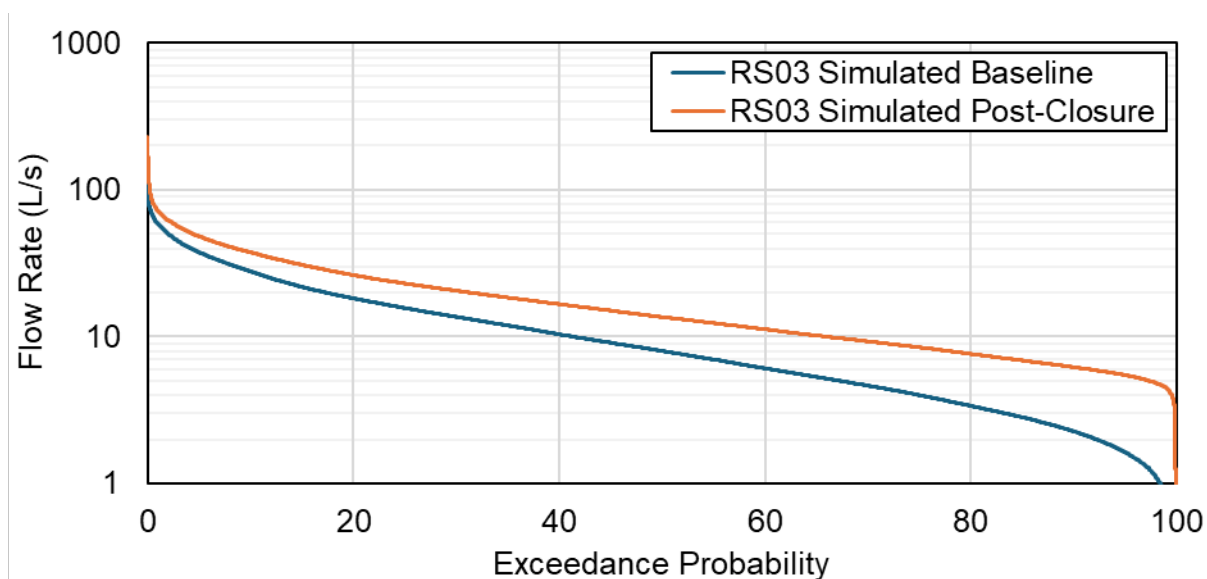


Figure 32: RS03 forecasted flows regime.

Table 22: Forecast creek flow summary statistics.

	PEAK FLOW (L/s))	MEAN FLOW (L/s)	MEDIAN FLOW (L/s)	7D MALF (L/s)	5YR-7D LF (L/s)
SC01 Simulated Baseline	176	18	12	2	1
SC01 Simulated Post-Closure	563	29	23	13	11
Change	387 (+220%)	11 (+59%)	11 (+92%)	11 (+535%)	10 (+787%)
RS03 Simulated Baseline	117	12	8	1	1
RS03 Simulated Post-Closure	229	18	14	5	5
Change	113 (+97%)	6 (+52%)	6 (+70%)	4 (+282%)	4 (+426%)

7D MALF = seven day mean annual low flow.

5YR-7D LF is the lowest weekly average flow that has a reoccurrence interval of 1 in 5 years.

Note flow values are rounded to reflect inferred accuracy.

5.5.2 Load Balance Results

This section discusses the load components of the WLBM.

5.5.2.1 Introduction

This section presents the WLBM results for the load balance:

- Yearly average tabulated results, covering up to 200 years, are provided in Table 21.
- Relevant components of the WLBM are presented including Shepherds Creek (SC01) and Rise and Shine Creek (RS03).
- Results for SC01 and RS03 are screened against recommended surface water and groundwater limits from the proposed compliance water quality standards (Ryder, 2025) as shown in Table 21.

Table 23: Summary of used reference limits for screening.

PARAMETER	SURFACE WATER LIMIT (mg/L)	GW LIMIT (mg/L)	SOURCE SW LIMIT / GW LIMIT
Al	0.08	1	Ryder (2025)
As	0.042	0.01	Ryder (2025)
B	-	2.4	ANZG (2018) 90% Protection
Cyanide (CN)	0.011	0.6	Ryder (2025)
Cd	0.0004 ⁵	0.004	Ryder (2025)
Co	0.001 ^{2,5}	1	SW Chronic; Ryder (2025)
Cr	0.0033 ^{3,5}	0.05	SW Cr(III); Ryder (2025)
Cu	0.0018	0.5	Ryder (2025)
Fe	-	0.3	Ryder (2025)
Mn	-	0.4	Ryder (2025)
Mo	0.034	0.01	Ryder (2025)
NO ₃ -N	2.4	11.3	SW Annual Median Ryder (2025)
Pb	-	0.01	Ryder (2025)
SO ₄	500 ¹	250	Ryder (2025)

PARAMETER	SURFACE WATER LIMIT (mg/L)	GW LIMIT (mg/L)	SOURCE SW LIMIT / GW LIMIT
Sb	0.074 ⁴	0.02	Ryder (2025)
Se	-	0.02	Ryder (2025)
Sr	-	4	Ryder (2025)
U	-	0.03	Ryder (2025)
Zn	0.015 ⁵	1.5	Ryder (2025)

1. No modification has been applied to this limit and a set value of 500 mg/L is used for assessment purposes.
2. Where the lower chronic limit has been applied 0.001 mg/L.
3. Where Cr(III) limits are used as proposed by Ryder (2025) being the lower limit for Cr (i.e., Cr(VI) is 0.006 mg/L).
4. The lower chronic limit (total) has been applied (0.074 mg/L) as a fixed value for annual data.
5. Where hardness modification has not been applied as a conservative approach

5.5.2.2 RAS Pit Lake

RAS Pit Lake receives input from three inflows: groundwater, pit wall runoff, and rainfall. Of these, only groundwater and pit wall runoff contribute significant loads. Rainfall is included in the water balance, but it only provides dilution and contributes minor loads of sulfate and nitrate-N.

The water quality results for selected parameters are shown in Figure 33 and Figure 34. Results show that compared to the reference limits, parameters are mostly lower. Parameters that are above at least one of the reference limits are: NO₃-N, Al, Sb, As, Fe, Cu and Mo.

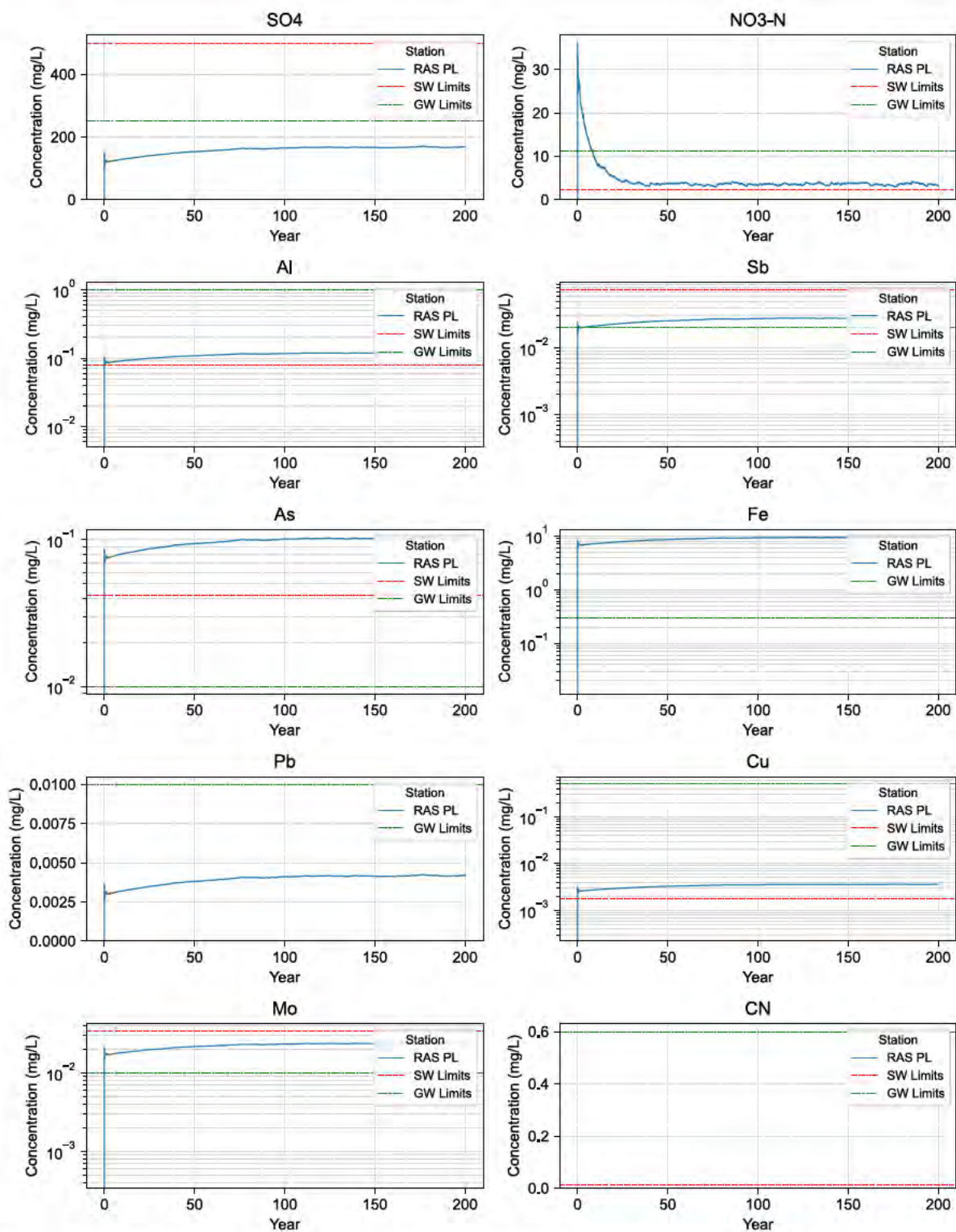


Figure 33. RAS Pit Lake water quality results. Part 1 of 2.

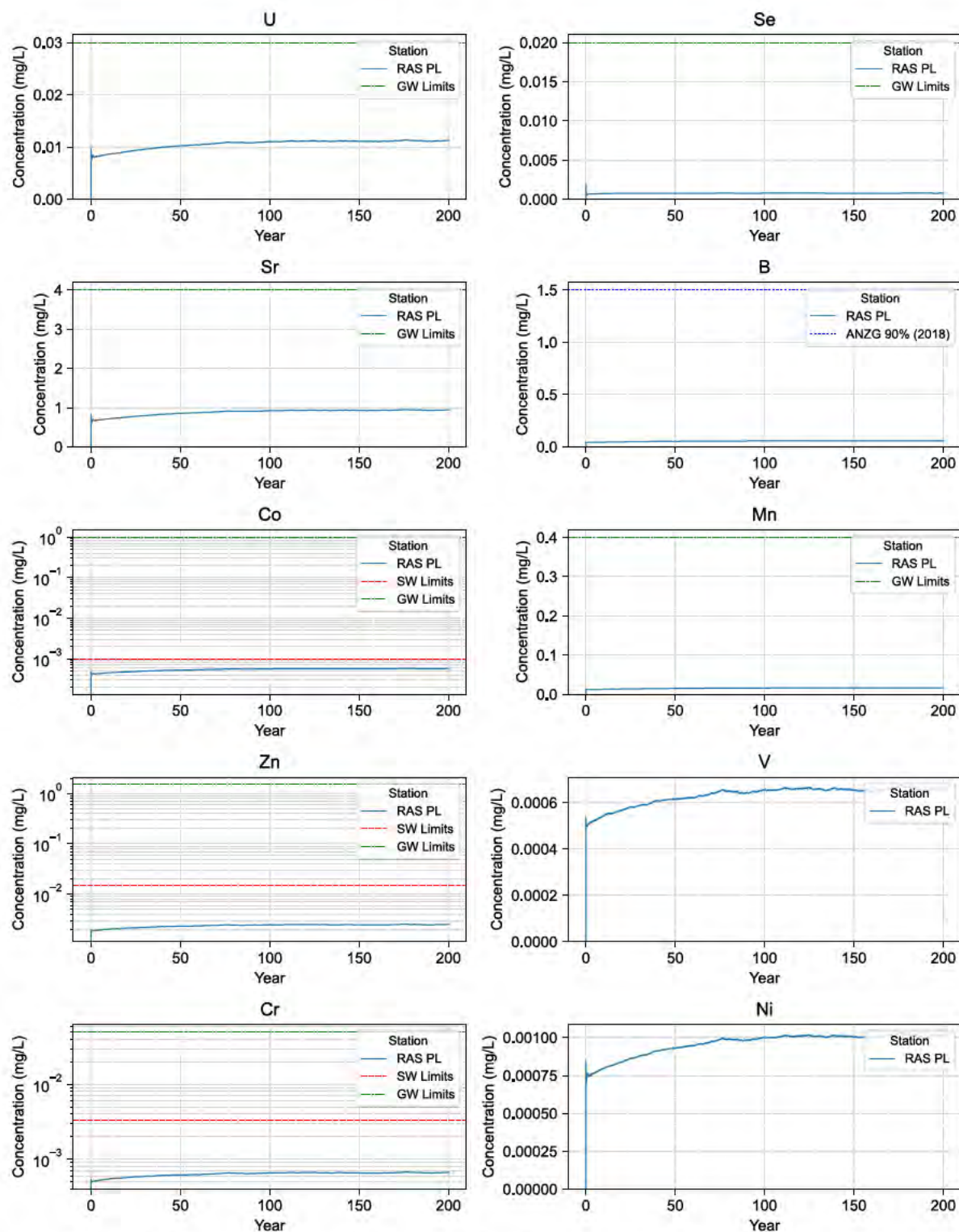


Figure 34. RAS Pit Lake water quality results. Part 2 of 2.

The average inflow loads to the RAS Pit Lake are shown on Table 22. The data show that pit wall runoff is the dominant source of contaminants, responsible for nearly all the assessed parameters.

Groundwater Inflow: Groundwater is the dominant source of Se (89 g/year, 68% of the total Se load). It also contributes significantly to boron (17%), chromium (23%), vanadium (23%), manganese (12%),

and zinc (18%). Whilst its influence is limited, groundwater still accounts for the majority of selenium reaching the lake.

Pit Wall Runoff

Pit wall runoff is the main driver of load for 17 of the 18 parameters assessed, contributing more than 98% of the load for elements such as Al, Fe, Mo, NO₃-N, Pb, Sb, SO₄, Sr, and U. Copper and arsenic are also largely derived from pit wall contributions, exceeding 93%. Nitrate loads are high, associated with blasting residues. There is a 25% yearly decay of nitrogen due to bacterial activity based on empirical evidence (Navarro-Valdivia et al., 2023).

Table 24. Average annual Inflow Loads to RAS Pit Lake.

PARAMETER	GW INFLOW	PIT WALL	RAINFALL	TOTAL
Al (kg/yr)	0.30 (1.5%)	19.3 (98.5%)	0 (0%)	19.6
As (kg/yr)	1.2 (7.0%)	15.8 (93.0%)	0 (0%)	17.0
B (kg/yr)	1.6 (17.4%)	7.8 (82.6%)	0 (0%)	9.4
Co (g/yr)	9.4 (10.0%)	84.8 (90.0%)	0 (0%)	94.2
Cr (g/yr)	24.8 (22.6%)	84.8 (77.4%)	0 (0%)	109.6
Cu (g/yr)	14.9 (2.5%)	576.3 (97.5%)	0 (0%)	591.2
Fe (kg/yr)	0.73 (0.0%)	1,543 (100.0%)	0 (0%)	1,543
Mn (g/yr)	337.2 (12.4%)	2,373 (87.6%)	0 (0%)	2,710
Mo (kg/yr)	0.02 (0.5%)	3.9 (99.5%)	0 (0%)	3.9
NO ₃ -N (kg/yr)	0.25 (0.0%)	6,780 (99.9%)	3.7 (0.1%)	6,784
Pb (g/yr)	9.9 (1.4%)	678.0 (98.6%)	0 (0%)	688.0
Sb (kg/yr)	0.02 (0.4%)	4.6 (99.6%)	0 (0%)	4.6
Se (g/yr)	89.3 (67.8%)	42.4 (32.2%)	0 (0%)	131.6
SO ₄ (kg/yr)	510.8 (1.8%)	27,121 (98.1%)	11.1 (0.0%)	27,643
Sr (kg/yr)	0 (0%)	154.3 (100.0%)	0 (0%)	154.3
U (g/yr)	49.6 (2.7%)	1,797 (97.3%)	0 (0%)	1,846
V (g/yr)	24.8 (22.6%)	84.8 (77.4%)	0 (0%)	109.6
Zn (g/yr)	74.4 (18.0%)	339.0 (82.0%)	0 (0%)	413.4

It is assumed in the WLBM that the RAS Pit Lake water flows to the Shepherds Creek via the underground workings, being an input to the SC01 monitoring point.

5.5.2.3 SRX Pit Lake

SRX Pit Lake receives input from four sources: groundwater inflow, pit wall runoff, SRX ELF seepage, and undisturbed runoff. Rainfall is present in the water balance but is mostly a dilution process, with no significant load.

The water quality results for selected parameters are shown in Figure 35 and Figure 36. Compared to the reference limits, most parameters are below the water quality limits. Parameters that exceed at least one of the reference limits include NO₃-N, As, Co, Sb, Fe, and Mo. Other elements are below the reference limits. Partial passive treatment of the SRX Pit Lake overflow is proposed (8 L/s) to ensure compliance with regards to water quality objectives at RS03.

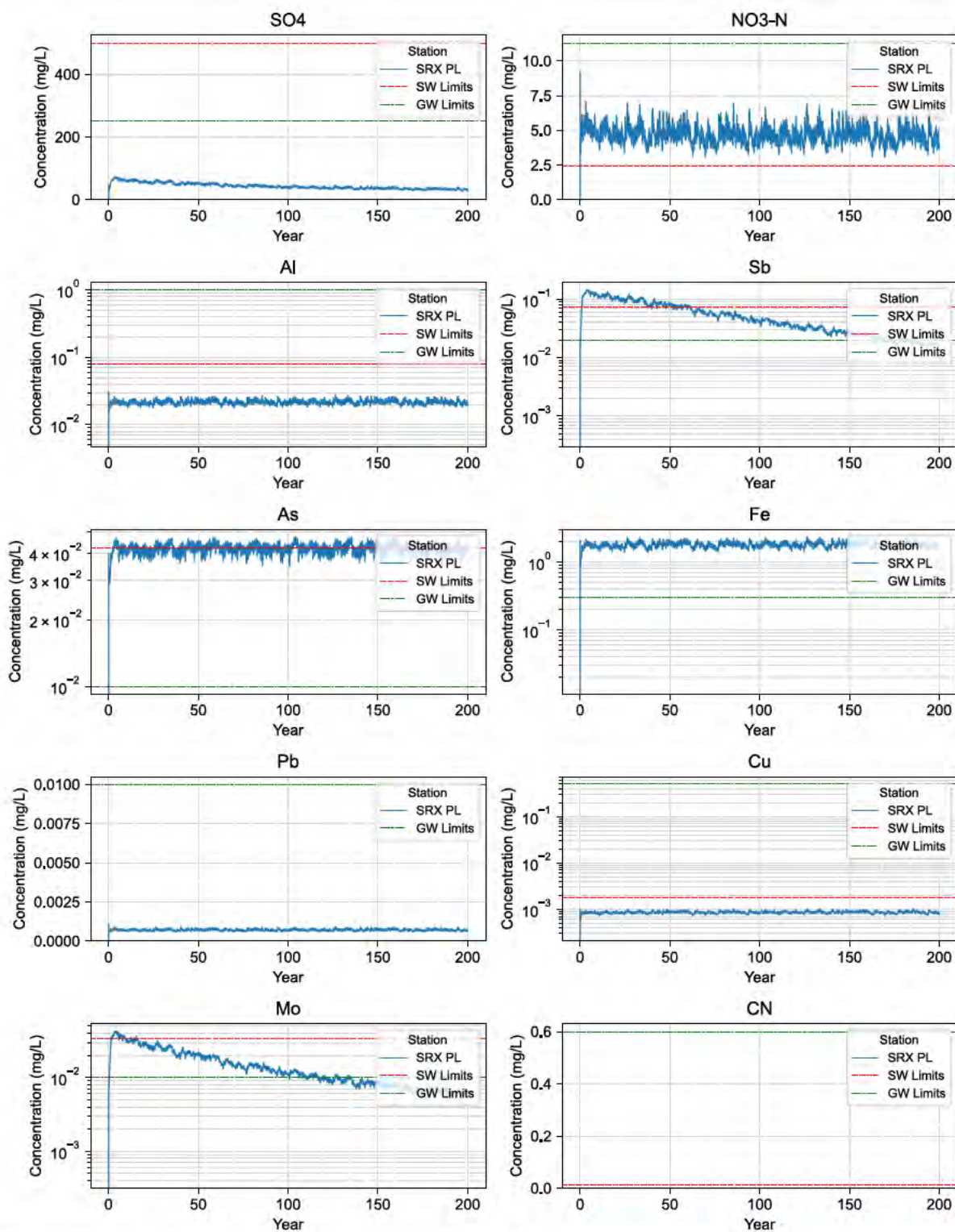


Figure 35. SRX Pit Lake water quality results. Set 1 of 2.

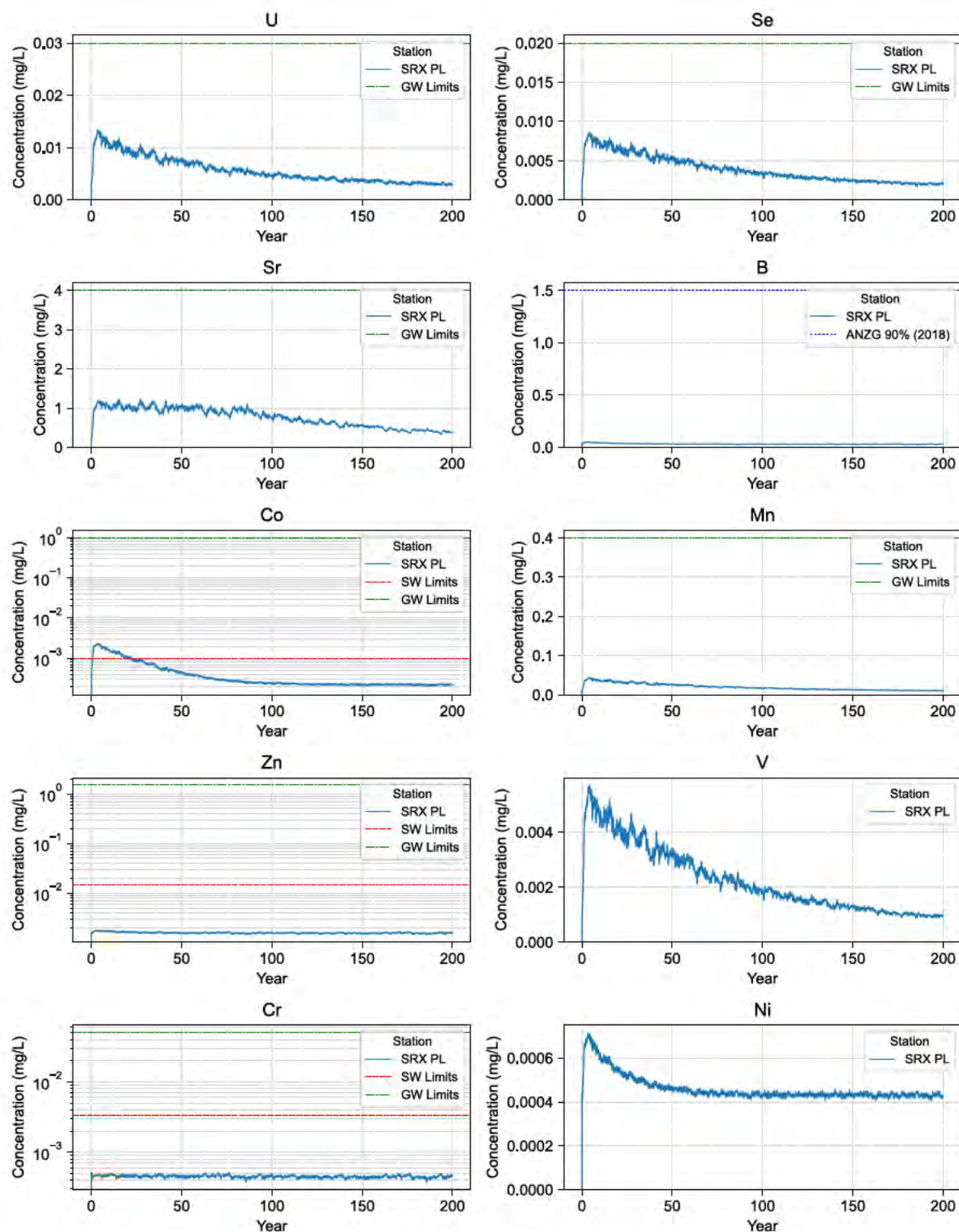


Figure 36. SRX Pit Lake water quality results. Set 2 of 2.

The average inflowing loads for the SRX Pit Lake are shown Table 23. The data indicate that SRX ELF seepage contributes the greatest load for a wide range of PCOC. Pit wall runoff and groundwater also play key roles, each dominating a smaller group of parameters.

Groundwater Inflow: Groundwater is the primary source for the following parameters:

- Selenium (285 g/year, 84%).

- Boron (5.2 kg/year, 70%).
- Chromium (79 g/year, 71%).
- Vanadium (79 g/year, 63%).
- Zinc (237 g/year, 61%).
- Manganese (,56%).
- Cobalt (30 g/year, 54%).

Pit Wall Runoff: Pit wall runoff is elevated for five parameters:

- Aluminium (4.1 kg/year, 75%).
- Copper (122.4 g/year, 56%).
- Iron (327.6 kg/year, 71%).
- Nitrate-N (1,440 kg/year, 99.8%).
- Lead (144 g/year, 80%).

This reflects the metal mobilisation of the exposed pit walls and nitrate contributions due to blasting residues.

SRX ELF Seepage: SRX ELF seepage is elevated for ten parameters:

- Arsenic (3.3 kg/year, 32%).
- Cobalt (111 g/year, 67%).
- Manganese (6 kg/year, 76%).
- Molybdenum (5.5 kg/year, 86%).
- Sulfate (6,600 kg/year, 47%).
- Antimony (24.5 kg/year, 96%).
- Selenium (1,248 g/year, 79%).
- Strontium (279.2 kg/year, 85%).
- Uranium (1.7 kg/year, 75%).
- Vanadium (868 g/year, 87%).

These results reflect the significant impact of the ELF on the pit lake.

Undisturbed Runoff: Runoff from undisturbed areas contributes modest but non-negligible loads for several parameters such as:

- Cu (47.9 g/year; 22%).
- Zn (82 g/year; 20%).
- Cr (15 g/year; 13%).

- B (640 g/year; 7%).
- Al (400 g/year; 7%).
- Sr (18.2 kg/year; 6%).

For most other elements, the contribution from undisturbed areas remains below 5%, indicating a generally minor role in overall contaminant loads.

Table 25: Average annual inflow loads to SRX Pit Lake.

PARAMETER	GW INFLOW	PIT WALL	RAINFALL	SRX ELF SEEPAGE	UNDISTURBED. RUN-OFF	TOTAL
Al (kg/yr)	0.96 (17.5%)	4.1 (74.4%)	0 (0%)	0.05 (0.9%)	0.40 (7.2%)	5.5
As (kg/yr)	3.8 (36.1%)	3.3 (31.8%)	0 (0%)	3.3 (31.6%)	0.06 (0.5%)	10.5
B (kg/yr)	5.2 (65.1%)	1.7 (20.6%)	0 (0%)	0.52 (6.4%)	0.64 (7.9%)	8
Co (g/yr)	30.1 (27.1%)	18.0 (16.2%)	0 (0%)	55.5 (49.9%)	7.5 (6.8%)	111
Cr (g/yr)	79.1 (69.8%)	18.0 (15.9%)	0 (0%)	1.2 (1.1%)	15.0 (13.2%)	113.3
Cu (g/yr)	47.5 (21.8%)	122.4 (56.2%)	0 (0%)	0 (0%)	47.9 (22.0%)	217.8
Fe (kg/yr)	2.3 (0.5%)	327.6 (71.2%)	0 (0%)	126.3 (27.4%)	3.9 (0.9%)	460.2
Mn (g/yr)	1,076 (21.8%)	504.1 (10.2%)	0 (0%)	2,998 (60.9%)	346.4 (7.0%)	4,924
Mo (kg/yr)	63.3 (1.7%)	828.1 (22.5%)	0 (0%)	2,769 (75.4%)	12.7 (0.3%)	3,673
NO3-N (kg/yr)	0.81 (0.1%)	1,440 (98.1%)	1.2 (0.1%)	26.1 (1.8%)	0.19 (0.0%)	1,468
Pb (g/yr)	31.6 (17.5%)	144.0 (79.7%)	0 (0%)	0.36 (0.2%)	4.6 (2.6%)	180.6
Sb (g/yr)	0.06 (0.5%)	0.97 (7.3%)	0 (0%)	12.2 (92.1%)	0.01 (0.1%)	13.3
Se (g/yr)	284.7 (29.5%)	9.0 (0.9%)	0 (0%)	624.2 (64.7%)	46.2 (4.8%)	964.1
SO4 (kg/yr)	1,629 (14.9%)	5,761 (52.8%)	3.7 (0.0%)	3,350 (30.7%)	161.7 (1.5%)	10,905
Sr (kg/yr)	0 (0%)	32.8 (17.2%)	0 (0%)	139.6 (73.3%)	18.2 (9.5%)	190.5
U (g/yr)	158.2 (11.2%)	381.6 (27.1%)	0 (0%)	849.9 (60.4%)	17.3 (1.2%)	1,407
V (g/yr)	79.1 (14.1%)	18.0 (3.2%)	0 (0%)	434.3 (77.5%)	28.9 (5.2%)	560.2
Zn (g/yr)	237.3 (59.9%)	72.0 (18.2%)	0 (0%)	5.0 (1.3%)	82.0 (20.7%)	396.3

5.5.2.4 CIT Backfill

The CIT Backfill Pit Void functions as a backfilled pit that temporarily stores water like a high-permeability reservoir and eventually overflows. It receives inflows from groundwater and CIT Backfill seepage, which together account for all PCOC loads. Rainfall is not part of the load balance as there is no direct precipitation to a pit lake surface, as it enters the system through the backfill material, as seepage.

The water quality results for selected parameters are shown in Figure 37 and Figure 38. Compared to the reference limits, most parameters are below the thresholds. Parameters that exceed the reference limits include Sb, As, Fe, Mo, U, Se, and Co. Other elements are below the reference limits.

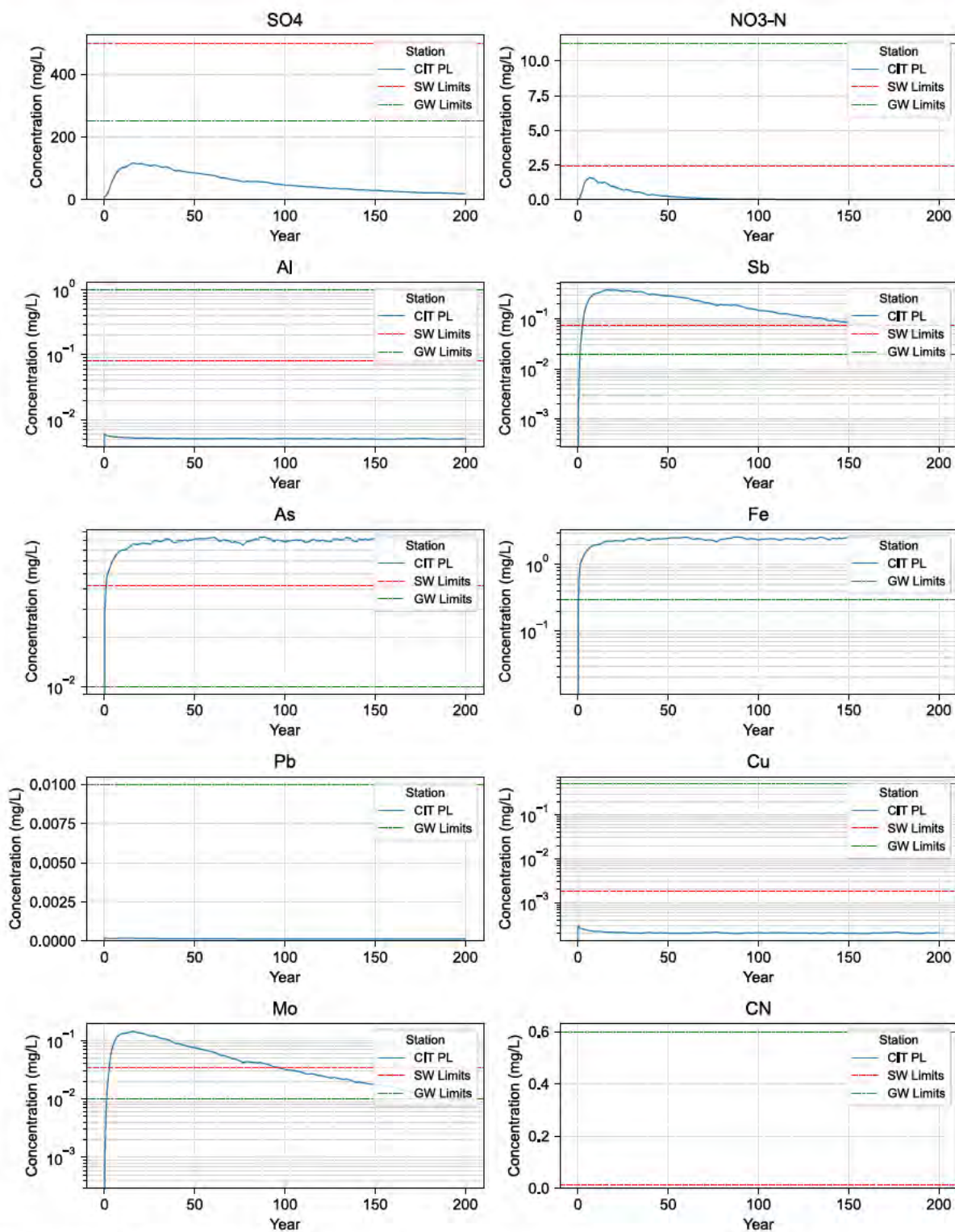


Figure 37. CIT Backfilled Void water quality results. Part 1 of 2.

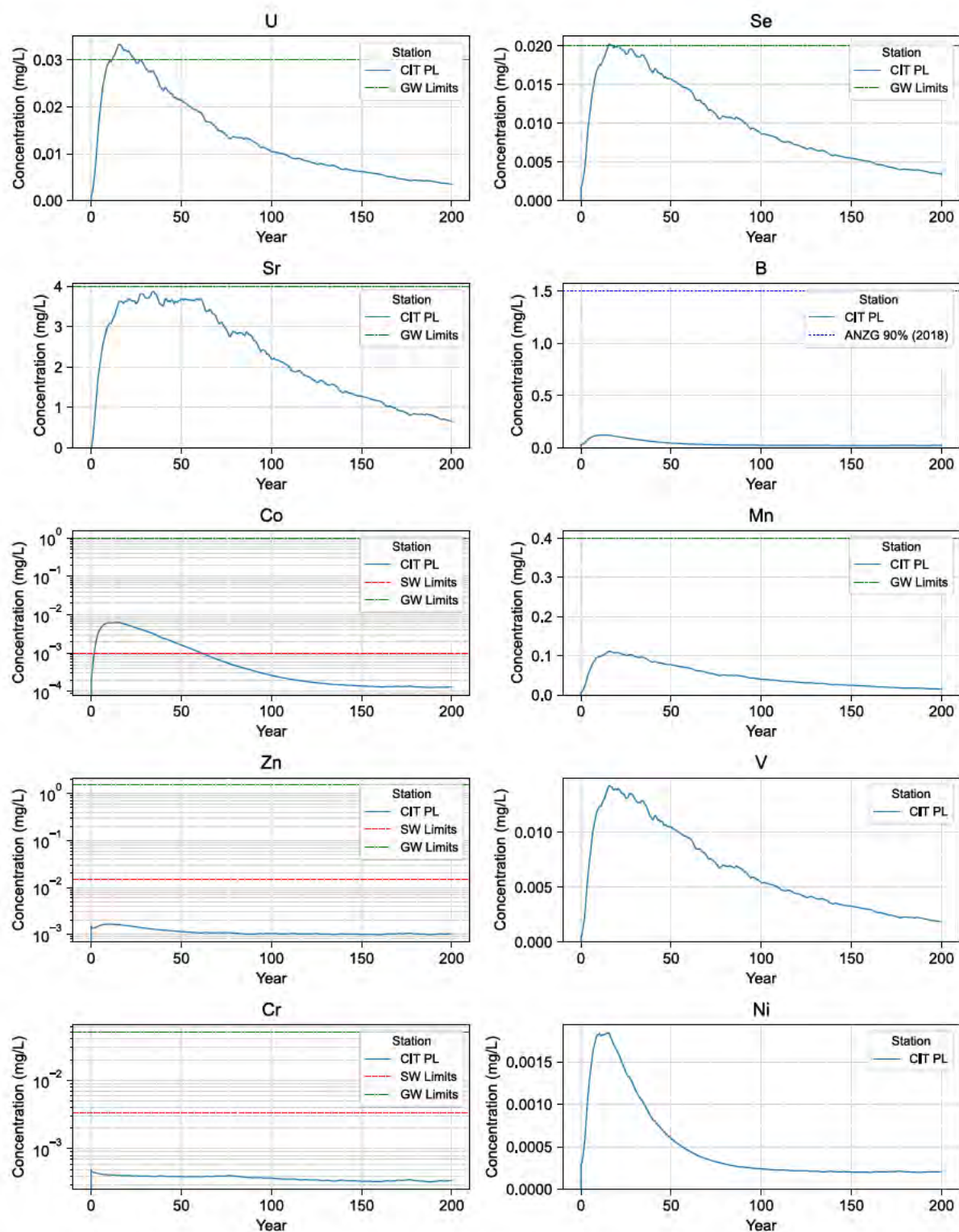


Figure 38. CIT Backfilled Void water quality results. Part 2 of 2.

The average inflowing loads for the CIT Backfill are shown on Table 24.

Groundwater Inflow: Groundwater is the primary contributor for five parameters:

- Cu – 9.6 g/year (100%).

- Pb – 6.4 g/year (91%).
- Cr – 16 g/year (86%).
- Zn – 48 g/year (84%).
- Al – 195 g/year (69%).

CIT Backfill Seepage: Seepage from the CIT Backfill dominates the load for the other 13 parameters as shown on Table 24. This pattern reflects significant mobilisation from within the backfill, due to oxidation of reactive materials and short-term solute release.

Table 26: Average annual inflow Loads to CIT Backfilled Void.

PARAMETER	CIT BACKFILL SEEPAGE	GW INFLOW	TOTAL
Al (g/yr)	43.6 (18.2%)	195.3 (81.8%)	238.9
As (kg/yr)	2.9 (79.3%)	0.77 (20.7%)	3.7
B (g/yr)	785.9 (42.6%)	1,060 (57.4%)	1846.0
Co (g/yr)	49.3 (89.0%)	6.1 (11.0%)	55.4
Cr (g/yr)	1.3 (7.5%)	16.0 (92.5%)	17.3
Cu (g/yr)	0 (0%)	9.6 (100%)	9.6
Fe (kg/yr)	111.9 (99.6%)	0.47 (0.4%)	112.4
Mn (kg/yr)	2.0 (90.4%)	0.22 (9.6%)	2.3
Mo (kg/yr)	2.2 (99.4%)	0.01 (0.6%)	2.2
NO ₃ -N (kg/yr)	26.8 (99.4%)	0.16 (0.6%)	26.9
Pb (g/yr)	0.32 (4.7%)	6.4 (95.3%)	6.7
Sb (kg/yr)	8.0 (99.8%)	0.01 (0.2%)	8.0
Se (g/yr)	403.8 (87.5%)	57.6 (12.5%)	461.5
SO ₄ (kg/yr)	2,200 (87.0%)	329.8 (13.0%)	2,529
Sr (kg/yr)	103.8 (100.0%)	0 (0%)	103.8
U (g/yr)	586.9 (94.8%)	32.0 (5.2%)	618.9
V (g/yr)	283.7 (94.7%)	16.0 (5.3%)	299.7
Zn (g/yr)	4.4 (8.5%)	48.0 (91.5%)	52.5

5.5.2.5 Shepherds Creek (SC01)

SC01 is the proposed compliance monitoring location at the outlet of the Shepherds Creek catchment, which integrates flows from multiple sources, including the TSF, RAS Pit Lake, Shepherds ELF, CIT Backfill Pit Lake, WELF, SCK Fill, and several runoff areas. This location represents the combined load of all upstream activities within the catchment and reflects the cumulative impact of seepage and surface pathways.

During the Active Closure Phase, it is assumed all mine impacted waters are treated by the WTP (Process Flow, 2025; MWM, 2025d) and that active treatment continues until passive treatment system can be installed and achieve compliance with the proposed water quality closure criteria. The post-closure model intentionally excludes the active WTP to evaluate whether closure criteria can be met without it, and to determine for how long active treatment would be required if implemented.

A passive treatment system is included in the WLBM using removal efficiencies detailed on the *Water Treatment Study* (MWM, 2025d). Both untreated and treated cases are presented in the figures below

to represent the impact of the passive treatment on mine-impacted waters and demonstrate the time period required for active treatment. The PCOC treatment efficiencies are shown in Table 25.

Table 27: Removal efficiencies for the passive treatment system.

PARAMETER	REMOVAL EFFICIENCIES (%)
Arsenic	99
Calcium ¹	-43.2
Magnesium	8
Aluminium	83.3
Iron	99.1
Nickel	97.9
Zinc	99.8
Manganese	86.4
Cadmium	85.2
Cobalt	98.4
Copper	85.6
Uranium	74
Vanadium	90
Sulfate	30
Cyanide	90
Nitrogen (Amm-N and NO ₃ -N)	99
Other metals	98

A negative value means Ca increases following treatment.

Source: MWM (2025d).

The mine-impacted waters that are treated by the passive treatment system at SC01 include six components: TSF seepage, Shepherds ELF seepage, groundwater flow from the RAS Pit Lake (via the underground workings), overflow from the CIT Backfill, WELF seepage, and seepage from the SCK Fill.

Some sources are not considered to be captured by the treatment system and may contribute additional load downstream of the treatment system but aren't considered to be significant contributors to loads. These include the portion of CIT Backfill outflow that reaches SC01 via groundwater, as well as runoff from the CIT Backfill, Shepherds ELF, TSF, and SCK Fill.

The water quality results for selected parameters are shown in Figure 39 and Figure 40 for untreated and treated simulations. Compared to the surface water and groundwater quality limits, most parameters are below the thresholds. Parameters that exceed at least one of the water quality limits at SC01 include:

- Untreated: SO₄, NO₃-N, Sb, As, Co, Fe, Mo, CN, Se, and Sr.
- After passive treatment: SO₄, Sb, and Mo.

Hence, active treatment is required for CN, SO₄, Sb, and Mo if no other water management option is applied. CN is expected to naturally (not included in the model) so performance monitoring should monitor the decay of CN. Active treatment would still be required for SO₄ up to year 35, Sb up to year 20, and Mo up to year 50.

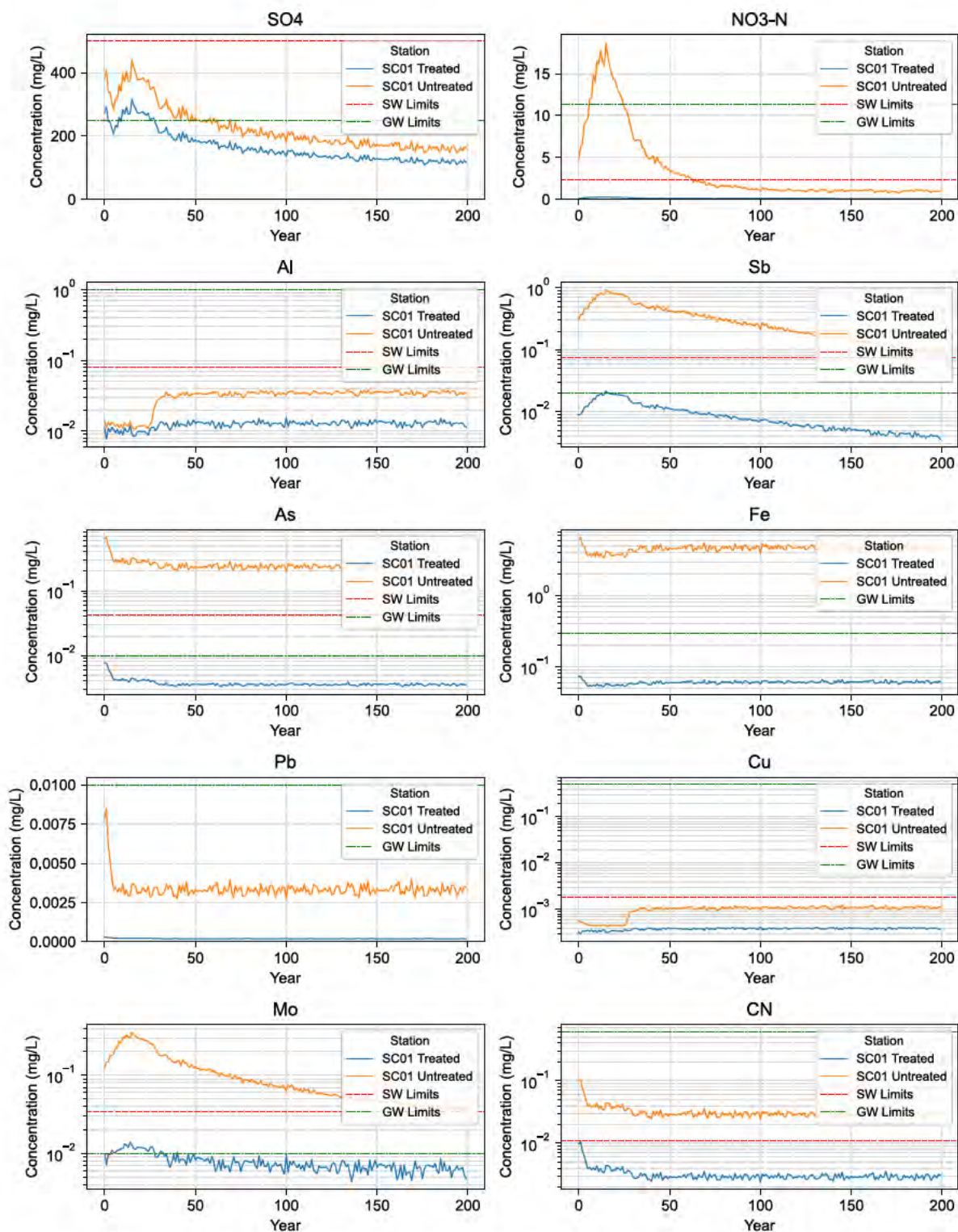


Figure 39. Yearly average water quality results at Shepherds Creek (SC01) treated and untreated scenarios. Part 1 of 2.

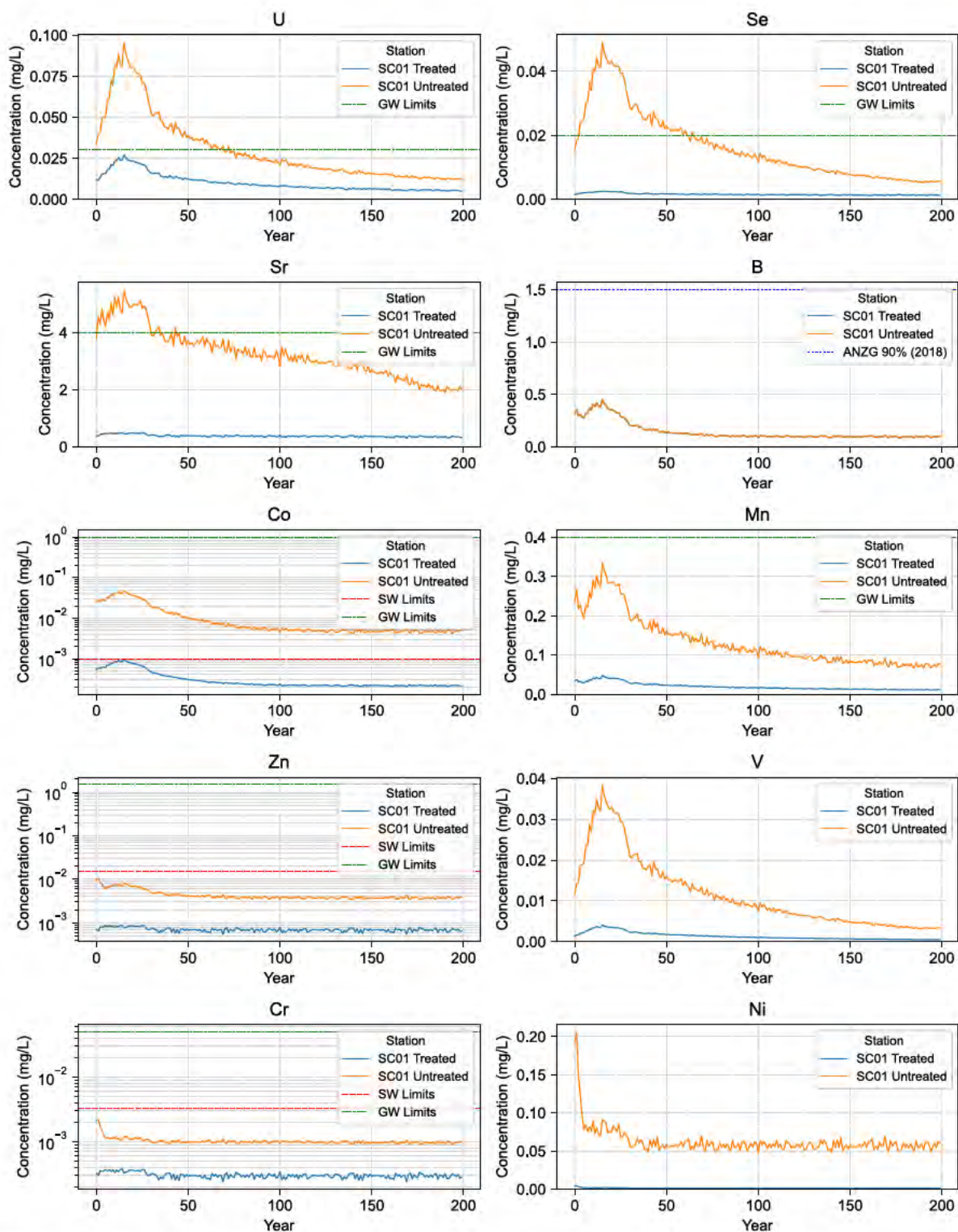


Figure 40. Yearly average water quality results at Shepherds Creek (SC01) treated and untreated scenarios. Part 2 of 2.

The load balance for the untreated SC01 shows that TSF Seepage and Shepherds ELF Seepage are the primary contributors for most parameters, with some notable influence from RAS Pit Lake outflow and other sources. The load profile reflects the cumulative water quality impacts of seepage, runoff, and groundwater pathways from multiple facilities.

TSF Seepage: TSF seepage is the dominant source for 9 parameters:

- CN (23.6 kg/year, 100%).
- As (138.9 kg/year, 73.7%).
- Pb (1,862 g/year, 71.6%).
- Zn (1,999 g/year, 57.1%).
- B (55.7 kg/year, 50%).
- Cr (429.6 g/year, 48.4%).
- Co (3,580 g/year, 48.3%).
- SO₄ (64,438 kg/year, 33.3%).
- Fe (1,037 kg/year, 29.0%).

Shepherds ELF Seepage: Shepherds ELF seepage has 8 parameters that are elevated:

- V (6,232 kg/year, 73.9%).
- Sb (165.2 kg/year, 72.2%).
- Se (8.5 kg/year, 68.0%).
- NO₃-N (1,525 kg/year, 64.7%).
- Mo (45.8 kg/year, 57.1%).
- Sr (1,387 kg/year, 53.8%).
- U (13.3 kg/year, 52.9%).
- Co (3,343 g/year, 45.1%).
- Mn (42.7 kg/year, 43.4%).

These two inflows collectively account for the majority of loading for nearly all parameters at SC01. In many cases, both sources contribute significantly to the same element. For example:

- Co is split between TSF seepage (3.58 kg/year, 48.3%) and Shepherds ELF seepage (3.34 kg/year, 45.1%).
- Fe receives notable contributions from both TSF seepage (1,037 kg/year, 29%) and Shepherds ELF seepage (905.5 kg/year, 25.3%).

RAS Pit Lake Groundwater Outflow: RAS Pit Lake outflow is the main contributor for two parameters:

- Al (16.2 kg/year, 48.7%).
- Cu (488.9 g/year, 53.8%).

The individual components that contribute to the overall load (t/yr) at SC01 are presented in Figure 41 and Figure 42. Results indicate that the key loads are derived from the TSF and Shepherds ELF.

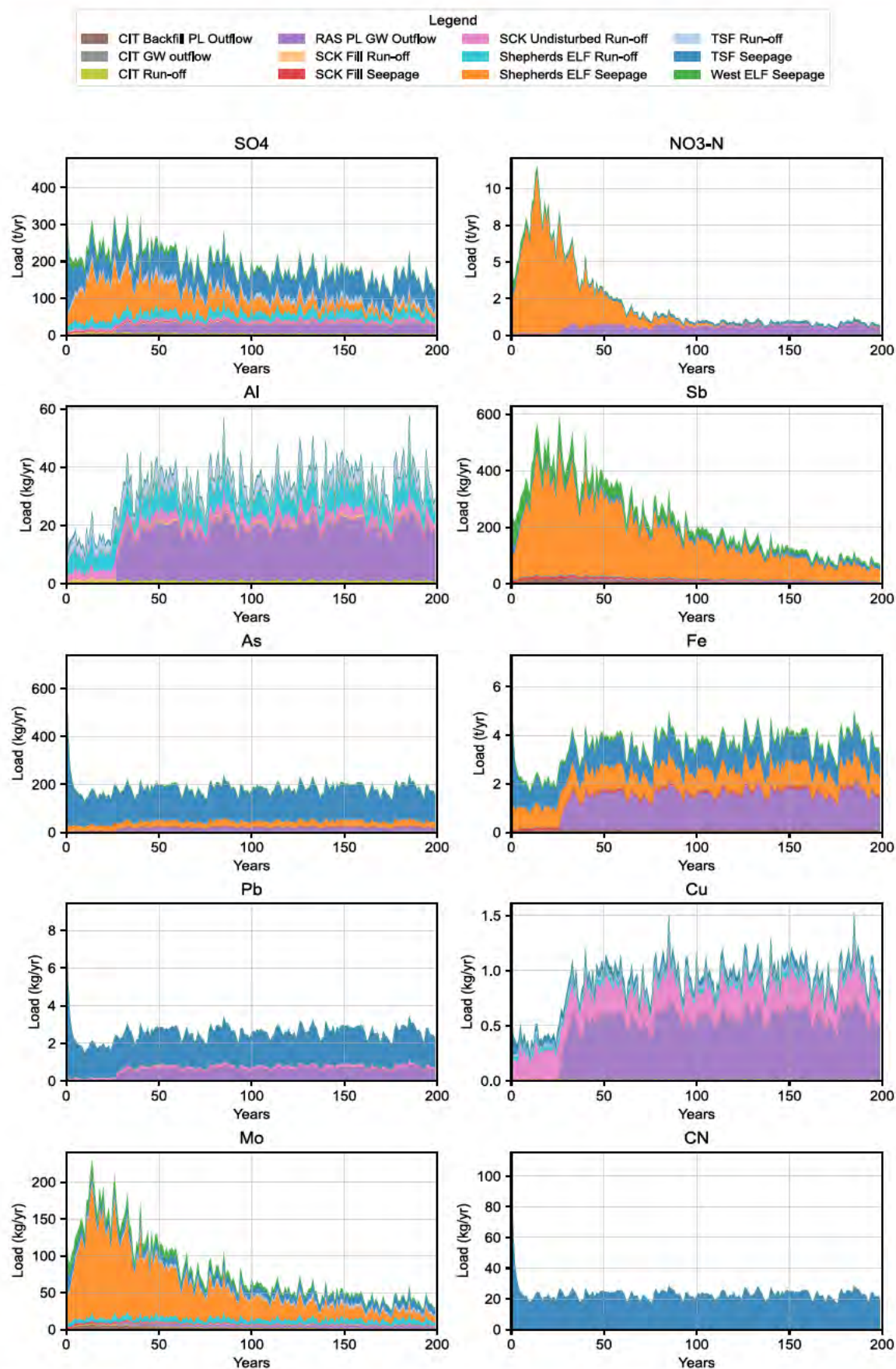


Figure 41. Stacked yearly average inflow load contributions to SC01 for selected parameters (Set 1 of 2).

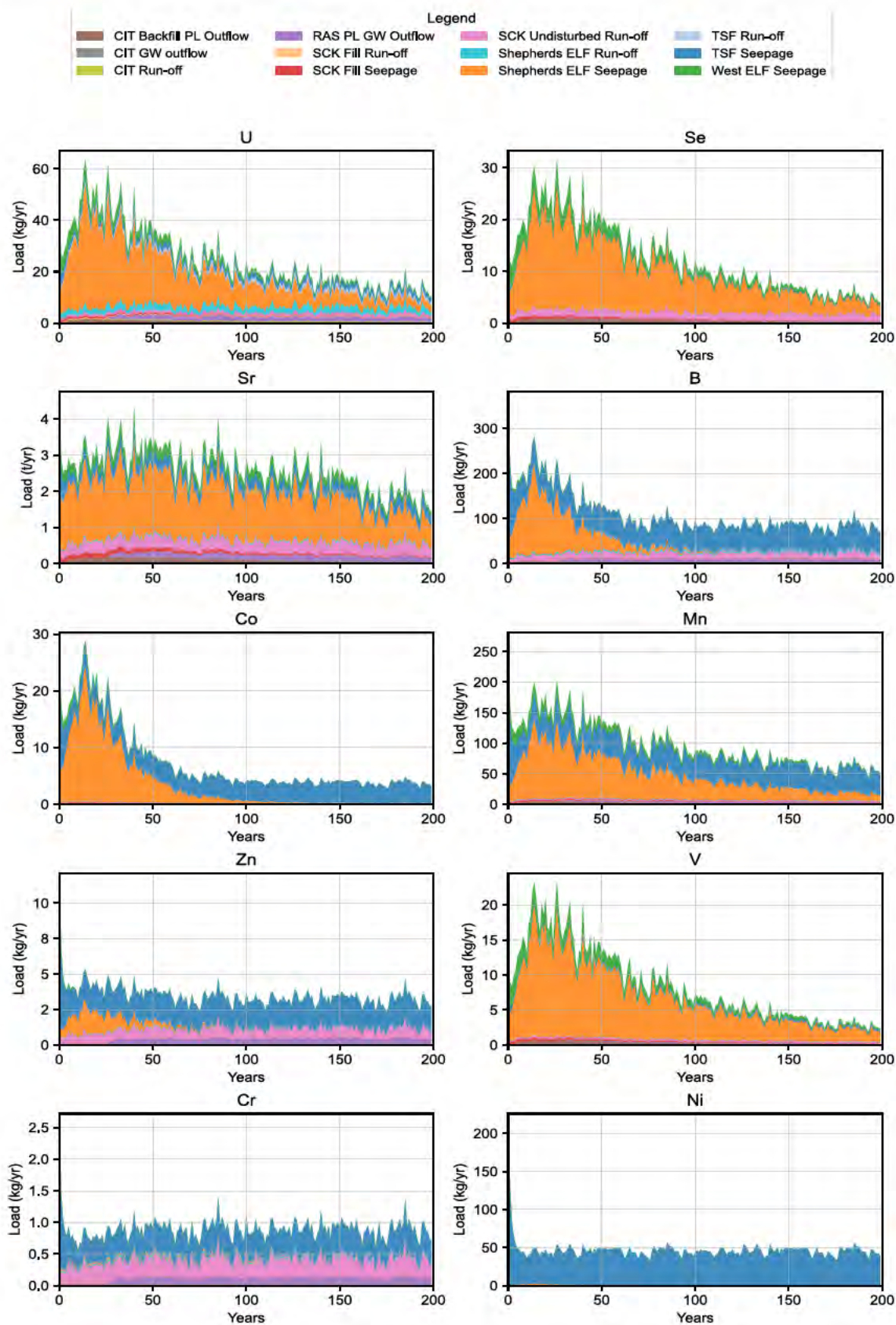


Figure 42. Stacked yearly average inflow load contributions to SC01 for selected parameters (Set 2 of 2).

5.5.2.6 Rise and Shine Creek (RS03)

RS03 receives inflows from multiple sources, including natural run-off catchments (upper and lower), undisturbed areas (CC Creek), and the SRX Pit Lake Overflow (which includes the SRX ELF) and the SRX ELF run-off. Among these, SRX Pit Lake overflow is the dominant contributor for a wide range of parameters, indicating a substantial impact on downstream water quality.

The water quality results for selected parameters are shown in Figure 43 and Figure 44 for untreated and treated simulations. All PCOC are low and below the water quality limits except for As, Fe, and NO₃. Partial passive treatment of SRX Pit Lake overflow (8 L/s) reduces concentrations to below surface water and groundwater limits.

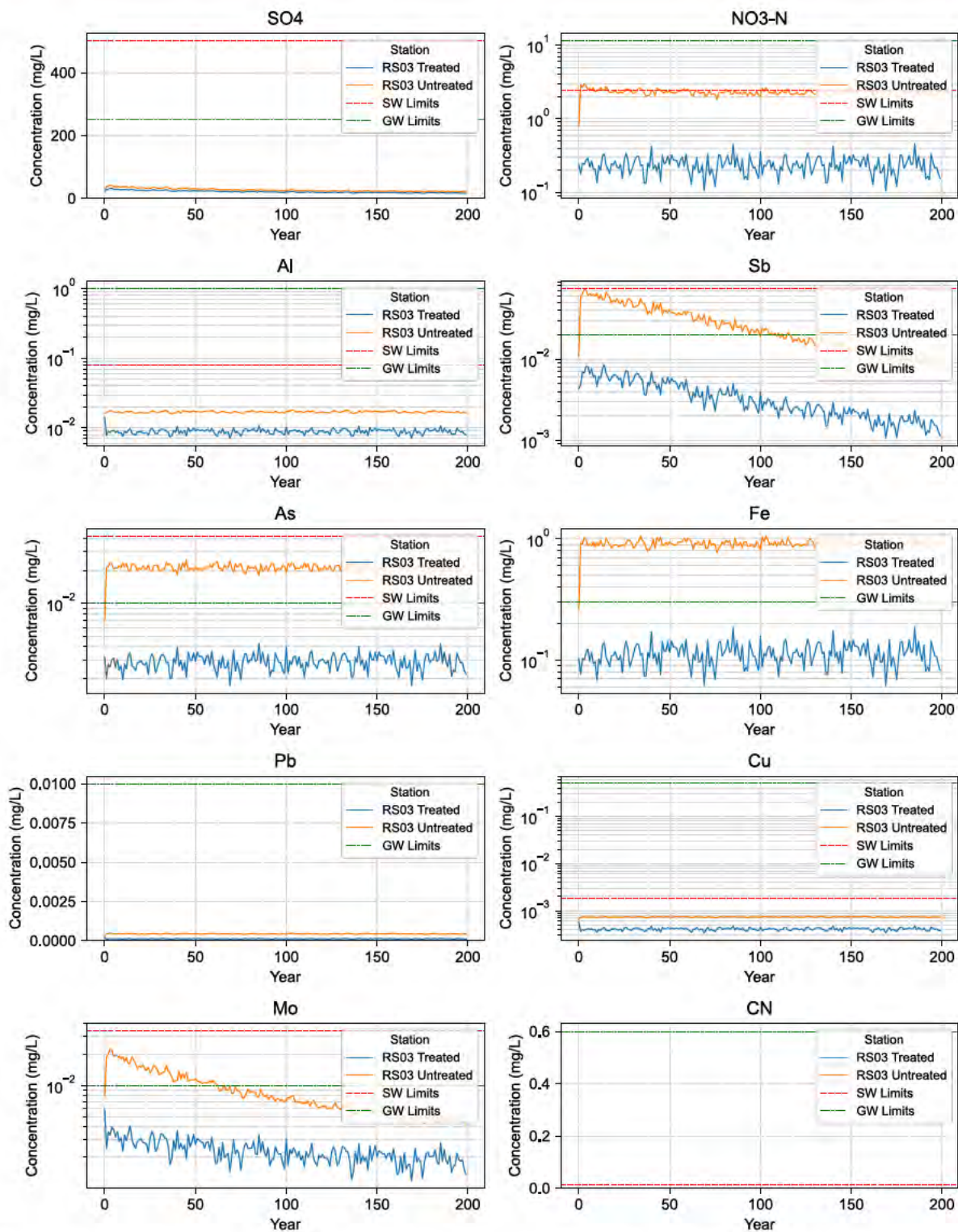


Figure 43. Yearly average water quality results at Rise and Shine Creek (RS03). Part 1 of 2.

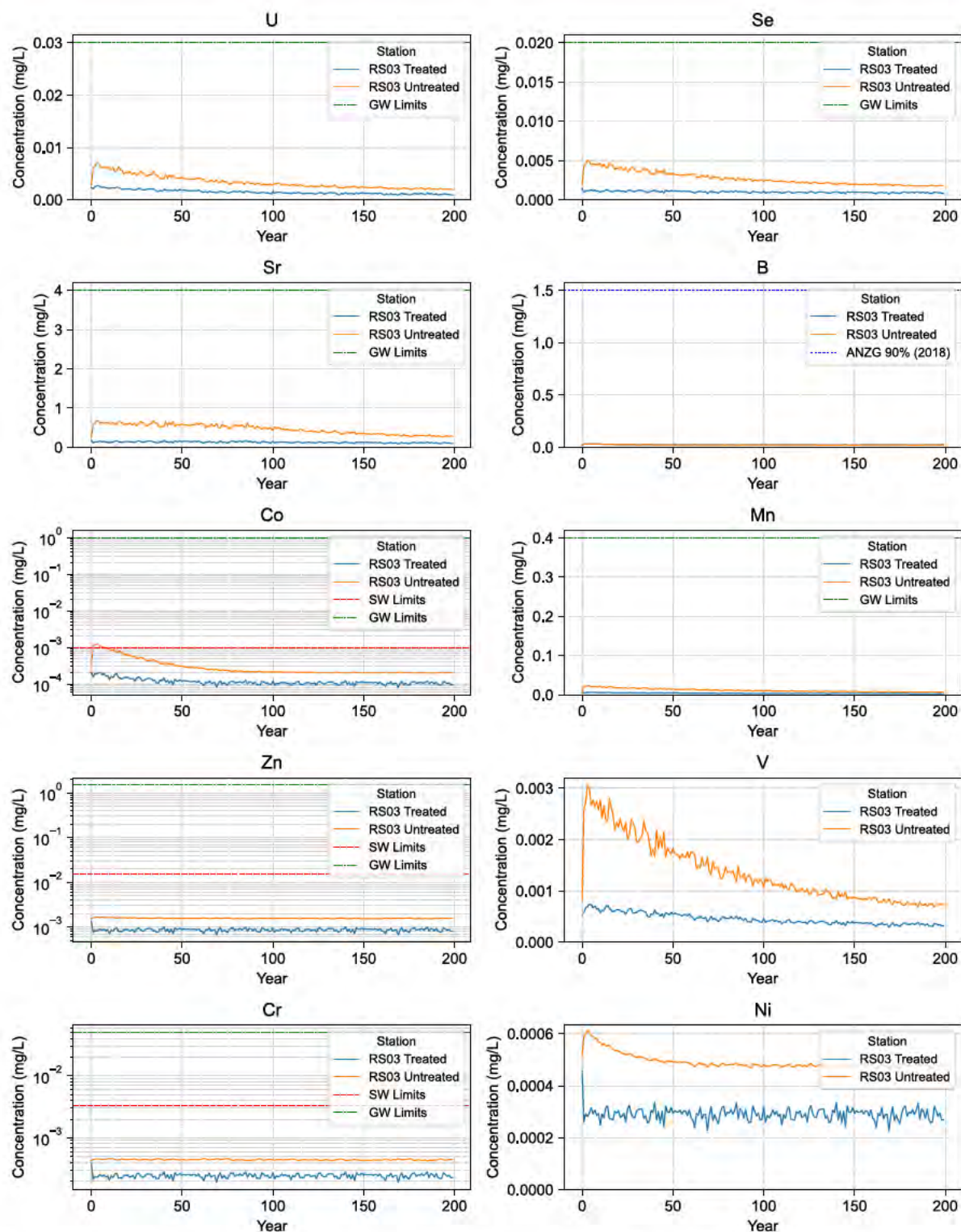


Figure 44. Yearly average water quality results at Rise and Shine Creek (RS03). Part 2 of 2.

Primary Contributor to Water Quality at RS03: SRX Pit Lake Overflow

This inflow is the main source of loading for 18 parameters, and it has to be noted that the pit lake receives water inflows from the SRX ELF (seepage and runoff), highlighting its critical role in the downstream chemistry. Notable contributions include:

- As: 10.5 kg/year (93.8%).

- Fe: 457.2 kg/year (96.4%).
- NO₃-N: 1,184 kg/year (99.4%).
- Sb: 13.3 kg/year (94.5%).
- Mn: 4.9 kg/year (79.3%).
- SO₄: 10,855 kg/year (61%).
- Sr: 190.2 kg/year (75.2%).
- U: 1,404 g/year (64.4%).
- V: 560 g/year (76.9%).

It also supplies the highest loads for several other metals, such as Cu (217 g/year, 50.8%), Zn (395 g/year, 43.4%), and Al (5.5 kg/year, 51.1%), though in these cases, other inflows also contribute significantly.

Some parameters receive important secondary contributions from other sources, even though SRX Pit Lake Overflow remains dominant. These include:

- Boron (B): 8 kg/year (58.8%) from SRX Pit Lake, with 2.9 kg/year (21.6%) from the Clearwater Creek (C. Creek); 1.6 kg/year (11.4%) from Undisturbed Upper Runoff.
- Cr: 112.9 g/year (43.7%) from SRX Pit Lake, but 94 g/year (36.4%) from C. Creek.
- Zn: 495 g/year (43.4%) from SRX Pit Lake, with relevant contributions from Undisturbed Upper: 201 g/year (22%) and C. Creek: 271 (29.7%).

Whilst the pit lake dominates total mass loading, natural catchments and undisturbed areas also play a relevant role for some trace metals, especially for Cr and Zn.

Table 28: Average annual inflow loads to RS03.

PARAMETER	SRX ELF RUNOFF	SRX PIT LAKE OVERFLOW	C. CREEK UNDIST.	UNDIST. RUNOFF UPPER	UNDIST. RUNOFF LOWER	WELF RUNOFF	TOTAL
Al (kg/yr)	1.0 (9.3%)	5.5 (51.1%)	2.1 (19.3%)	0.97 (9.1%)	0.10 (0.9%)	1.1 (10.3%)	10.7
As (kg/yr)	0.13 (1.2%)	10.5 (93.8%)	0.17 (1.5%)	0.14 (1.3%)	0.11 (1.0%)	0.14 (1.3%)	11.2
B (kg/yr)	0.41 (3.0%)	8.0 (58.8%)	2.9 (21.6%)	1.6 (11.4%)	0.25 (1.8%)	0.45 (3.3%)	13.6
Co (g/yr)	3.2 (1.8%)	110.8 (63.5%)	35.3 (20.2%)	18.4 (10.6%)	3.3 (1.9%)	3.5 (2.0%)	174.6
Cr (g/yr)	3.2 (1.2%)	112.9 (43.7%)	94.2 (36.4%)	36.9 (14.3%)	7.7 (3.0%)	3.5 (1.4%)	258.5
Cu (g/yr)	6.5 (1.5%)	216.5 (50.8%)	72.3 (17.0%)	117.7 (27.6%)	6.0 (1.4%)	7.1 (1.7%)	426.1
Fe (kg/yr)	0.90 (0.2%)	457.2 (96.4%)	4.9 (1.0%)	9.6 (2.0%)	0.49 (0.1%)	0.99 (0.2%)	474.2
Mn (g/yr)	0.07 (1.2%)	4.9 (79.3%)	0.15 (2.4%)	0.85 (13.7%)	0.12 (2.0%)	0.08 (1.3%)	6.2
Mo (g/yr)	949.2 (16.5%)	3,668 (63.8%)	55.5 (1.0%)	31.2 (0.5%)	4.3 (0.1%)	1,044 (18.1%)	5,752
NO ₃ -N (kg/yr)	2.6 (0.2%)	1,184 (99.4%)	1.6 (0.1%)	0.47 (0.0%)	0.11 (0.0%)	2.8 (0.2%)	1,191

PARAMETER	SRX ELF RUNOFF	SRX PIT LAKE OVERFLOW	C. CREEK UNDIST.	UNDIST. RUNOFF UPPER	UNDIST. RUNOFF LOWER	WELF RUNOFF	TOTAL
Pb (g/yr)	1.2 (0.5%)	179.4 (76.8%)	37.0 (15.8%)	11.3 (4.9%)	3.3 (1.4%)	1.3 (0.6%)	233.5
Sb (g/yr)	0.32 (2.3%)	13.3 (94.5%)	0.07 (0.5%)	0.02 (0.2%)	0.01 (0.0%)	0.35 (2.5%)	14.1
Se (g/yr)	1.6 (0.1%)	963.5 (65.0%)	370.1 (25.0%)	113.4 (7.6%)	32.6 (2.2%)	1.8 (0.1%)	1,483
SO ₄ (kg/yr)	3,035 (17.1%)	10,855 (61.0%)	141.8 (0.8%)	397.0 (2.2%)	20.5 (0.1%)	3,337 (18.8%)	17,786
Sr (kg/yr)	4.3 (1.7%)	190.2 (75.2%)	7.1 (2.8%)	44.7 (17.7%)	1.8 (0.7%)	4.8 (1.9%)	252.8
U (g/yr)	342.2 (15.7%)	1,404 (64.4%)	15.1 (0.7%)	42.5 (1.9%)	1.6 (0.1%)	376.3 (17.2%)	2,182
V (g/yr)	3.2 (0.4%)	560.0 (76.9%)	84.1 (11.5%)	70.9 (9.7%)	6.5 (0.9%)	3.5 (0.5%)	728.4
Zn (g/yr)	6.5 (0.7%)	394.8 (43.4%)	270.9 (29.7%)	201.3 (22.1%)	29.9 (3.3%)	7.1 (0.8%)	910.5

The individual components that contribute to the overall load (t/yr) at RS03 are presented in Figure 45 and Figure 46. Load derived from the SRX Pit Lake is the dominant source of PCOC.

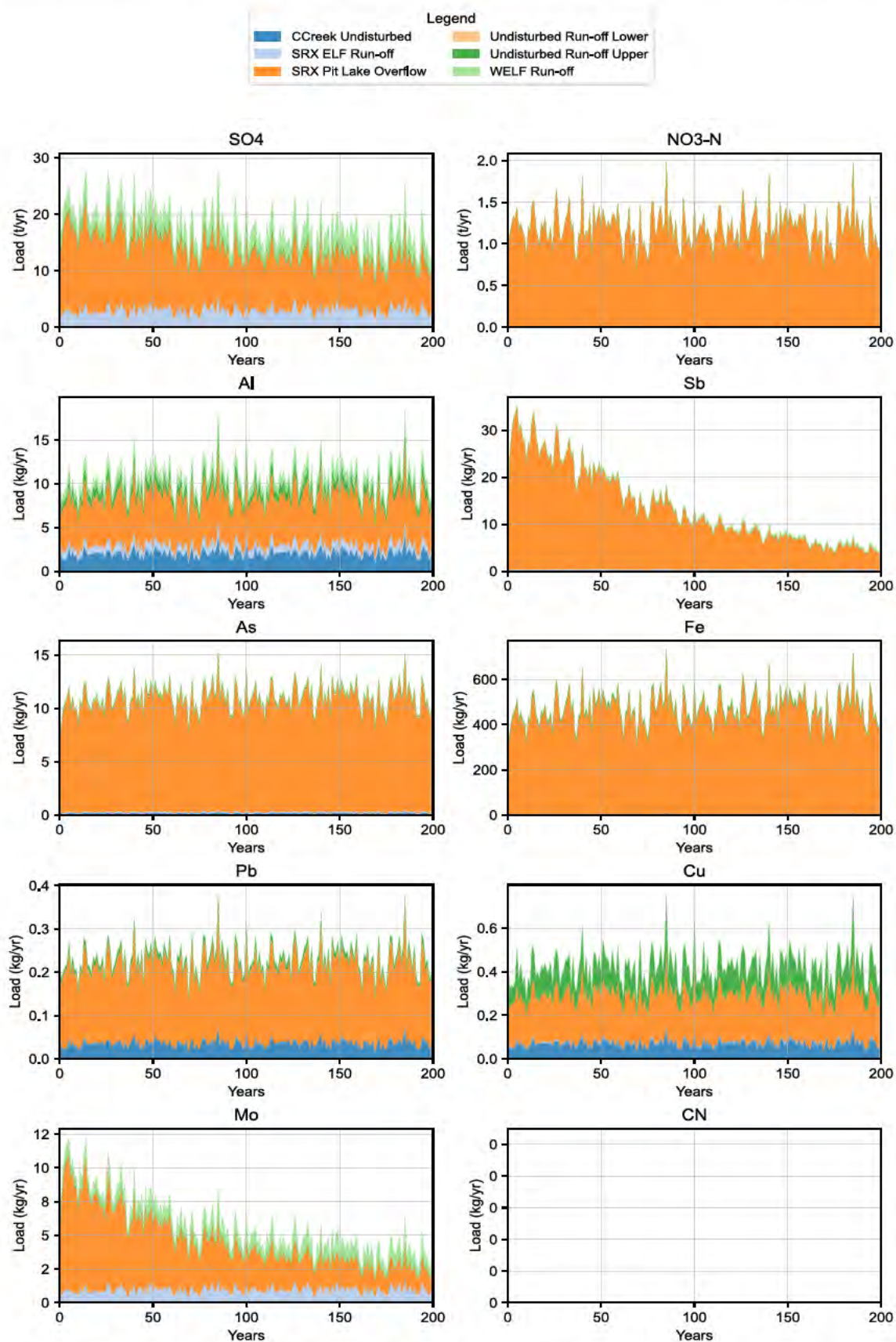


Figure 45. Stacked yearly average inflow load contributions to RS03 for selected parameters (Set 1 of 2).

No Cyanide (CN) is used in this catchment, so the CN load is zero.

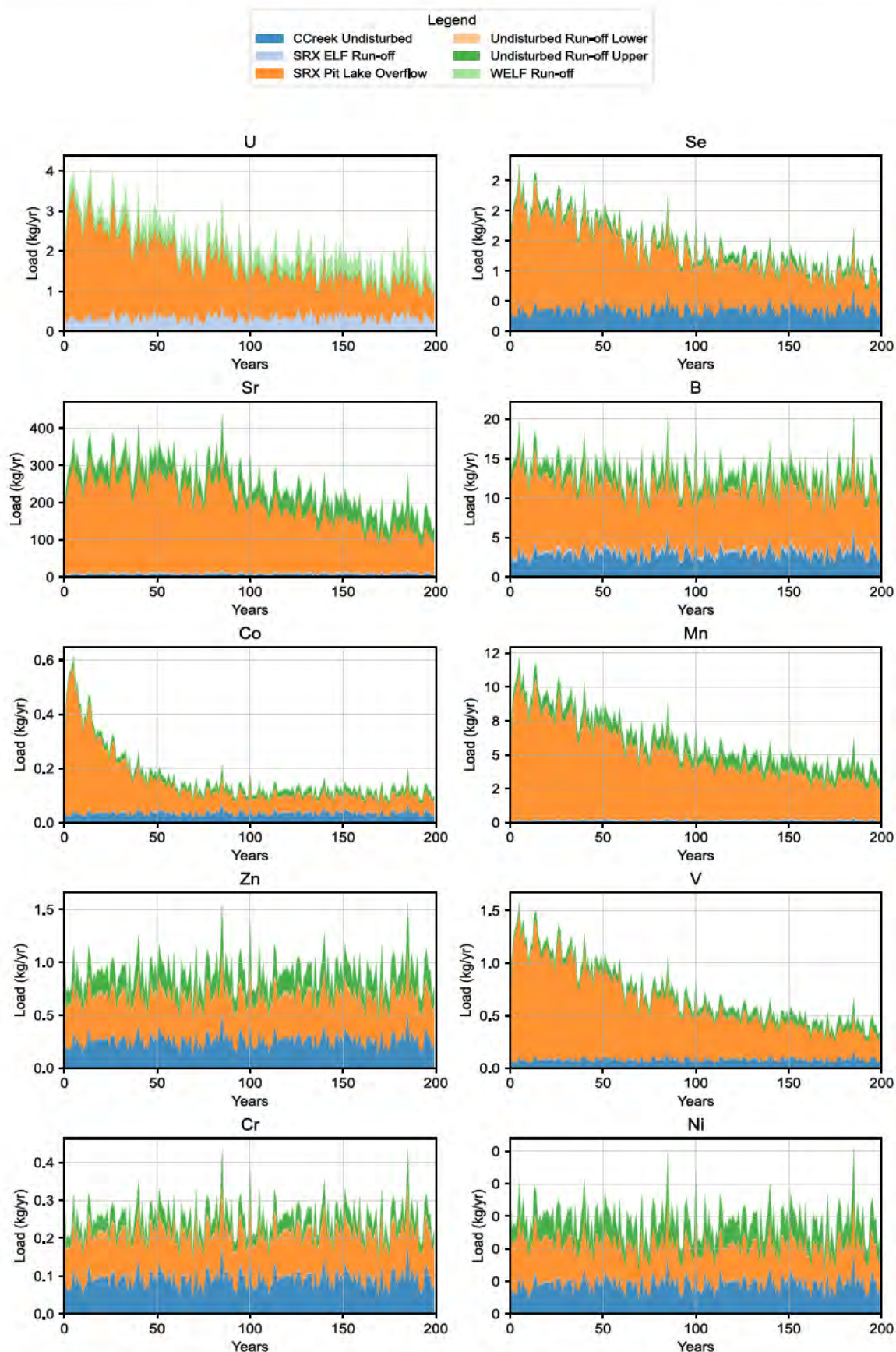


Figure 46. Stacked yearly average inflow load contributions to SC01 for selected parameters (Set 2 of 2).

5.5.2.7 Assessment SC01: Surface Water Quality Compliance

Using yearly average concentrations at SC01 (both untreated and treated), a summary table (Table 27) was prepared to compare the effect of passive treatment against the water quality reference limits.

The following observations can be made:

- Always below the limit: Al, Cr, Cu, Mn, SO₄, and Zn remained consistently below the limits both before and after treatment.
- Improved to below the limit after passive treatment: Co, CN, Sb, As, Mo, NO₃-N, and SO₄, shifted from exceeding the surface water (SW) limits in untreated conditions to being below the limit after treatment.

Table 29. Yearly average water quality (SC01) before and after passive treatment against the SW reference limits.

ELEMENT	STATUS	% ¹ YEARS GREATER THAN THE SW LIMIT	
		BEFORE	AFTER
Co	Improved	100	0
CN	Improved	100	0
Sb	Improved	100	0
As	Improved	100	0
Mo	Improved	100	0
NO ₃ -N	Improved	31.5	0
SO ₄	Always Below the Limit	0	0
Al	Always Below the Limit	0	0
Cu	Always Below the Limit	0	0
Mn	Always Below the Limit	0	0
Zn	Always Below the Limit	0	0
Cr	Always Below the Limit	0	0

1. Percent is calculated on the total 200 year of the model.

Elements not assessed are Ni, Fe, Pb, U, Se, Sr, B, and V, as no surface water limits are defined.

5.5.2.8 Assessment SC01: Groundwater Quality Compliance

The water quality results at SC01 before and after passive treatment were screened against the groundwater quality limits (Table 28). Results indicated:

- Always below the limit: Al, Mn, Pb, Cu, B, Co, Zn, Cr, and CN.
- Improved elements to below the GW limit are: As, Fe, U, Sr, Se, NO₃-N.
- Persistent elements that, whilst improved, still remain above the groundwater (GW) limit for a number of years: SO₄, Mo, and Sb.

Table 30: Comparison of yearly averages for SC01 before and after passive treatment against the GW Limits. Percent is calculated on the total 200 years of the model.

ELEMENT	STATUS	% ¹ YEARS GREATER THAN THE GW LIMIT	
		BEFORE	AFTER
Mo	Persistent	100	13.5
SO4	Persistent	27	10.5
Sb	Persistent	100	1
As	Improved	100	0
Fe	Improved	100	0
U	Improved	35.5	0
Se	Improved	30	0
Sr	Improved	17	0
NO3-N	Improved	9.5	0
Mn	Always Below the Limit	0	0
Al	Always Below the Limit	0	0
Pb	Always Below the Limit	0	0
Cu	Always Below the Limit	0	0
CN	Always Below the Limit	0	0
B	Always Below the Limit	0	0
Co	Always Below the Limit	0	0
Zn	Always Below the Limit	0	0
Cr	Always Below the Limit	0	0

1. Percent is calculated on the total 200 year of the model.

5.5.2.9 Assessment RS03: Surface Water and Groundwater Quality Compliance

For RS03, a comparison against both GW and SW limits is provided in Table 30 and Table 30. The results indicate that there are no exceedances after passive treatment.

Table 31: Comparison of yearly averages for RS03 before and after passive treatment against the SW Limits. Percent is calculated on the total 200 years of the model.

ELEMENT	STATUS	% ¹ YEARS GREATER THAN THE SW LIMIT	
		BEFORE	AFTER
NO3-N	Improved	15	0
Sb	Always Below the Limit	0	0
Co	Always Below the Limit	0	0
Mo	Always Below the Limit	0	0
SO4	Always Below the Limit	0	0
Al	Always Below the Limit	0	0
As	Always Below the Limit	0	0
Cu	Always Below the Limit	0	0
CN	Always Below the Limit	0	0
Zn	Always Below the Limit	0	0
Cr	Always Below the Limit	0	0

1. Percent is calculated on the total 200 year of the model.

Table 32: Comparison of yearly averages for RS03 before and after passive treatment against the GW Limits. Percent is calculated on the total 200 years of the model.

ELEMENT	STATUS	% ¹ YEARS GREATER THAN THE GW LIMIT	
		BEFORE	AFTER
As	Improved	99.5	0
Fe	Improved	99.5	0
Sb	Improved	54.5	0
Mo	Improved	31	0
SO ₄	Always Below the Limit	0	0
NO ₃ -N	Always Below the Limit	0	0
Al	Always Below the Limit	0	0
Pb	Always Below the Limit	0	0
Cu	Always Below the Limit	0	0
CN	Always Below the Limit	0	0
U	Always Below the Limit	0	0
Se	Always Below the Limit	0	0
Sr	Always Below the Limit	0	0
B	Always Below the Limit	0	0
Co	Always Below the Limit	0	0
Mn	Always Below the Limit	0	0
Zn	Always Below the Limit	0	0
Cr	Always Below the Limit	0	0

1. Percent is calculated on the total 200 year of the model.

5.5.2.10 Water Quality Compliance Summary: SC01 and RS03

A summary table of model exceedances (as a percent of years over the 200 years of the model) for SC01 after treatment and RS03 is shown in Table 31.

Table 33: Summary table of exceedances screened against reference surface water (SW) and groundwater (GW) limits for SC01 and RS03.

PARAMETER	SC01 - TREATED		RS03 - TREATED	
	SW Limits	GW Limits	SW Limits	GW Limits
As	-	-	-	-
U	-	-	-	-
Co	-	-	-	-
SO ₄	-	10.5%	-	-
Mo	-	13.5%	-	-
Sb	-	1%	-	-
Fe	-	-	-	-
NO ₃ -N	-	-	-	-
Cu	-	-	-	-
CN	-	-	-	-

The following observations and findings summarise key water quality outcomes at monitoring points SC01 and RS03. They focus on the duration and extent of exceedances relative to groundwater and surface water limits.

Water quality findings at SC01:

- Groundwater limits are exceeded even after passive treatment for SO₄ (to Year 35), Mo (to Year 50), and Sb (to Year 20). For surface waters, all parameters are predicted to remain below the limits after passive treatment.
- Exceedances are linked to peak concentrations from Shepherds ELF seepage.

Water quality findings at RS03:

- All PCOC are predicted to be below the groundwater and surface water quality limits after partial passive treatment of the SRX Pit Lake overflow (8 L/s).

5.6 Scenario Modelling – Water Management Opportunities

Scenario modelling was undertaken to understand management opportunities.

5.6.1 Model Background

A PCOC load analysis for SC01 indicates that the dominant sources are the TSF seepage and Shepherds ELF seepage. It was noted that:

- Model analysis associated with minor inflows have negligible influence on SC01 water quality outcomes.
- Net percolation rates have a strong effect on the duration of active treatment using the WTP.

To evaluate water management options for the Shepherds ELF and TSF an additional scenario was modelled and compared to the base case model (NP20) presented in previous sections. This is an alternative management scenario in which the TSF and ELF seepage is redirected into the RAS Pit Lake to promote dilution and generate a time lag before discharge, decreasing peak concentrations.

5.6.2 Model Results

Parameters that were above the groundwater limit for the NP20 base case scenario are shown in Figure 47 where it can be observed that Mo surpasses the GW limit in some years. Other results are presented in Figure 48 and Figure 49. Groundwater limits are used at SC01 to confirm that compliance can be achieved without dilution within the downgradient aquifer.

Diverting Shepherds ELF and TSF seepage to RAS Pit Lake results in lower peak concentrations at SC01. This is attributed to the pit lake providing dilution and a temporal load sink. A portion of the contaminant mass is retained within the pit, effectively delaying release and smoothing concentration peaks. By decreasing the peak concentrations, some of exceedances are avoided for SO₄, Mo, and Sb, although Mo still remains elevated over the yearly time steps.

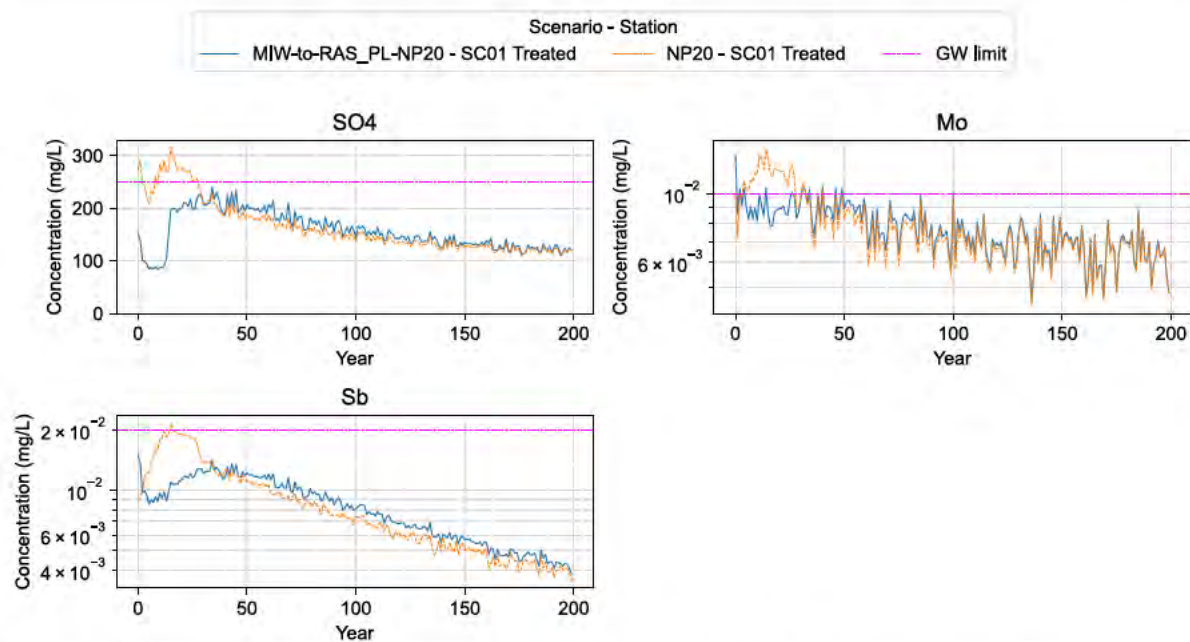


Figure 47. Scenarios results for parameters above the GW Limit for the base case scenario.

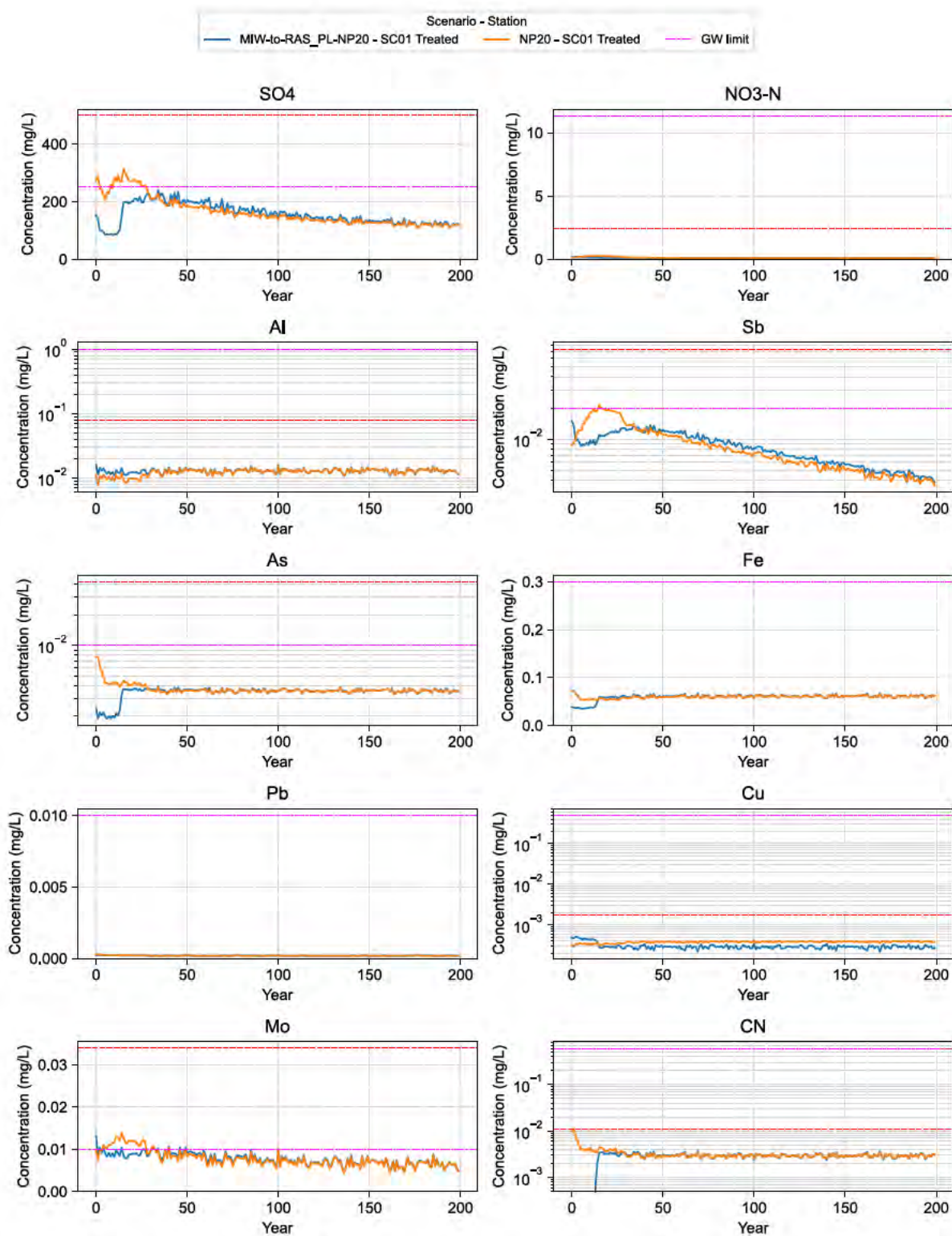


Figure 48. Scenario model results at SC01. Part 1 of 2.

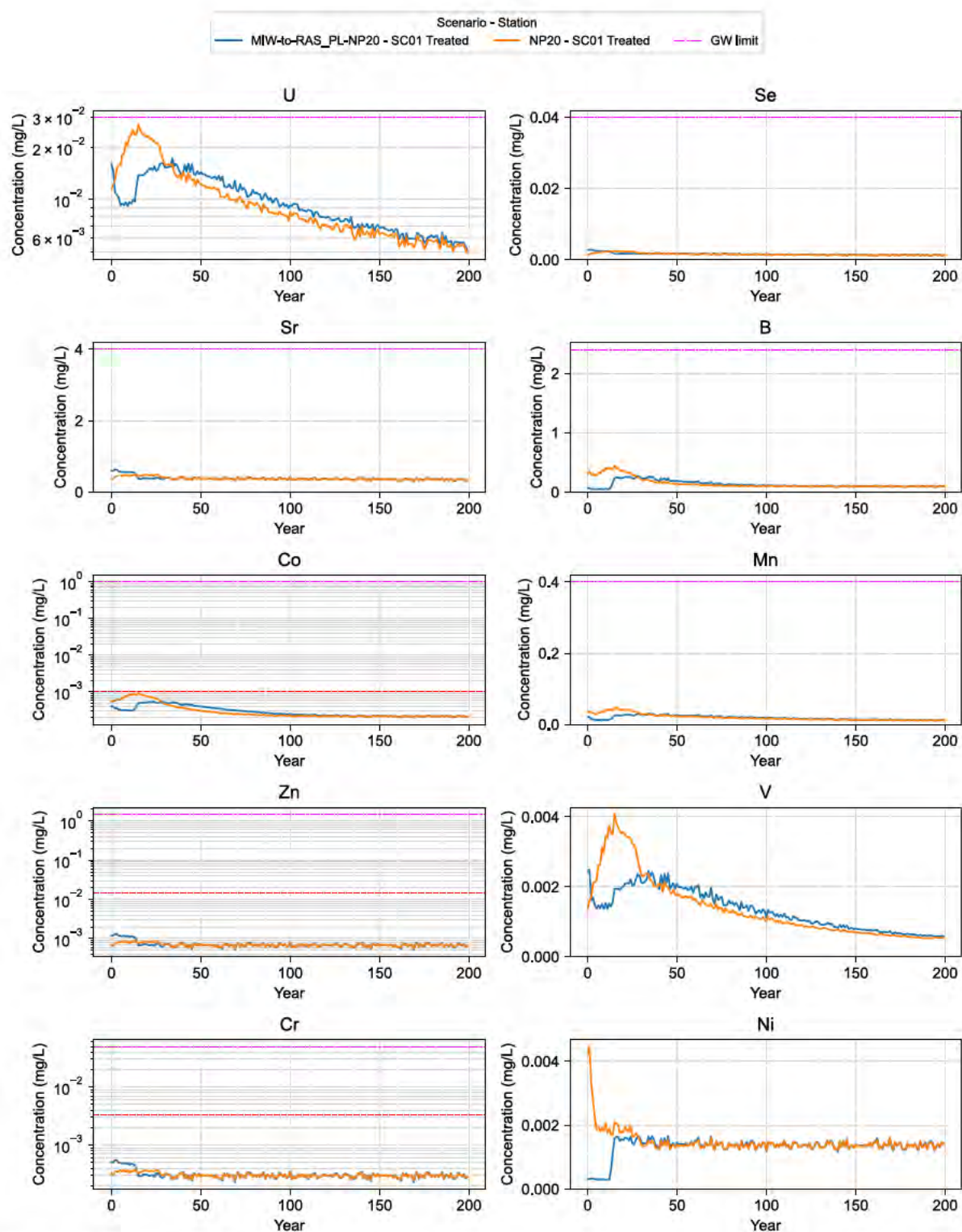


Figure 49. Scenario model results at SC01. Part 2 of 2.

6 SUMMARY AND RECOMMENDATIONS

6.1 Summary

The BOGP operational and post-closure assessment findings are summarised below.

6.1.1 Operational Phase Model Results

The Operational Phase calculations suggest the following:

- Water balance calculations suggest that the site will be in a water deficit condition up to Year 8. After this point, dewatering from satellite pits (i.e., SRX and to a lesser extent CIT) may push the site to a water surplus condition for the last few years of mine life without additional controls. Engineering controls (e.g., construct the water treatment plant prior to closure) are available to manage potential water surpluses, and can be evaluated during detailed design phases. Ongoing site water balance reconciliation of the site will be required to confirm water balance conditions remain in a water deficit condition.
- Based on mine features that will retain water on site and not be discharged to the receiving environment during operations, creek flows at SC01 are estimated to be reduced by approximately 17% on average at the full life of mine, while RS03 reduced by 13%. 7D MALF will reduce by 27% and 15% at SC01 and RS03, respectively.
- Interpretation of the mixing model results suggests surface water quality at SC01 and RS03 will remain below the proposed compliance limits for both surface and groundwater if groundwater is used for dust suppression.

6.1.2 Post-Closure Phase Model Results

The Post-Closure WLBM results suggest the following:

- Pit voids will fill with water and discharge MIW at average rates of approximately 6 L/s, 8 L/s, 1.5 L/s, from the RAS Pit, SRX Pit, and CIT Pit, respectively. RAS Pit Lake will reach a stable condition at ~25 years, with SRX and CIT pits will do so in <5 years.
- Of the MWSFs, Shepherds ELF, using a net percolation rate of 20%, will have the highest average seepage rate of MIW of approximately 4 L/s, followed by the TSF seepage rate of approximately 2 L/s on average. SRX ELF, WELF, and SCK Fill all had seepage rates of approximately 0.5 L/s or less.
- Creek flows will increase, with average flows increasing by approximately 60% and 50% at Shepherds Creek (at SC01) and Rise and Shine Creek (at RS03), respectively. Low flow conditions also increased, showing 7D MALF increasing by approximately 530% and 280%, respectively. These increases are mainly attributed to:
 - o The higher infiltration and NP rates of the ELFs resulting in more stable seepage hydrodynamics.
 - o The storage and discharge water filled pit voids.

- Without active water treatment, water quality findings for the base case model at SC01, based on yearly time steps indicate:
 - o Groundwater limits are exceeded after passive treatment has been implemented for molybdenum (Mo) (to Year 50), SO₄ (to Year 35), and Sb (to Year 20).
 - o Surface water limits are not exceeded after passive treatment is implemented.
 - o Exceedances, especially for SO₄ and Sb are related to peak concentrations from Shepherds ELF seepage. This indicates that for the base case model that active water treatment is required for up to 50 years.
- Water quality findings for the base case model at RS03 indicate:
 - o No limits are exceeded after passive treatment.
 - o Active treatment of MIW from SRX Pit and SRX ELF is not required.

6.2 Operational Management Recommendations

The following management recommendations are proposed for the Operations Phase:

- Prolonged wet years and changes of water balance assumptions (e.g., dust suppression water sources) may move the site into a water surplus condition. As such, detailed water balance modelling by mine stage and that includes rainfall variability is recommended to support detailed mine design and improve confidence in a water deficit being maintained. Development of an adaptive management process related to the site water balance would also support proactive management of identified risks.
- A site water balance reconciliation be completed regularly (e.g., annually or more frequent) to confirm water balance model results are appropriate, and/or make model updates to improve confidence in model results projected into the future.
- Pit sump water can potentially be used for dust suppression early on in mine life. An adaptive management process should be developed to proactively manage and respond if performance and/or compliance monitoring data suggests use of pit sump water may begin to provide a risk of non-compliance.
- Accordingly, plan for use of clean water sources (i.e., bore water) for dust suppression. Calculations suggests later in mine life that the use of pit sump water for dust suppression could have the potential to cause exceedance of compliant limits at SC01 and RS03.
- Other water management options include the early construction, during operations, of the water treatment plant if prolonged water surplus conditions eventuate.

6.3 Closure Management Recommendations

The following management recommendations are proposed for the active closure and post closure phases:

- Active water treatment in the Shepherds Creek catchment through a WTP is required until passive treatment systems can achieve the proposed water quality compliance limits at SC01.

- Passive treatment of the SRX Pit Lake is required to achieve water quality limits at RS03. Noting that passive treatment is modelled at 8 L/s (average SRX Pit flow rate) with higher flows being untreated.
- Active and passive water treatment systems need to be developed through to a detailed design level:
 - o For the WTP, these studies need to be completed within the first few years of the mine commencing so that the technology is ready for operation and closure (if needed). Early design of the WTP would mean it is ready as part of any adaptive management process for water management.
 - o Passive water treatment systems should be designed once the project is operational using actual water quality from the project mine domains to confirm the proposed approach is appropriate.
- The majority of PCOC loads originate from Shepherds ELF and the TSF; therefore, performance monitoring of both flow rates and water quality is recommended at these locations.
- Modelled outcomes indicate that active water treatment will be required for approximately 50 years. This duration reflects the time needed for concentrations of Mo, SO₄ and Sb to reduce - following passive treatment - to levels that comply with applicable surface water and groundwater quality limits for the base case model scenario.
- Other management option is diverting Shepherds ELF and TSF seepage to the RAS Pit Lake for dilution which according to the modelling, decreases concentrations of SO₄ and Sb to below GW limits. Mo can reach elevated concentrations at times, with exceedances occurring intermittently until year 50.
- Performance monitoring is necessary to confirm management mechanisms.

6.4 Forward Works

The following forward works are proposed:

- A transient operational site wide water and load balance model needs to be developed prior to mine commencing to improve confidence in water accumulation or losses over time and water quality, particularly for seasonal dynamics. Such a model will support detailed design of the TSF.
- Additional ground investigations, groundwater monitoring, and detailed modelling will be required at the detailed design to confirm mine waste storage facility seepage collection systems will achieve anticipated collection requirements.
- The collection of performance monitoring data to improve model input data reliability is required, including:
 - o Water quantity and quality data from mine domains and water movement around the site.
 - o Water quantity and quality data at compliance locations.
 - o Records of pit lake filling levels over time.

- Once the mine is operational, collection of water quantity and quality data (obtained as part of performance monitoring) should be compared to the developed operational site wide water balance model periodically to confirm model results are reasonable. Model revisions and/or calibration may be required if a material difference is apparent.
- A cover system trial should be established early on in mine life to demonstrate that a NP of 20% of mean annual rainfall can be achieved. Such a study would provide confidence that water quality closure objectives can be achieved and support closure planning.
- Additional scenario modelling to understand opportunities and threats including:
 - o Higher rainfall.
 - o Lower and higher net percolation rates.
 - o Variance to the proposed passive water treatment efficiencies.
- The closure WLBM needs to be updated once sufficient data are available to calibrate the model (e.g., cover system performance and net percolation rates; source terms; water treatment efficiencies, etc).

7 LIMITATIONS

Attention is drawn to the document “Limitations”, which is included in Appendix E of this report. The statements presented in this document are intended to provide advice on what the realistic expectations of this report should be, and to present recommendations on how to minimise the risks associated with this project. The document is not intended to reduce the level of responsibility accepted by Mine Waste Management, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in doing so.

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APPENDIX A ABBREVIATIONS

ABBREVIATION	EXPLANATION
AEE	Assessment of environmental effects
AEP	Annual exceedance probability
BOGP	Bendigo-Ophir Gold Project
CCreek	Clearwater Creek
CIL	Carbon-in-leach
CIT	Come in Time
ELF	Engineered Landform
GW	Groundwater
LOM	Life of mine
LOR	Limit of reporting
MAV	Maximum acceptable value
MIW	Mine-impacted water
MGL	Matakanui Gold Limited
MWM	Mine Waste Management Ltd
MWSF	Mine waste storage facility
NAF	Non-acid forming
NAPP	Net acid production potential
NP	Net percolation
PCOC	Potential constituents of concern
PET	Potential evapotranspiration
PSD	Particle size distribution
QA/QC	Quality assurance and quality control
ROM	Run of mine
Srex	SRX
Srex East	SRE
SW	Surface waters
TSF	Tailings storage facility
UG	Underground
WELF	West ELF
WLBM	Water and Load Balance Model
WTP	Water Treatment Plant

APPENDIX B CLIMATE ANALYSIS

MEMORANDUM

TO	Hamish McLauchlan, Santana Minerals
FROM	Mandy Chater, Hydrology Consultant ¹
DATE	19 February 2023
SUBJECT	Development of synthetic rainfall time series, Bendigo Project
Matakanui Gold Ltd requested that synthetic rainfall record be created, for the purpose of water balance assessment, water treatment considerations, and model development at their Bendigo Project site. Also, an assessment of data availability for rainfall frequency analysis was requested. This is for design purpose. Comment was sought as to what work is required, and whether further data collection is needed to undertake the analysis. This memo provides detail on the approach and outcomes, in fulfilment of these requests.	

Contents:

1. Task Brief
2. Collation of Data Inputs
3. Data Quality Assurance (QA)
4. Data comparisons and initial regressions
5. Finalized regression and consideration of wind direction
6. Model script and generation of synthetic rainfall record
7. Test model data against actual; reliability and shortcomings
8. Applications of the synthetic data
9. Model refinement and data assessment for frequency analysis

1. Mandy Chater, MSc (Geography). 20+ years' experience in hydrological analysis and environmental science (NIWA, ECAN, West Coast Regional Council, Solid Energy/Bathurst Resources)

1 Task Brief

Long term rainfall estimates are required for the development of a GoldSim model, to be used for water management purposes at Matakanui Gold's 'Bendigo Project' site.

It was requested that "synthetic" rainfall record, at a daily interval, to be developed for a period of ten years or more. The actual length of synthetic record being dependent on the availability of data suitable for generating reliable rainfall estimates.

The availability of data for storm design purposes was also to be sought, and recommendations for further data collection and work around this be made.

The following documents the approach to developing the daily synthetic rainfall record.

2 Collation of Data Inputs

Figures 1 below shows the location of the Bendigo Project in the context of New Zealand's lower South Island. Figure 2, at a closer scale, shows the location of the three Matakanui Gold meteorological stations, for which rainfall record is to be extended. The terrain is obvious in its complexity, but also noteworthy is that the study area is at the most inland point of New Zealand, and therefore the climate has a far more continental tendency than other parts of the country.

A full suite of meteorological parameters is measured at each of the meteorological sites (Figure 2) , at ten minute interval . The sites are telemetered using Harvest Technology cell phone communication and the data (unvalidated) can be easily downloaded from a user portal. Records begin in November 2022 and are available up to date.

In terms of extending the 14 months of record (available at the time of this analysis) all available recorded rainfall in the vicinity the Matakanui Gold gauges was considered. The availability of these surrogate (or predictor) sites was investigated via the following channels:

- **CliFlo** – New Zealand's National Climate Database (managed by NIWA, and from which data can be downloaded by any subscribed user). The data pool here is large and varied. Many sites include only daily observations. Rainfall sites within a 50 km radius of the Matakanui Gold gauges, that had daily record or better, were initially considered. Records that were incomplete were disregarded. From here records were grouped by whether or not they overlapped with the Matakanui Gold record (therefore current). Those that didn't overlap could be used in a "secondary regression" (i.e regressed with a third site which did overlap with the Matakanui Gold record), but such gauges were given less preference due to inaccuracies introduced by using a secondary regression.
 - **Otago Regional Council (ORC):** rainfall for water resource management purposes is widely collected by Regional Councils and not necessarily fed through to the CliFlo database. The Otago Regional Council (ORC) provides a very good online environmental database, and the data is easily accessible. Available ORC records were all from sites further from the Matakanui Gold gauges than the closest gauges found in CliFlo. However the ORC gauges record at ten minute interval, where many of the nearer CliFlo sites have only daily record. The ORC sites are therefore important where design rainfall estimates are concerned – as for the relatively small catchment areas concerned, rainfall intervals of much less than one day will be relevant.
 - **"Land Air Water Aotearoa" (LAWA):** No extra rainfall information, beyond that available on CliFlo and ORC websites, was found on the LAWA website.
-

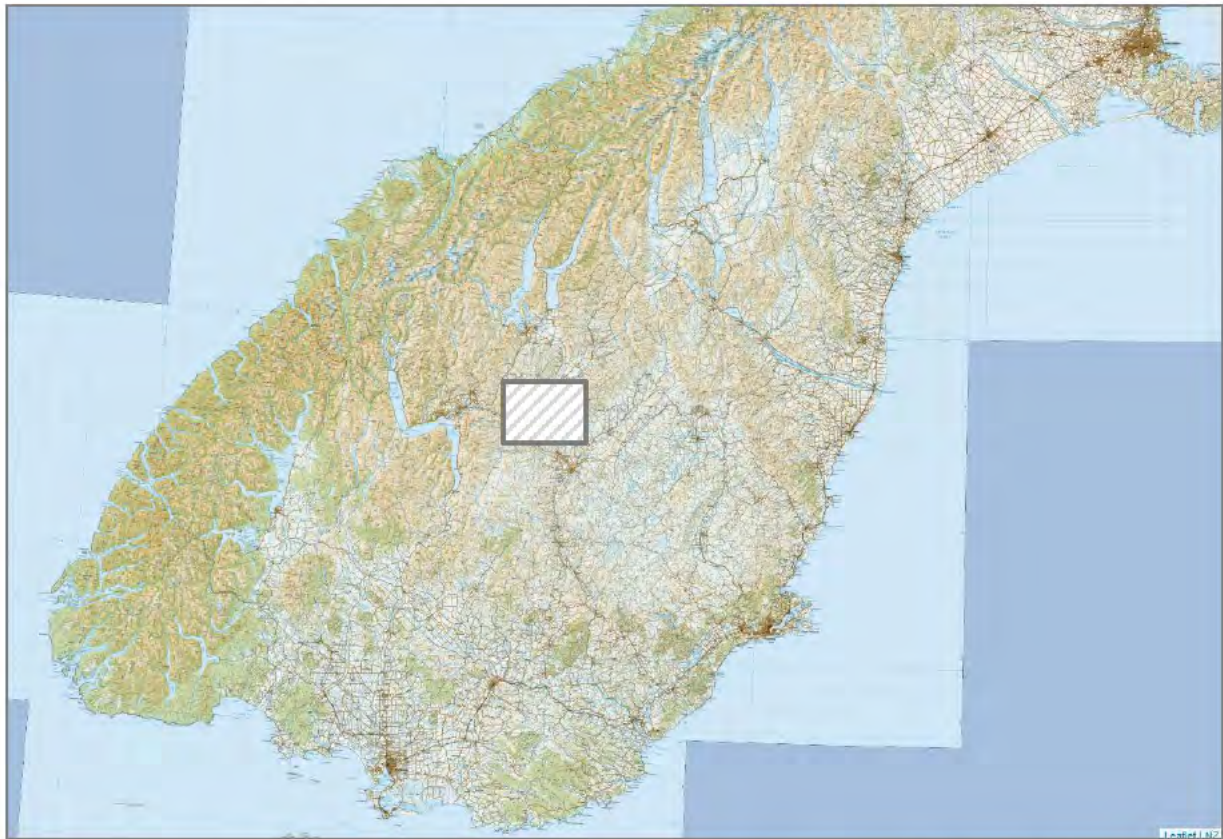


Figure 1: Study location with respect to respect to lower half of New Zealand's South Island



Figure 2: Matakanui Gold Meteorological (Met) sites at the Bendigo Project area, flanked by Dunstan Mountains to the east, and the Clutha River Valley and Pisa Range to the north-west.

Table 1 details the CliFlo sites within 30 kilometres of the Lake Clearview Met Station, and highlights sites that are potentially most useful as predictor sites for generating synthetic records at the Bendigo Project site. Figure 3 gives the location of these potentially useful sites.

Table 2 details the ORC and Clif Flo sites that would be useful for gaining an understanding of the occurrence of extreme rainfall at the Matakanui Gold sites, as a means of providing design rainfall estimates for the latter. The location of the most promising gauges with short interval record can be seen in Figure 4.

Table 1: Sites with daily rainfall record in near vicinity to Matakanui Gold gauges - CliFlo database

Sites with daily rainfall record in near vicinity to Matakanui Gold gauges - CliFlo database

denotes potential primary regression site - data overlaps with Matakanui Gold records (Nov 2022 onwards).

denotes secondary site of interest due to vicinity or length of record

Agent Number	Name	Start Date	End Date	Percent Complete	Dist km (from Lake Clearview Met)
5243	Bendigo 2	1/05/1978	31/05/1992	100	3.3
5242	Bendigo 1	1/01/1956	30/06/1979	100	3.6
5241	Mt Pisa Station	1/05/1908	31/05/1924	90	6.1
5233	Lochar	1/04/1947	31/03/1956	80	6.8
5234	Queensbury Ews	1/11/1978	31/05/1992	100	6.9
5236	Tarras	1/01/1902	31/07/1986	80	12.2
5528	Northburn	1/11/1978	31/05/1992	100	12.5
5228	Willowbank	1/11/1953	30/06/1963	90	16.1
26381	Cromwell Ews	6/04/2006	17/01/2024	100	16.7
5529	Cromwell 2	1/07/1984	31/07/2007	100	16.8
5526	Cromwell M.W.D.	1/06/1949	30/06/1985	100	16.8
5524	Cromwell Sub Stn	1/04/1976	31/10/2023	20	19.3
5530	Matakanui	1/05/1947	31/12/2021	100	19.6
5523	Ripponvale	1/09/1925	31/03/1961	100	20.5
5225	Luggate	30/06/1913	28/02/2006	90	22
5240	Upper Meg Power Stn	1/05/1953	31/05/2013	100	23.3
7426	Wanaka Aero Aws	30/04/1992	16/01/2024	100	24
5227	Lagoon Valley	1/01/1949	31/08/1964	100	25.4
5231	Merrivale	21/04/1953	31/05/1963	100	25.4
5224	Mt Barker	1/01/1967	31/01/2011	90	26.1
5232	Cardrona	1/01/1948	31/12/2014	100	26.2
5542	Clyde	1/08/1973	31/10/1977	90	26.4

Agent Number	Name	Start Date	End Date	Percent Complete	Dist km (from Lake Clearview Met)
5229	Lindis Pass	1/11/1947	31/08/1948	100	27.4
5522	Waitiri Stn	1/01/1954	31/12/1968	70	28
5540	Bannockburn	1/07/1971	30/04/2018	90	28.7
5544	Ophir 2	1/04/1924	30/11/2023	90	28.9
5223	Wanaka	1/09/1927	31/08/1990	100	29.1
5230	Geordie Hill	1/05/1987	31/01/1990	80	29.1
5546	Ophir 1	1/11/1914	31/01/1931	20	29.2
5543	Clyde Dam	1/05/1978	30/06/2007	100	29.4
5535	Lauder Ews	20/08/1985	17/01/2024	100	29.6
43486	Lauder Raine Ews	29/04/2016	4/12/2023	100	29.6
5537	Lauder Flat	1/01/1945	30/11/2023	100	29.6
5249	Lauder Station	1/01/1987	31/01/1990	100	29.6
5541	Clyde, Fraser St	1/08/1896	30/09/1989	90	29.6
5216	Albert Town	1/12/1970	11/08/1972	100	29.6
41237	Wanaka Cws	29/10/2015	15/01/2024	100	29.7
5532	Lauder Pel	1/08/1981	31/05/1986	100	29.7
5531	Lauder	1/11/1947	31/03/1965	100	30
5217	Wanaka, Park Hq	5/09/1990	31/01/1994	100	30.1
39564	Clyde 2 Ews	25/05/2011	17/01/2024	100	30.8
5220	Maungawera	1/10/1915	30/04/1944	90	30.8
26567	Lauder 2	1/01/2000	31/03/2023	100	31.1

Table 2: Rain gauge sites with short duration record, for extreme event analysis, in near vicinity to Matakanui Gold gauges

Rain gauge sites with short duration rainfall in near vicinity to Matakanui Gold gauges

denotes the most likley useful sites, on the basis of vicinity/geography and length of record.

CliFlo data base

Agent Number	Name	Start Date	End Date	Altitude (m)	Dist km (from Lake Clearview Met)
26381	Cromwell Ews	5-Apr-06	7-Feb-24	213	14
41237	Wanaka Cws	28-Oct-15	7-Feb-24	331	28.9
39564	Clyde 2 Ews	17-May-12	7-Feb-24	170	30
5535	Lauder Ews	31-Dec-95	7-Feb-24	375	32.1
43486	Lauder Raine Ews	27-Apr-16	4-Dec-23	375	32.2
43904	Alexandra Ews	18-Apr-19	7-Feb-24	132	36.2
41331	Queenstown Ews	24-Feb-16	7-Feb-24	322	51.5
40257	Mt Larkins Ews	4-Nov-21	7-Feb-24	1900	64.9
18593	Ranfurly Ews	21-Nov-00	7-Feb-24	450	66.1
35098	Albert Burn	21-Apr-10	7-Feb-24	1280	68.1
18437	Middlemarch Ews	30-Aug-00	4-Feb-24	213	92.1

Otago Regional Council

Name	Start Date	End Date	Altitude (m)	Dist km (from Lake Clearview Met)
Cluden Stream at Stockyards	25/05/2021	current	357	19.1
Manuherikia at Tunnel Hill	18/03/2008	current	807	41.7
Lauder Creek at Lauder Basin	26/01/2022	current	1520	25.9
Ida Burn at Hills Creek	1/01/1988	current	580	41.4
Tairei at Ranfurly (NIWA)	21/11/2000	current	427	63
Poolburn at Merino Ridges	21/04/2009	current	440	39.3
Dunstan Peaks (ECAN)	26/08/2017	current	575	53.6

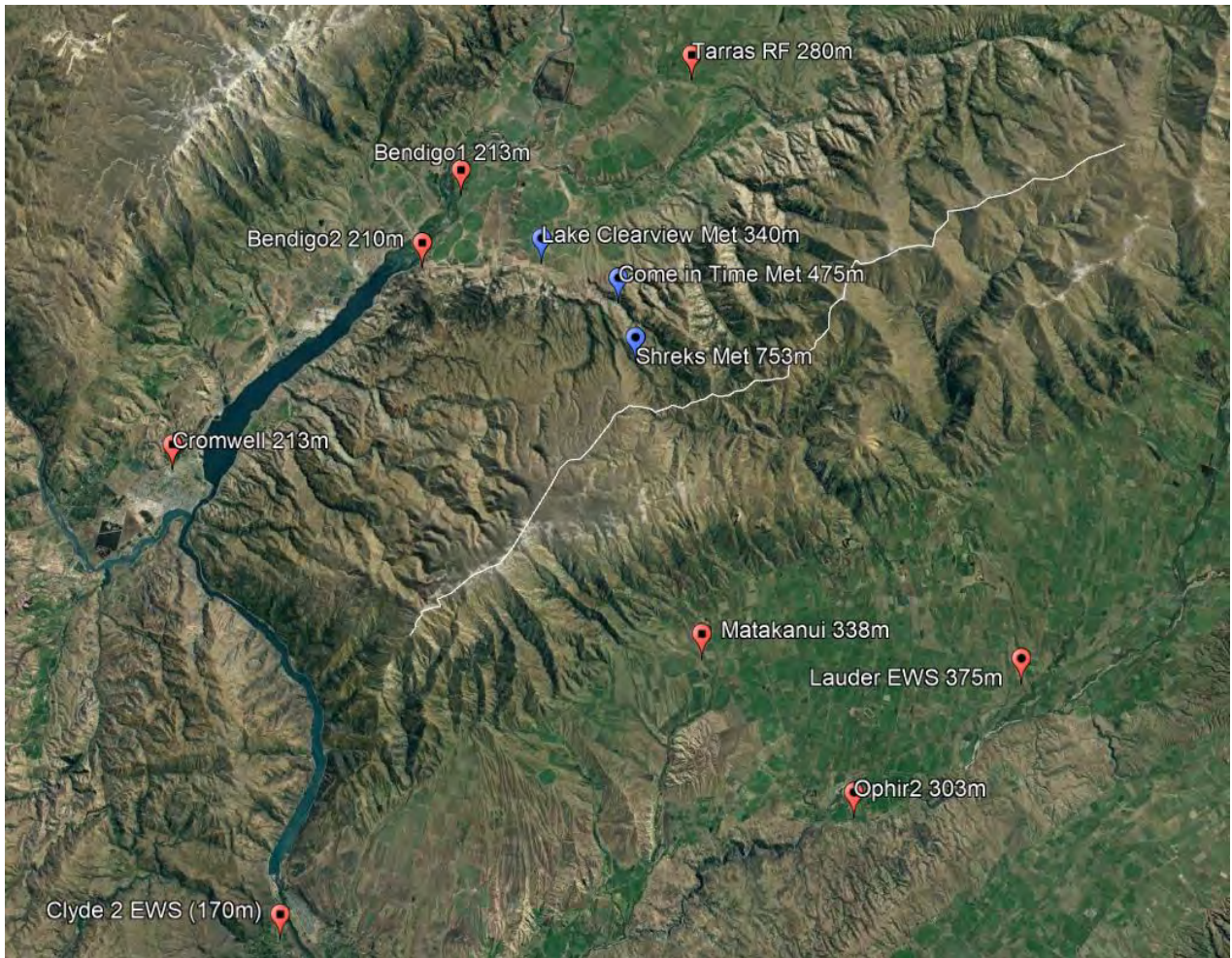


Figure 3: Potentially most useful predictor sites (red) for generating synthetic rainfall record at the Bendigo project site (Wanaka EWS excluded)



Figure 4: Location of the most promising sites for making rainfall intensity estimates (green) at the Bendigo Project site.

3 Data Quality Assurance (QA)

All relevant rainfall data was downloaded from the Matakanui Gold harvest portal and the NIWA climate data base. The Harvest data is available Pacific/Auckland or UTC time zones only (UTC being 12 hour behind NZ standard time). All climate station data is logged in NZ standard time (i.e does change for daylight saving) or UTC. Thus all records were downloaded in UTC as that was the only time unit to make the records temporally compatible.

The data was then loaded into Hilltop Software which provides tools for managing and analysing time series data.

The Matakanui Gold data was overplotted cumulatively and showed good overall agreement – with the higher gauges receiving slightly more rainfall as would be expected (Figure 5).

The cumulative comparison was then combed at a ten-day timestep to highlight any discrepancies in any of the records. Several discrepancies appeared, and, alongside the Cromwell EWS rainfall, were investigated. When considering temperature and wind direction data, it could be seen that most of the data discrepancies are likely to relate to snowfall at the higher elevation.

There remains one large unexplained anomaly in the Lake Clearview record on 21/22 February 2023, and this can be seen in Figure 5. Lake Clearview received 6.2mm of rainfall over this time, whereas adjacent sites Come in Time, Shreks, Cromwell, and Lauder received 43.8mm, 42.6mm, 38.6mm, and 57.6 mm respectively. This shortfall of rainfall at Lake Clearview was hugely anomalous compared to the rainfall relationships throughout the rest of the record. The storm event involved high air temperatures preceding a (cold) frontal passage, and a complicated wind pattern. At the time of writing this report comment is still being sought as to whether the gauge may have been blocked or similar at the time. However, as the relationships either side of the anomaly remain “as expected”, it’s unlikely there was recorder error at Lake Clearview on 21/22 February 2023, and so the discrepancy is in fact real. It is unknown with what frequency such a disparity would occur, but it is assumed rarely , in that it is not seen elsewhere in the record. Therefore it was chosen to treat the event as an outlier going forwards (essentially discard), as it is way outside the expected rainfall pattern.

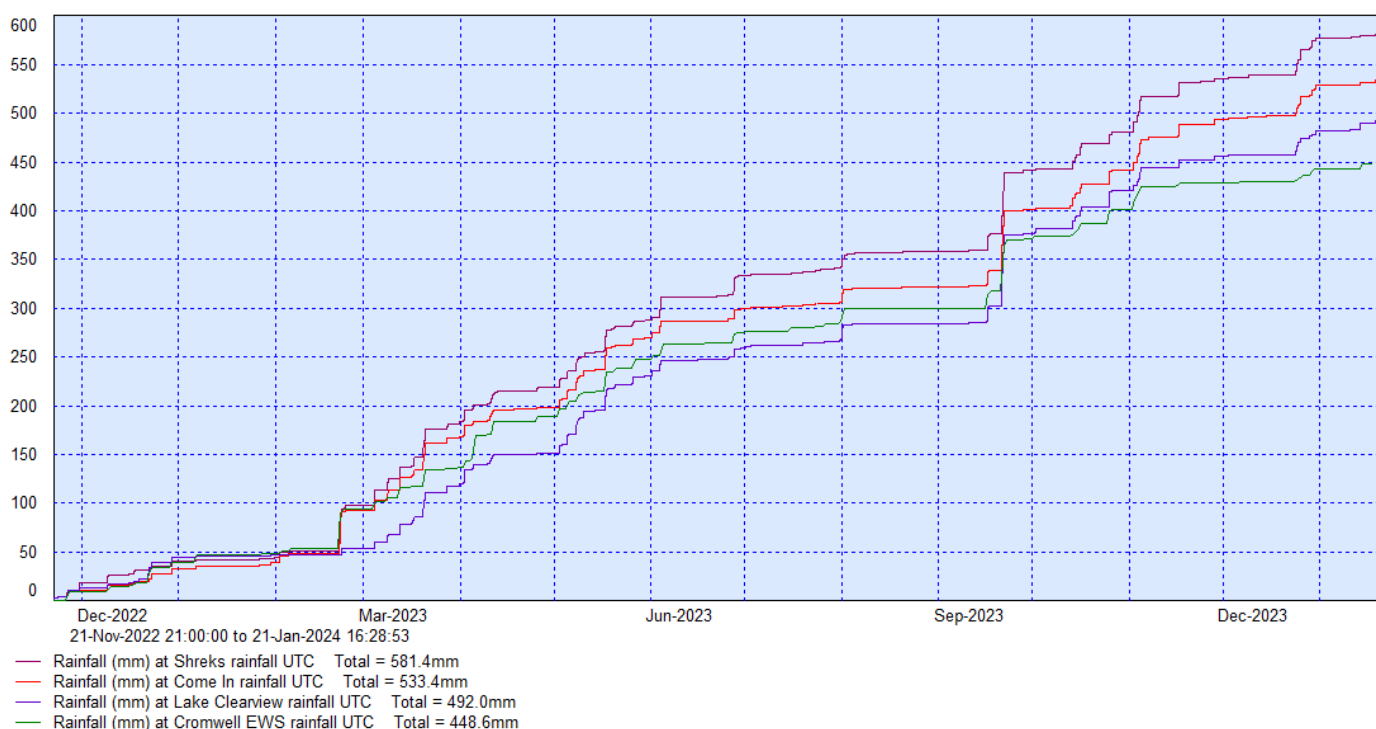


Figure 5: Cumulative rainfall at the three Matakanui Gold gauges and Cromwell EWS, November 2022 to date

There was a large body of rainfall data downloaded from the Climate database. Data from the Climate database has already had checks undertaken, therefore it was decided only the surrogate data adopted in the final regressions needed to be combed for further quality assurance.

4 Data Comparisons and Initial regressions

Rainfall was compared, proportionally, between gauges to get an initial feel for the rainfall distributions. Box and Whisker plots nicely summarised where the rainfall records sit with respect to one another, in terms of amount and variability.

Firstly the three Matakanui Gold gauges, one for which we are wanting to extend rainfall record, were considered. Figure 5 shows the relationship of Lake Clearview and Shreks rainfall, as a proportion of that received at the middle rain gauge “Come In Time”. The Clearview distribution has a median of 1, is well centred, and has few outliers. The “Shreks” median is naturally higher at 1.1; but with more variability shown in the data. Figure 5 suggests the “Come in Time” rainfall is actually very similar to that of Lake Clearview. This was confirmed when the cumulative rainfall plot in Figure 4 was started on 1/03/2023 (beyond the discussed February 2023 anomaly).

Of the three Matakanui Gold gauges the Lake Clearview site, is of most similar altitude to the potential surrogate sites Bendigo1, Bendigo2, Tarras, Cromwell, Matakanui, Lauder and Ophir (Figure 3). Further to that, in comparison to the higher two gauges, the Lake Clearview gauge likely suffers less from snow, freezing, and wind (undercatch). Therefore, of the three Matakanui Gold rainfall sites **Lake Clearview was chosen as the key “hinge” site - to regress with adjacent predictor sites.** (Record extension at “Come In Time” and “Shreks” could be carried out subsequently - based on their close relationship with Lake Clearview).

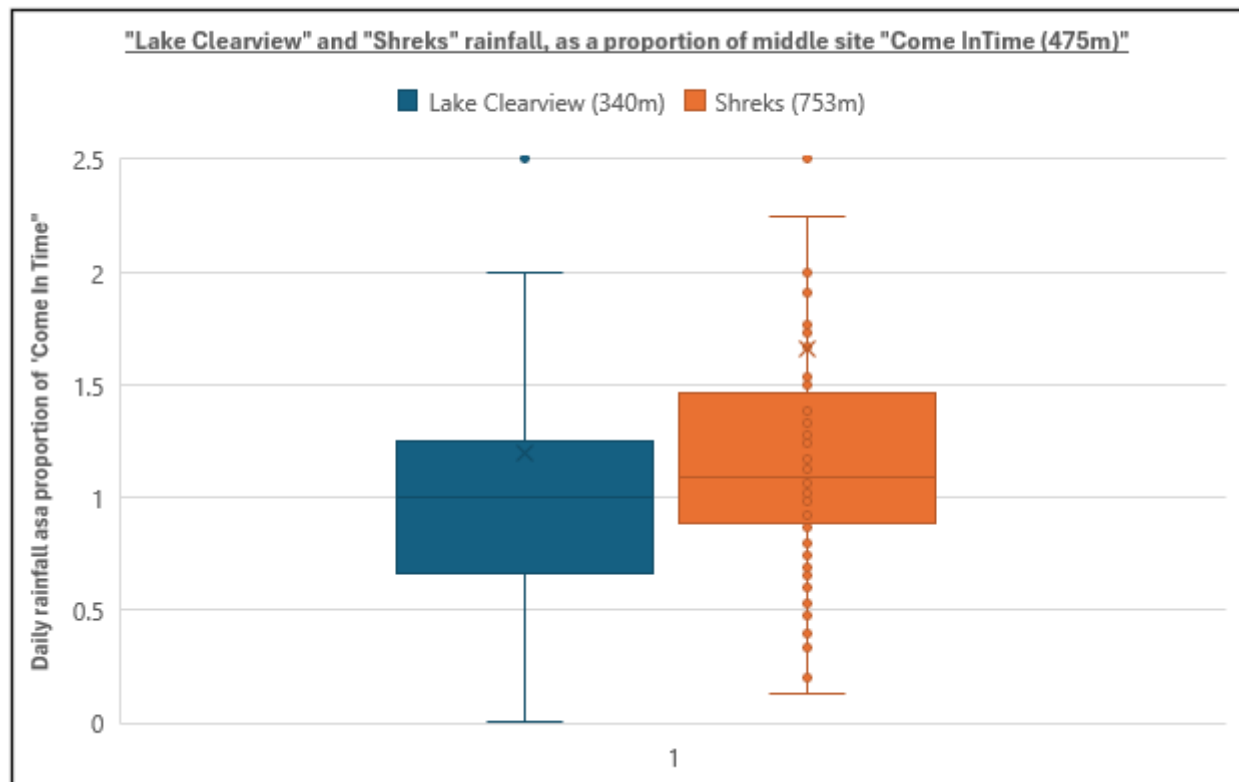


Figure 5: Box and Whisker plots of comparative rainfall between the 3 Matakanui Gold Sites (refer Figure 2)

With the “hinge” site chosen, the most suitable surrogate sites for producing synthetic record at that hinge site were then considered. Cromwell and Lauder offered the two best options, due to their overlapping record with Lake Clearview (Table 1). Any other sites, bar Ophir2, would require ‘secondary’ regressions. Ophir2 and Lauder are of similar location, but with Lauder being an ‘atmospheric research station’ it was logical to use this (likely more reliable) data over the Ophir2 record. A general comparison showed that Lake Clearwater rainfall is about 118% of that received at Cromwell, and similar to slightly more of that that received at Lauder.

Figures 6 and 7 show initial regressions for Lake Clearview rainfall with Cromwell and Lauder, respectively, for the time the Lake Clearview site has been running. The regression for the “Lake Clearview versus Cromwell EWS” comparison is obviously tighter. Although Lake Clearview receives similar overall amounts of rainfall to Lauder, Figure 7 suggests that this rain is not necessarily concurrent. Noticeable also is the number of days where it was raining at Lauder but no, or little, rain occurred at Lake Clearview. The slope of the regression with Lauder is influenced (flattened) by the lower limit (zero) for rainfall, and a regression with Lauder would produce a number of ‘false rain days’ for Lake Clearview.

At this stage, as another check, “Shreks” Met was also regressed against Lauder. The “Shreks versus Lauder” regression did produce a stronger relationship than that of “Lake Clearview versus Lauder”. However, the regression still contained more scatter than the “Lake Clearview versus Cromwell EWS” regression. **This validated the use of that Lake Clearview as the key “hinge’ site; and the use of Cromwell rainfall record for extending the of Lake Clearview record.**

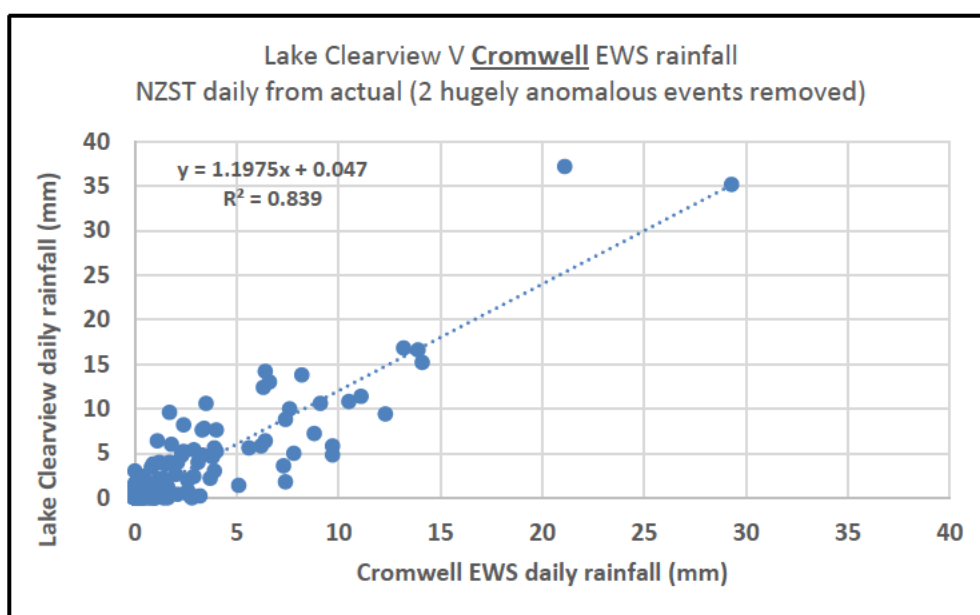


Figure 6: Initial regression between Lake Clearview (lowest Matakanui Gold site) rainfall and that at potential surrogate site Cromwell EWS.

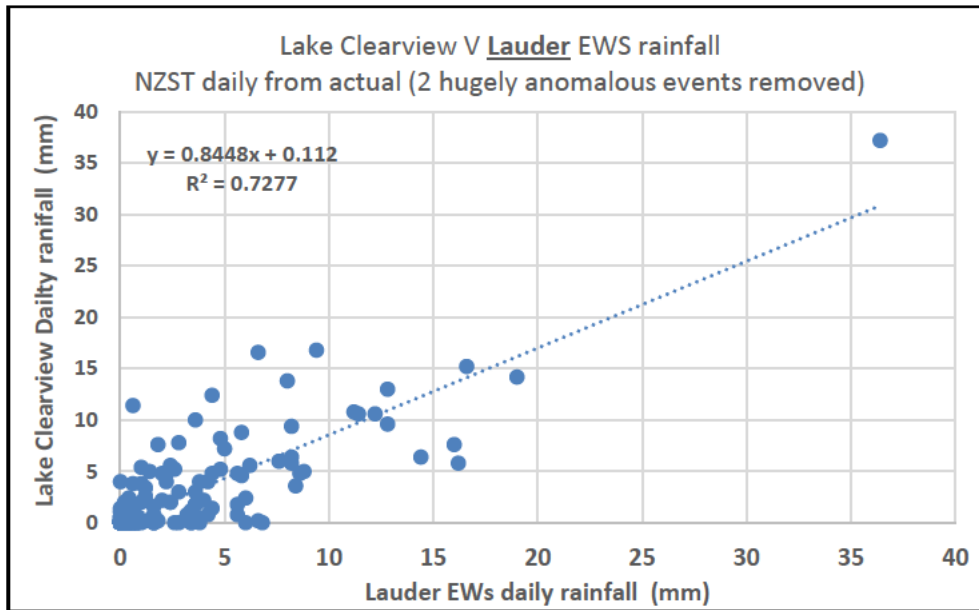


Figure 7: Initial regression between Lake Clearview (lowest Matakau Gold site) rainfall and that at potential surrogate site Lauder EWS

5 Finalised regression and consideration of wind direction

A QA check on the chosen surrogate rainfall site of Cromwell EWS was then undertaken. The Cromwell EWS rainfall was plotted cumulatively with concurrent data from NIWA's Lauder climate centre. The comparison showed a consistent relationship (Figure 8). This comparative plot was then fine combed at a 30-day interval. Although there were inevitable discrepancies, none of them would constitute as erroneous data. A script was run to check if there was any missing record across the entire dataset (i.e time step of over one hour between values), and none was found.

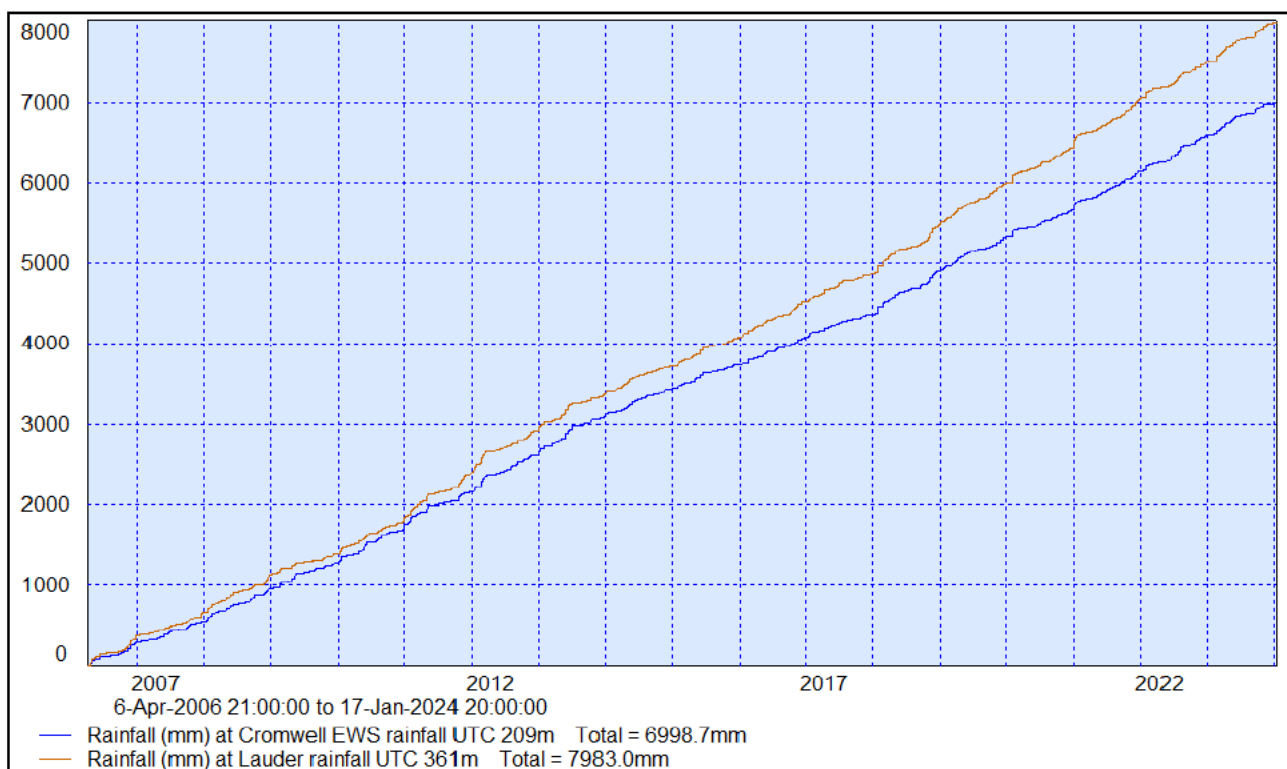


Figure 8: Cromwell EWS rainfall verses Lauder - April 2006 to January 2024

The regression between Cromwell EWS and Lake Clearview in Figure 6 shows perhaps a diverging into 2 different relationships, as rainfall increases. Rainfall in the area is typically pre-frontal (from the north-west quarter) or post-frontal (from the south/southeast quarter) in the area. Because of the way the different air streams interact with the topography it was hypothesised that the relationship between Cromwell and Lake Clearview rainfall could be dependent on these prevailing wind directions. (It is acknowledged that rainfall can also be associated with widespread low pressure systems over the South island – but the “directional” effect would remain). Wind direction data from Cromwell EWS was therefore used to isolate rainfall according to those predominant north-west and south-east quarter flows. The windrose for Cromell EWS is given in Figure 9. With consideration of windspeeds, and the channelling effects of the terrain surrounding Cromwell , “south-east quarter flows were actually considered as any direction from 100 through to 235 degrees , and “north-west” quarter flows any directions logged between 235 and 99 degrees.

Wind Direction at Cromwell EWS wind UTC
Wind Speed km/hr at Cromwell EWS wind UTC
From 5-Apr-2006 02:00:00 to 31-Jan-2024 21:00:00

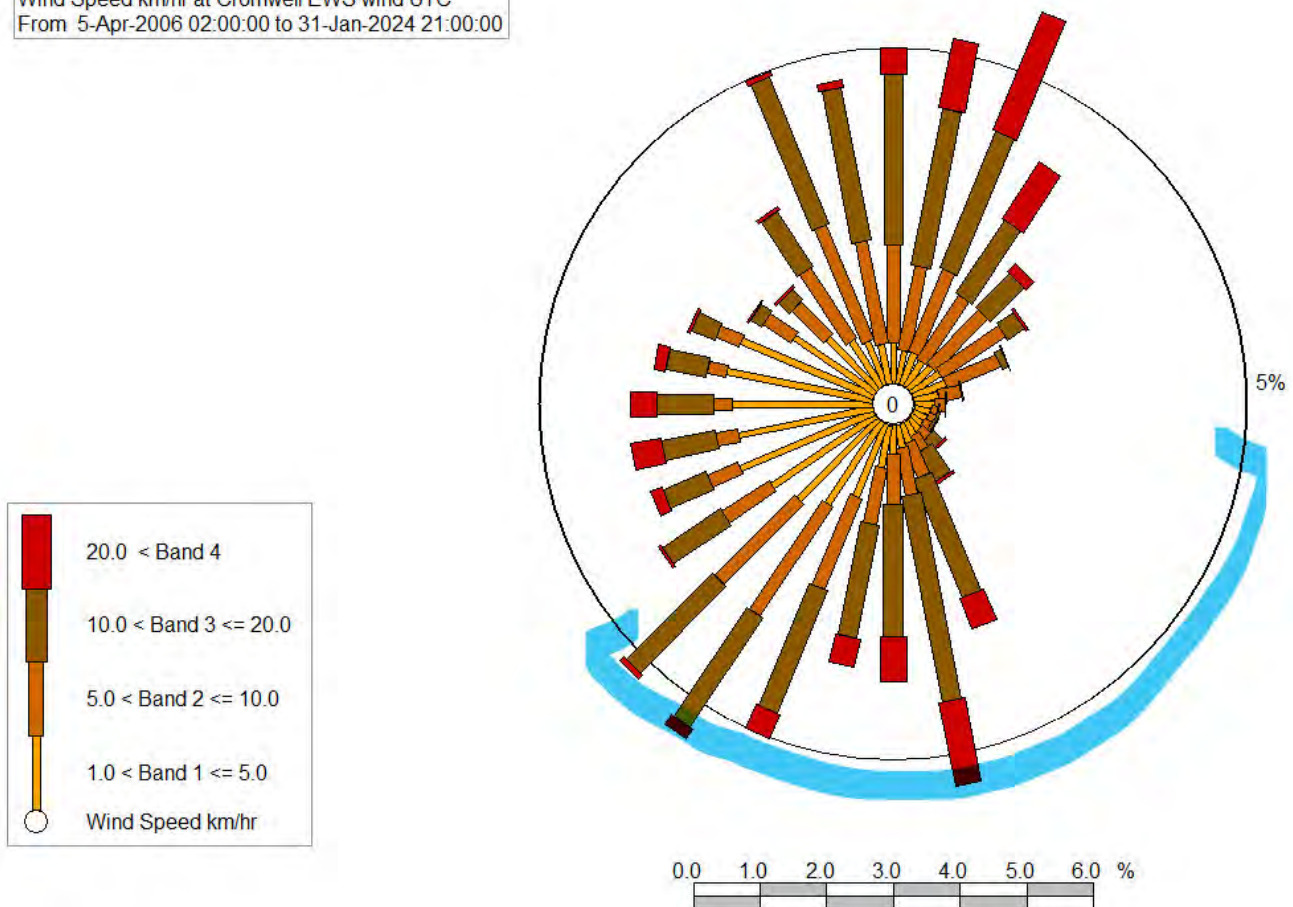


Figure 9: Wind rose for Cromwell EWS Met Station. Wind directions between 100 and 235 degrees (as highlighted blue) being considered “south-east quarter” events. All other directions were considered “north-west quarter” events.

The Clearview versus Cromwell EWS paired data was coupled with both the “average daily” and the “end of day” wind direction at Cromwell EWS. Obviously there are limitations in categorising daily rainfall as “northwest” or “southeast”, due to wind direction often changing within a day. It was found that the data split into two more discrete regressions when the subsets were defined by the “end of day” wind direction. Inevitably there were some outliers – and these were investigated. Three data points were removed where it was obvious that rain was borne from both the northwest and the southeast direction, within the same day.

Figure 10 shows the two direction dependent regressions. There is quite a lot of scatter across both regression and the application of the two regressions actually produce a similar long-term amount of rainfall as the single regression in Figure 6 . However it is felt that, storm by storm, the match between modelled and actual rainfall will improve by applying the two different regressions . Due to its vicinity, and sheltering effects of the Pisa range, it is logical that the Clearview gauge, would receive more rainfall from southeast quarter than from north-west quarter storms - relative to Cromwell. This which is what the regressions reflect.

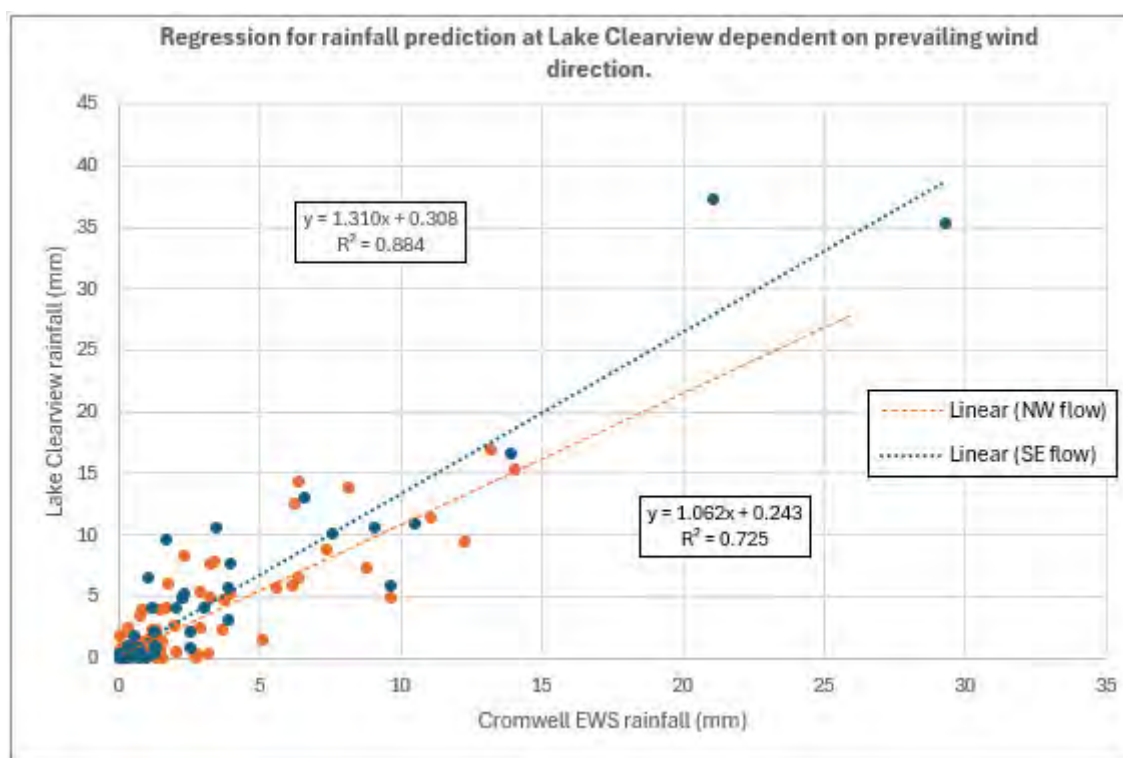


Figure 10: Cromwell EWS verses Lake Clearview daily rainfall, by wind direction

6 Model Script and generation of synthetic rainfall record

It can be seen in Table 1 that the Cromwell EWS rainfall site was a successor to Cromwell MWD and Cromwell2. Grid locations show all these sites to be within 100m of one another. There is overlap between each of the records.

Where they overlap, the Cromwell MWD and Cromwell2 records are exactly the same. However the Cromwell2 rainfall proves to be slightly, though consistently, higher than that of Cromwell EWS. The Cromwell EWS rainfall data is collected via an automated gauge and the record is logged electronically. It is assumed that the Cromwell EWS data is the more accurate record of the two sites.

On this basis of the above was **it was decided to generate synthetic record for Clearview based on Cromwell EWS record alone, for the following reasons:**

- 18 years of reliable synthetic record could be produced from Cromwell EWS, where the brief requested that ten years or more of reliable daily record, for model and water management purposes, be developed.
- Cromwell EWS rainfall showed to have a good workable correlation to that Lake Clearview, but the record from Cromwell EWS was not consistent with the predecessor sites Cromwell MWD and Cromwell2.
- Wind direction record at Cromwell starts in April 2006, the same time as the Cromwell EWS record begins.

QA checks on the Cromwell wind direction data were at this point undertaken. A period of obviously erroneous data (anomaly 1), and a period of missing direction data (anomaly 2), were found. These anomalies were dealt with in the following way:

Anomaly 1: Wind vane stuck about 330 though to 30 degrees mid October to end November 2019 (yellow highlight Figure 11). On this basis of wind direction at other sites, most of the rainfall during this time was actually borne out of the north west quarter, so the “330 to 30 degree” record sufficed. There was one exception where rainfall was obviously from the south, so for the purposes of the model direction was changed to 180 degrees for 2 days (9th and 10th November, green highlight in Figure 11).

Anomaly 2: Missing wind direction record mid May to mid August 2020. On the basis of higher rainfall at eastern sites Matakanui and Lauder for the major rainfall events over this periods, it is assumed that the wind direction during rainfall events was predominately from the southeast quarter . There is one small event at the end of the period for which this is likely not the case but this will have minimal effect on the final synthetic record. The wind direction at Cromwell was therefore set to 180 degrees for this period for which there is missing wind direction record.

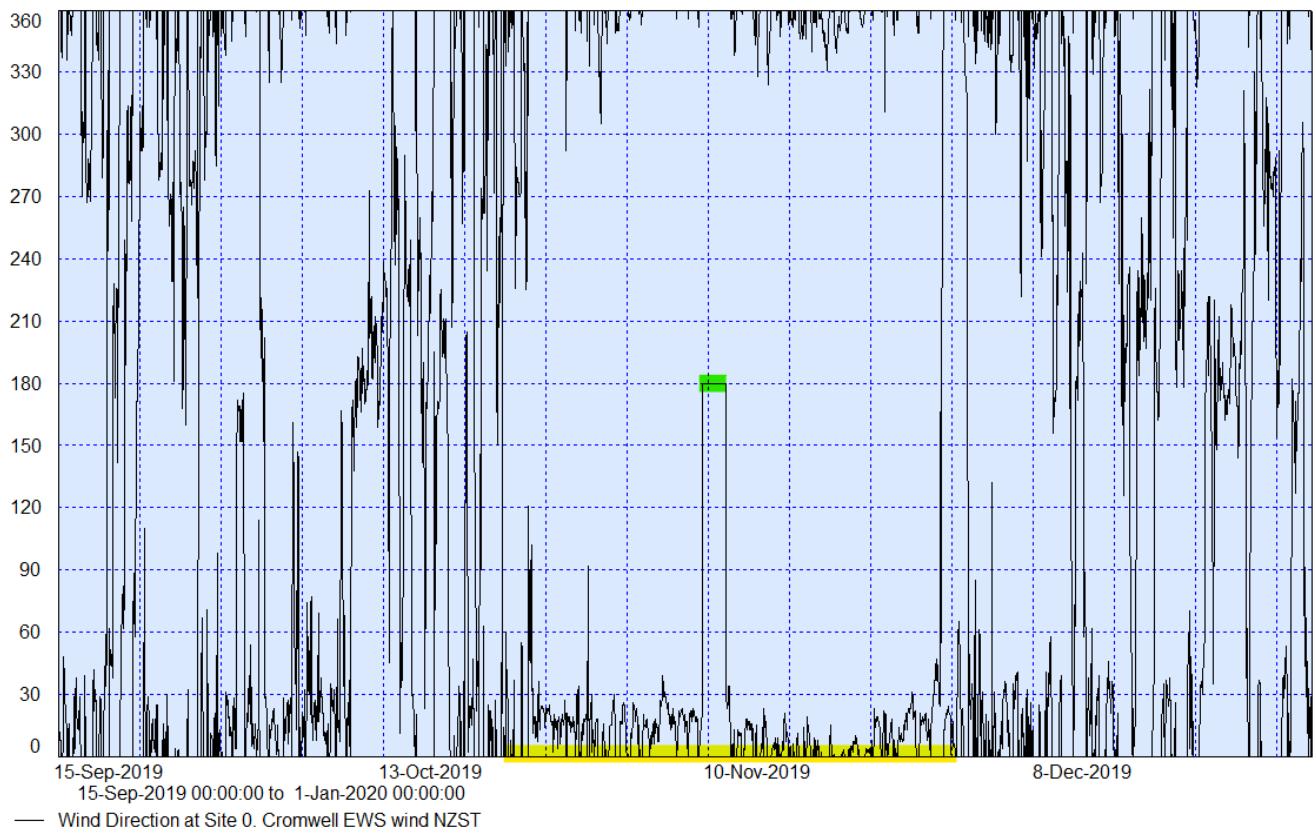


Figure 11: Period of erroneous wind direction data at Cromwell EWS mid October to end November 2019.

With all the check and balances carried on the data inputs a script was written to generate estimated rainfall at Lake Clearview from Cromwell EWS. The script considers the prevailing wind direction at any given time to adopt the applicable regression. As the model is run on hourly rainfall and wind direction data, it changes from one regression to another immediately as wind direction changes. Figure 13 shows the entire synthetic rainfall record for Lake Clearview, plotted cumulatively. The period for which actual Clearview record is available highlighted green. The synthetic rainfall record can be readily exported to excel at a daily timestep.

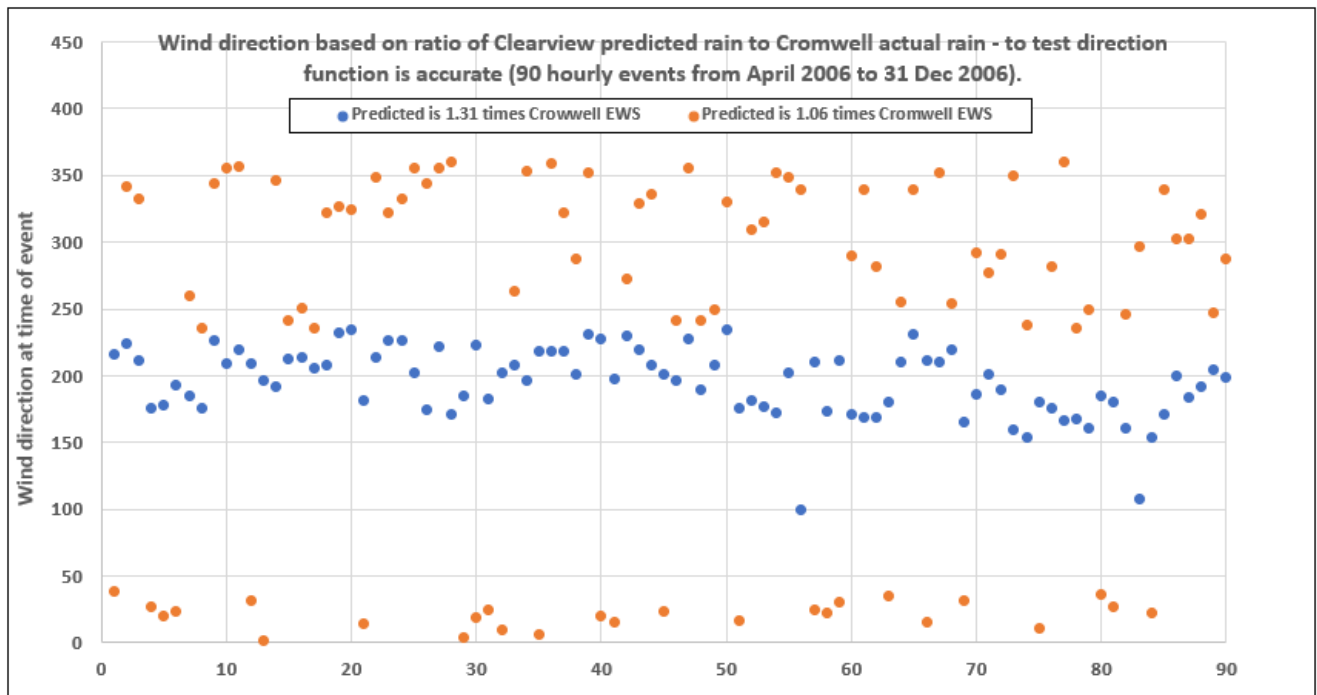


Figure 12: Graph confirming the direction function in the model is working and sensible.

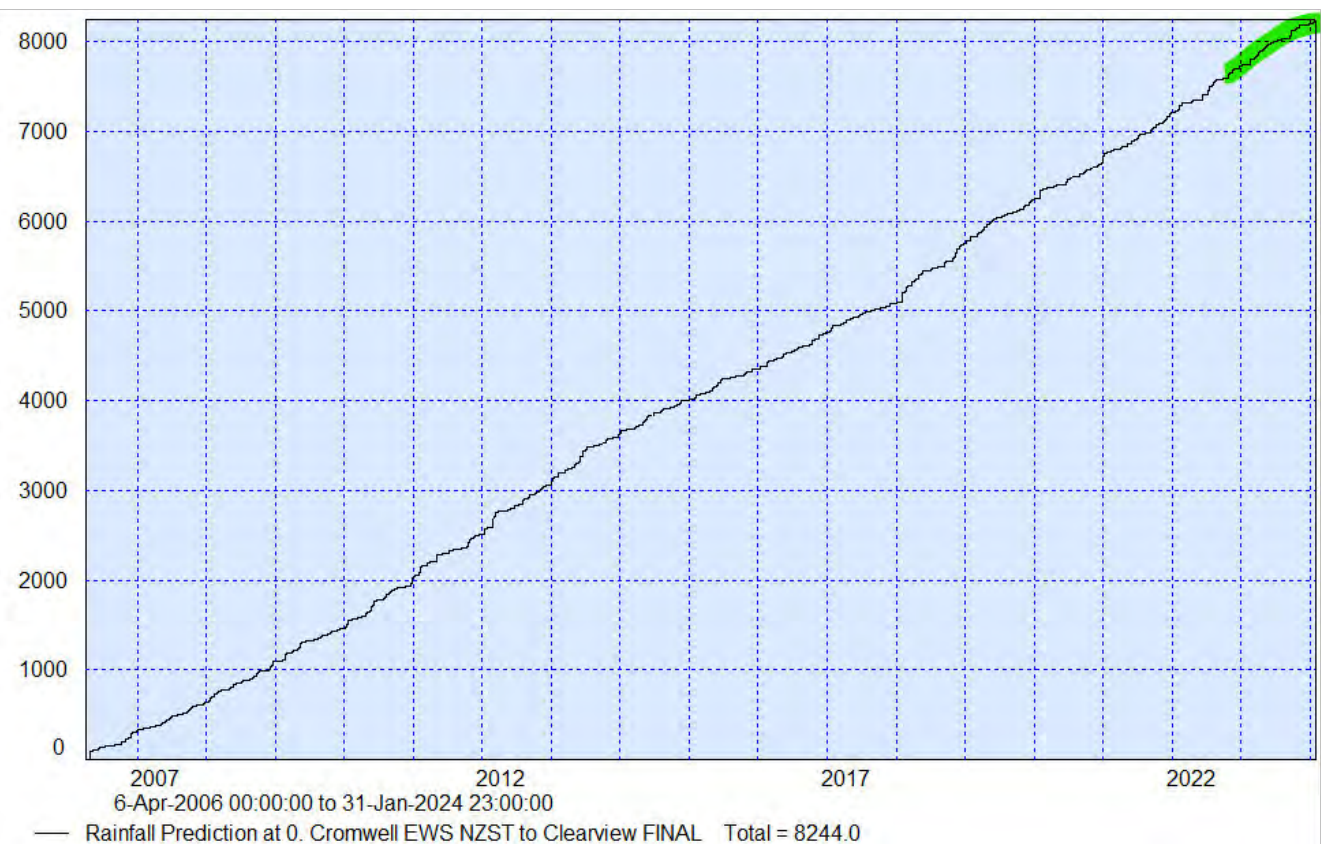


Figure 13: Modelled rainfall data for Lake Clearview. Green highlight is period for which actual Like Clearview data exists.

7 Test model data against actual; reliability and shortcomings

The regression between Cromwell EWS and Lake Clearview rainfall showed the relationship to have some inconsistency, at a daily interval. This is not surprising given the complexity of the surrounding terrain and variable directions of rain bearing wind. So two separate relationships were fitted to the data, according to wind direction, to try and alleviate some of this temporal inconsistency. It was opted not to incorporate other adjacent gauges in a multiple regression approach, as such a model would still be specific to wind direction, would be harder to replicate, and shortcomings in the model output would be harder to account for. Cromwell EWS was used over the next most applicable predictor site, Lauder, due the daily relationship with Lauder being more inconsistent than with Cromwell. With the “Cromwell EWS” regressions then applied, there are number of ways we can test the model output displayed in Figure 13:

1. Overplot of modelled rainfall at Clearview with actual recorded data:

Figure 14 shows the modelled against actual record from November 2022, and Figure 15 from 1st March 2023, so to exclude the February 2023 outlier event. The comparison is good, but obviously complicated by the February 2023 outlier. Modelled rainfall is significantly more than actual in Figure 14, and slightly less than actual in Figure 15. As the February 2023 appears to be far outside the expected norms (as detailed in Section3), little weight was given to matching the modelled record to this event. The model versus actual rainfall match in Figure 15 is considered a better measure of the model accuracy.

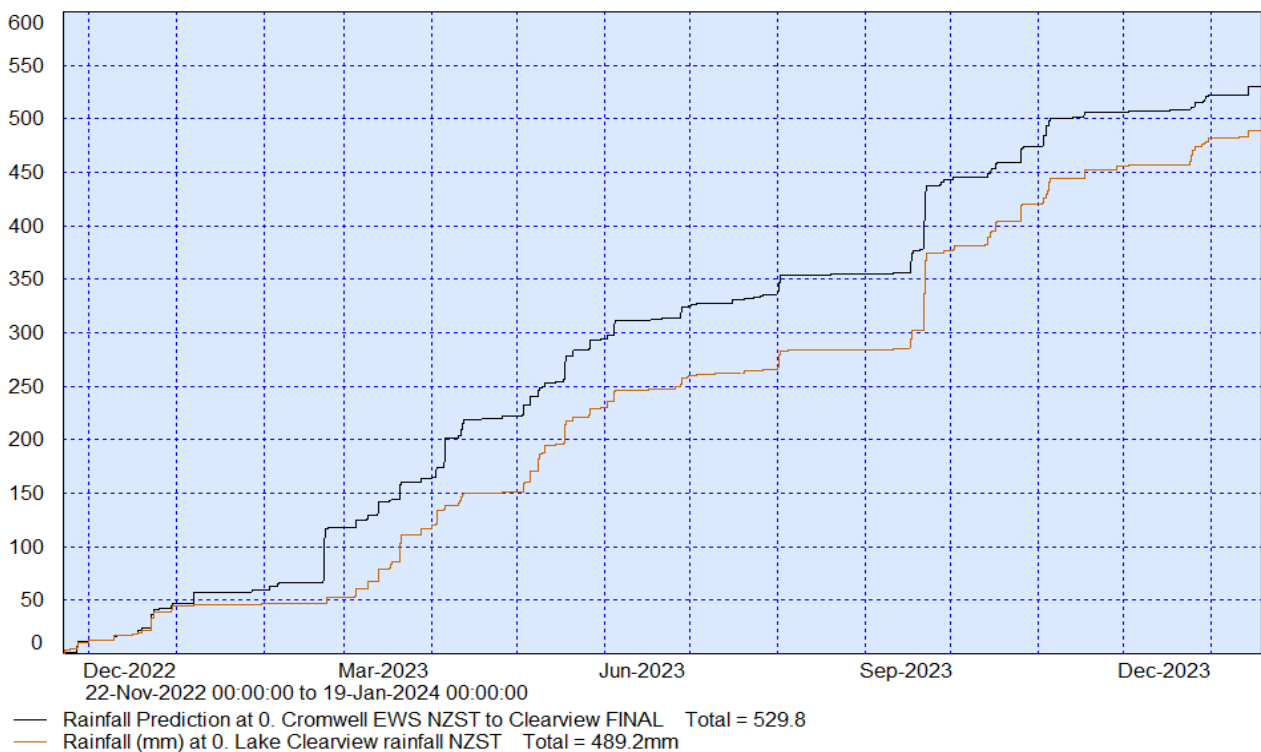


Figure 14: Modelled cumulative rainfall at Lake Clearview (black) with actual recorded data (brown) for the entire period there is concurrent data. (includes large rainfall anomaly in February 2023)

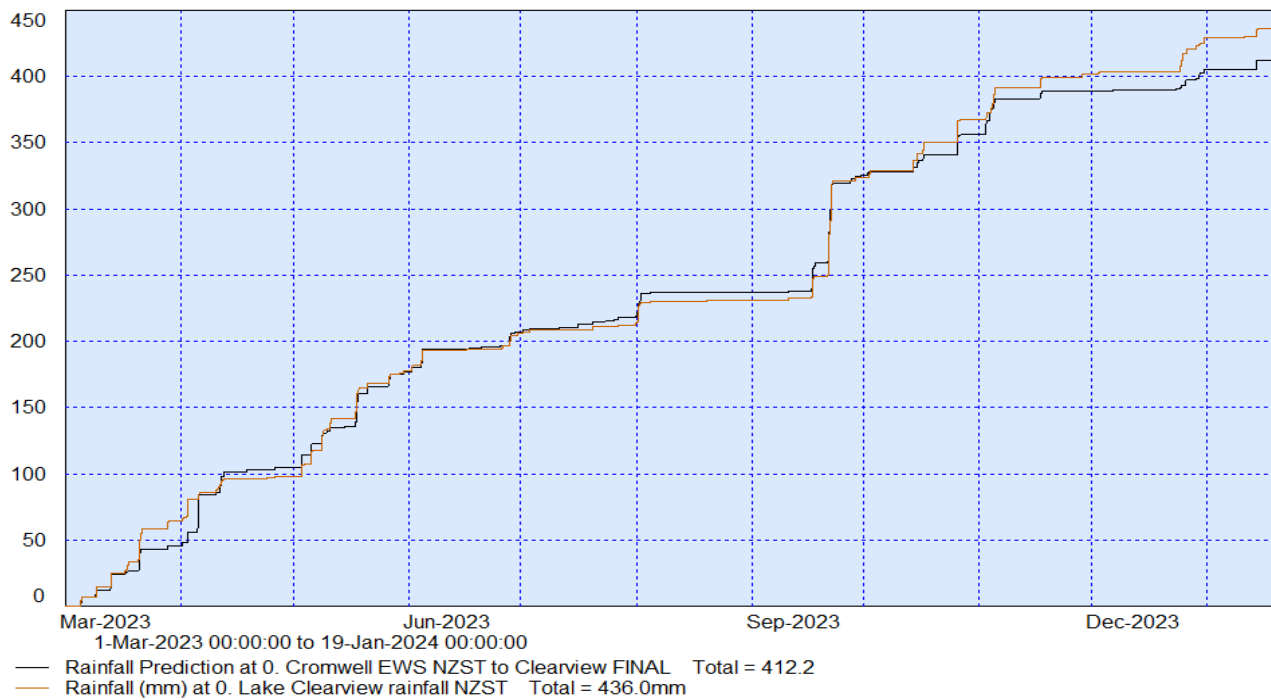


Figure 15: Modelled cumulative rainfall at Lake Clearview (black) with actual recorded data (brown) from 1/03/2023 to January 2024 – to exclude the large, likely misleading, anomaly in February 2023.

2. Regional comparison of average annual rainfall for Lake Clearview synthetic record with other sites in the vicinity, (to ensure the synthetic record is sensible with respect to location and altitude)

Figure 16 uses Box and Whisker plots to compare actual Lake Clearview rainfall, with that from gauges in closest vicinity. This is done the basis of each gauge's relationship to Cromwell. Cromwell record spans over a long time, and so overlaps with all these gauges at different points in time. It is acknowledged here that there is a slight disparity between the current Cromwell EWS site and the former Cromwell sites, but the below comparison is still considered useful. Figure 16 suggest that in the longer term we would expect Lake Clearview cumulative rainfall (dark green) to be less than Tarras and Matakanui, similar to Bendigo 1 (the closest gauge to Clearview), and more than Bendigo2 and Lauder.

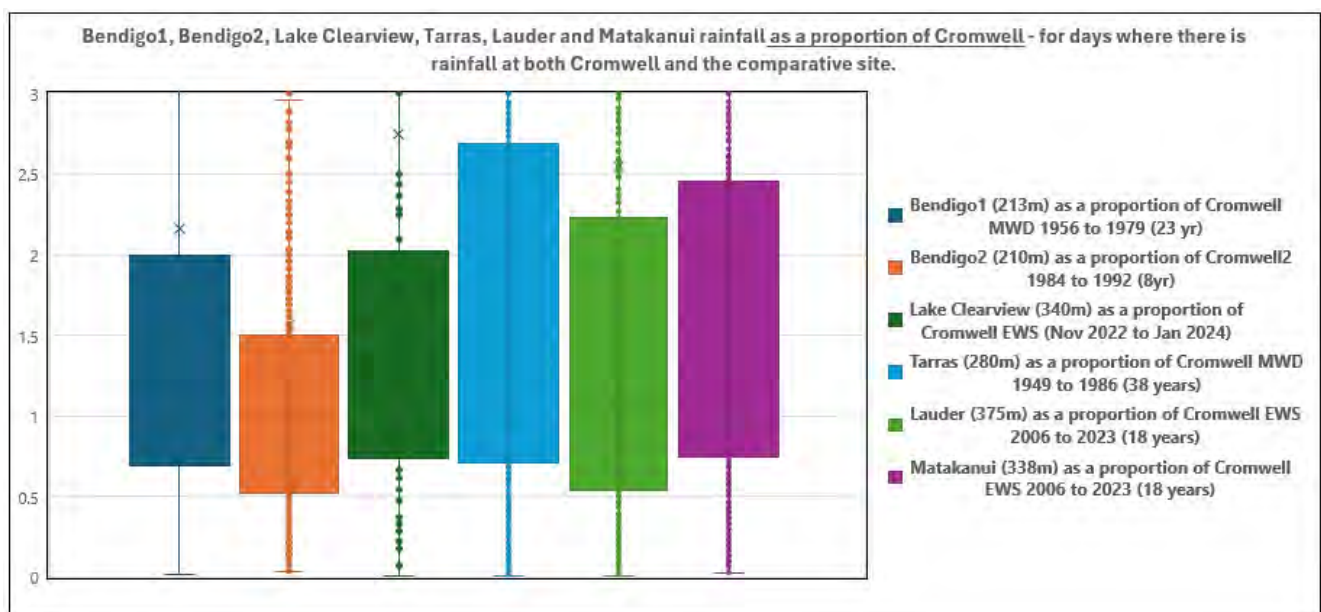


Figure 16: Box and Whisker plots of rainfall in the vicinity if Lake Clearview, expressed as a proportion of that received at in Cromwell.

The mean annual rainfall for the predicted Clearview record (2006 to 2024) is consistent in rank, to that which is expected (Table3). Therefore the model, over time, is not generating bulk rainfall totals at Lake Clearview that are inconsistent with adjacent sites. Where Figures 14 and 15 compared the modelled rainfall against actual, the comparison in Table 3 validates the 18 years of modelled rainfall in a more regional type context.

Table 3: Mean annual rainfall for gauges within vicinity of Lake Clearview.

<u>Mean annual rainfall for gauges within vicinity of Lake Clearview:</u>		
	Rainfall (mm)	Altitude:
Cromwell EWS	394	213m
Bendigo2	418	210m
Bendigo1	445	213m
Lauder EWS	452	375m
<u>Predicted</u> Lake Clearview (2006 to date)	463	340m
Tarras	472	280m
Matakanui (windward)	516	338m

3. Analysis of individual storm events should show the modelled data to be aligned with actual lake Clearview data.

This often was the case, but for some rainfall events the difference between modelled and actual was quite significant. This of course reflects the scatter of data points around the relationship used. This needs to be recognised as one of the shortcomings of the model - it replicates rainfall at a monthly and annual interval well, but cannot be assumed to be 100% accurate day by day. In terms of water management outcomes the model provides a robust estimate of the rainfall input into the catchment over time. Inaccuracies at a daily timestep must be assumed. However the inaccuracies are not considered positively or negatively biased (Figure 17)

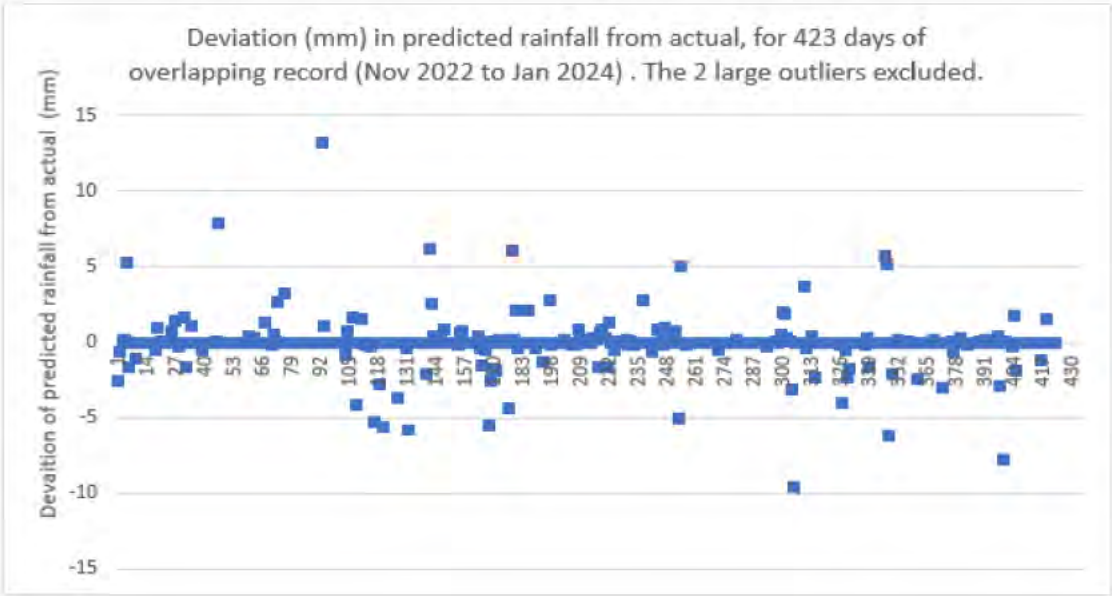


Figure 17: Millimetre difference between predicted and actual Lake Clearview rainfall.

8 Application of the synthetic data

The modelled data has been generated in Hilltop software at an hourly timestep and can be exported and supplied at any interval greater than this. It represents at-site daily rainfall estimates from 2006 to date at the Lake Clearview recorder site.

The estimate of catchment wide rainfall over the entire area of the Bendigo Project site is beyond the scope of this report. To date no delineation of the mine catchment area, and that area which is requiring water treatment, has been provided. However the Lake Clearview gauge shows a solid relationship to the higher two gauges (“Come In Time” and “Shreks”). Thus extrapolation of the synthetic Lake Clearview record across the entire catchment would be viable, and reasonably accurate.

It is noted here that the record from nearby Bendigo1 (see Figure 3) appeared to be closely aligned to that of Lake Clearview, albeit perhaps slightly less. Bendigo 1 record, which spans from 1956 to 1979, may be quite useful in terms of indicating likely number of annual rain days, rainfall variability etc. Climate change considerations would need to be kept at the forefront here though.

Unfortunately as only at a daily timestep the Bendigo1 record wouldn't be overly useful for extreme rainfall analysis, as storm durations of 12 hours or less are likely the most relevant with the small catchment area concerned.

9 Model refinement and data assessment for frequency analysis.

The predicted rainfall record for Lake Clearview can be further validated as more actual rainfall for Lake Clearview is collected. Documenting any site visits, issues with the gauge, change of calibration etc would be very useful. Then data can be more easily validated, and there would be better grounds for including or excluding outlier data. It may be that model could be improved by including more regressions based around wind direction; but it's questionable how many gains would be made by doing so.

The brief for this project also requested that a data assessment be made for storm analysis and design purposes at the Bendigo Project site. At the moment there is insufficient rainfall record to carry out rainfall frequency analysis directly on the Lake Clearview, “Come In Time” or “Shreks” rainfall record. At least ten years of data is really required here. However, there are other sites in the region that could be used to normalise the rainfall intensities that have been recorded thus far at the Matakanui Gold gauges. The location of these gauges can be found in Figure 4. Normalised estimates of rainfall intensity and frequency could still only be considered “indicative”, although the reliability of the estimates would improve as time goes on.

There are no further data requirements for storm design estimates, as the catchment is already well monitored. However an assessment of rainfall “concentration times”, using the current Matakanui Gold rainfall and flow data, is needed. By doing so intensity /frequency estimates can be made for durations that are likely to be the most damaging to infrastructure.

MEMORANDUM

TO	Hamish McLauchlan, Santana Minerals
FROM	Mandy Chater, Hydrology Consultant
CC	Ryan Burgess
DATE	4 th April 2024
SUBJECT	Estimated rainfall-altitude relationship, Bendigo Project Area
Matakanui Gold Ltd requested that a relationship between rainfall and altitude at their Bendigo Project Area be established. This is for the purpose of integrating rainfall over entire catchment areas, and so requiring rainfall estimates for areas beyond the vicinity of the actual gauges. A relationship has been established based on rainfall from the 3 Bendigo project gauges, and on the Otago Regional Council's Cluden and Lauder Basin gauges for extending to higher altitudes.	

In November 2022 three automated rain gauges were established in the Bendigo Project Area. Work has already been undertaken to create an estimated ten-year daily rainfall record for the lowest gauge (Lake Clearview). The likely expression of this ten year rainfall higher up in the catchment can be established from concurrent data for the 3 Bendigo gauges; and for the very highest portion of the catchment through the relationship between the nearby Cluden (357m) and Lauder Basin (1502m) gauges, which are run by Otago Regional Council. See Figure 1 for gauge locations.

Regression analysis showed that on a daily timestep the rainfall relationship between the respective Bendigo sites is inconsistent. The regressions tend to be clustered by non-rainfall days, and are susceptible to days where there is only rainfall at one site, or times when rain may fall as snow. Also, it could be seen that the temporal distribution of rainfall is inconsistent. Particularly, longer term rainfall totals at the higher sites tend to depend on a few anomalous storms where the rainfall at altitude is substantially higher (as opposed to a relationship which is constant across all rainfall events).

To establish the overall rainfall relationship between the respective Bendigo sites, monthly and annual running rainfall totals were calculated, to step away from the daily and weekly anomalies. Even monthly running totals were reasonably volatile, when compared to one another, still being affected by the daily inconsistencies discussed above. Therefore annual running total rainfall calculations were utilised. The annual running totals excluded the 21st and 22nd February 2023 record. Over these days all gauges in the region recorded significant rainfall (45mm+), but Lake Clearview only received 6mm. With its' inclusion, this event dominated the subsequent ratio calculations for an entire year, and thus detracted from the likely rainfall relationships. The annual running rainfall totals for the 3 Bendigo sites are shown in Figure 2. The Shreks and "Come In Time" running totals are then expressed as a portion of the Lake Clearview running total in Figure 3.

The median value of the the Shreks/Lake Clearview running total is 1.11, and the median value for "Come In time"/"Lake Clearview" running total is 1.01. Encouragingly these values are very similar to the monthly running total calculations – where (since 1 April 2023) the median value for the Shreks/Cleaview ratio is 1.11 and the median value for the "Come In time"/Clearview is ratio 0.98. Being only 135m higher than Lake Clearview, the "Come In Time" gauge appears to receive little if any additional rainfall. Being 413m higher, the Shreks gauge shows a definite increase in rainfall rates.

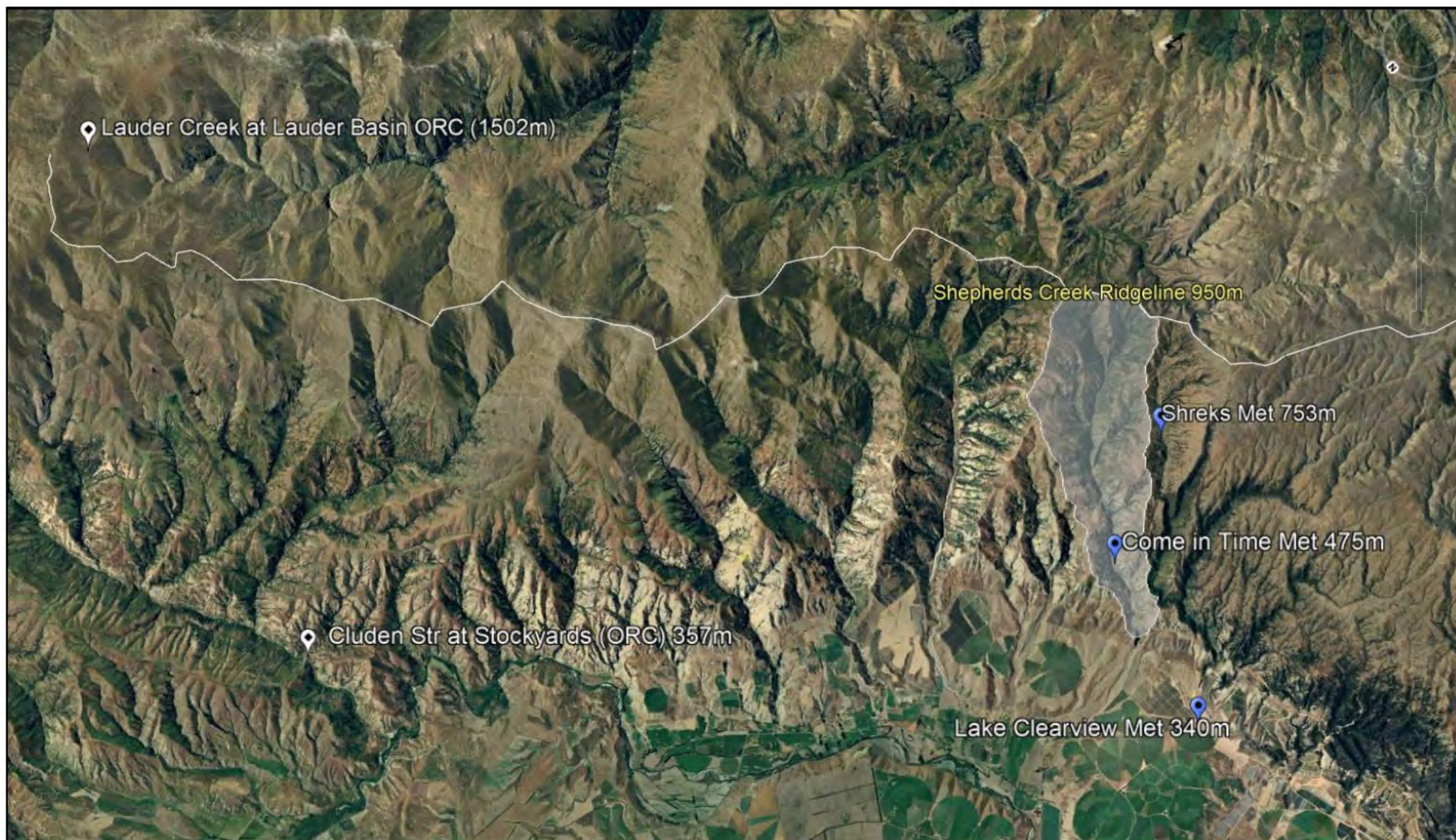


Figure 1: Location of Bendigo Project gauges, along with Otago Regional Council's "Cluden" and "Lauder Basin" gauges. The Bendigo Project catchment area extends to 950m.

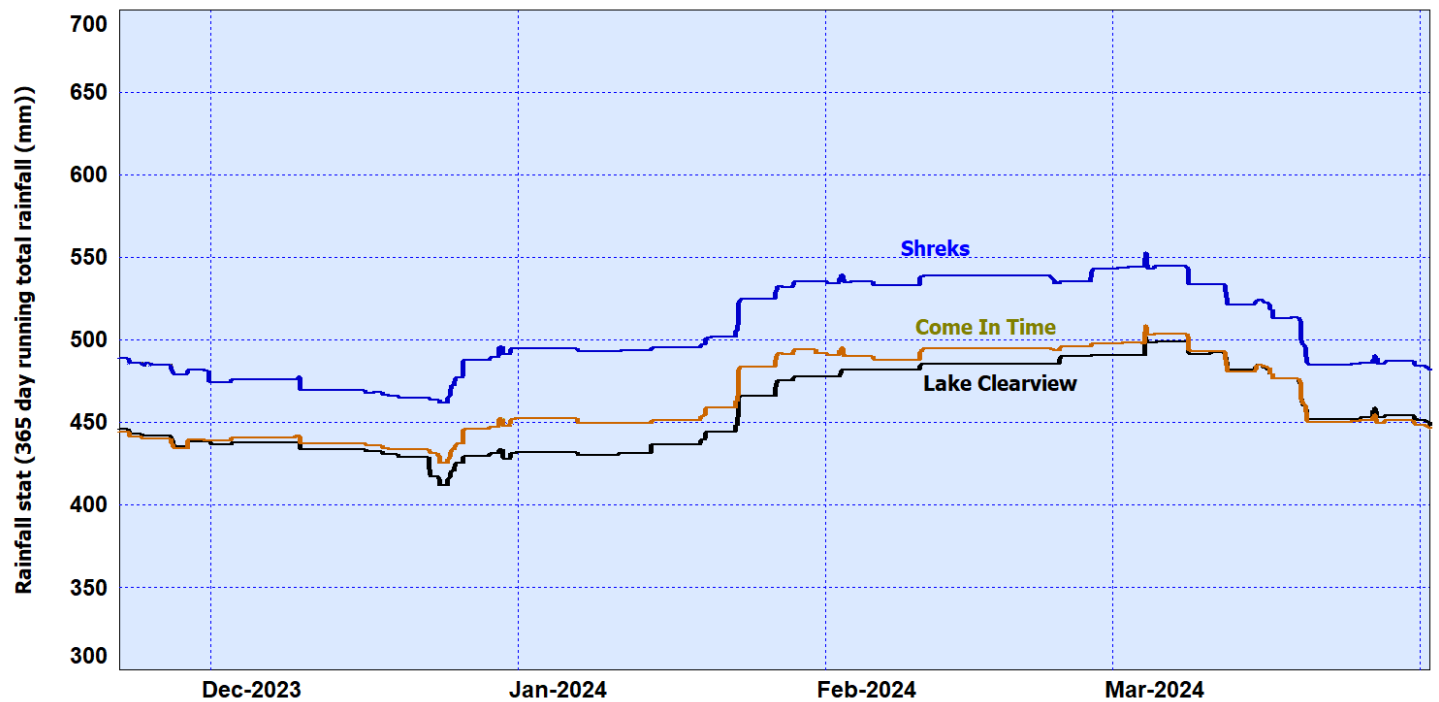


Figure 2: Annual running rainfall totals for 3 Bendigo project gauges.

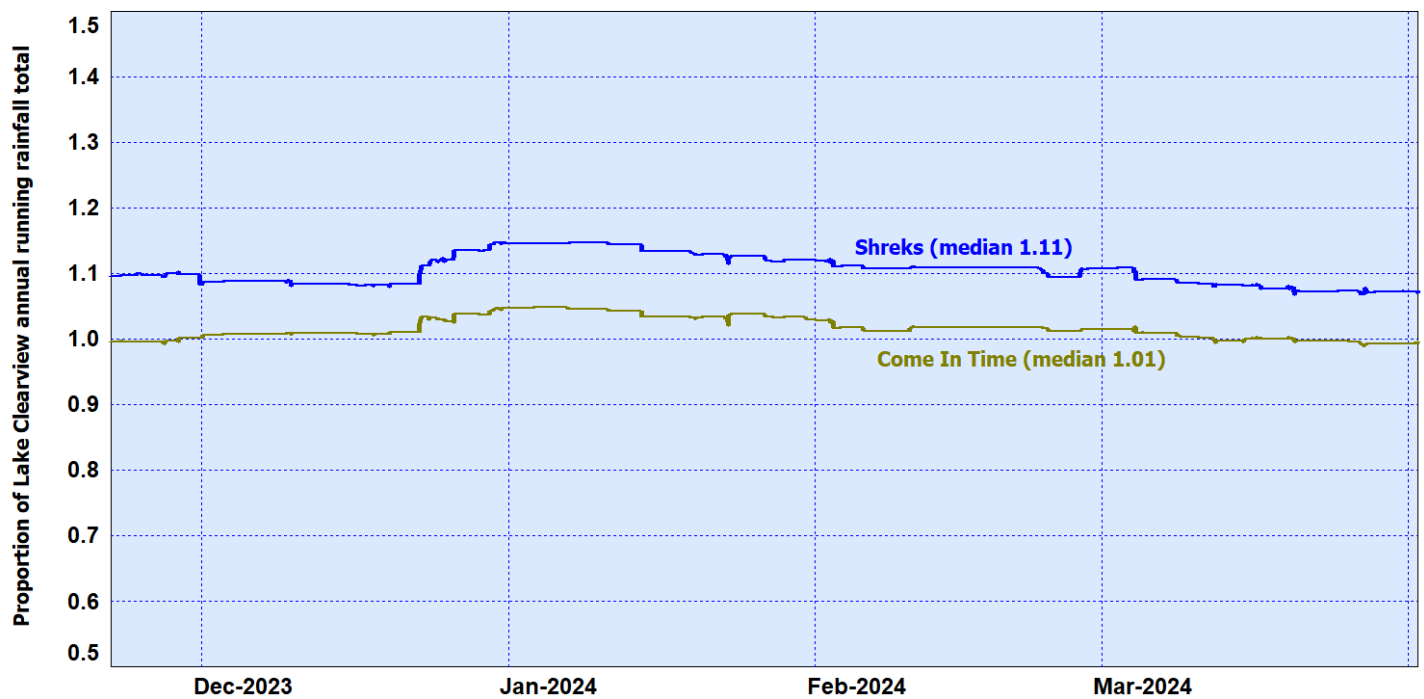


Figure 3: Shreks and “Come In Time” running annual rainfall totals, expressed at a proportion of Lake Clearview running annual rainfall total.

With the Cluden rain gauge (357m) being of very similar height to that of Lake Clearview gauge (540m), it could be compared to the much higher Lauder Basin gauge as way of extending the rainfall-altitude relationship above the Shreks gauge (753m). Cluden and Lauder Basin gauges are located about 18km to the north-east of the Bendigo gauges, but still within the Dunstan Mountain range. There is likely some disparity in the Cluden-Lauder Basin rainfall relationship, to that in the Bendigo Project Area, due to localised topographic effects. However the Cluden to Lauder Basin relationship is only needed to help to extend the relationship from Shreks gauge to the top of the Bendigo project catchment area (950m) – so is considered useful in this case.

The same annual and monthly running total approach was taken – with Lauder Basin then being expressed as a proportion of Cluden. The respective median values of those comparisons were 1.51 and 1.58. The traces did show more fluctuation, which is to be expected due to the larger altitudinal difference, and the sites being offset horizontally but about 5km. For this reason daily rainfall correlation was also considered. In this snowfall was obvious by a number of days in winter where rainfall occurred at Cluden not at Lauder Basin. June to September months were removed, along with non-rainfall days and the correlation was repeated. The paired data showed a lot of scatter, but a fitted linear regression indicated Lauder basin rainfall to be approximately 1.198 times that of Cluden. It is thought here that, again, a few large isolated storms have a large bearing on the overall totals received at Lauder Basin – explaining the lower ratio (to Cluden) produced by daily regression.

Of these 3 separately derived ratios the highest (1.58) and lowest (1.198) were added to the plot in Figure 4, along with an average value of 1.389. This was done to support (or otherwise) a linear fit through the Bendigo Project data alone (Clearview, Come In Time and Shreks). The polynomial curve, fitted through all the available data points, was used to calculate a likely amount of rainfall at ridgeline (950m). This calculation is shown as a green dot in Figure 4 and is fairly consistent with linear regression at 950m.

It is recommended that that the polynomial equation in Figure 4 be adopted as a means of calculating rainfall at different altitudes across the Bendigo Project area. Due to storm variability the relationship cannot always be considered accurate for a daily or lesser intervals.

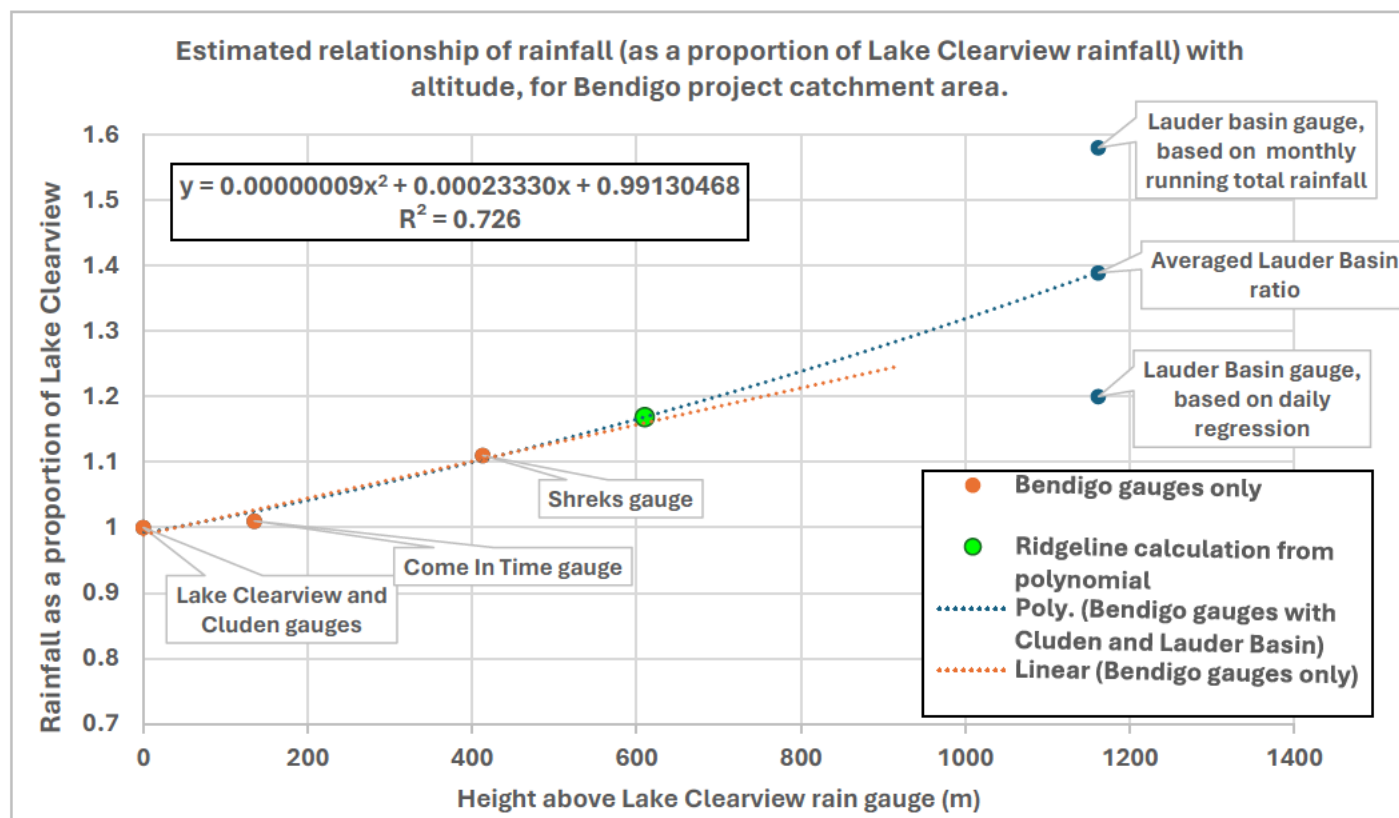


Figure 4: Estimated rainfall-altitude relationship in the Bendigo project area.

MEMORANDUM

TO	Hamish McLauchlan, Santana Minerals
FROM	Mandy Chater, Hydrology Consultant ¹
DATE	August 2024
SUBJECT	Extension of synthetic rainfall time series, Bendigo Project

Synthetic rainfall for the Bendigo 'Lake Clearview Site' has been extended back to 1949. This follows an initial extension of the data back to 2006 using rainfall and wind direction from "Cromwell EWS". The procedure for this initial extension is documented in "Development of a synthetic rainfall database at Bendigo".

The extension back to 1949 uses slightly less reliable rainfall inputs, and does not consider wind direction like the "back to 2006" extension. However, comparison with long term rainfall records in the region indicate the synthetic rainfall back to 1949 is sensible, and consistent with patterns at other gauges. This is especially where monthly or annual rainfall is concerned. Predicted rainfall on any given day though has less reliability.

This memo details how the record was extended back from 2006 to 1949, and builds on the detail already supplied the "Development of a synthetic rainfall database at Bendigo" memo.

1. Mandy Chater, MSc (Geography). 20+ years' experience in hydrological analysis and environmental science (NIWA, Environment Canterbury, West Coast Regional Council, Solid Energy/Bathurst Resources)

1 Data Inputs

Figure 1 and Table 1 below recap the use of Cromwell rainfall for creating synthetic rainfall data at Lake Clearview; based on vicinity and data availability.

The initial extension was limited back to 2006 only for the following reasons;

- 18 years of reliable synthetic record could be produced from Cromwell EWS, where the brief requested that ten years or more of reliable daily record, for model and water management purposes, be developed.
- Cromwell EWS rainfall showed to have a good workable correlation to that at Lake Clearview, but the record from "Cromwell EWS" was not consistent with the predecessor sites "Cromwell MWD" and "Cromwell 2".
- Wind direction record at Cromwell starts in April 2006, the same time as the Cromwell EWS rainfall record begins.

With a longer length of record now requested, it was chosen to continue with the use of Cromwell rainfall as a surrogate, but the points on the availability of wind direction data, and the inconsistency between the Cromwell gauges, needed to be addressed.

The 2006 to 2023 synthetic rainfall data was generated from 2 regressions - which were applied to the Cromwell data depending on wind direction. The slope of the regressions proved to be different depending on storm direction, so the use of the wind direction allowed rainfall to be supposedly predicted with better accuracy (on a day to day basis). The regression in Figure 2, which is on all "Cromwell EWS versus Lake Clearview" daily rainfall (so no storm direction consideration), has a slope of 1.1975. The slope of the south-east storm regression was 1.310 and of the north-west storm regression was 1.062. Therefore the application of the "all data" slope of 1.1975 did produce overall rainfall totals similar to those produced by the two "direction dependent" regressions. So for the purpose of deriving rainfall totals it was deemed that excluding the direction component was appropriate; but recognising that the predicted record prior to 2006 was likely to be less accurate on a day to day basis.

A relook at the rainfall data confirmed the inconsistency between the Cromwell EWS and Cromwell 2 rainfall data – where they overlap (April 2006 to July 2007). Grid locations show the Cromwell MWD, Cromwell 2 and Cromwell EWS sites to be within 100m of one another. As it is available at hourly time steps, the Cromwell EWS (electronic weather station) data is obviously from an automated gauge; whereas MWD and Cromwell 2 data is very likely from manual daily readings. For this reason, the Cromwell EWS data is considered the more accurate record. (The Cromwell 2 and earlier Cromwell MWD data, where they overlap, is virtually the same)

Figure 3 below expresses the Cromwell EWS rainfall as a proportion of Cromwell 2 – showing the former to read slightly lower than the latter most of the time. The largest discrepancies are for daily rainfall less than 3mm, where the discrepancy is inflated and not of great relevance from a water resource point of view. However, even for the larger events there is a bias in the data comparison. This bias needed to be addressed to make a continuous surrogate dataset, to which the Cromwell EWS V Lake Clearview regression could then be applied. **The Cromwell2 and Cromwell MWD rainfall record was therefore multiplied by 0.9** – as this correction resulted in the total Cromwell 2 data matching the total Cromwell EWS data – for the period which they overlap.

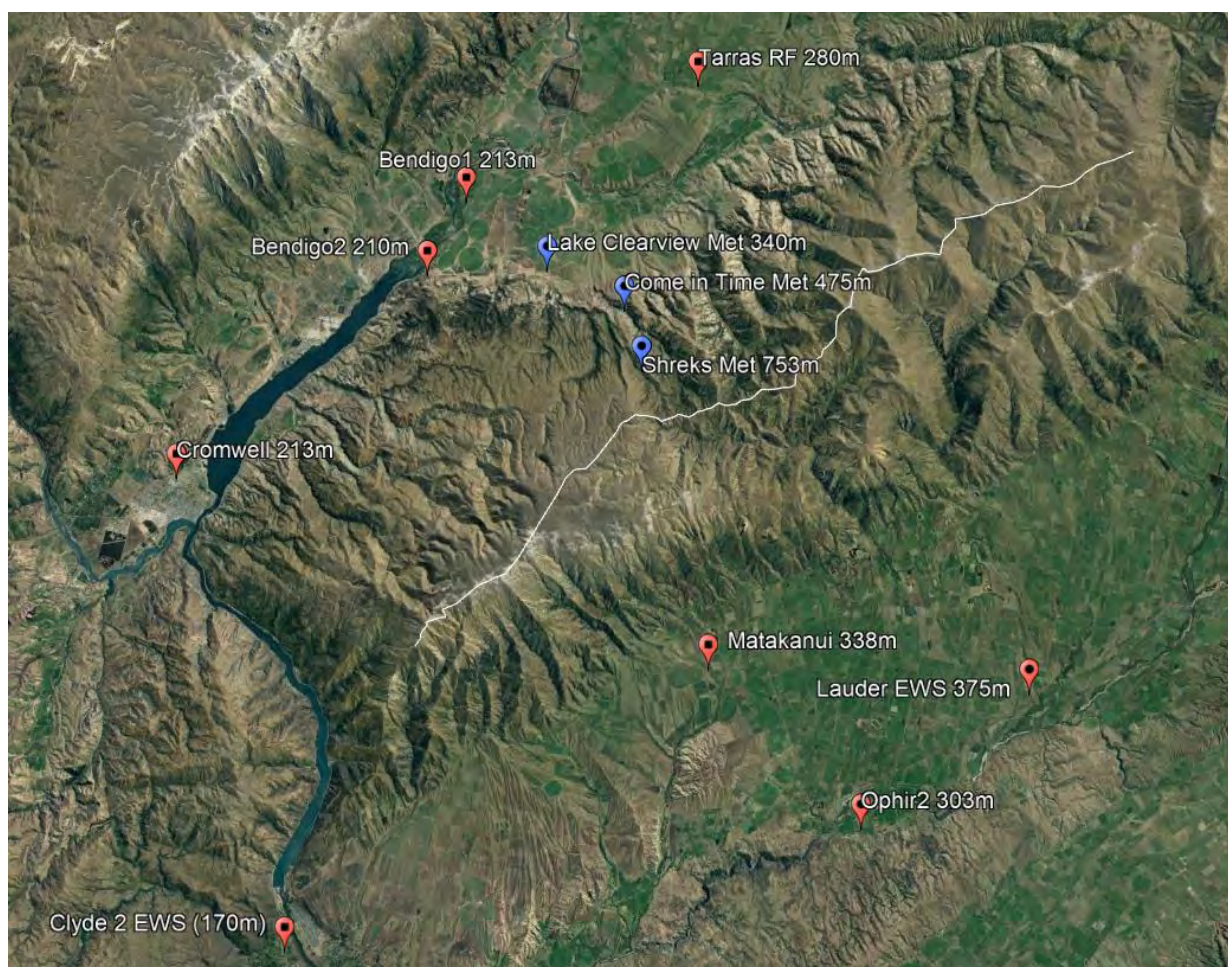


Figure 1: Gauges that were considered for the initial development of “Lake Clearview” synthetic rainfall record.

Table 1: Sites with daily rainfall record in near vicinity to Bendigo Project gauges - Cliflo database

denotes potential primary regression site - data overlaps with Matakanui Gold records (Nov 2022 onwards),
denotes secondary site of interest due to vicinity or length of record

Agent Number	Name	Start Date	End Date	Percent	Dist km
				Complete	(from Lake Clearview Met)
5243	Bendigo 2	1/05/1978	31/05/1992	100	3.3
5242	Bendigo 1	1/01/1956	30/06/1979	100	3.6
5241	Mt Pisa Station	1/05/1908	31/05/1924	90	6.1
5233	Lochar	1/04/1947	31/03/1956	80	6.8
5234	Queensbury Ews	1/11/1978	31/05/1992	100	6.9
5236	Tarras	1/01/1902	31/07/1986	80	12.2
5528	Northburn	1/11/1978	31/05/1992	100	12.5
5228	Willowbank	1/11/1953	30/06/1963	90	16.1
26381	Cromwell Ews	6/04/2006	17/01/2024	100	16.7
5529	Cromwell 2	1/07/1984	31/07/2007	100	16.8
5526	Cromwell M.W.D.	1/06/1949	30/06/1985	100	16.8
5524	Cromwell Sub Stn	1/04/1976	31/10/2023	20	19.3
5530	Matakanui	1/05/1947	31/12/2021	100	19.6
5523	Ripponvale	1/09/1925	31/03/1961	100	20.5
5225	Luggate	30/06/1913	28/02/2006	90	22
5240	Upper Meg Power Stn	1/05/1953	31/05/2013	100	23.3
7426	Wanaka Aero Aws	30/04/1992	16/01/2024	100	24
5227	Lagoon Valley	1/01/1949	31/08/1964	100	25.4
5231	Merrivale	21/04/1953	31/05/1963	100	25.4
5224	Mt Barker	1/01/1967	31/01/2011	90	26.1
5232	Cardrona	1/01/1948	31/12/2014	100	26.2
5542	Clyde	1/08/1973	31/10/1977	90	26.4

Agent Number	Name	Start Date	End Date	Percent	Dist km
				Complete	(from Lake Clearview Met)
5229	Lindis Pass	1/11/1947	31/08/1948	100	27.4
5522	Waitiri Stn	1/01/1954	31/12/1968	70	28
5540	Bannockburn	1/07/1971	30/04/2018	90	28.7
5544	Ophir 2	1/04/1924	30/11/2023	90	28.9
5223	Wanaka	1/09/1927	31/08/1990	100	29.1
5230	Geordie Hill	1/05/1987	31/01/1990	80	29.1
5546	Ophir 1	1/11/1914	31/01/1931	20	29.2
5543	Clyde Dam	1/05/1978	30/06/2007	100	29.4
5535	Lauder Ews	20/08/1985	17/01/2024	100	29.6
43486	Lauder Raine Ews	29/04/2016	4/12/2023	100	29.6
5537	Lauder Flat	1/01/1945	30/11/2023	100	29.6
5249	Lauder Station	1/01/1987	31/01/1990	100	29.6
5541	Clyde, Fraser St	1/08/1896	30/09/1989	90	29.6
5216	Albert Town	1/12/1970	11/08/1972	100	29.6
41237	Wanaka Cws	29/10/2015	15/01/2024	100	29.7
5532	Lauder Pel	1/08/1981	31/05/1986	100	29.7
5531	Lauder	1/11/1947	31/03/1965	100	30
5217	Wanaka, Park Hq	5/09/1990	31/01/1994	100	30.1
39564	Clyde 2 Ews	25/05/2011	17/01/2024	100	30.8
5220	Maungawera	1/10/1915	30/04/1944	90	30.8
26567	Lauder 2	1/01/2000	31/03/2023	100	31.1

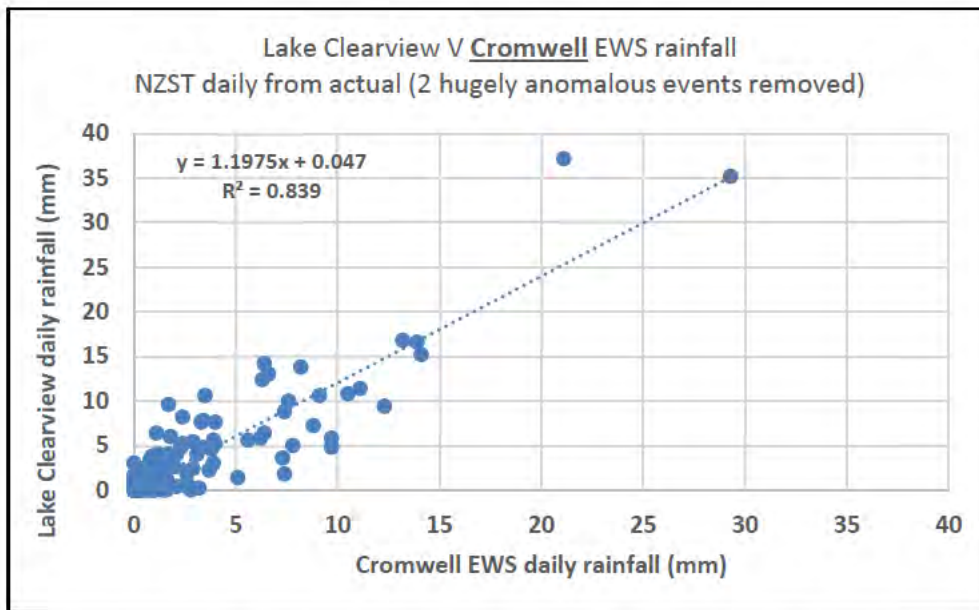


Figure 2: Regression between Lake Clearview and Cromwell EWS rainfall (All data)

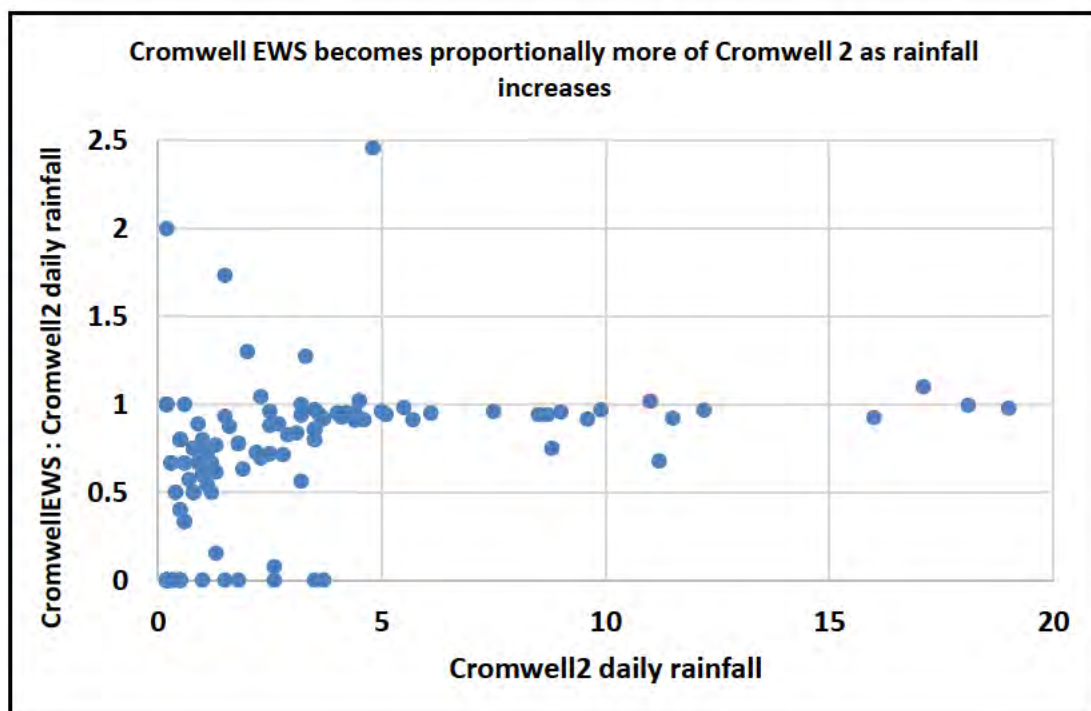


Figure 3: Cromwell EWS rainfall expressed as a proportion of Cromwell2 rainfall
(for overlapping data, April 2006 to July 2007)

2 Data Quality Assurance (QA)

A QA check on Cromwell2 and Cromwell MWD was undertaken across their length of record. Rainfall from these stations was plotted cumulatively with concurrent data from Tarras, Matakanui and Lauder Flat. The comparison showed consistent relationships (Figures 4 and 5). The comparative plots were then fine combed at a 6-month interval. Although there were inevitable discrepancies, none of them would constitute as erroneous data. A script was run to check if there was any missing record across the entire dataset (i.e time step of over one day between values). A few missing days were found at Cromwell 2 - but by which time the gauge was running concurrently with Cromwell EWS.

The QA check incidentally highlighted quite a lot of missed daily readings at the other comparative sites (Lauder Flat and Tarras). This further validates the continued use of Cromwell data - being from a gauge that appears to have been read very consistent by staff at Ministry of Works and Development, and its' successors.

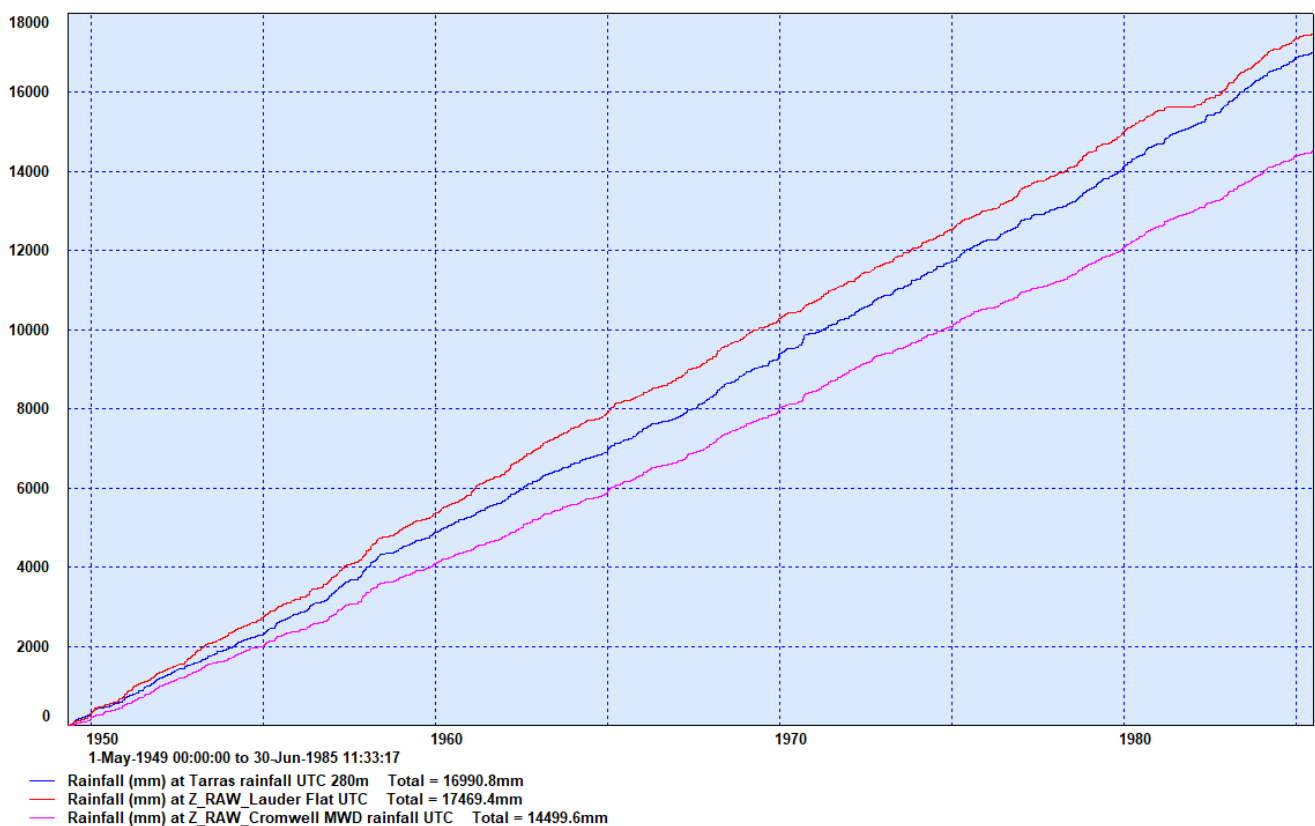


Figure 4: Cromwell MWD rainfall plotted cumulatively with Tarras and Lauder Flat (a period of missing record at Lauder Flat in 1981 presents as a flat line)

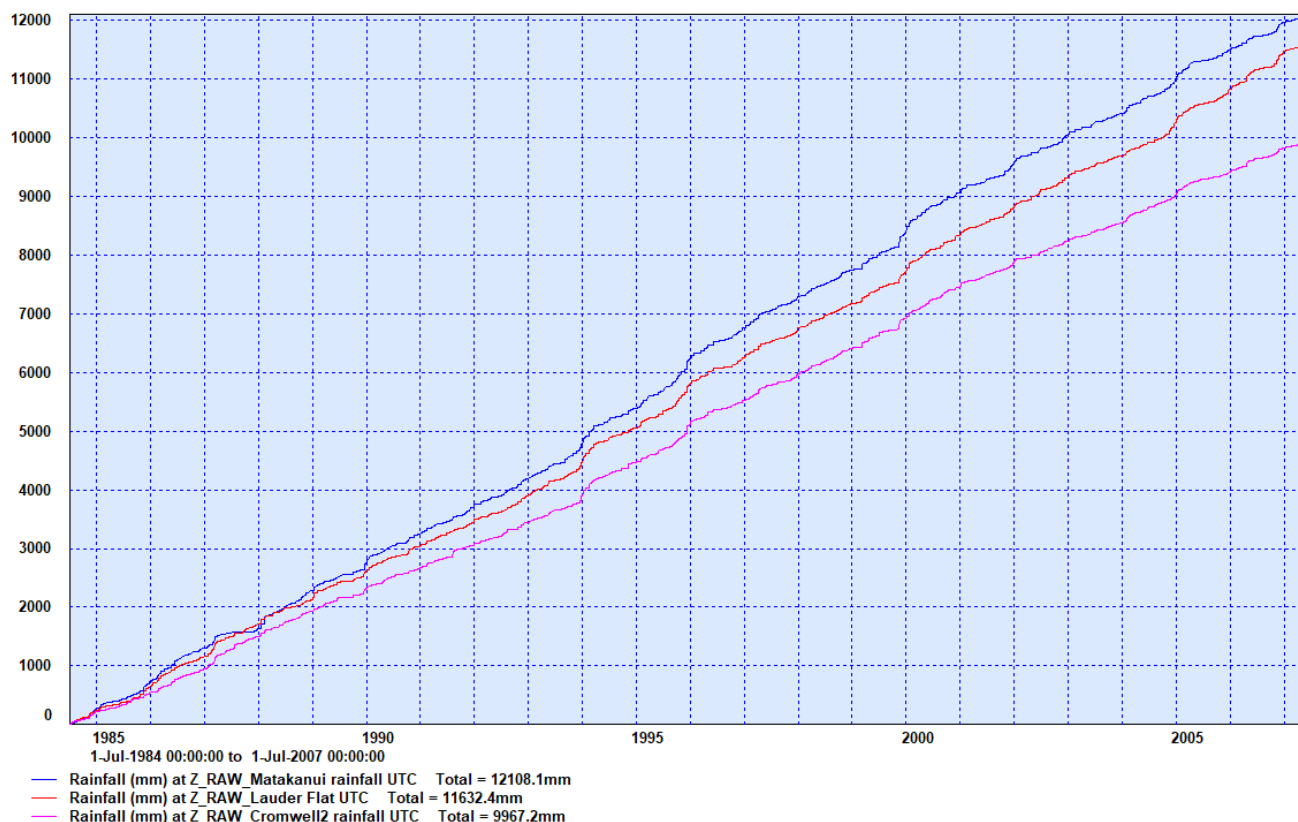


Figure 5: Cromwell2 rainfall plotted cumulatively with Matakanui and Lauder Flat

3 Generation of synthetic rainfall record

With the QA checks proving Cromwell data back to 1949 to be complete record, the regression slope of 1.1975 was applied to the “Cromwell MWD x 0.9” and “Cromwell 2 x 0.9” data - to generate estimated daily record for Lake Clearview. The predicted records for Lake Clearview were then amalgamated into one continuous data record. Record generated from Cromwell EWS was used as a priority over that generated from Cromwell 2 (for the period that both gauges were running); and the record derived from Cromwell EWS was that using the 2 different regressions dependent on wind direction (April 2006 to 2023)

Figure 6 shows the entire synthetic rainfall record for Lake Clearview, plotted cumulatively. This synthetic rainfall record can be readily exported to excel at a daily timestep, or greater.

Table 3 shows there has been little change in the mean annual rainfall of the predicted data whether the initial 2006 to 2023, or the extended 1950 to 2023 record is used. Lauder Flat, like “Clearview predicted”, also produces a lower mean annual rainfall value using the 1950 to 2023 record. (That trend at Matakanui is the opposite, but being windward to southeast storms Matakanui may not be representative of trends at Lake Clearview).

Ten-year return period estimates of annual rainfall minima, calculated from the two respective lengths of record, were found to be similar. However annual rainfall maxima results did show a bit of difference (specifics beyond the scope of this memo). What is noticeable is the larger variability in annual rainfall, at Cromwell, and so in the Lake Clearview predicted record, since about the mid 1990s. See Figure 7.

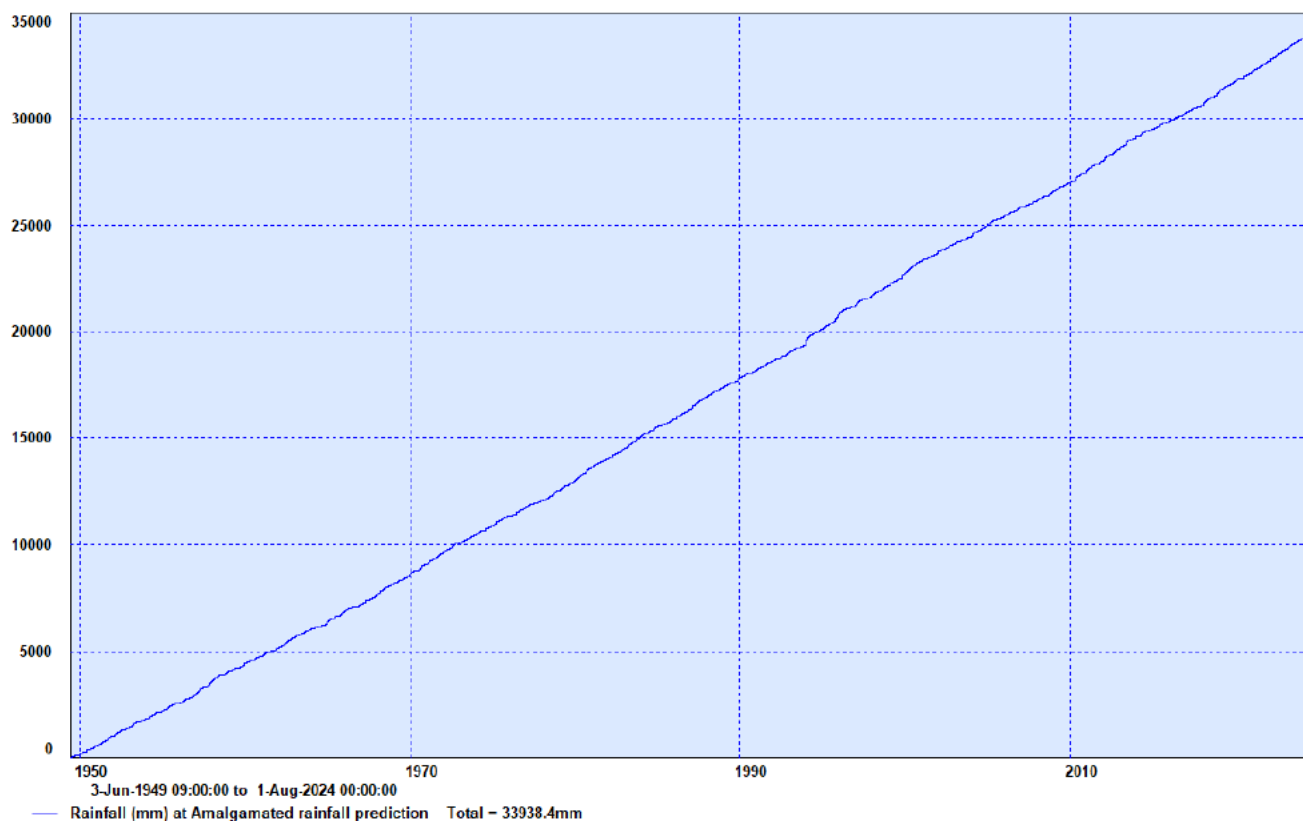


Figure 6: Modelled rainfall data for Lake Clearview 1949 to 2023

Table 3: Mean annual rainfall for gauges within vicinity of Lake Clearview.

<u>Mean annual rainfall for gauges within vicinity of Lake Clearview:</u>		
	Rainfall (mm)	Altitude:
Cromwell EWS	394	213m
Bendigo2	418	210m
Bendigo1	445	213m
Lauder EWS	452	375m
<u>Predicted</u> Lake Clearview (2006 to 2023)	463	340m
<u>Predicted</u> Lake Clearview (1950 to 2023)	450	340m
Matakanui (windward)	516	338m

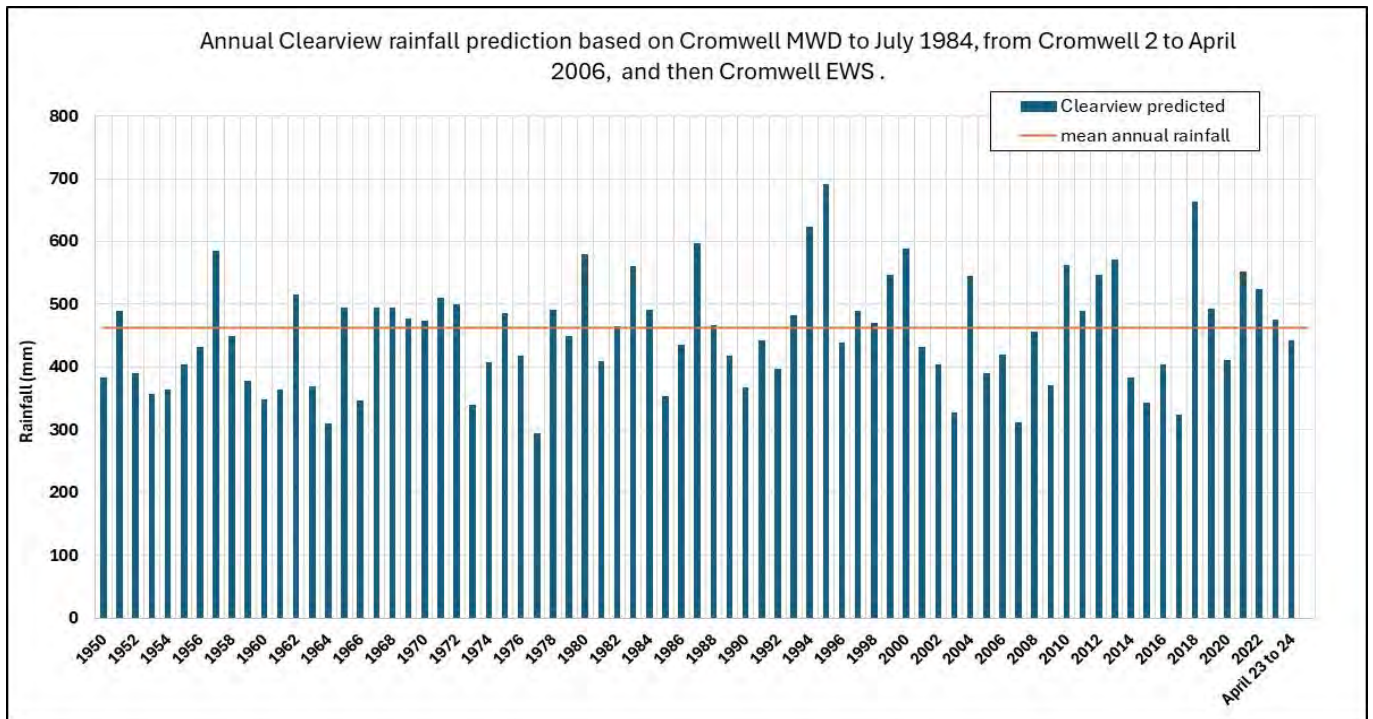


Figure 7: Annual Lake Clearview rainfall estimates from successive Cromwell gauge sites.

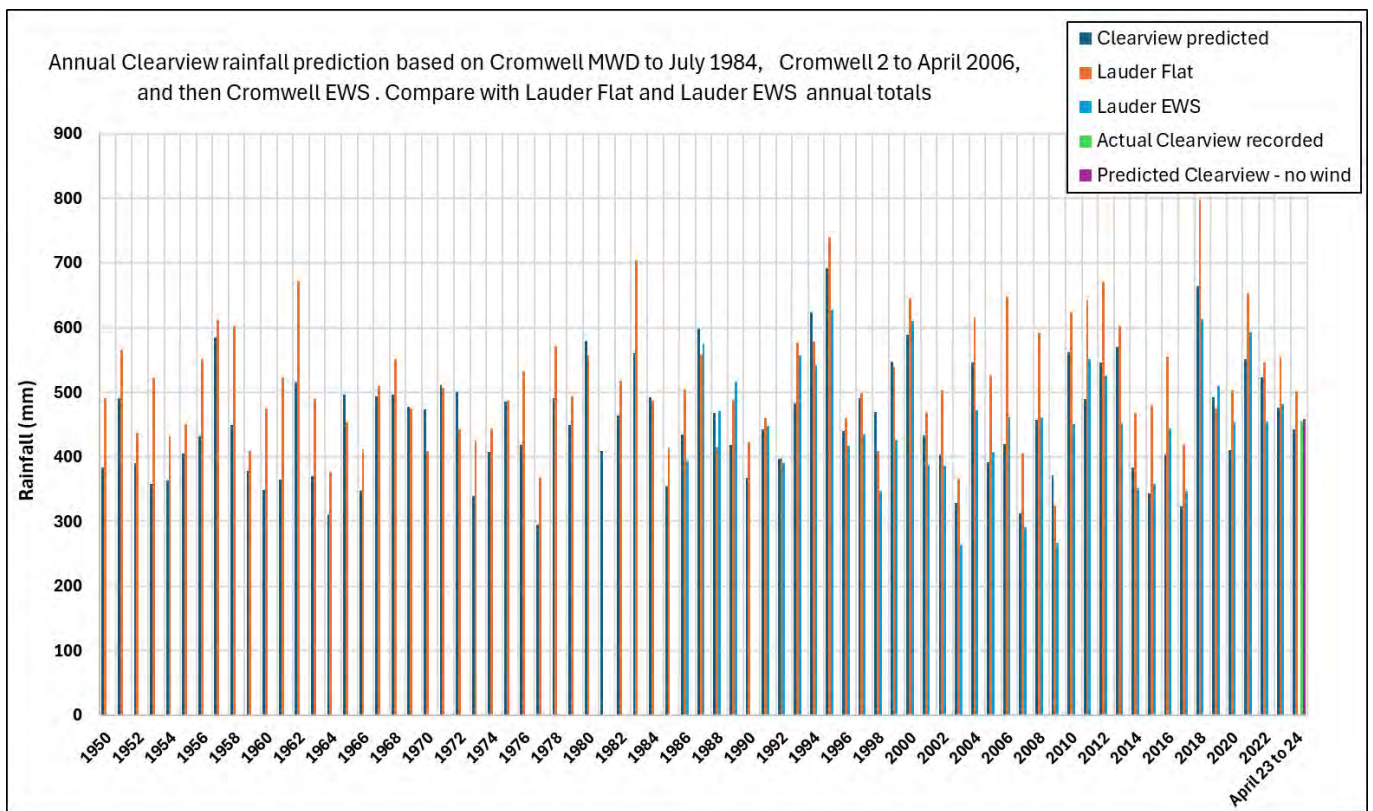


Figure 8: Annual Lake Clearview rainfall estimates from successive Cromwell gauge sites, with adjacent gauges at Lauder

APPENDIX C SURFICIAL MIW WATER QUALITY MODEL RESULTS

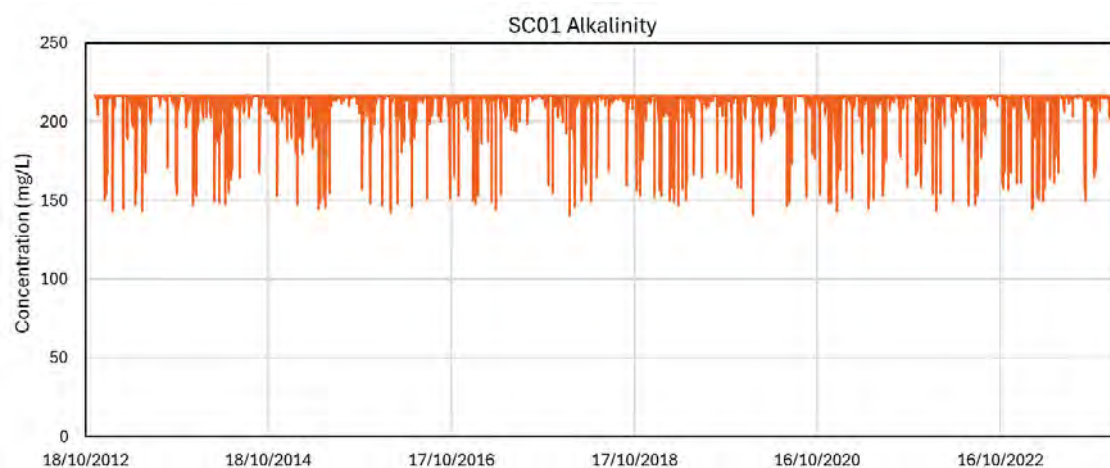


Figure 1: Calculated alkalinity concentrations for SC01. Note Bore water and pit sump water dust suppression have the same source term.

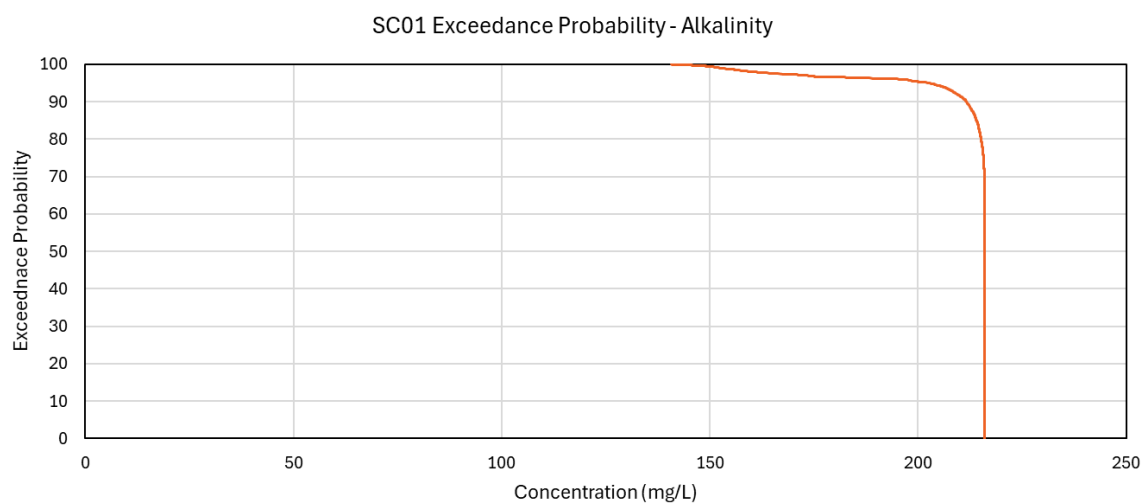


Figure 2: Exceedance probability – alkalinity in SC01.

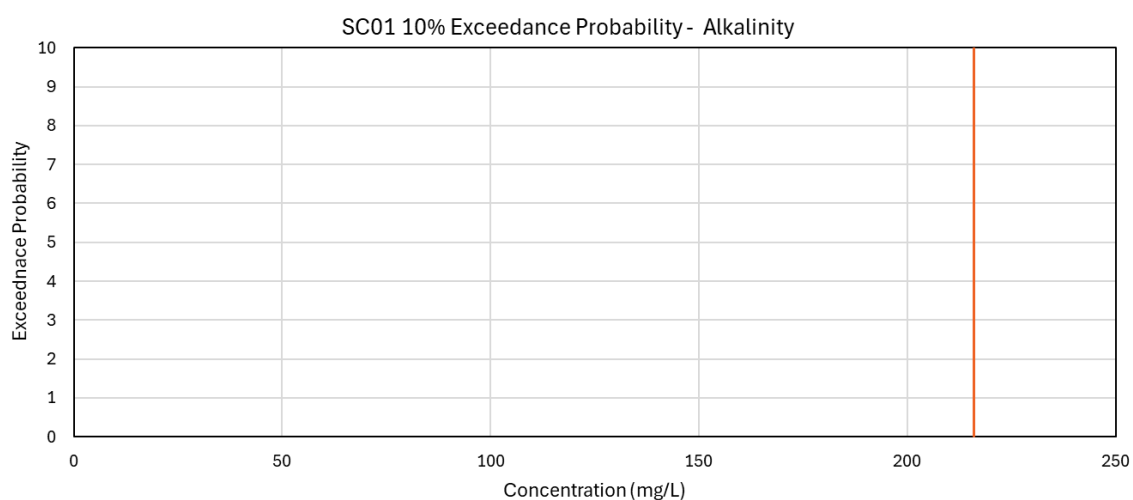


Figure 3: Top 10% exceedance probability for alkalinity in SC01.

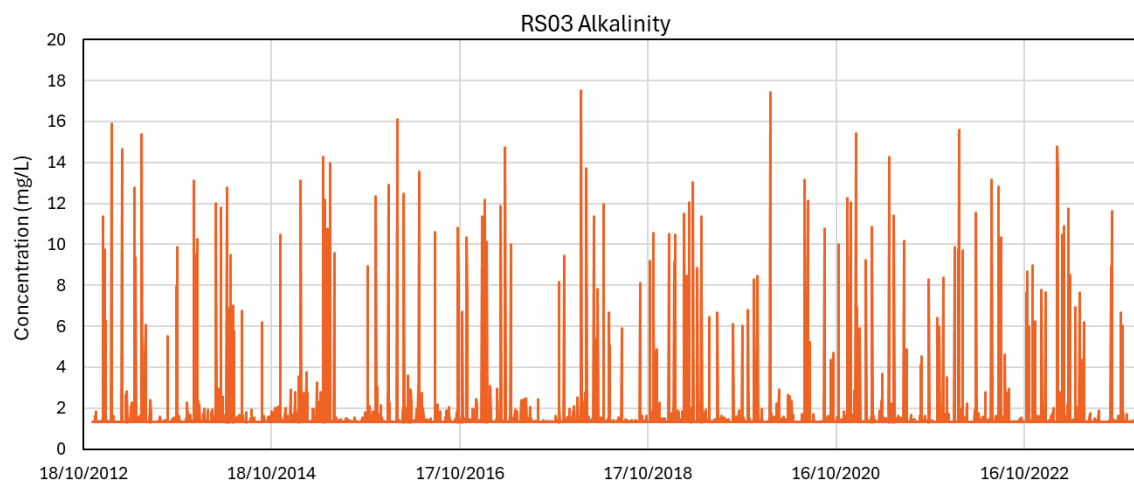


Figure 4: Calculated alkalinity concentrations for RS03. Note Bore water and pit sump water dust suppression have the same source term.

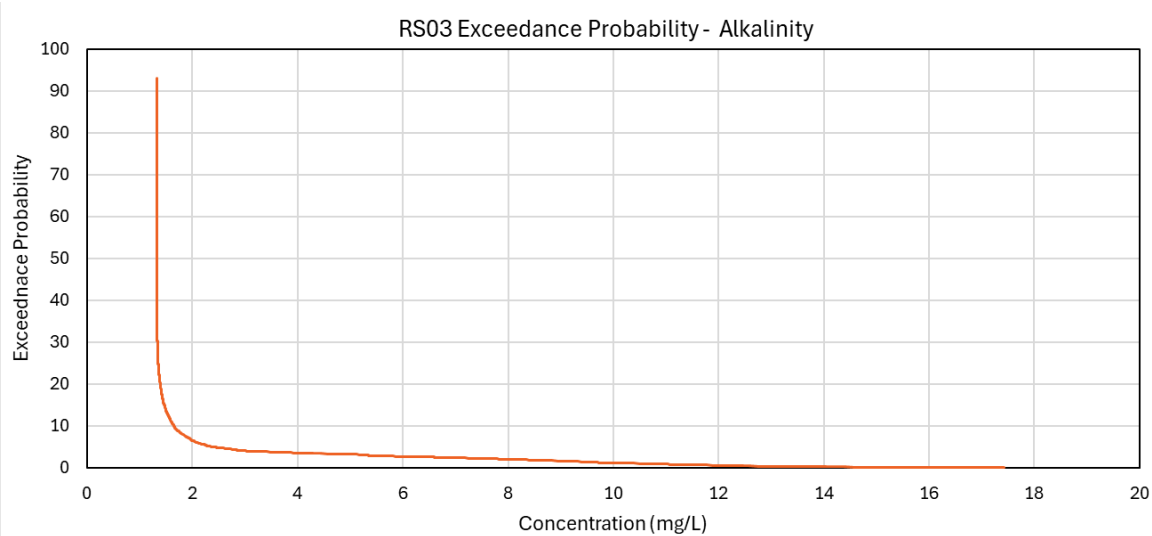


Figure 5: Exceedance probability – alkalinity in RS03.

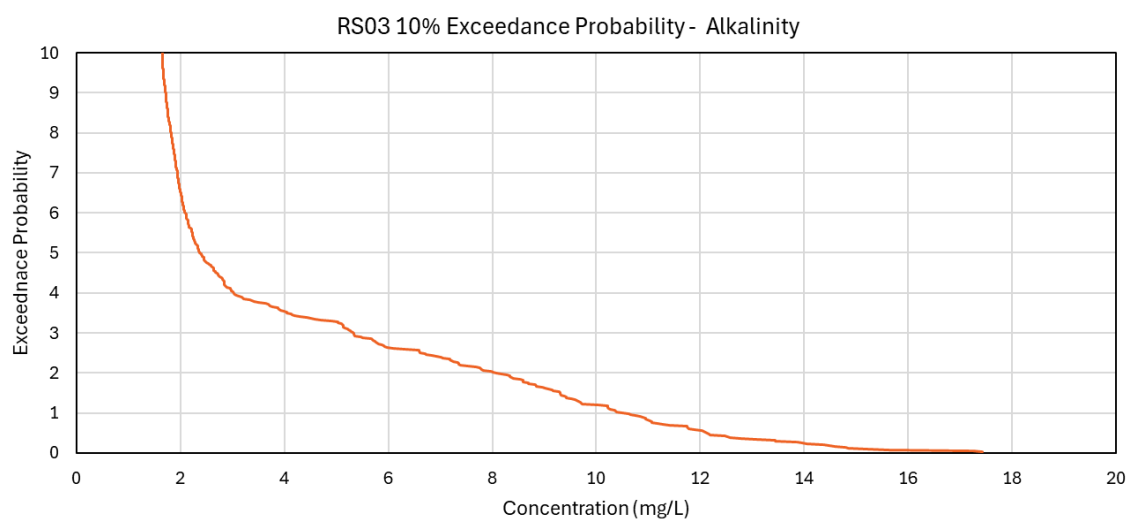


Figure 6: Top 10% exceedance probability for alkalinity in RS03.

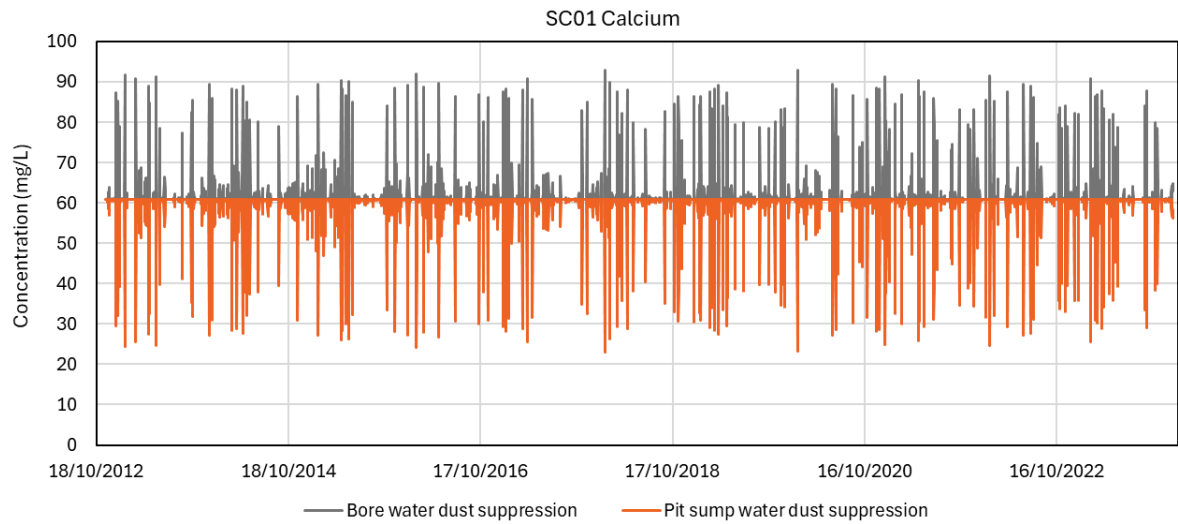


Figure 7: Simulated calcium concentrations in SC01 for bore water and pit water dust suppression scenarios.

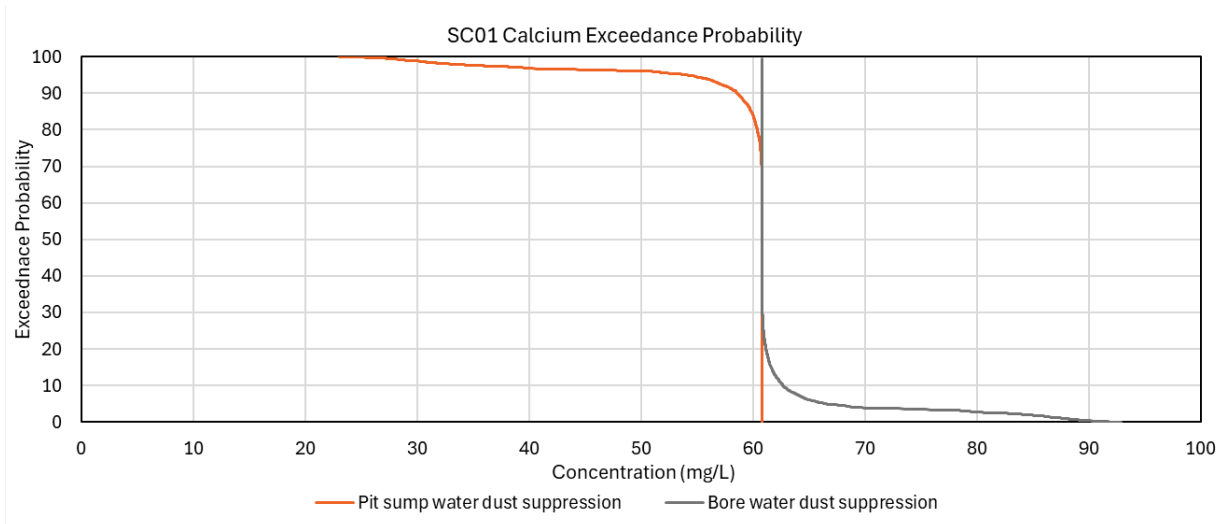


Figure 8: Exceedance probability – calcium in SC01.

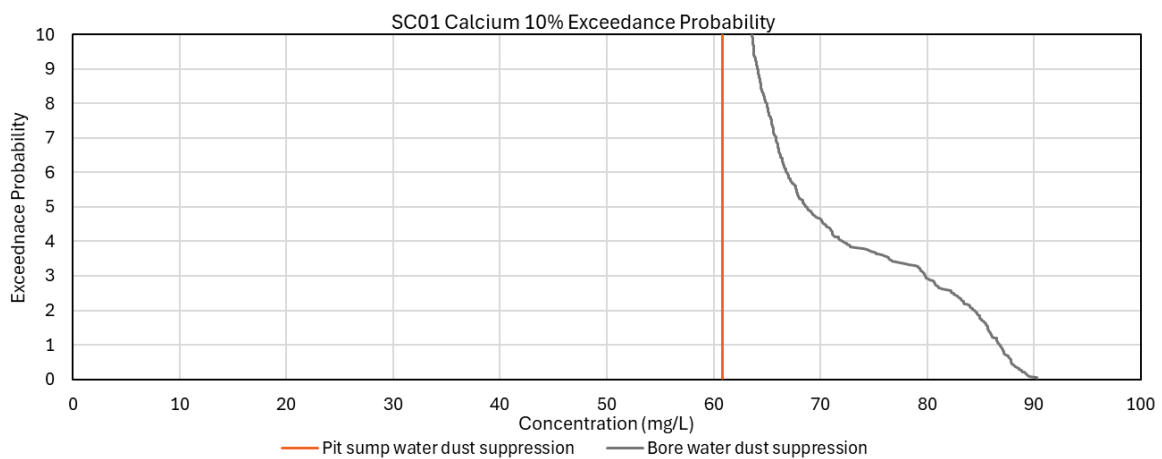


Figure 9: Top 10% exceedance probability for calcium in SC01.

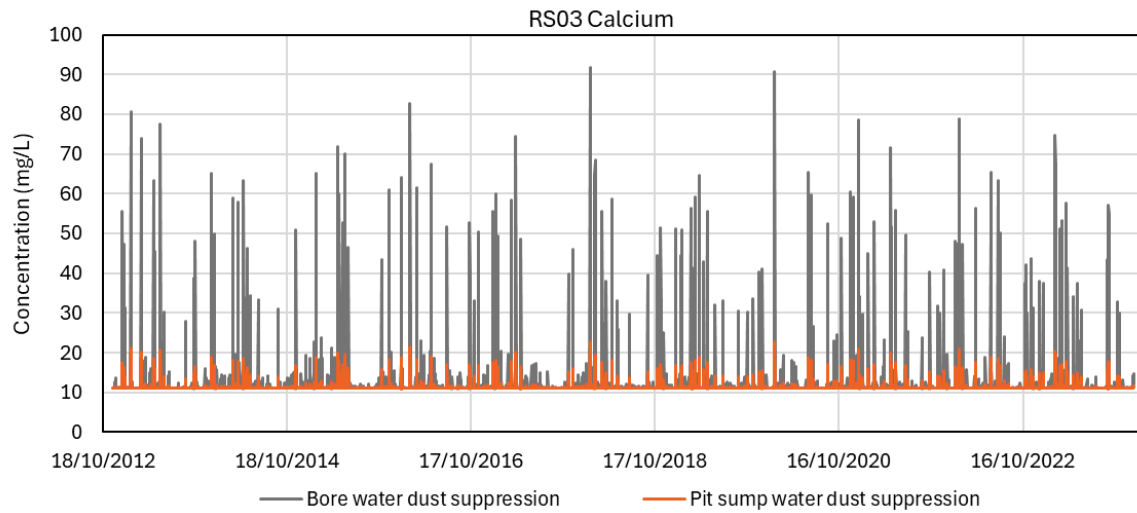


Figure 10: Simulated calcium concentrations in RS03 for bore water and pit water dust suppression scenarios.

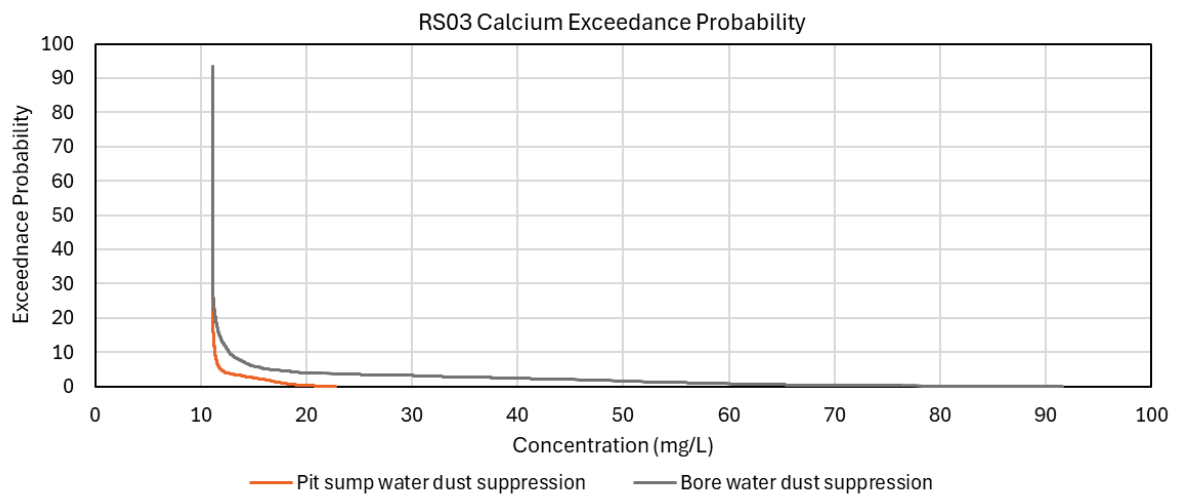


Figure 11: Exceedance probability – calcium in RS03.

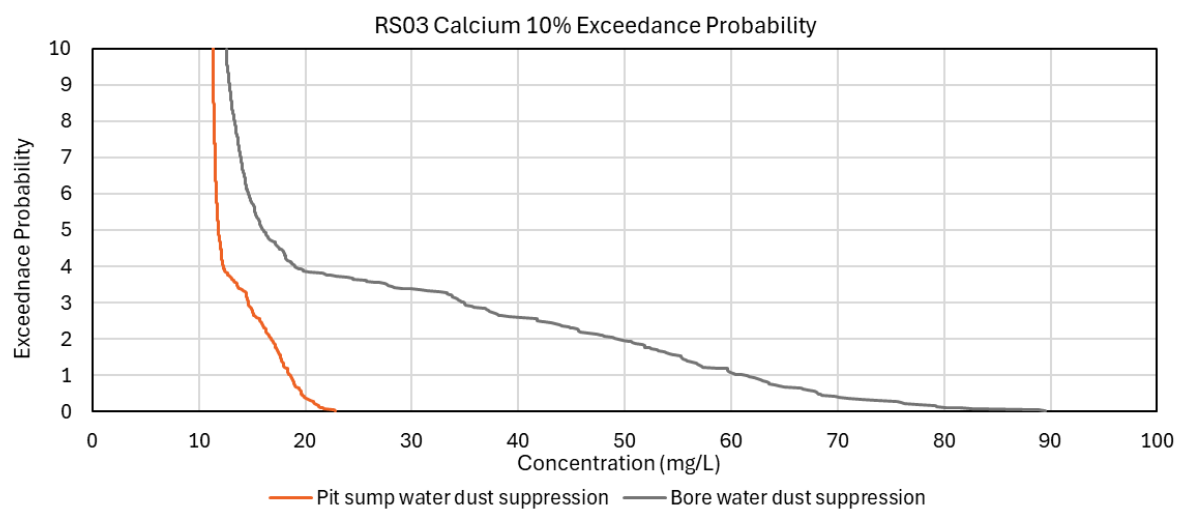


Figure 12: Top 10% exceedance probability for calcium in RS03.

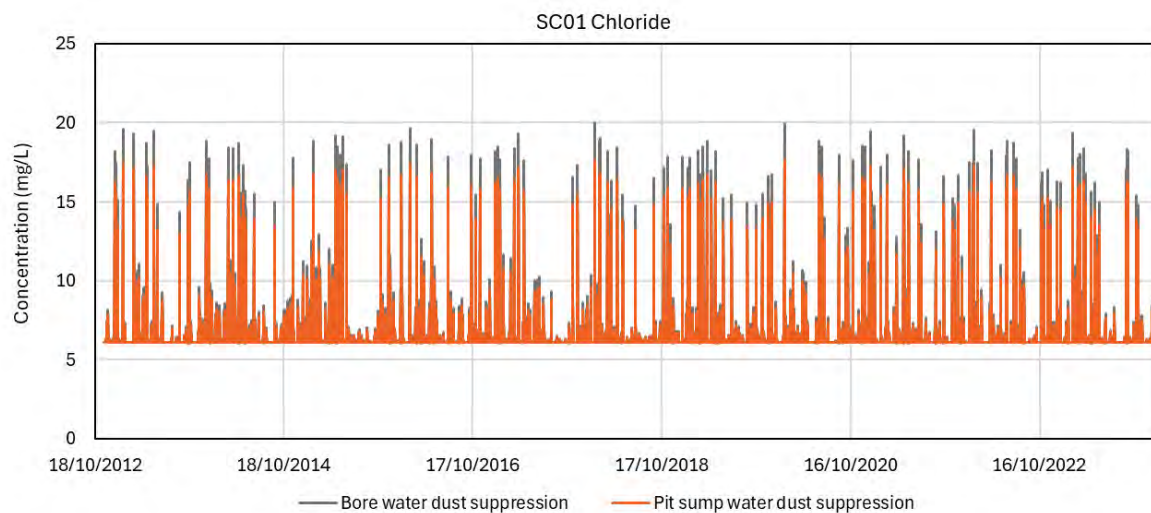


Figure 13: Simulated chloride concentrations in SC01 for bore water and pit water dust suppression scenarios.

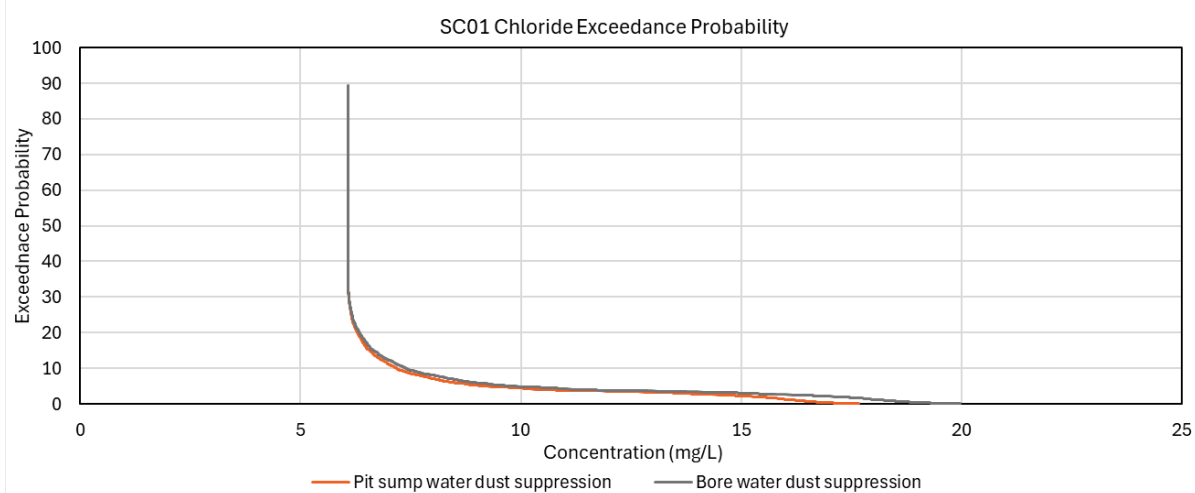


Figure 14: Exceedance probability – chloride in SC01.

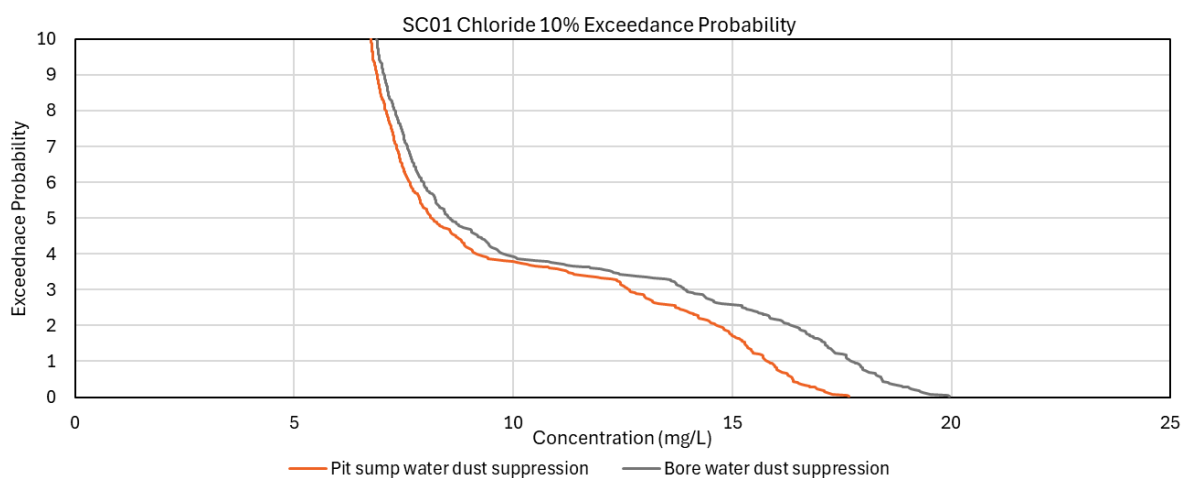


Figure 15: Top 10% exceedance probability for chloride in SC01.

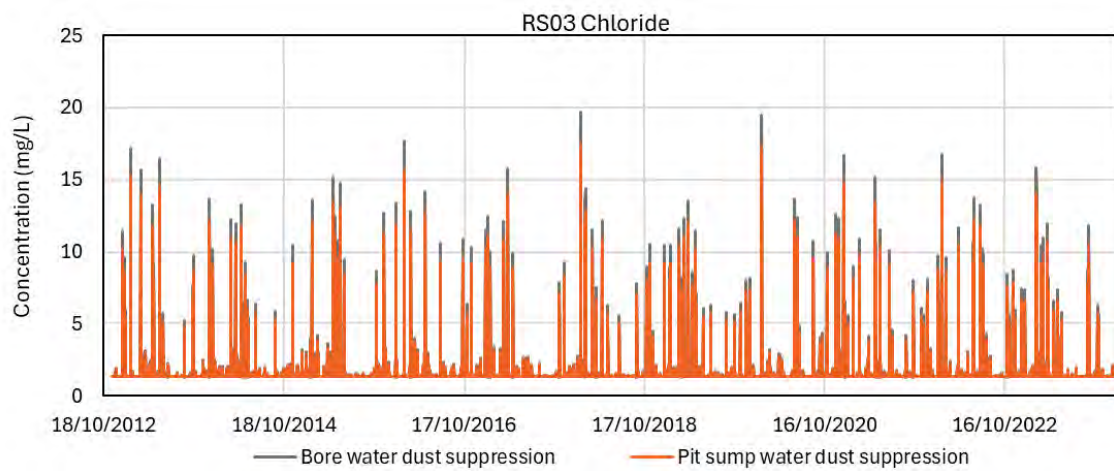


Figure 16: Simulated chloride concentrations in RS03 for bore water and pit water dust suppression scenarios.

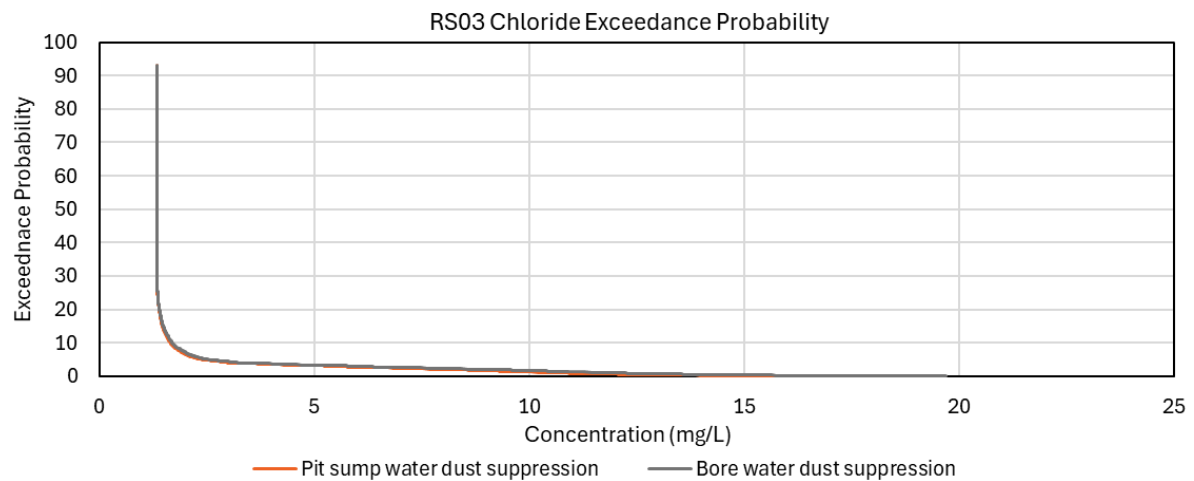


Figure 17: Exceedance probability – chloride in RS03.

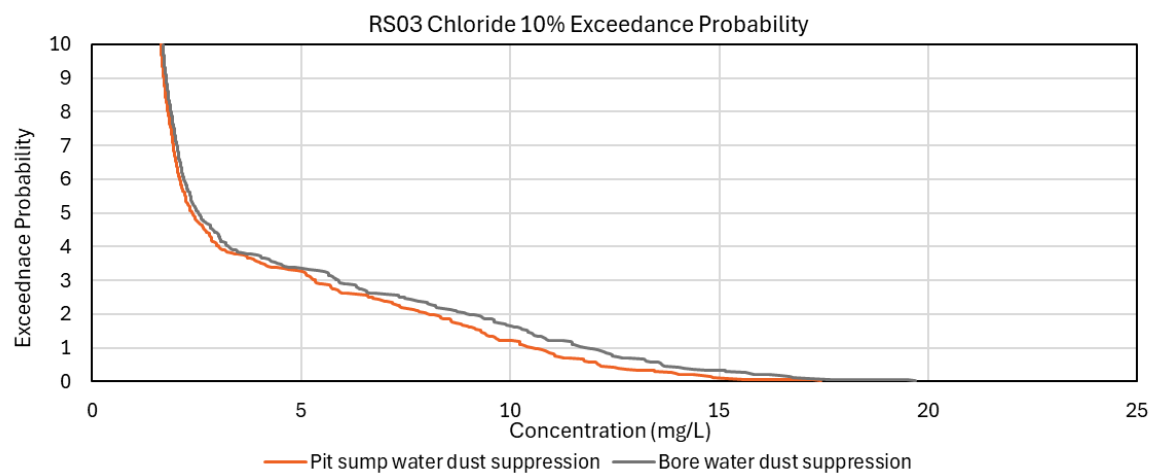


Figure 18: Top 10% exceedance probability for chloride in RS03.

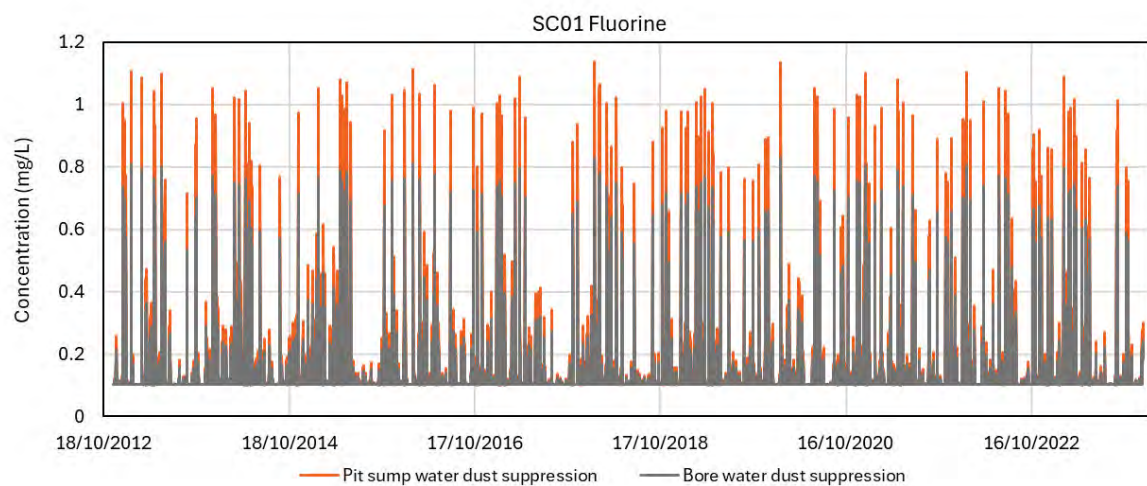


Figure 19: Simulated fluorine concentrations in SC01 for bore water and pit water dust suppression scenarios.

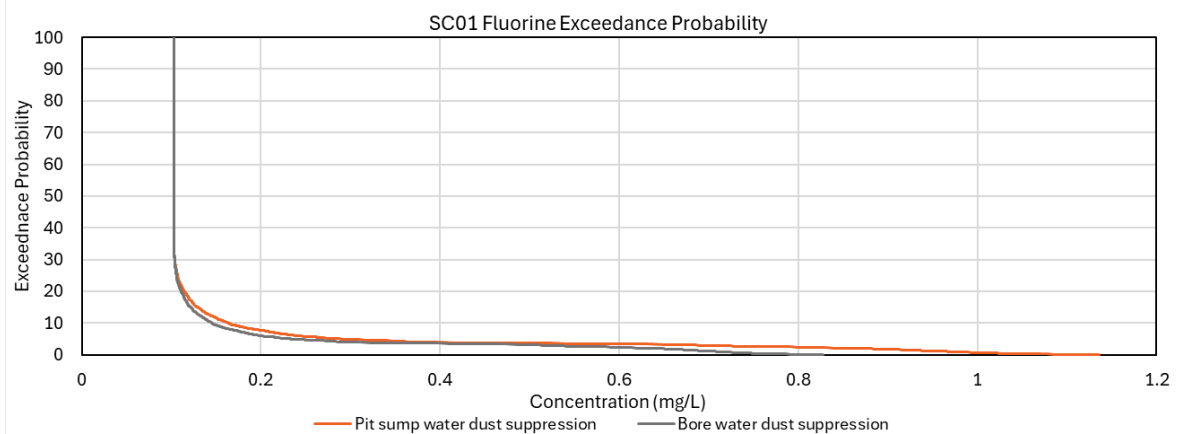


Figure 20: Exceedance probability – fluorine in SC01.

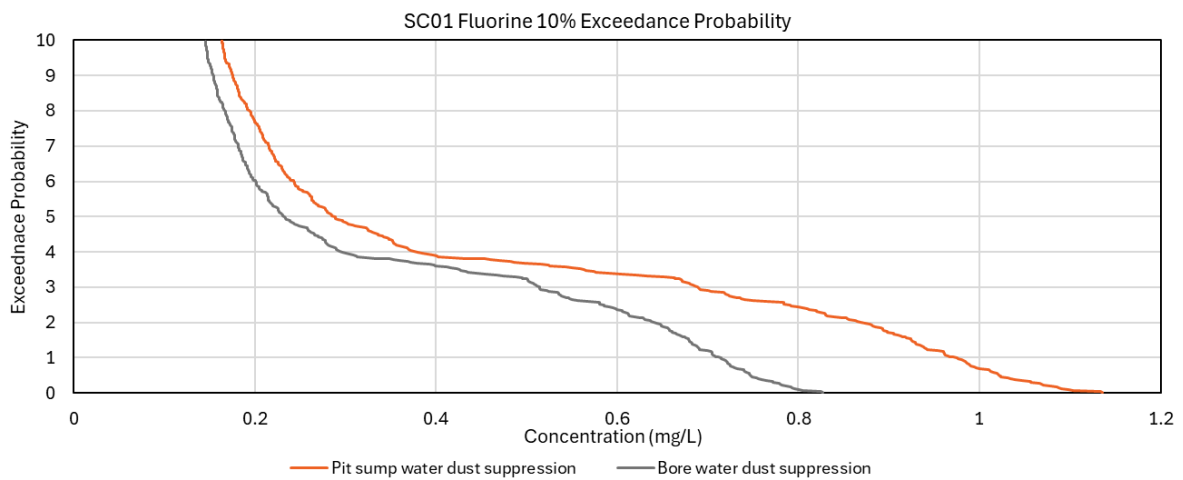


Figure 21: Top 10% exceedance probability for fluorine in SC01.

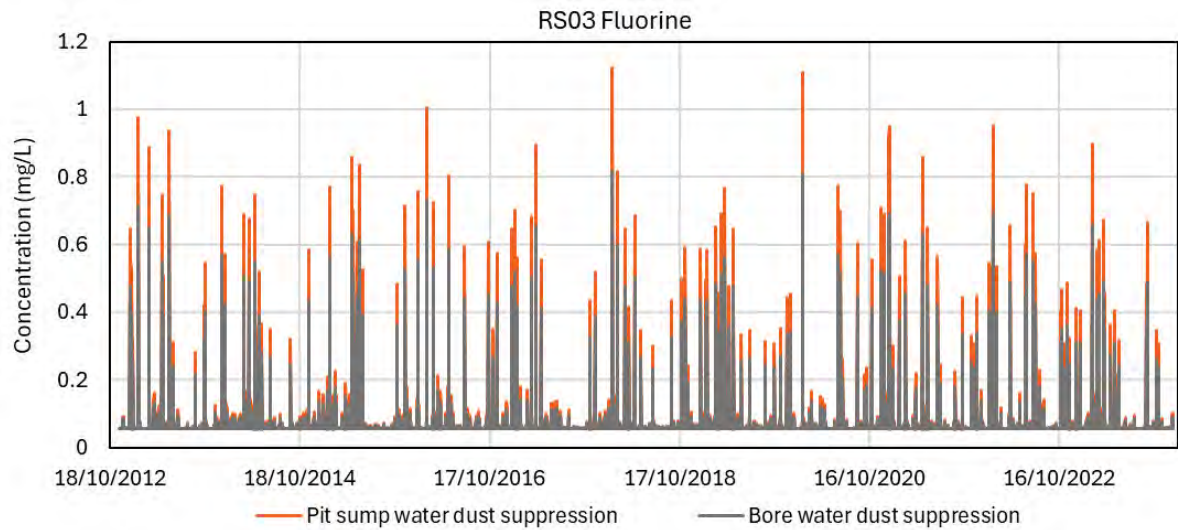


Figure 22: Simulated fluorine concentrations in RS03 for bore water and pit water dust suppression scenarios.

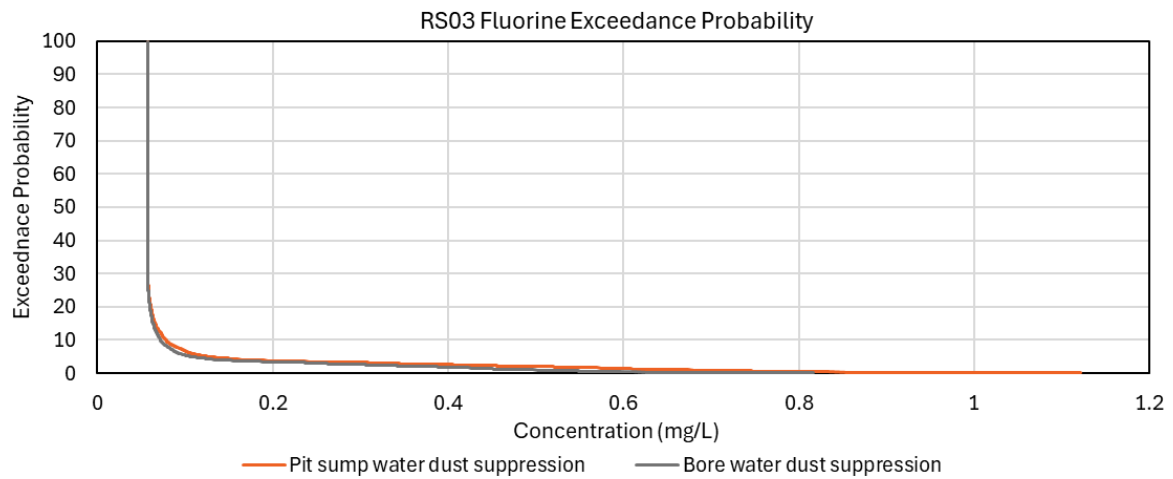


Figure 23: Exceedance probability – fluorine in RS03.

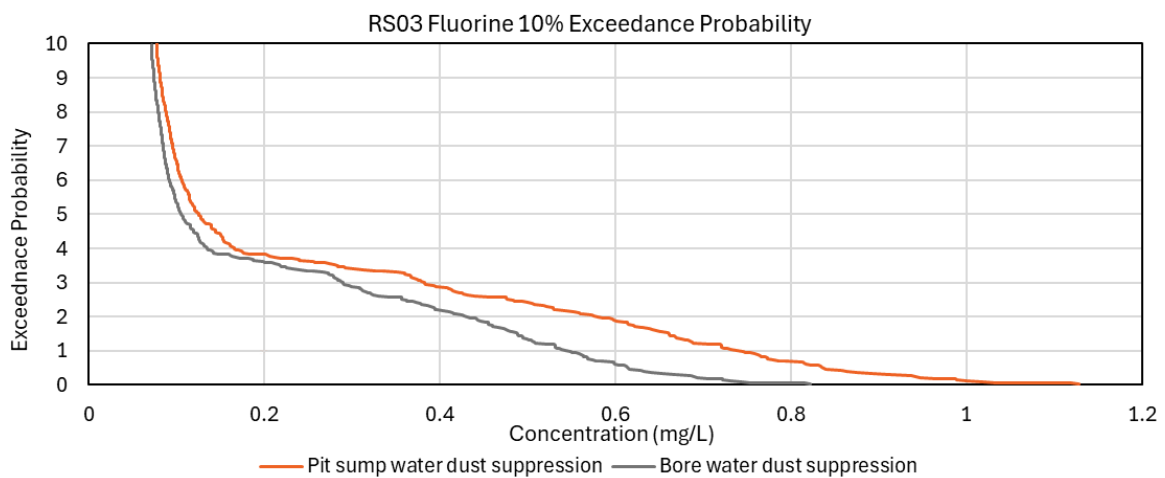


Figure 24: Top 10% exceedance probability for fluorine in RS03.

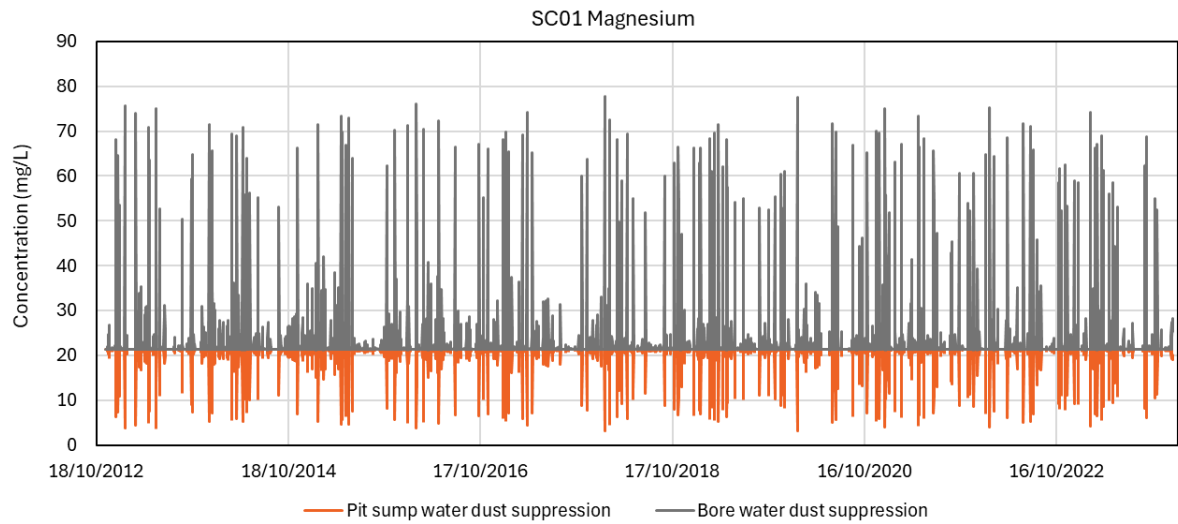


Figure 25: Simulated magnesium concentrations in SC01 for bore water and pit water dust suppression scenarios.

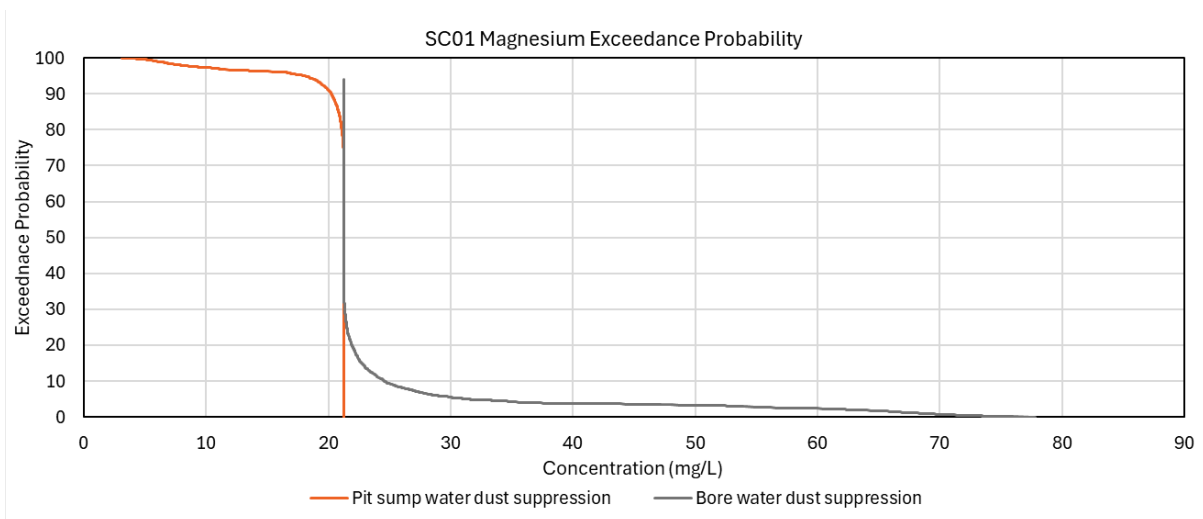


Figure 26: Exceedance probability – magnesium in SC01.

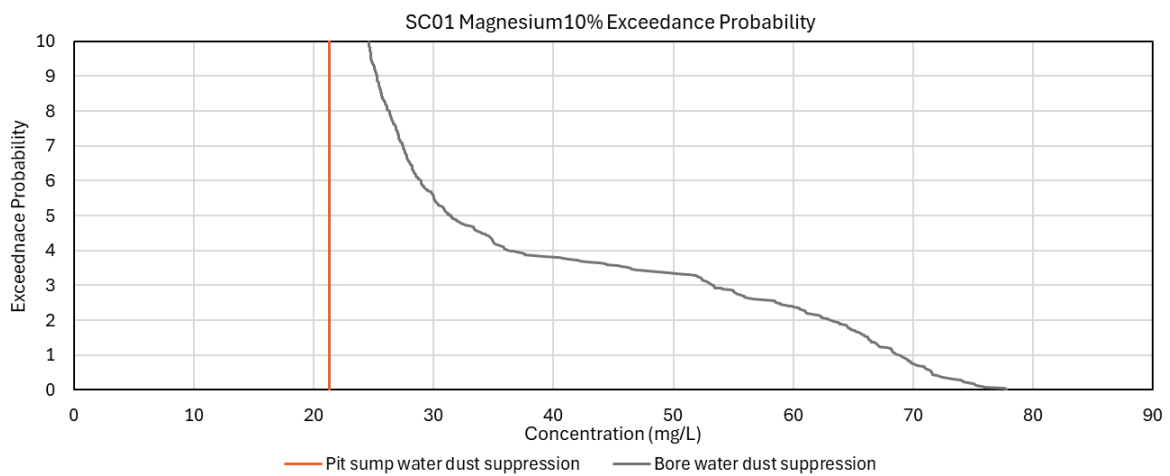


Figure 27: Top 10% exceedance probability for magnesium in SC01.

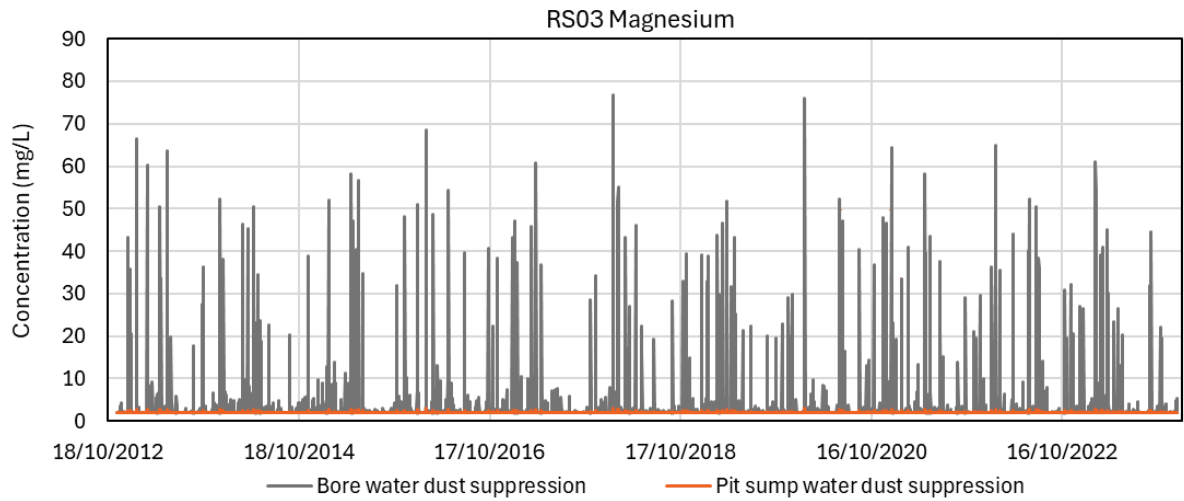


Figure 28: Simulated magnesium concentrations in RS03 for bore water and pit water dust suppression scenarios.

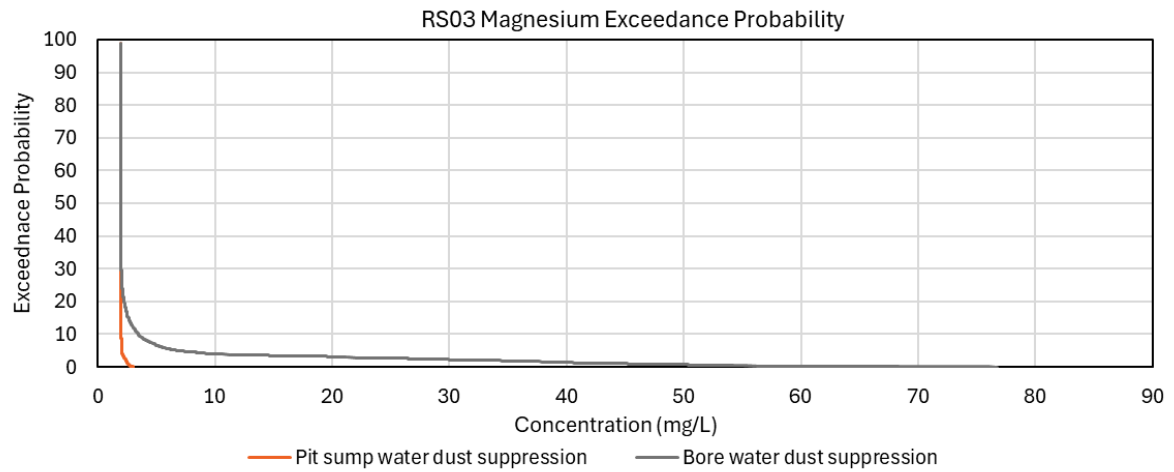


Figure 29 Exceedance probability – magnesium in RS03.

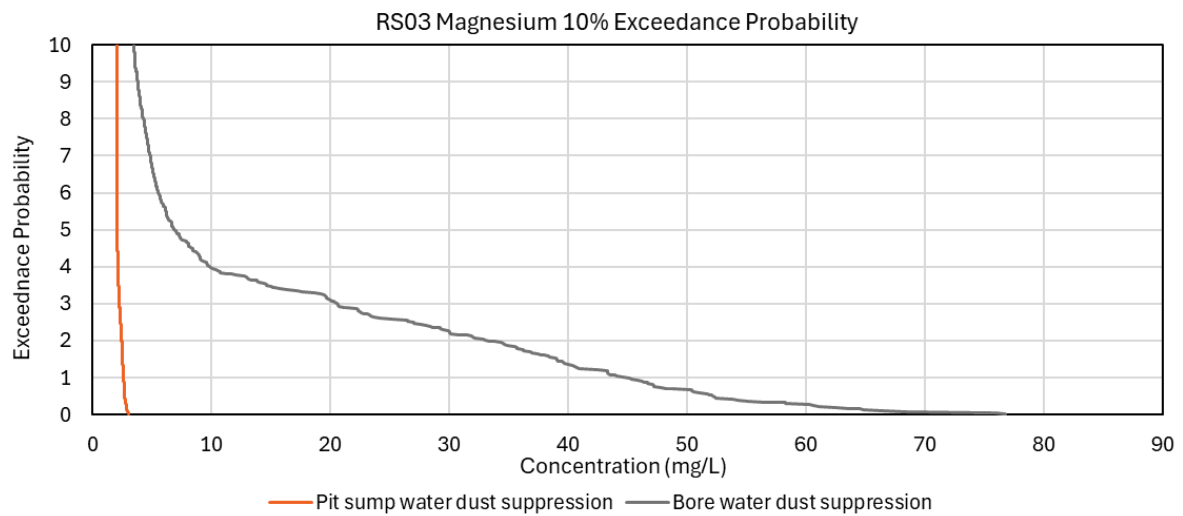


Figure 30: Top 10% exceedance probability for magnesium in RS03.

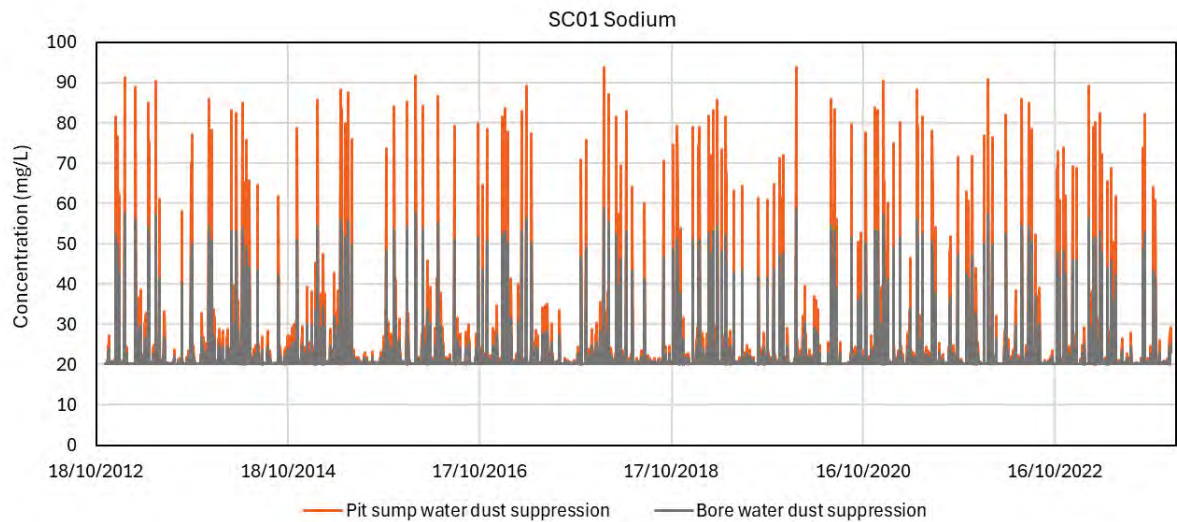


Figure 31: Simulated sodium concentrations in SC01 for bore water and pit water dust suppression scenarios.

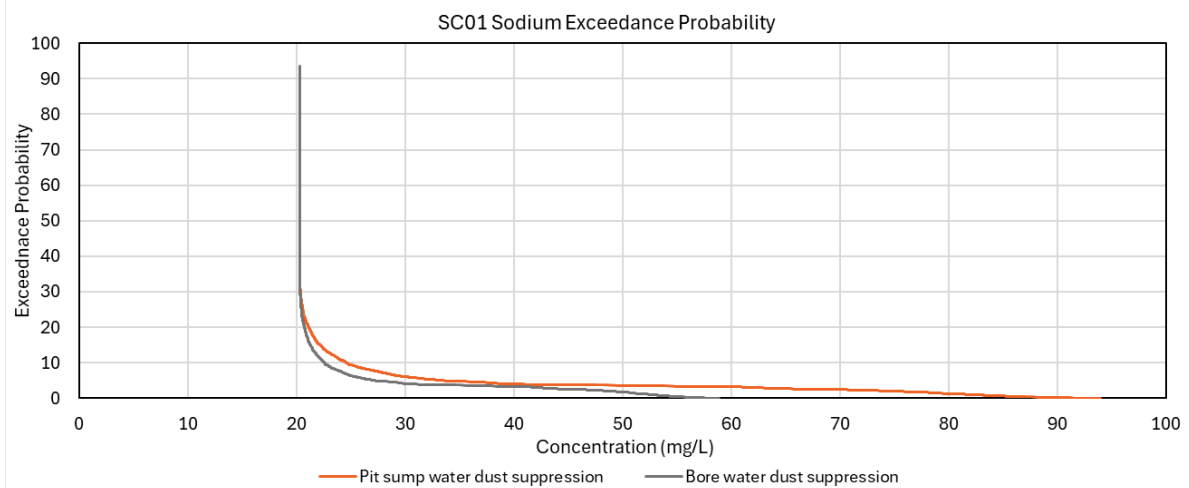


Figure 32: Exceedance probability – sodium in SC01.

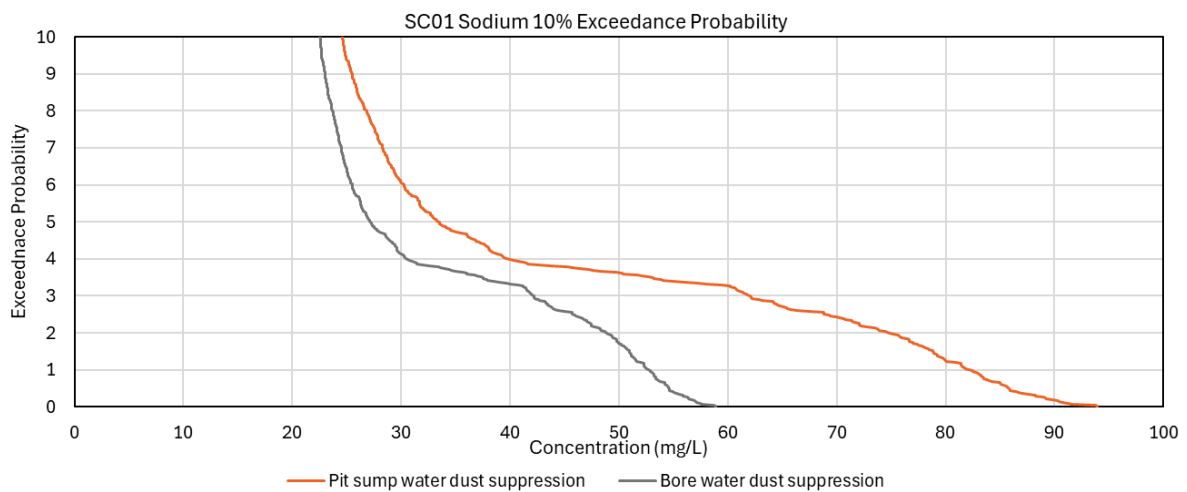


Figure 33: Top 10% exceedance probability for sodium in SC01.

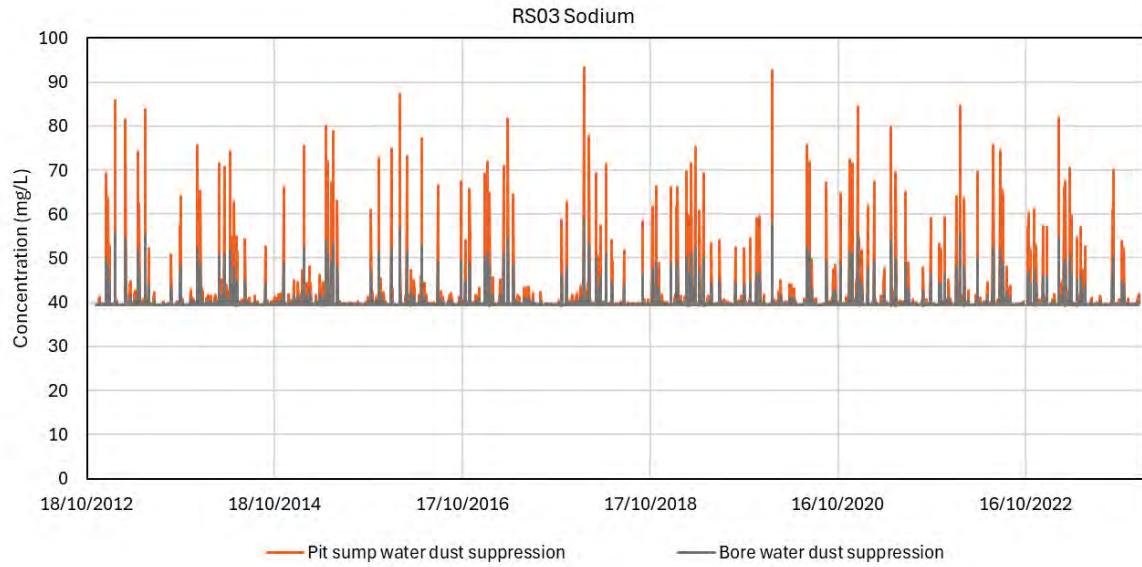


Figure 34: Simulated sodium concentrations in RS03 for bore water and pit water dust suppression scenarios.

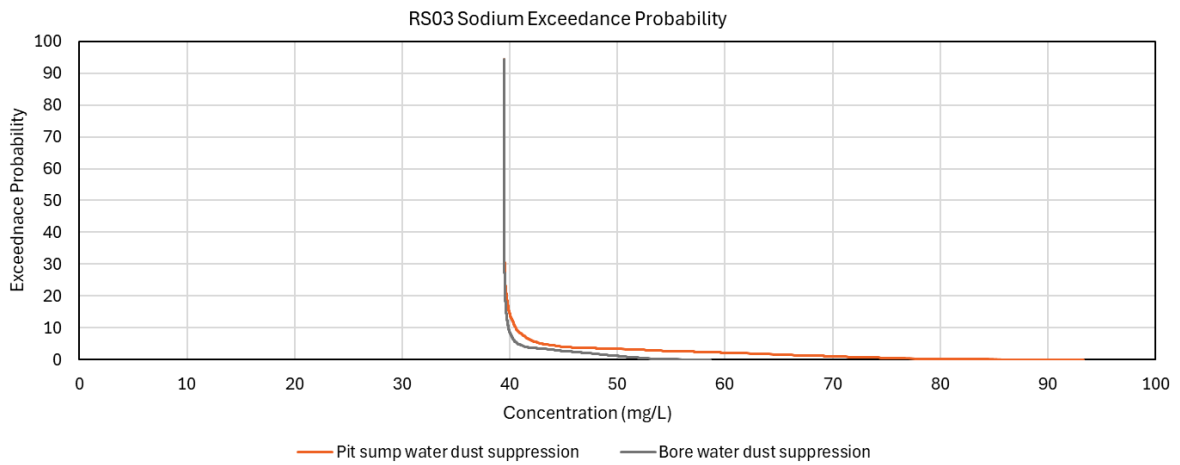


Figure 35: Exceedance probability – sodium in RS03.

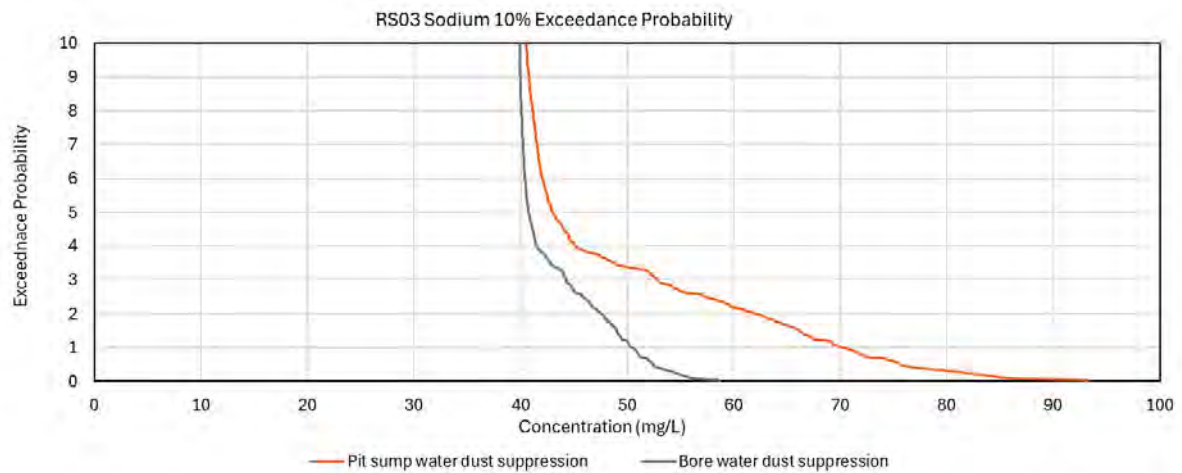


Figure 36: Top 10% exceedance probability for sodium in RS03.

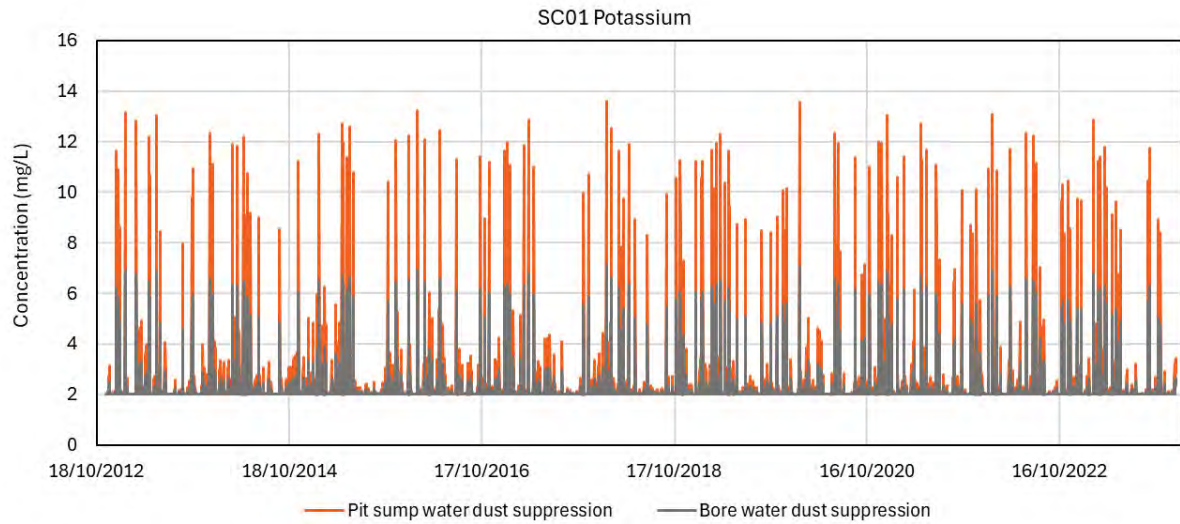


Figure 37: Simulated potassium concentrations in SC01 for bore water and pit water dust suppression scenarios.

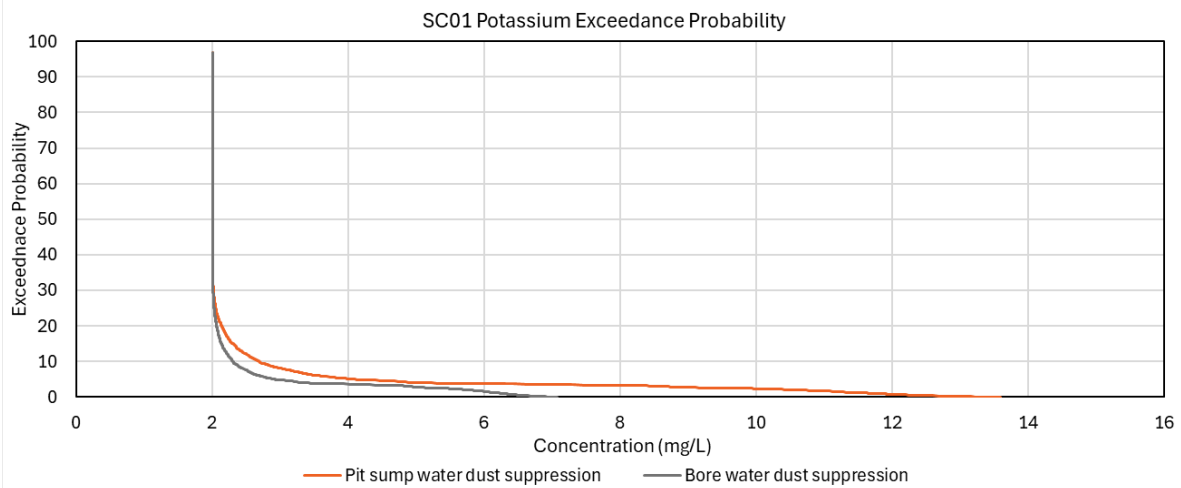


Figure 38: Exceedance probability – potassium in SC01.

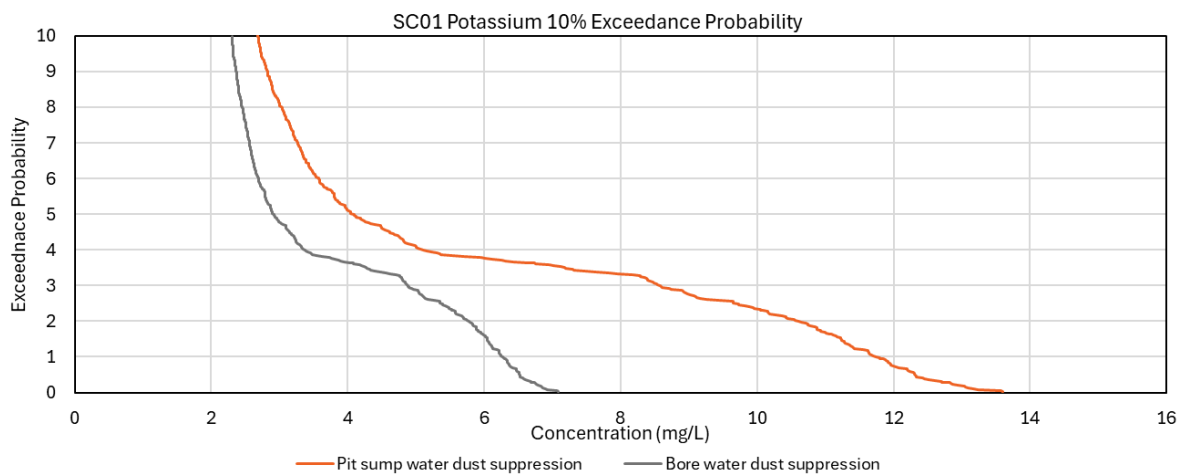


Figure 39: Top 10% exceedance probability for potassium in SC01.

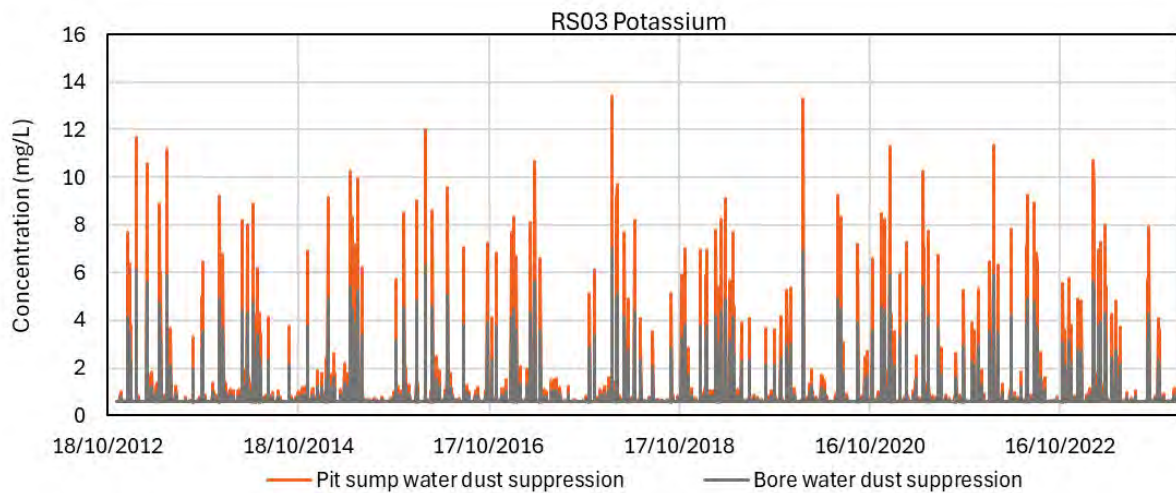


Figure 40: Simulated potassium concentrations in RS03 for bore water and pit water dust suppression scenarios.

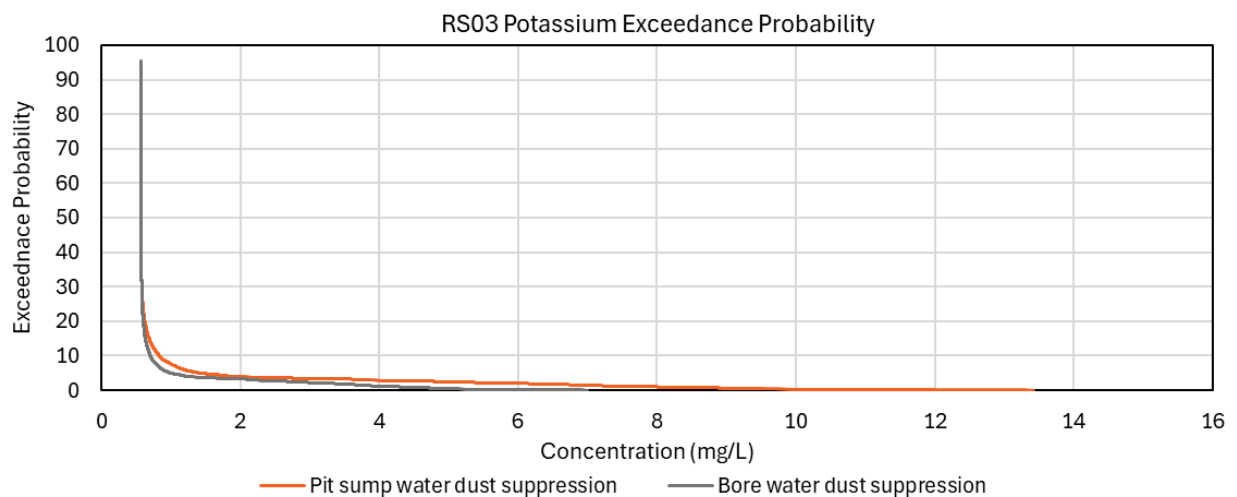


Figure 41: Exceedance probability – potassium in RS03.

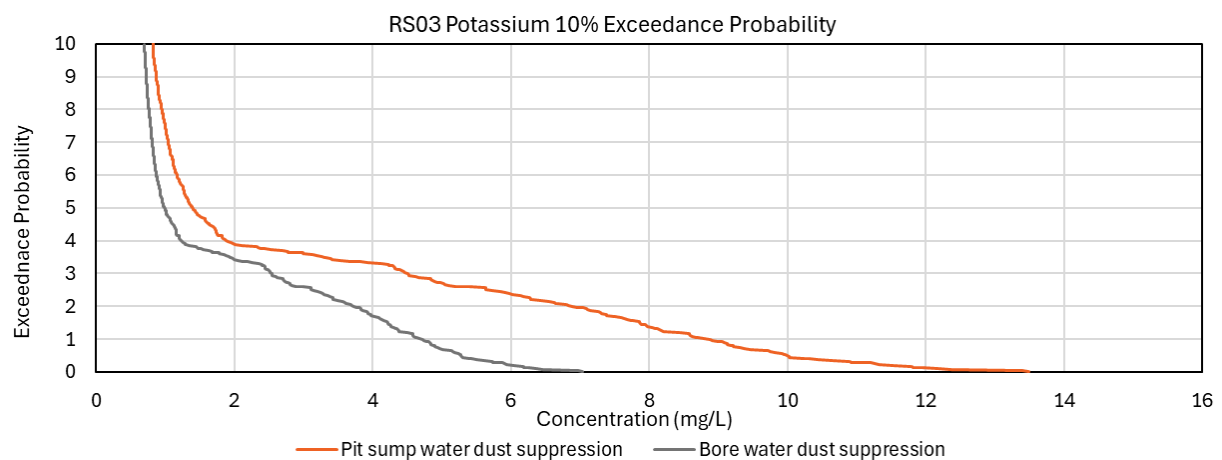


Figure 42: Top 10% exceedance probability for potassium in RS03.

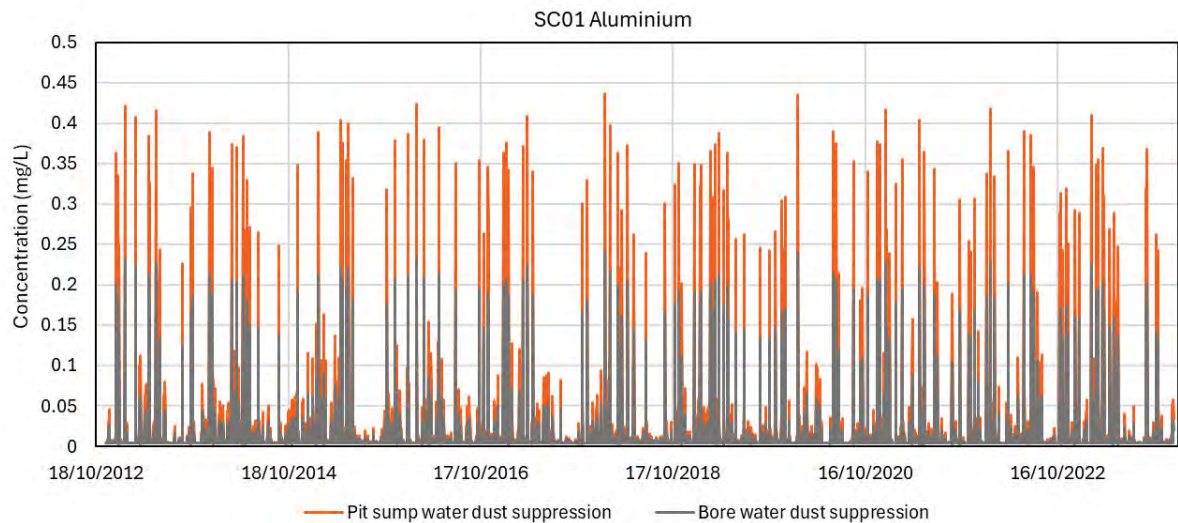


Figure 43: Modelled aluminium concentrations in SC01 over time.

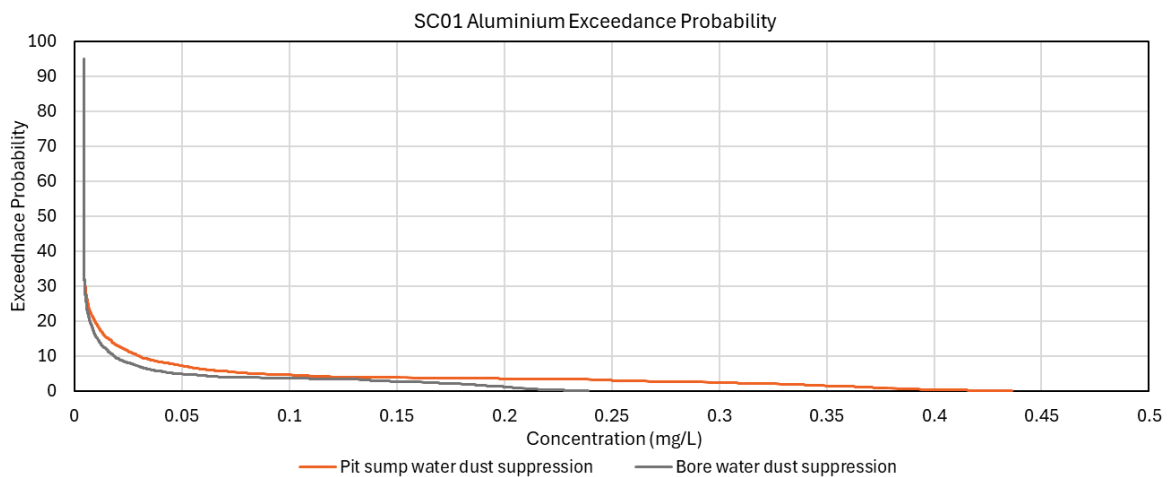


Figure 44: SC01 exceedance probability - aluminium.

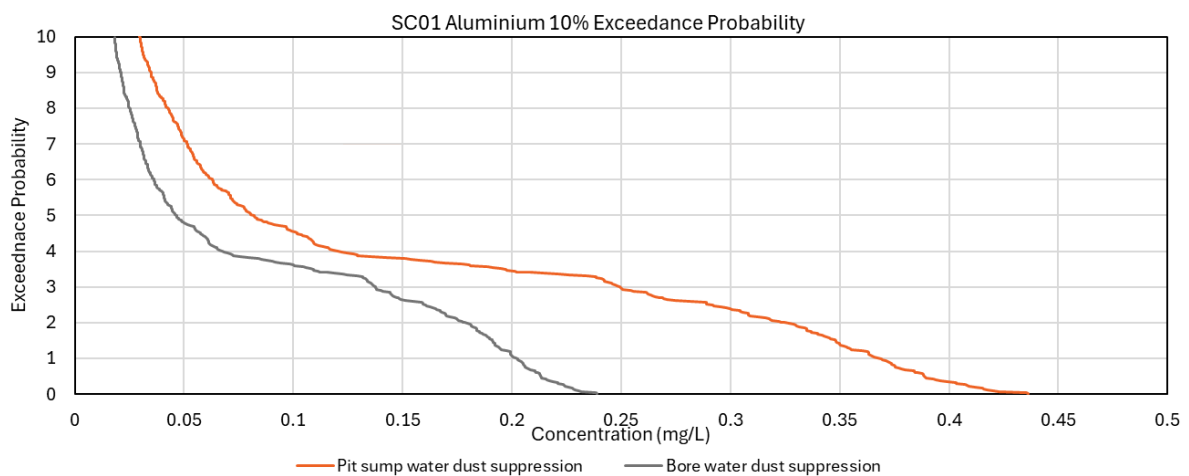


Figure 45: SC01 10% exceedance probability - aluminium.

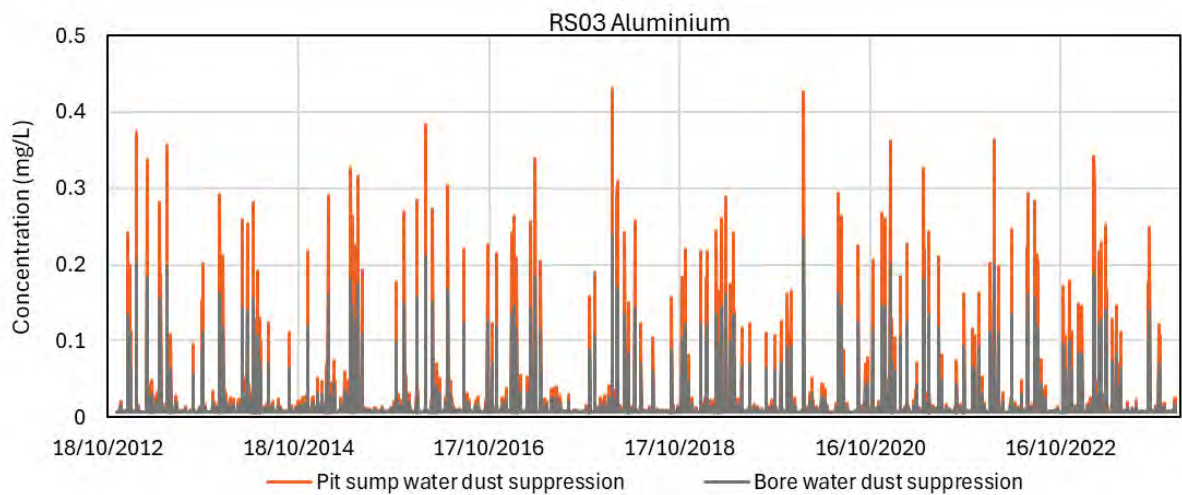


Figure 46: Modelled aluminium concentrations in RS03 over time.

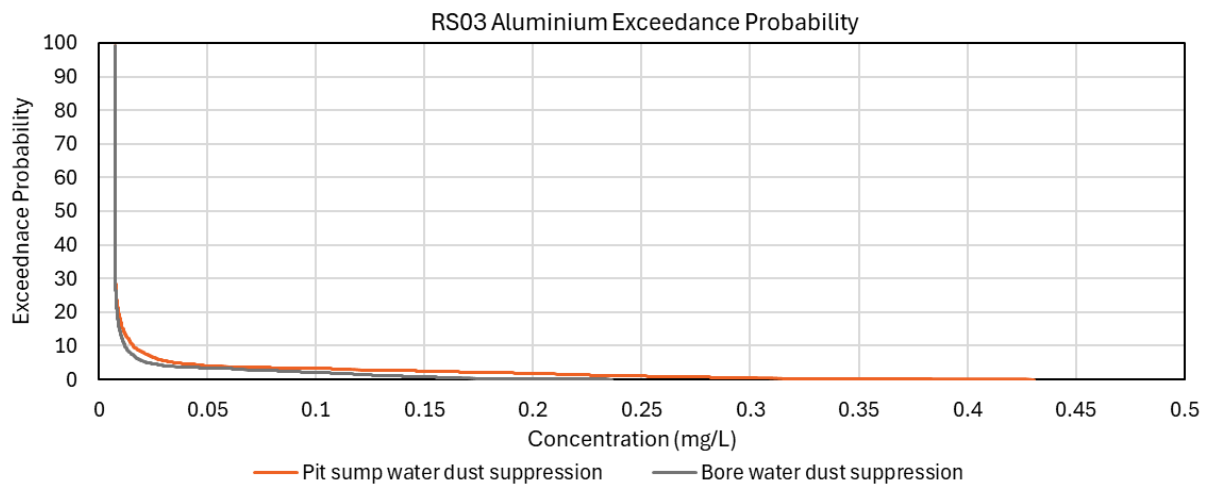


Figure 47: RS03 exceedance probability - aluminium.

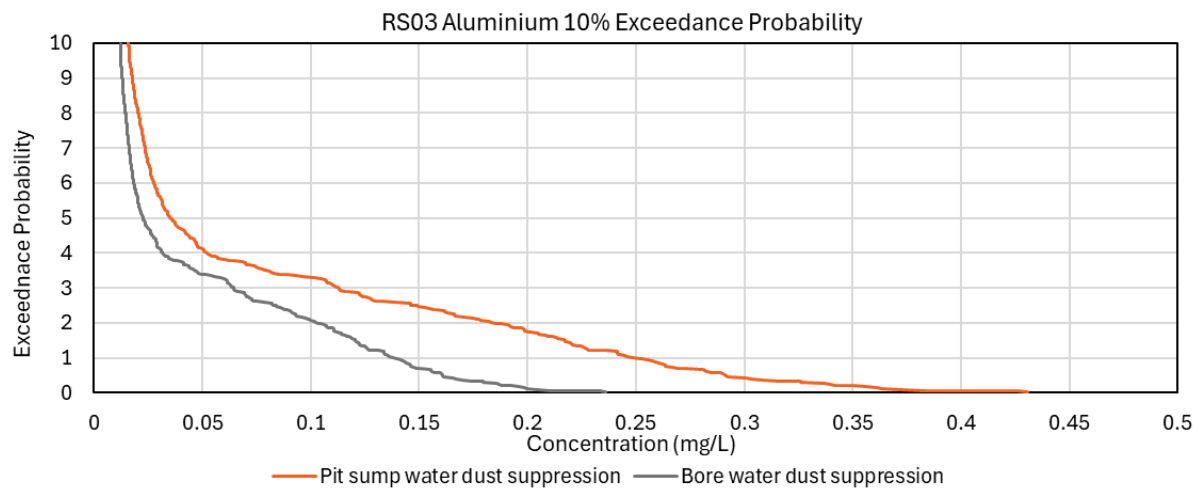


Figure 48: RS03 10% exceedance probability - aluminium.

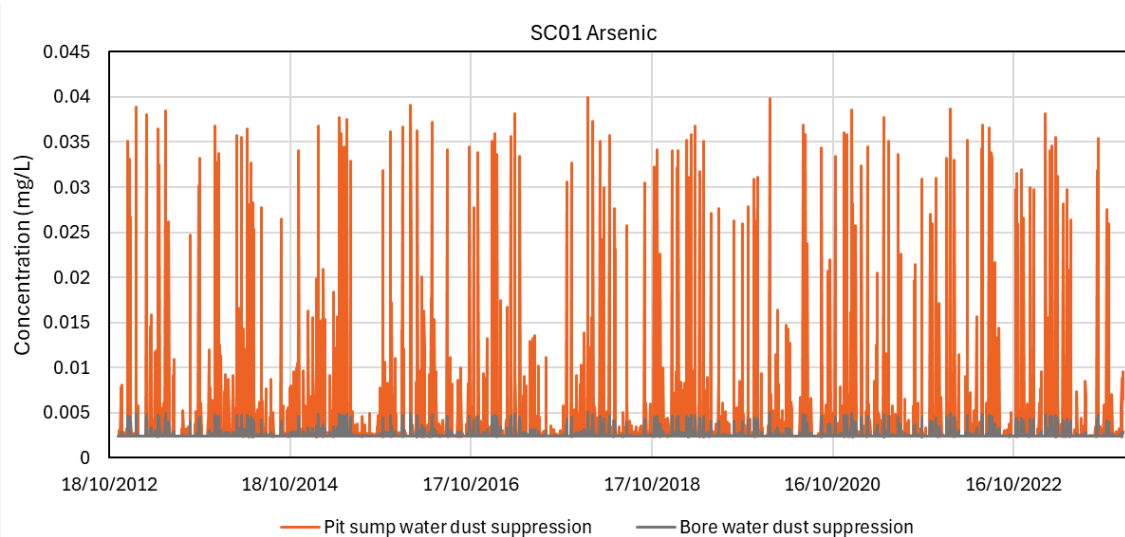


Figure 49: Modelled arsenic concentrations in SC01 over time.

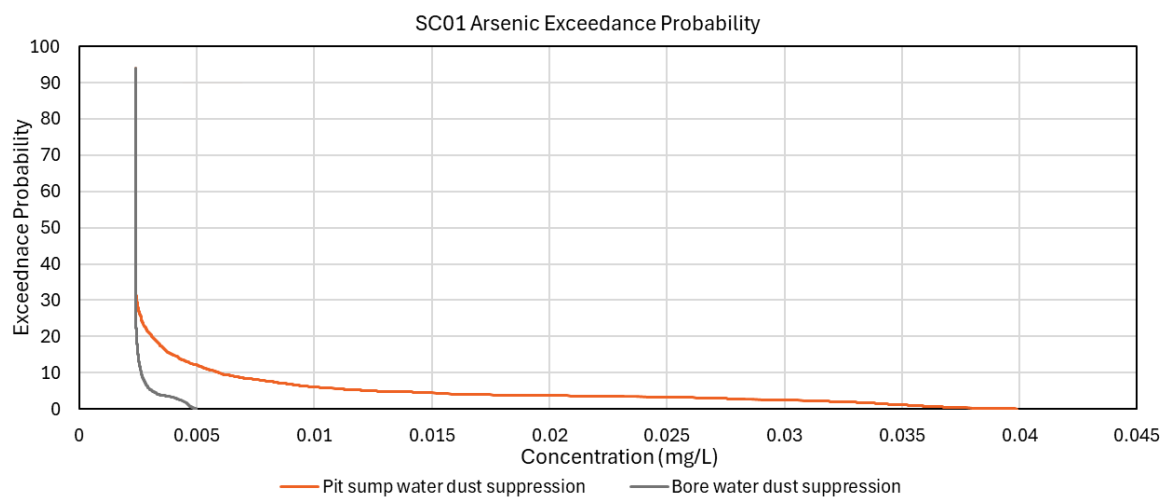


Figure 50: SC01 exceedance probability - arsenic.

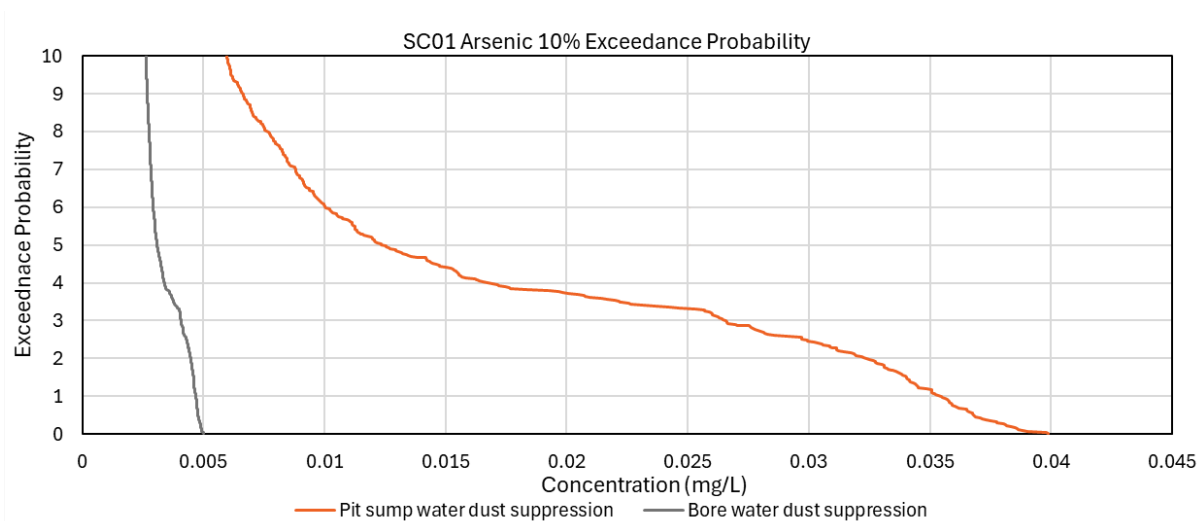


Figure 51: SC01 10% exceedance probability - arsenic.

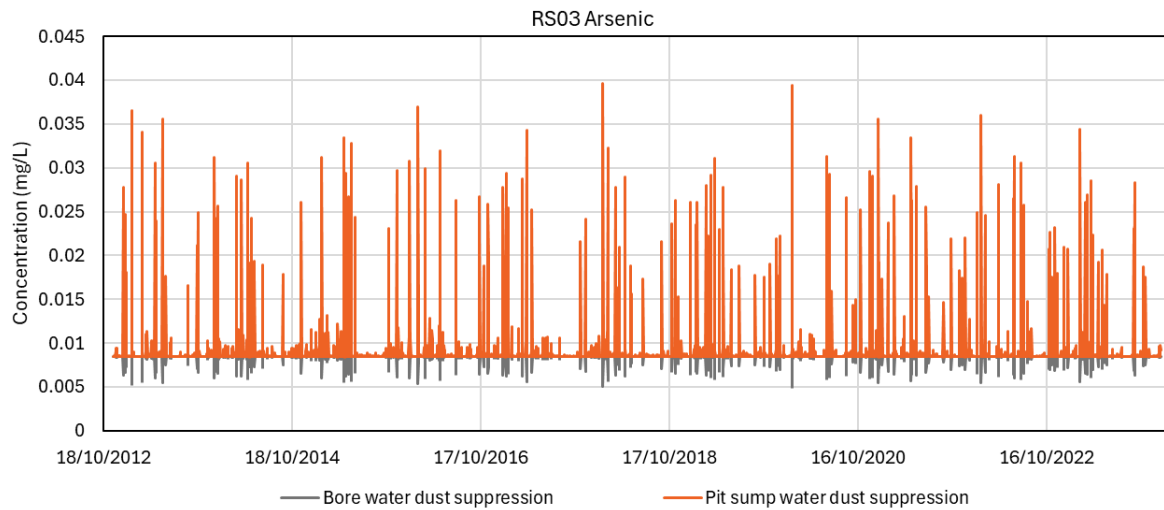


Figure 52: Modelled arsenic concentrations in RS03 over time.

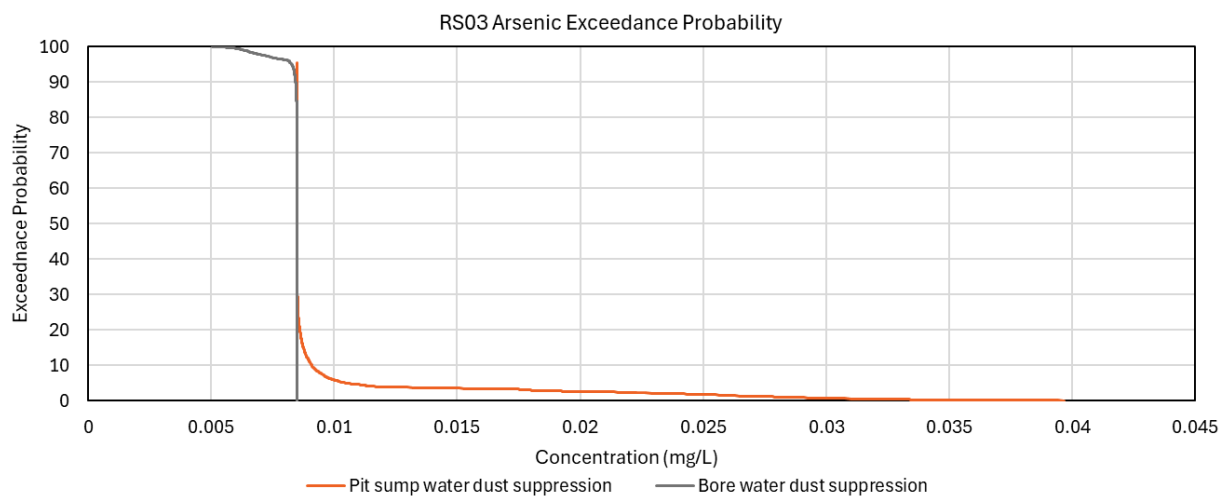


Figure 53: RS03 exceedance probability - arsenic.

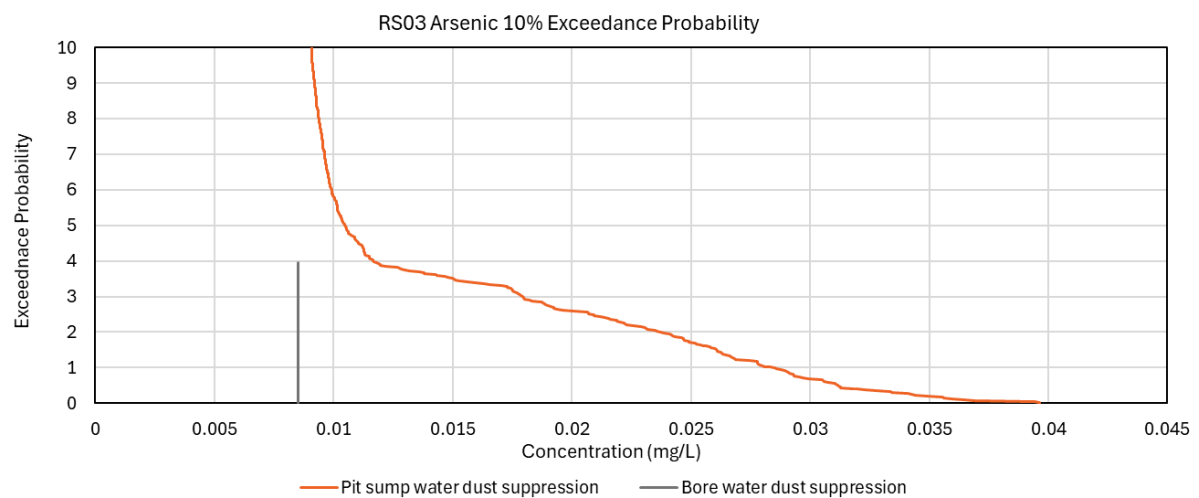


Figure 54: RS03 10% exceedance probability - arsenic.

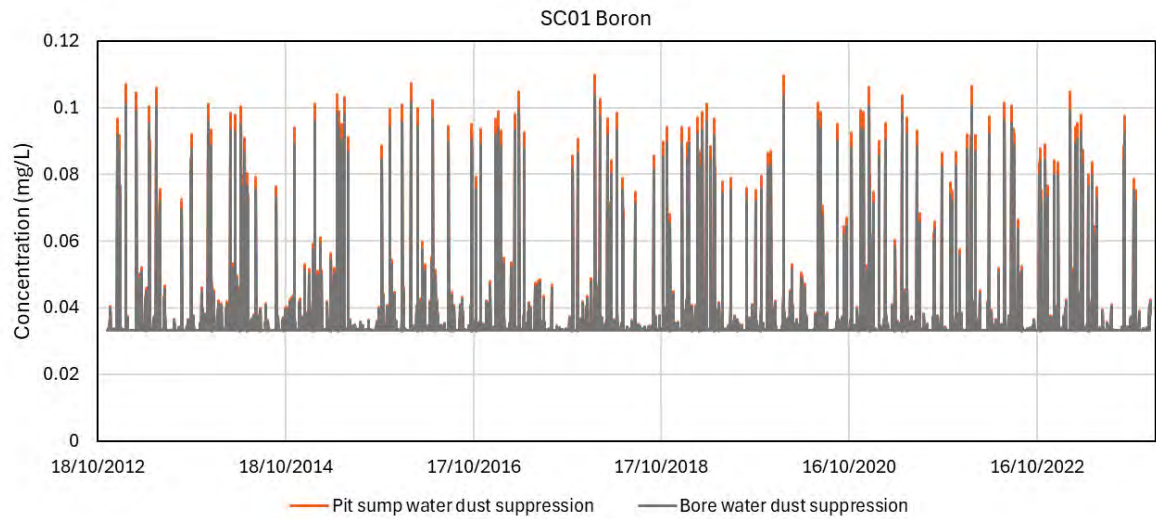


Figure 55: Modelled boron concentrations in SC01 over time.

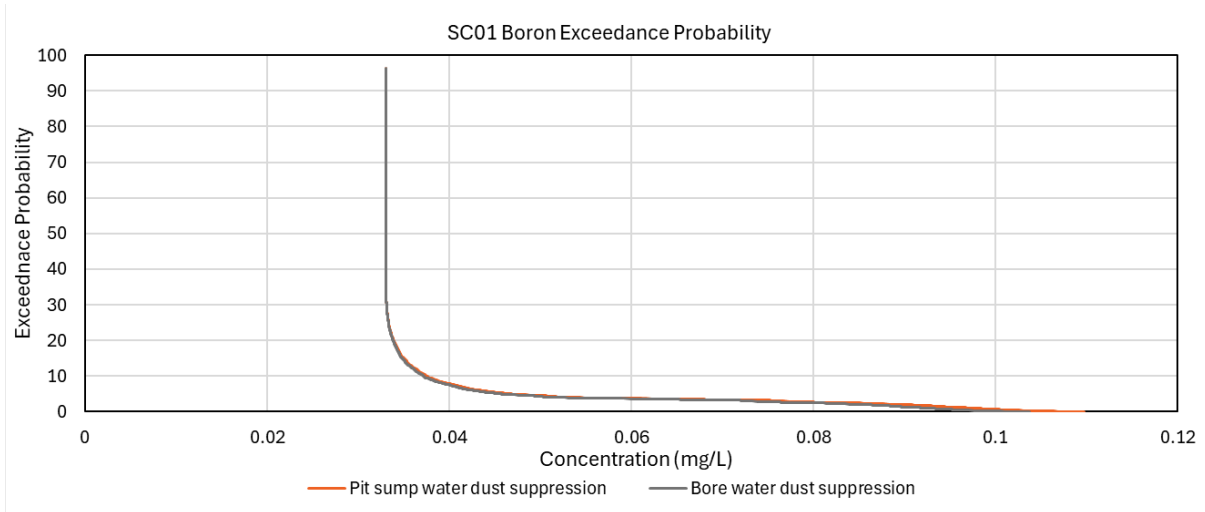


Figure 56: SC01 exceedance probability - boron.

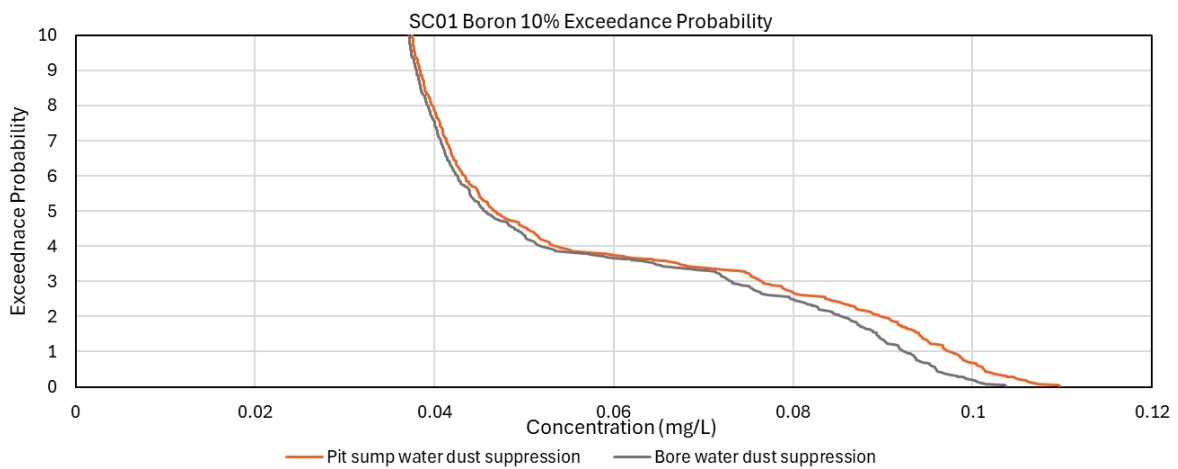


Figure 57: SC01 10% exceedance probability - boron.

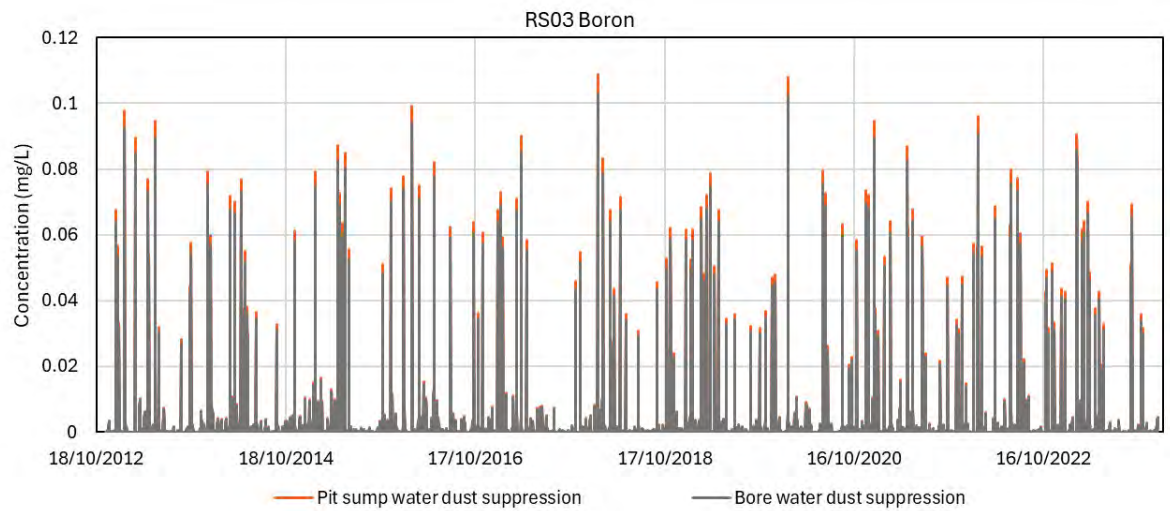


Figure 58: Modelled boron concentrations in RS03 over time.

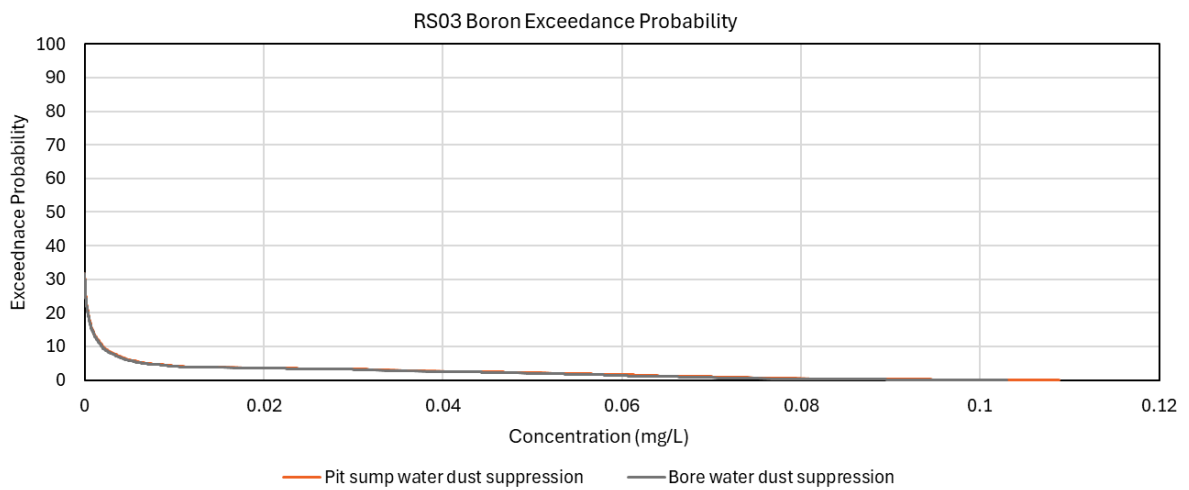


Figure 59: RS03 exceedance probability - boron.

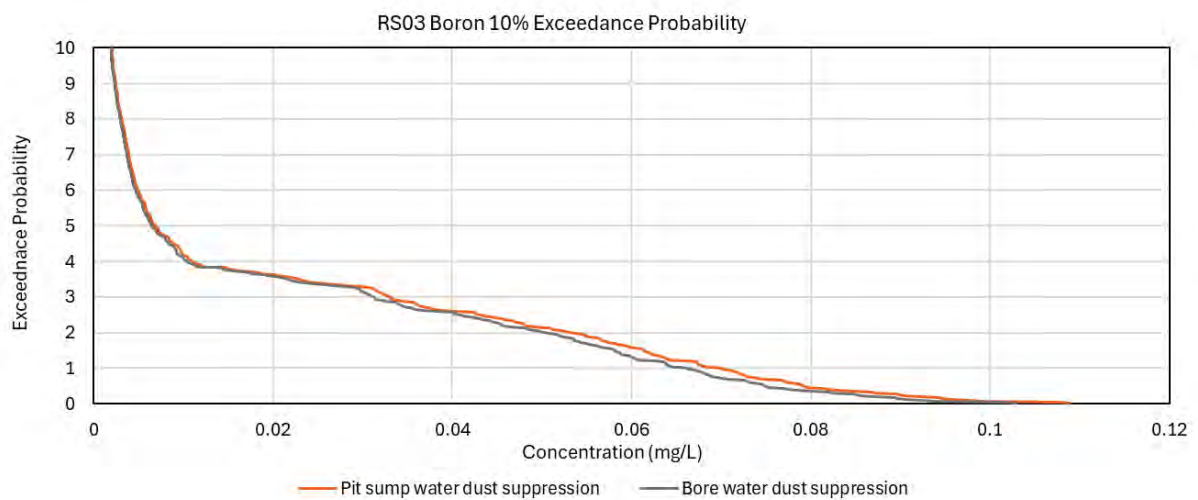


Figure 60: RS03 10% exceedance probability - boron.

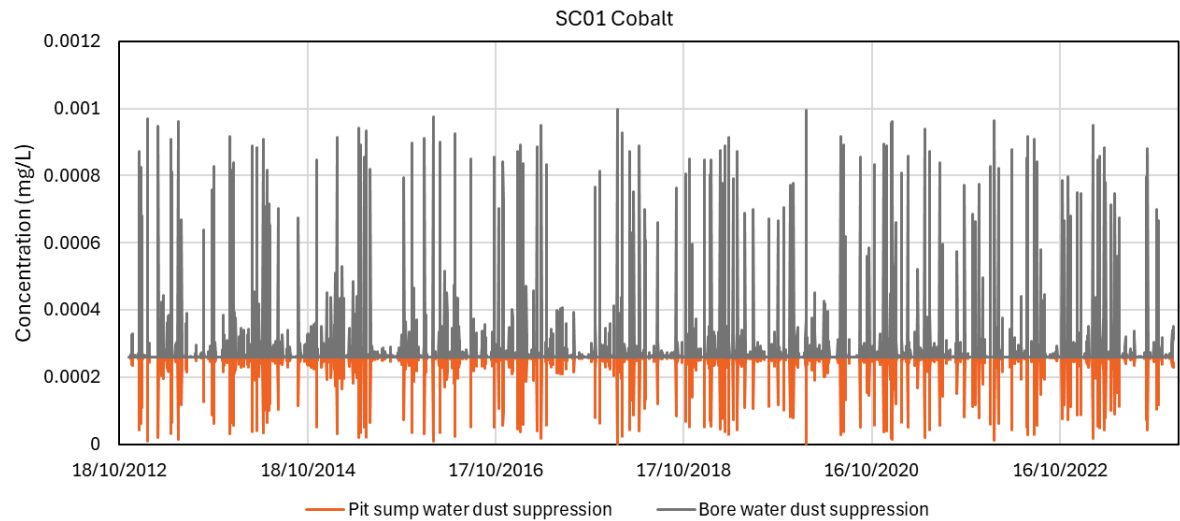


Figure 61: Modelled cobalt concentrations in SC01 over time.

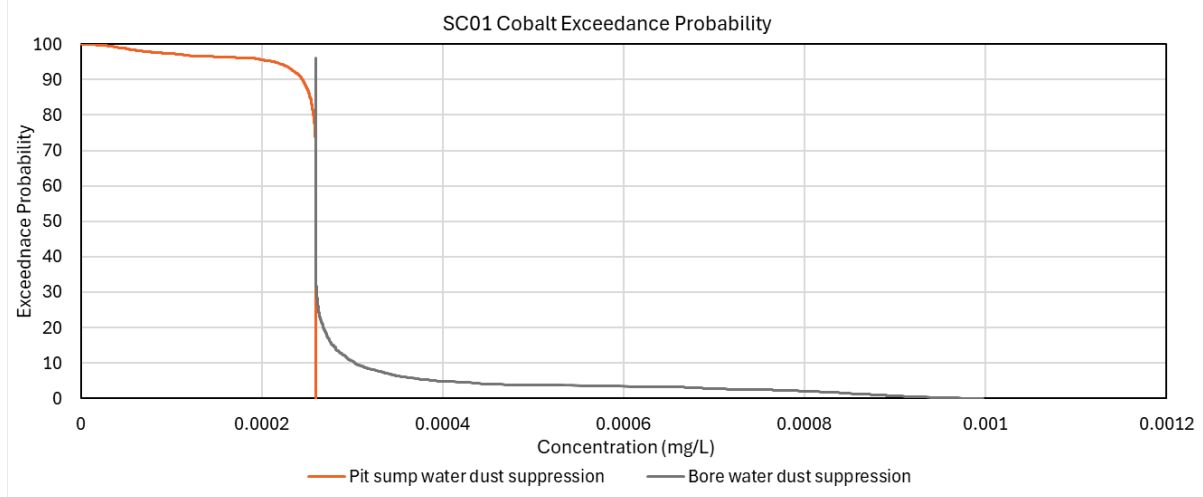


Figure 62: SC01 exceedance probability - cobalt.

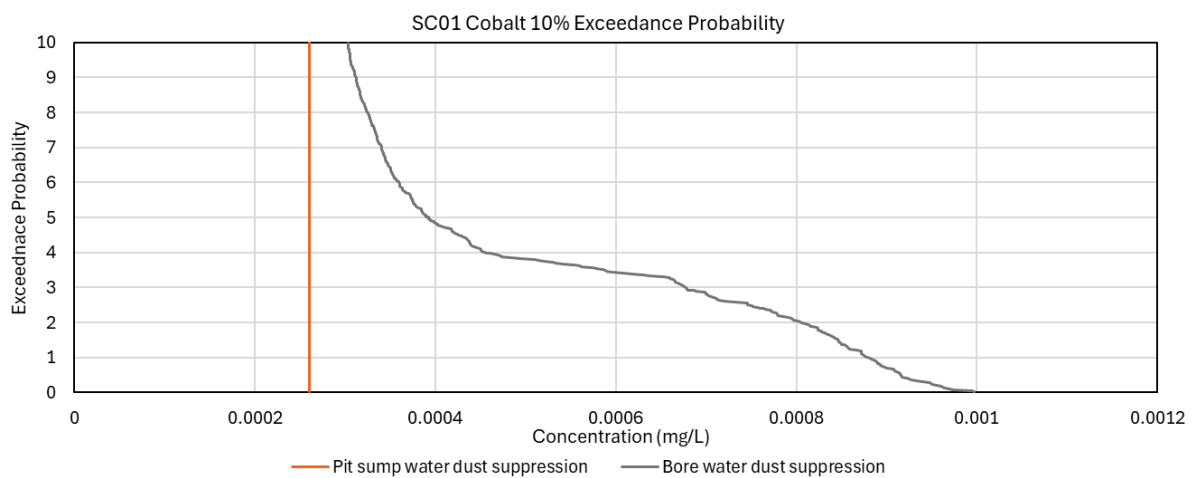


Figure 63: SC01 10% exceedance probability - cobalt.

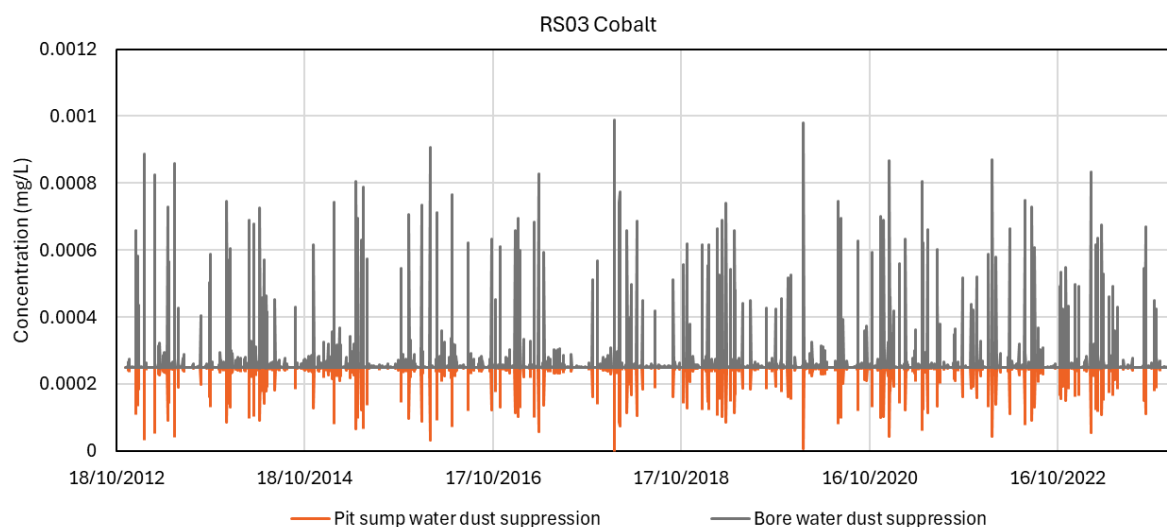


Figure 64: Modelled cobalt concentrations in RS03 over time.

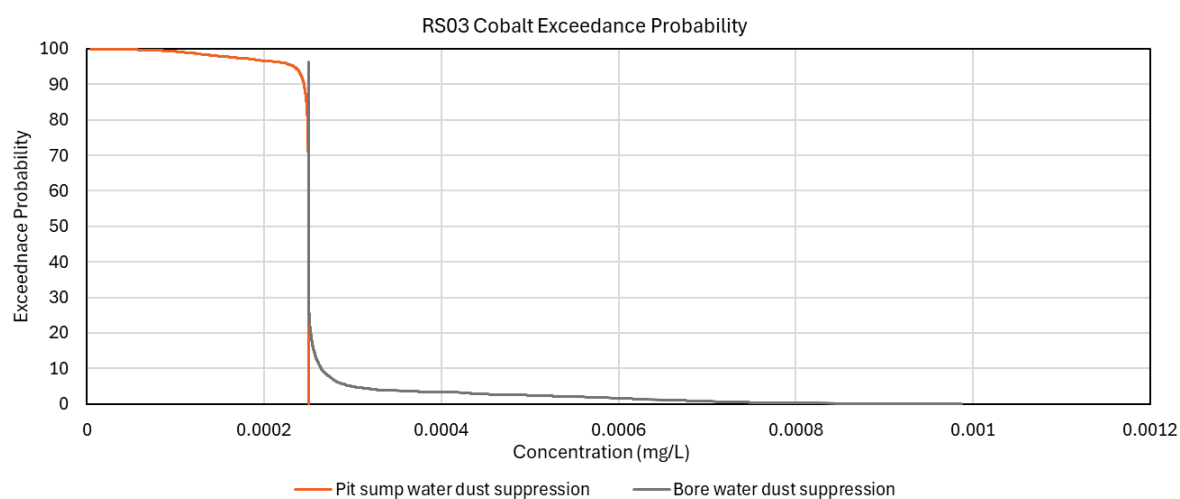


Figure 65: RS03 exceedance probability - cobalt.

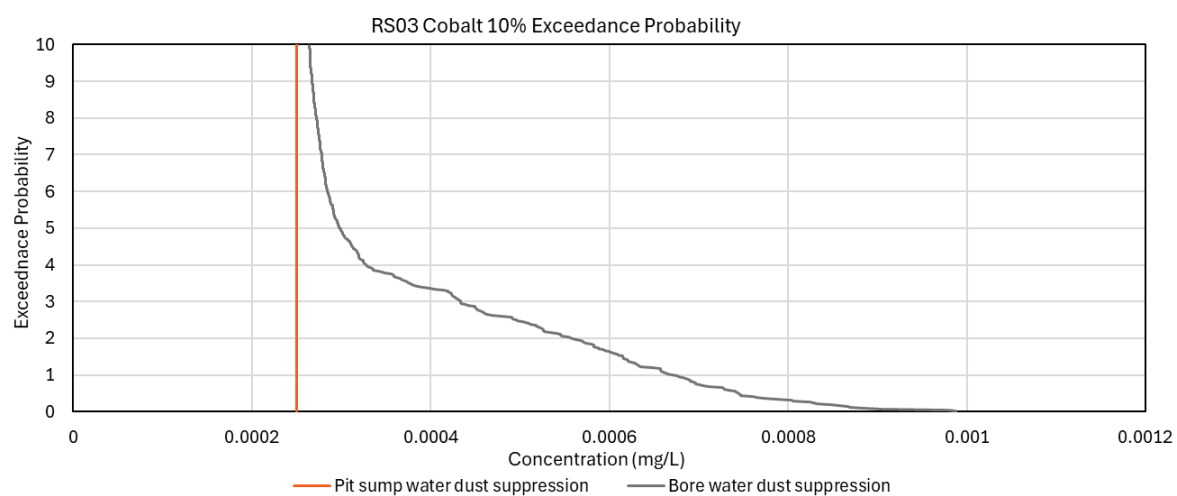


Figure 66: RS03 10% exceedance probability - cobalt.

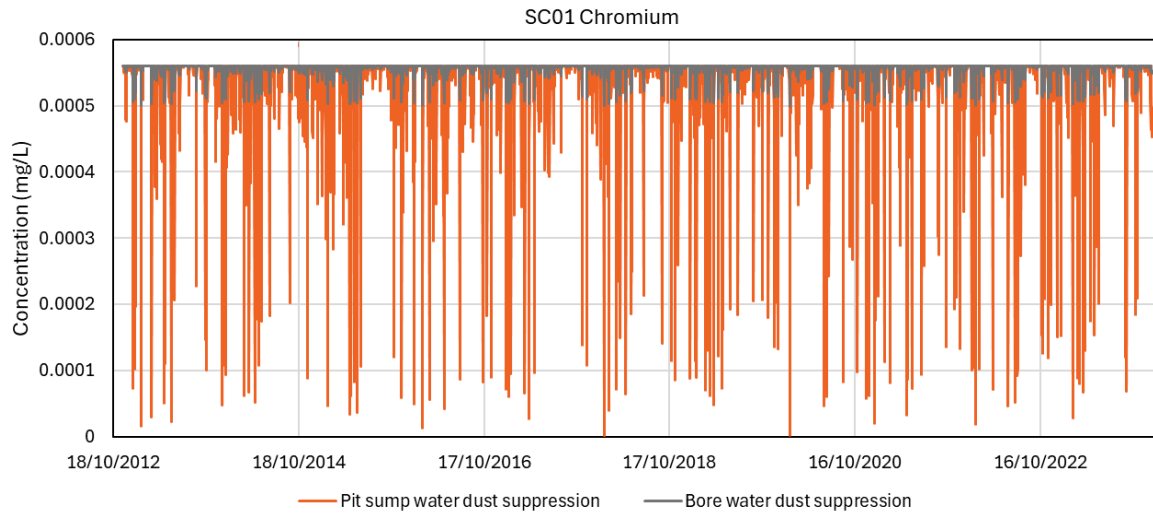


Figure 67: Modelled chromium concentrations in SC01 over time.

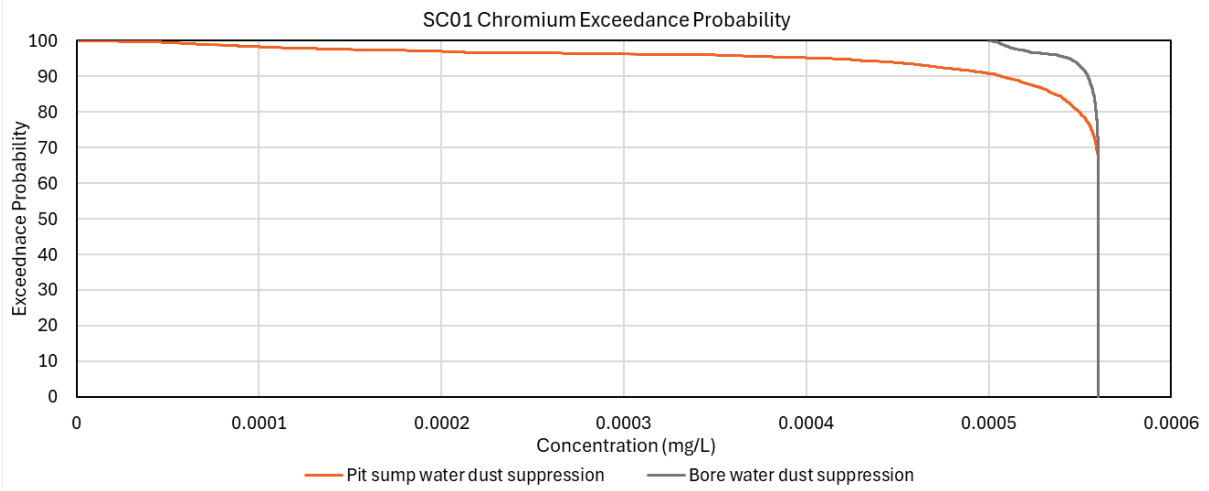


Figure 68: SC01 exceedance probability - chromium.

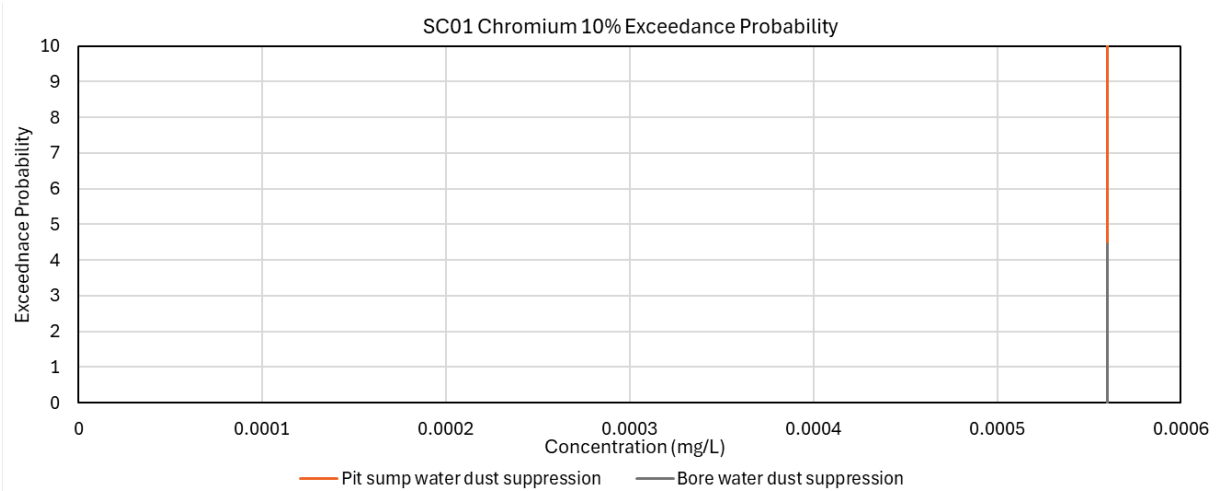


Figure 69: SC01 10% exceedance probability - chromium.

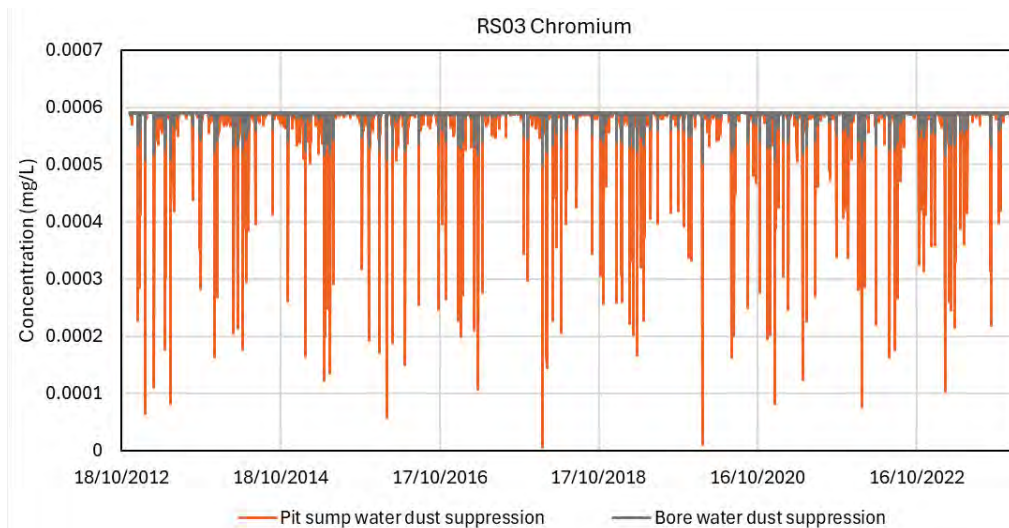


Figure 70: Modelled chromium concentrations in RS03 over time.

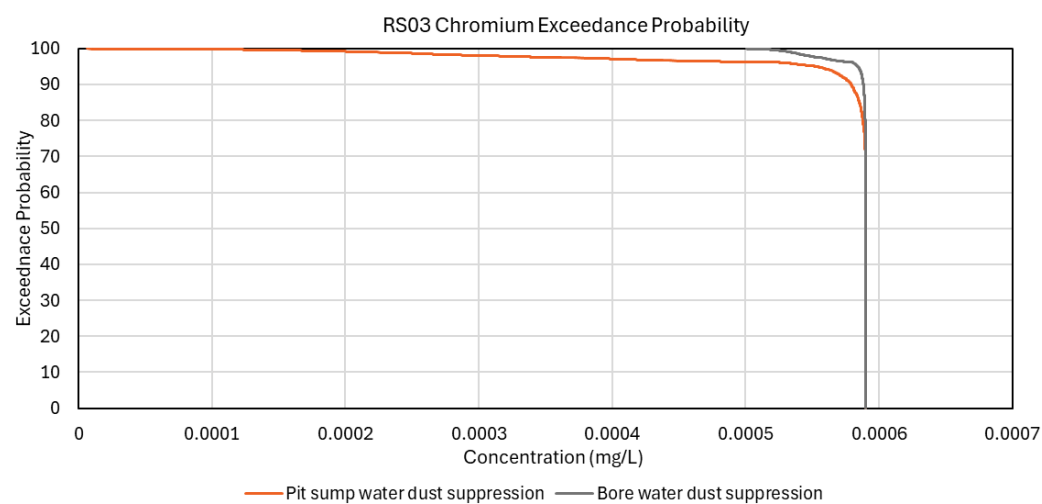


Figure 71: RS03 exceedance probability - chromium.

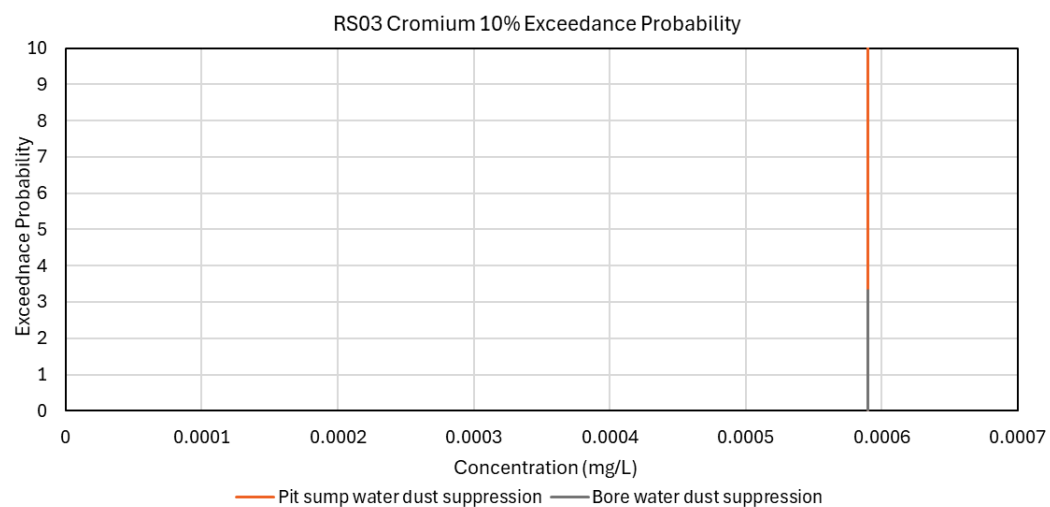


Figure 72: RS03 10% exceedance probability - chromium.

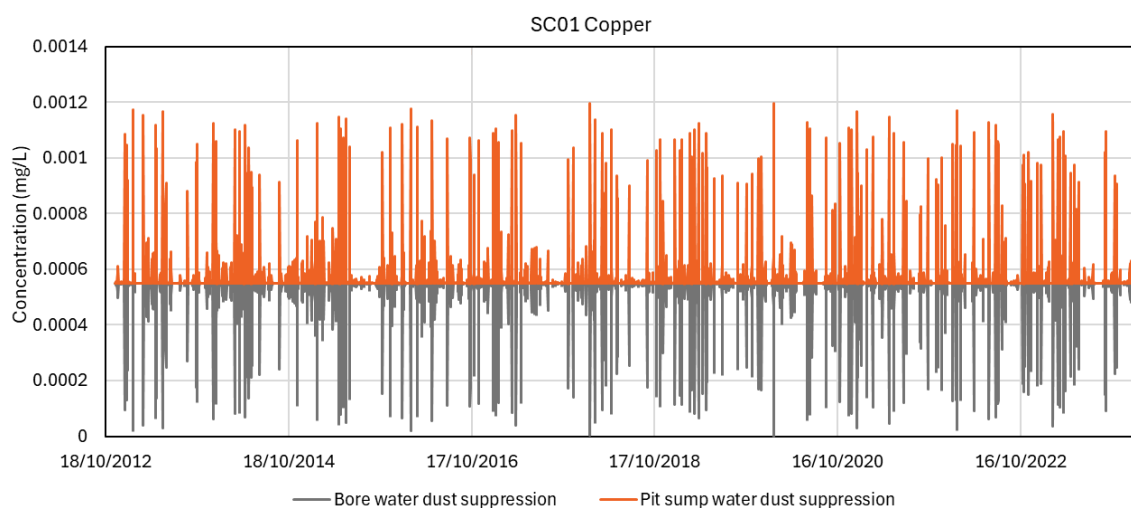


Figure 73: Modelled copper concentrations in SC01 over time.

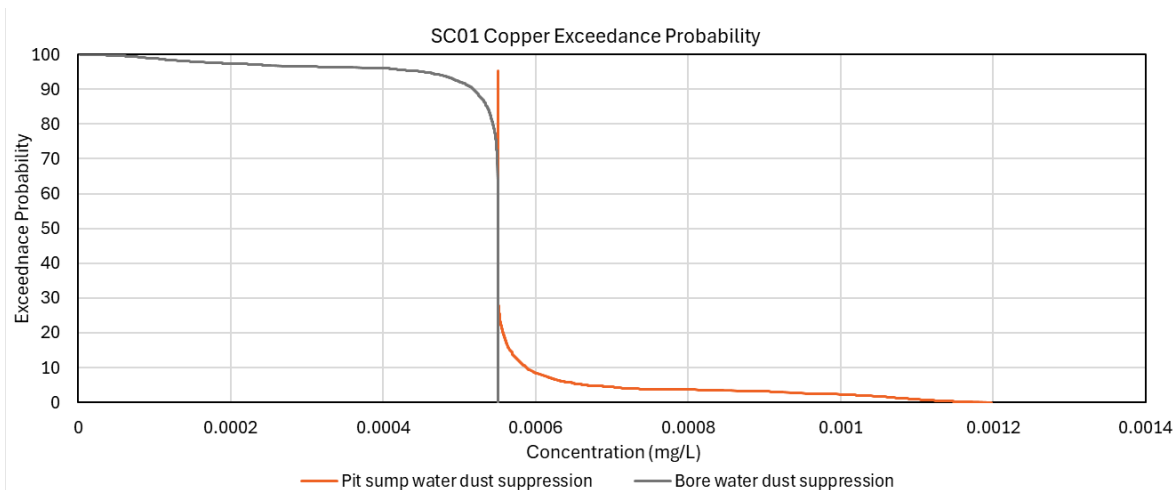


Figure 74: SC01 exceedance probability - copper.

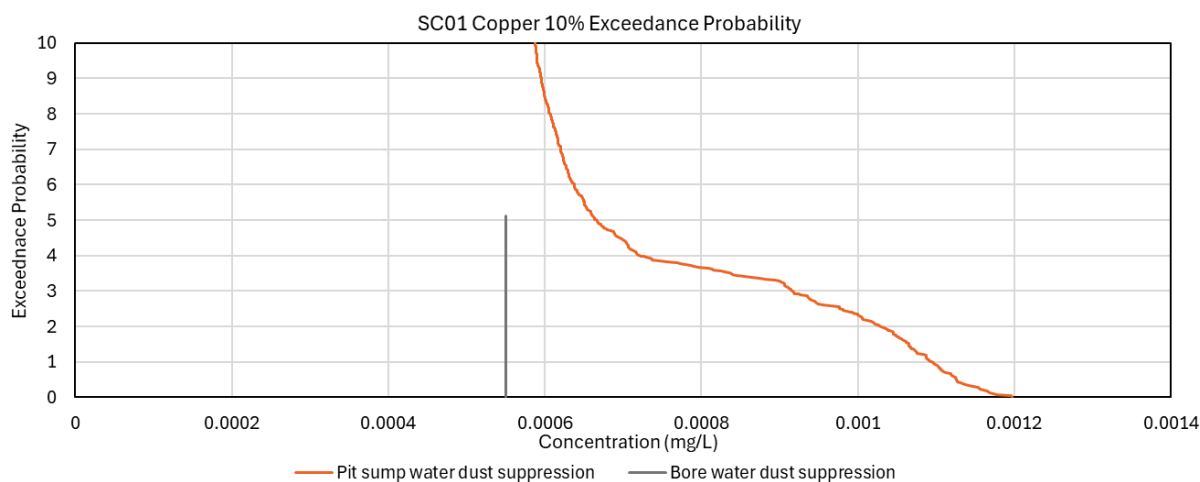


Figure 75: SC01 10% exceedance probability - copper.

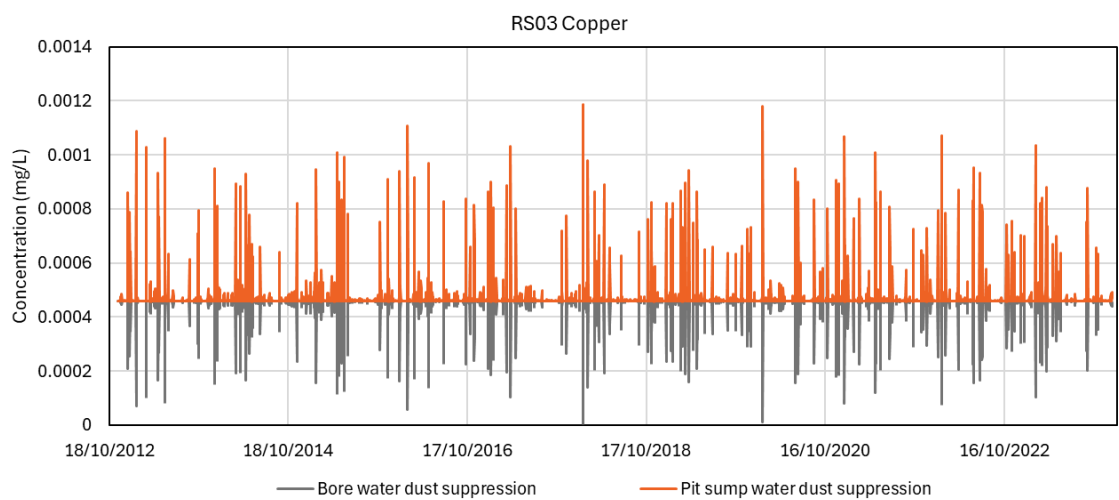


Figure 76: Modelled copper concentrations in RS03 over time.

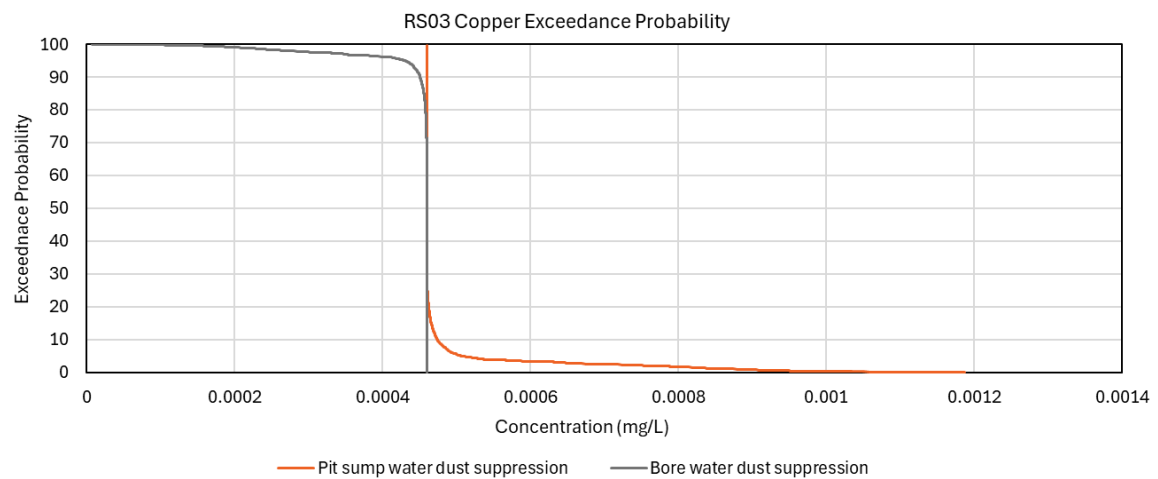


Figure 77: RS03 exceedance probability - copper.

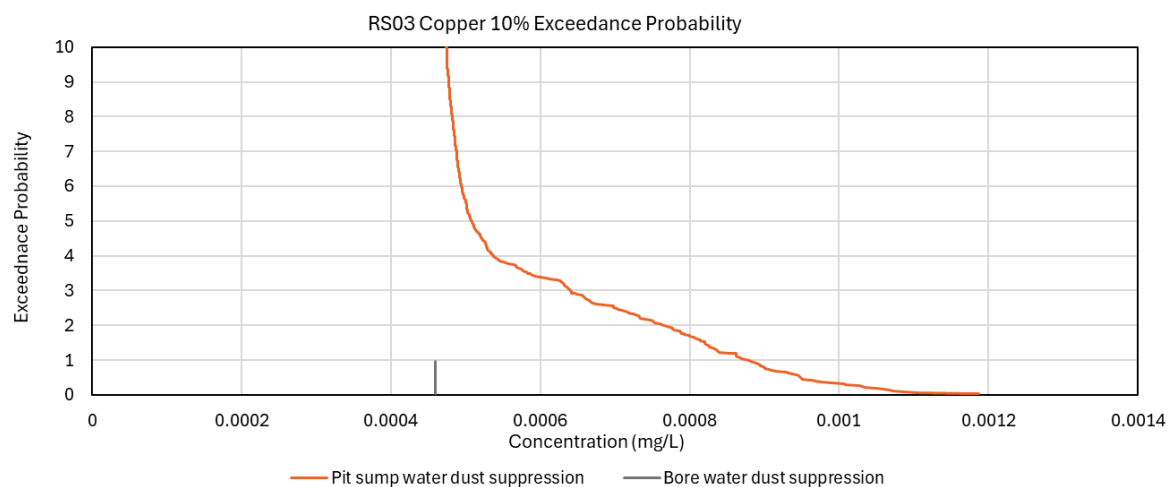


Figure 78: RS03 10% exceedance probability - copper.

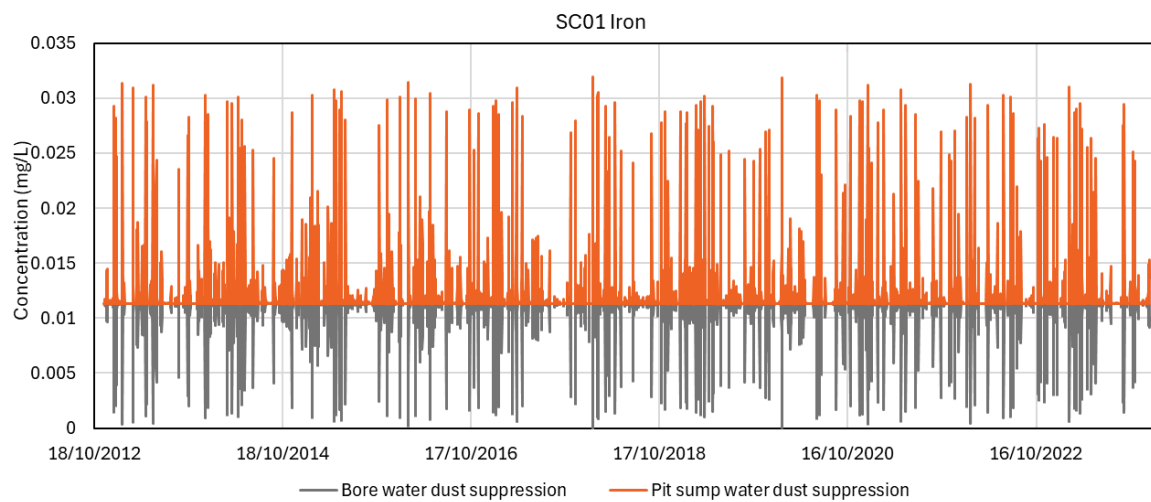


Figure 79: Modelled iron concentrations in SC01 over time.

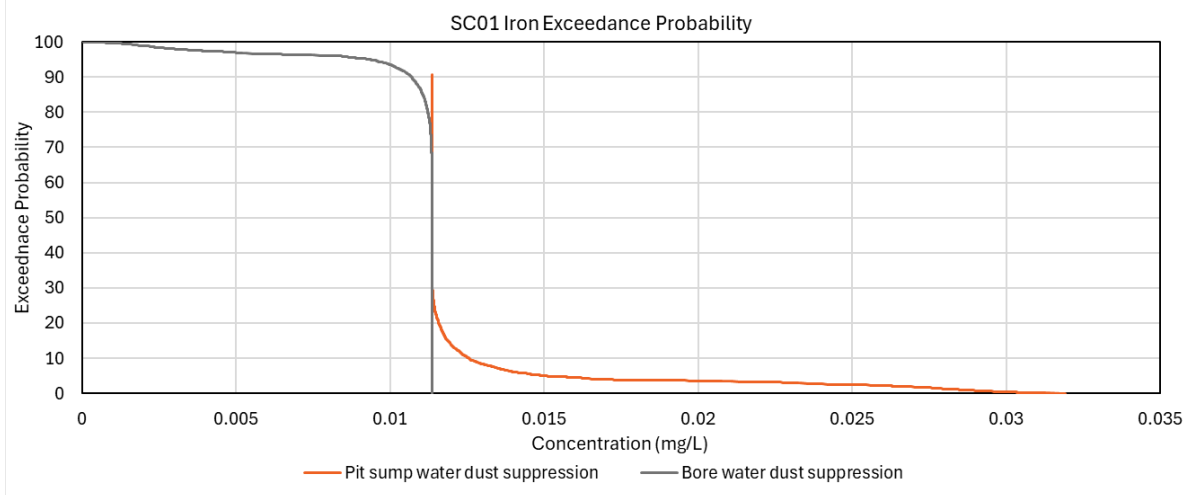


Figure 80: SC01 exceedance probability - iron.

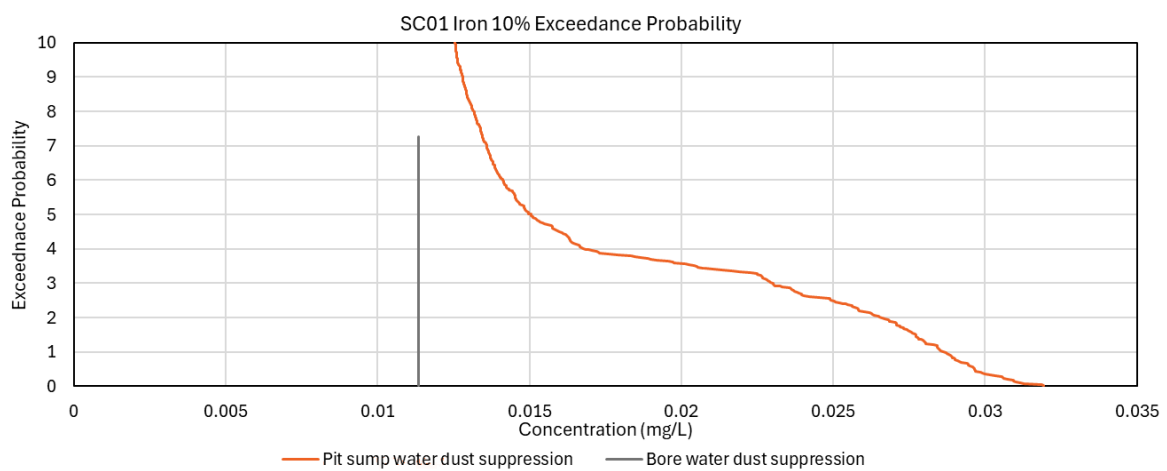


Figure 81: SC01 10% exceedance probability - iron.

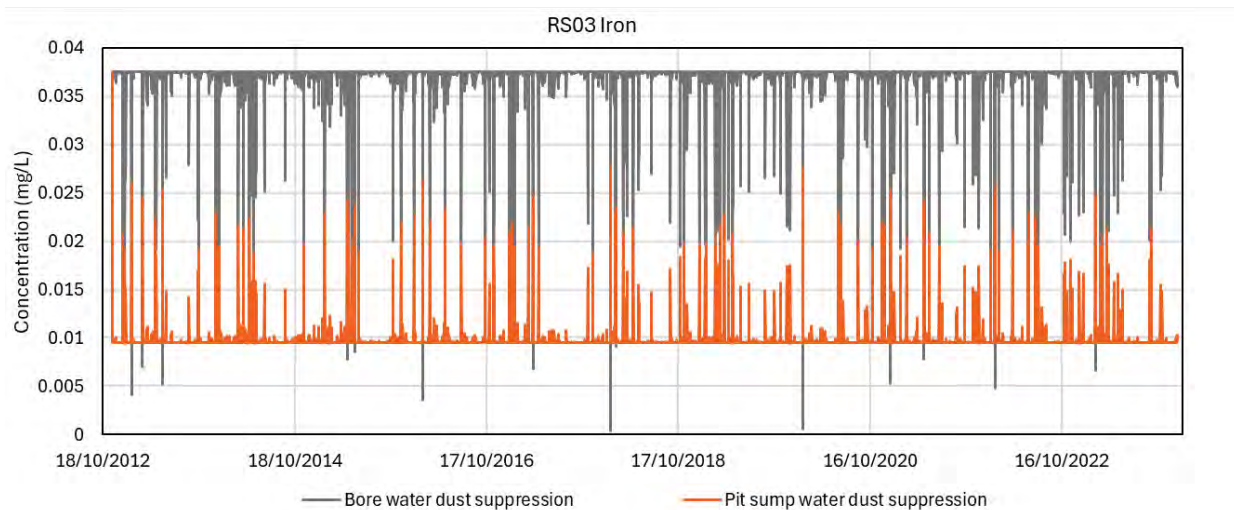


Figure 82: Modelled iron concentrations in RS03 over time.

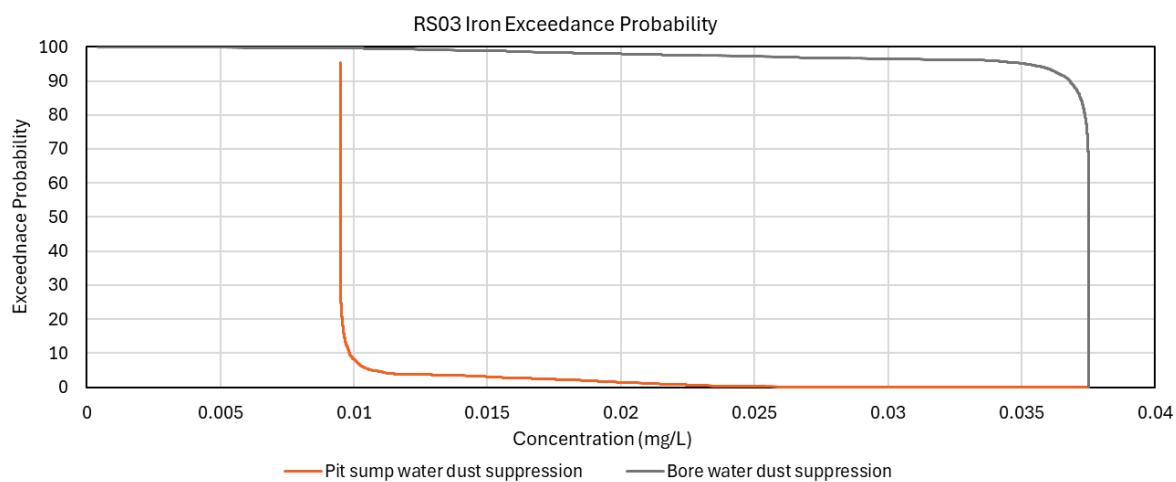


Figure 83: RS03 exceedance probability - iron.

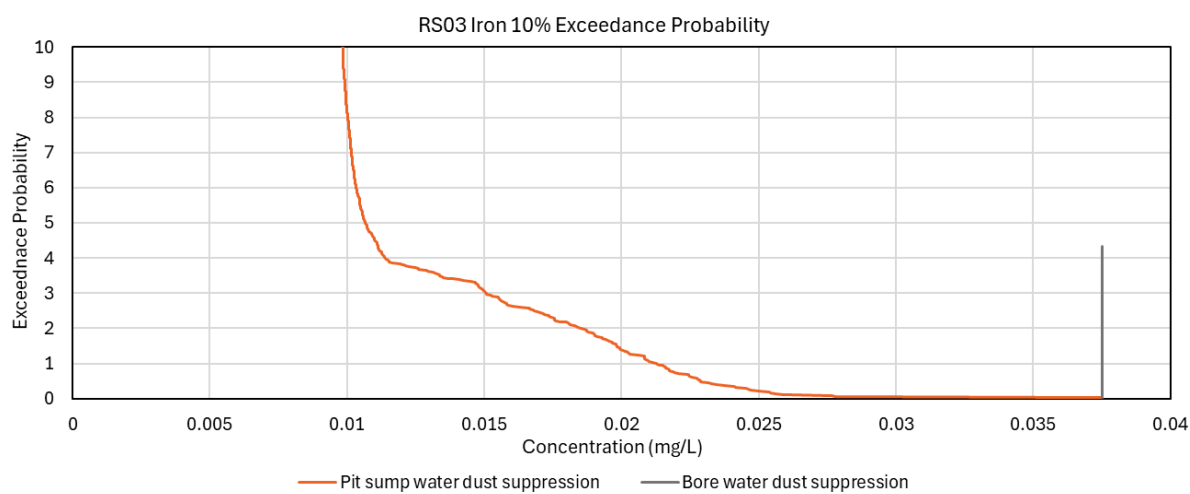


Figure 84: RS03 10% exceedance probability - iron.

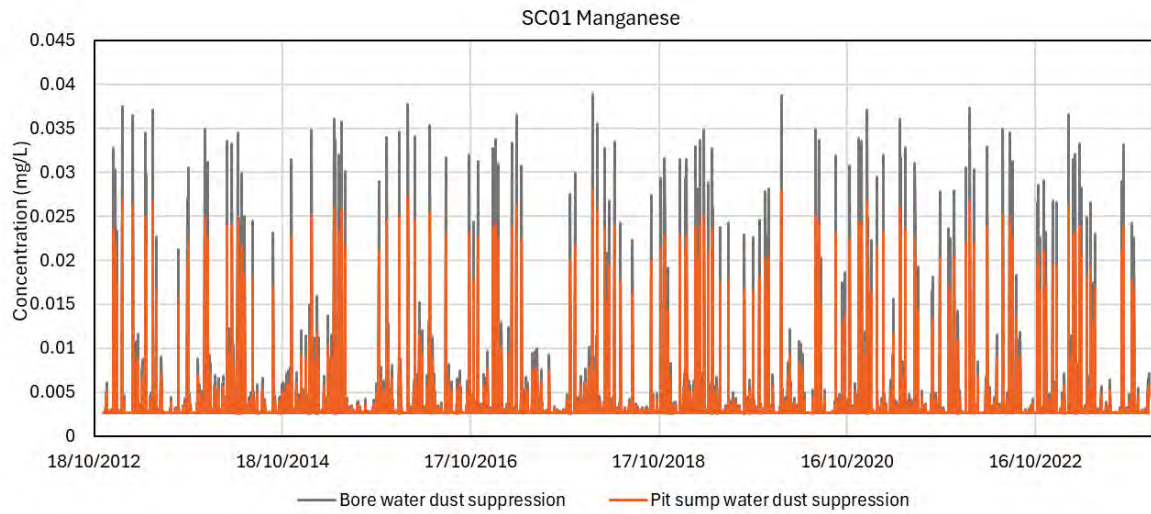


Figure 85: Modelled manganese concentrations in SC01 over time.

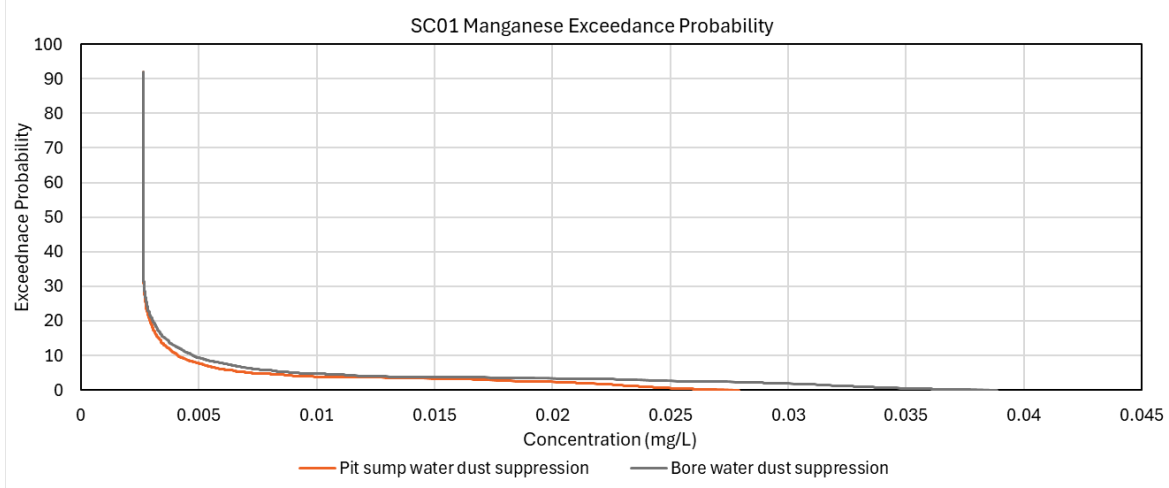


Figure 86: SC01 exceedance probability - manganese.

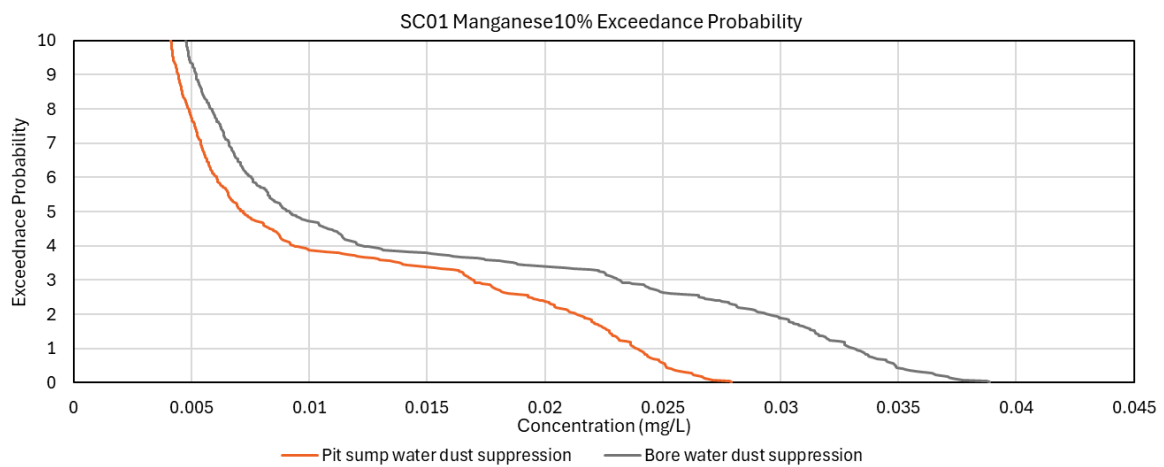


Figure 87: SC01 10% exceedance probability - manganese.

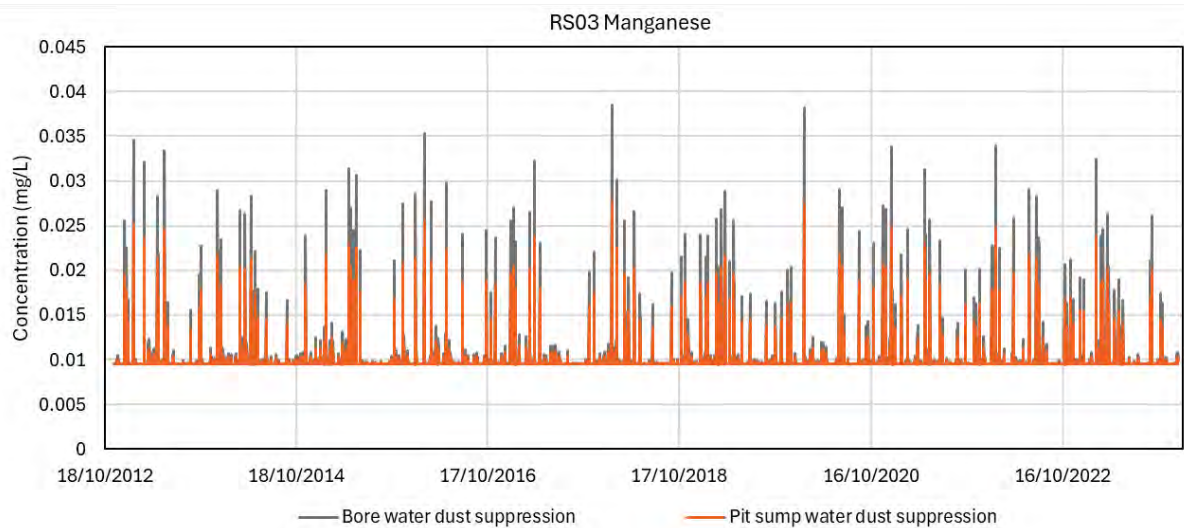


Figure 88: Modelled manganese concentrations in RS03 over time.

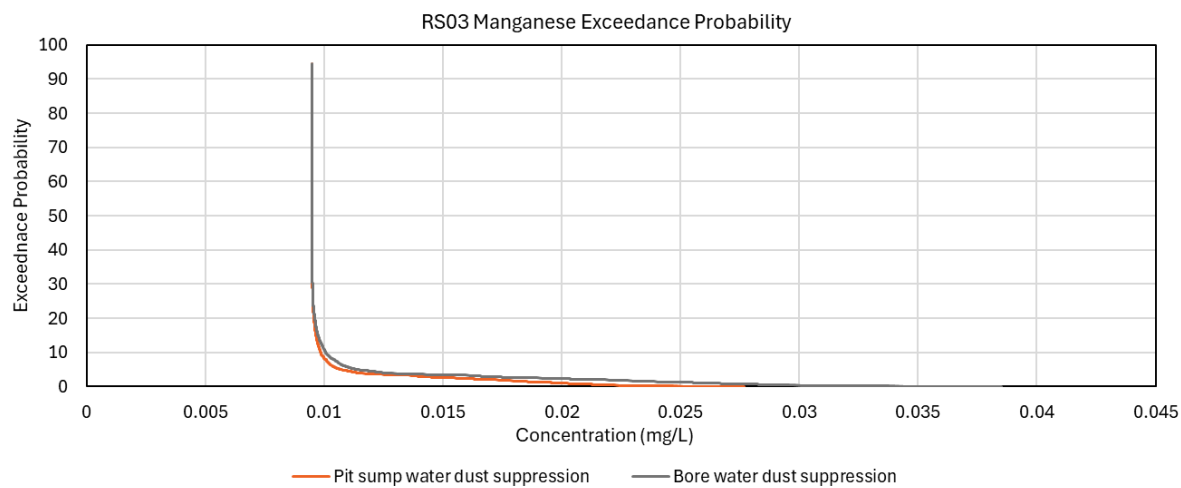


Figure 89: RS03 exceedance probability - manganese.

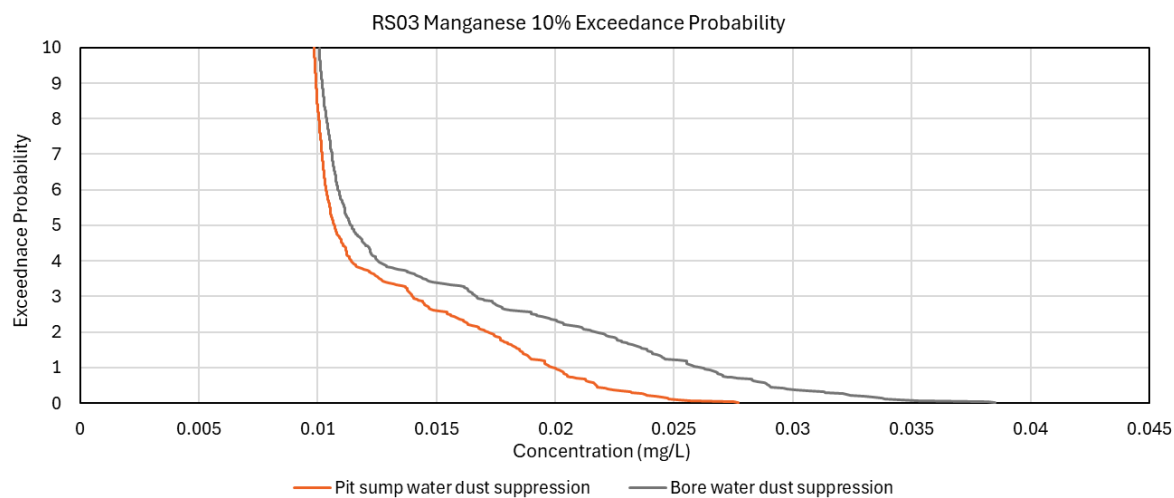


Figure 90: RS03 10% exceedance probability - manganese.

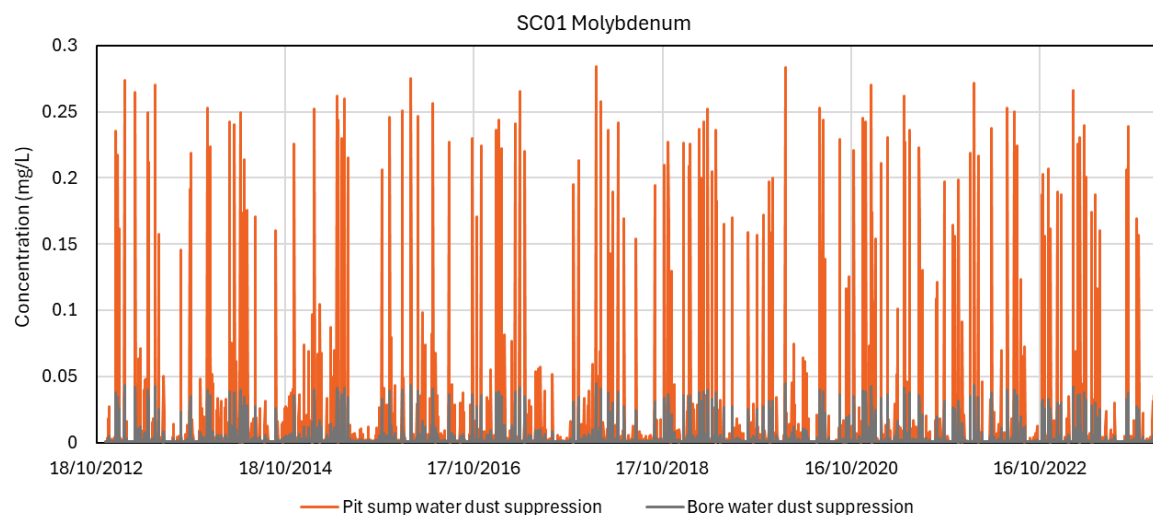


Figure 91: Modelled molybdenum concentrations in SC01 over time.

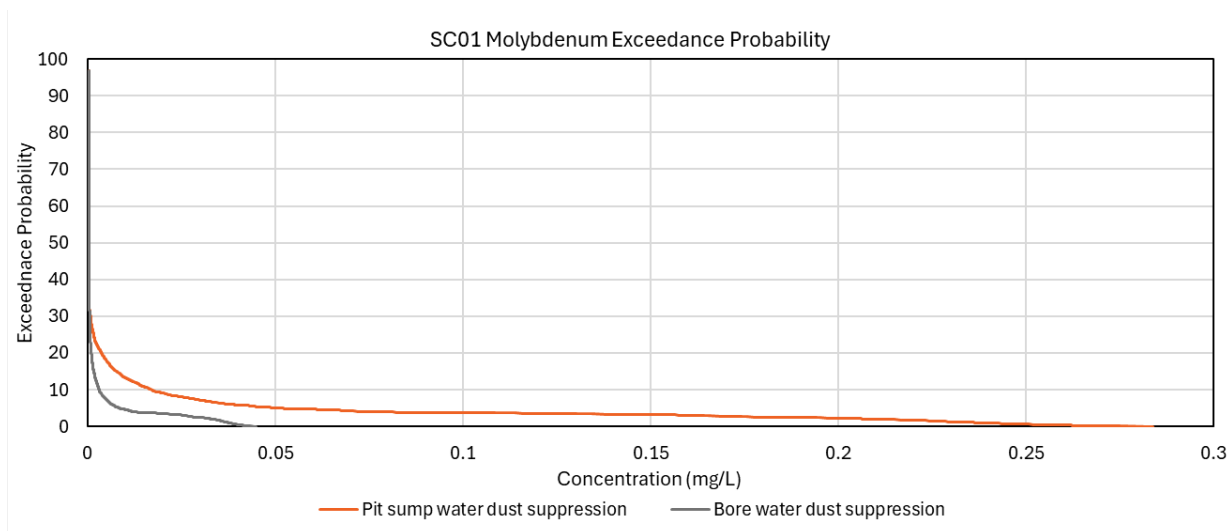


Figure 92: SC01 exceedance probability - molybdenum.

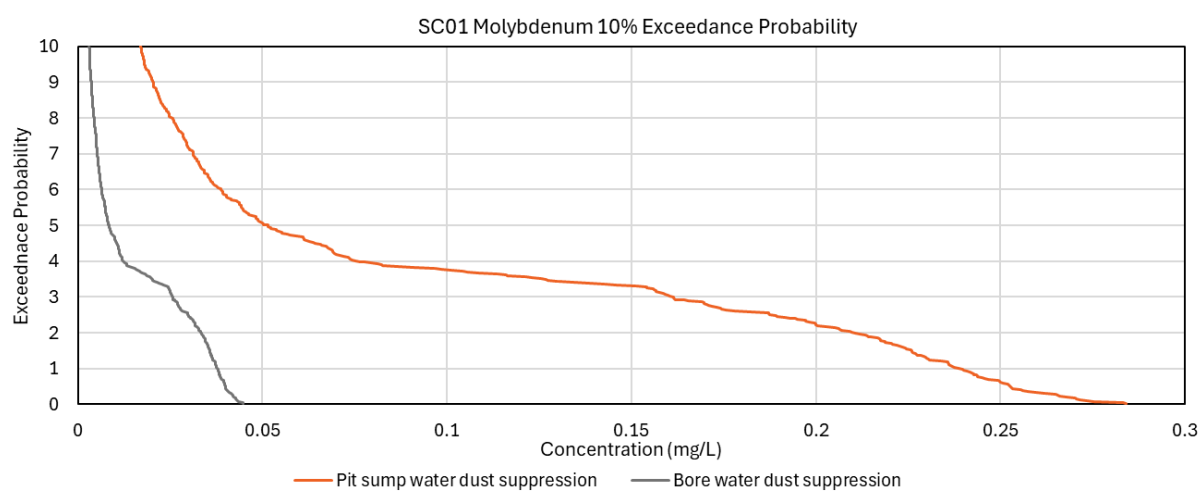


Figure 93: SC01 10% exceedance probability - molybdenum.

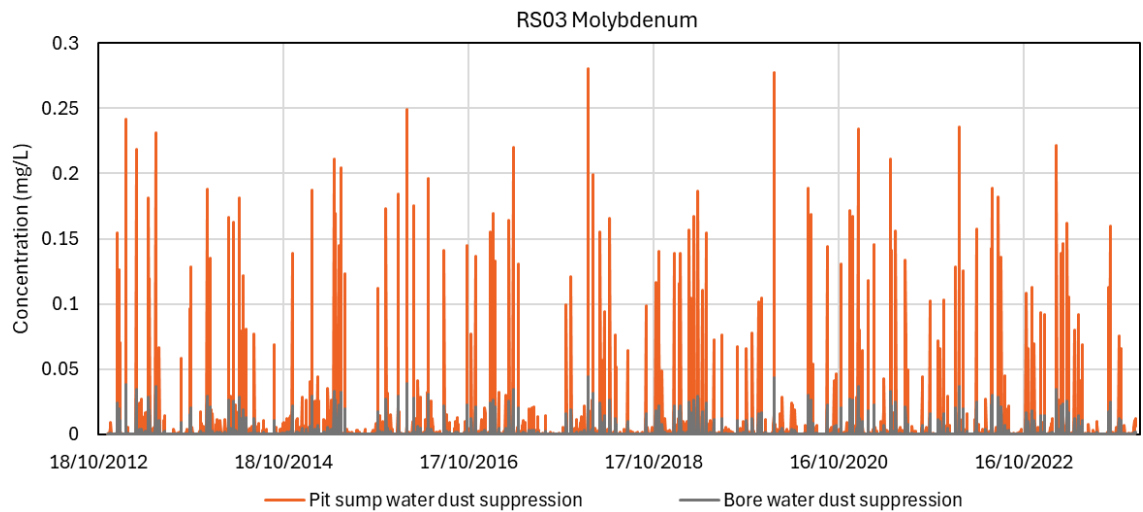


Figure 94: Modelled molybdenum concentrations in RS03 over time.

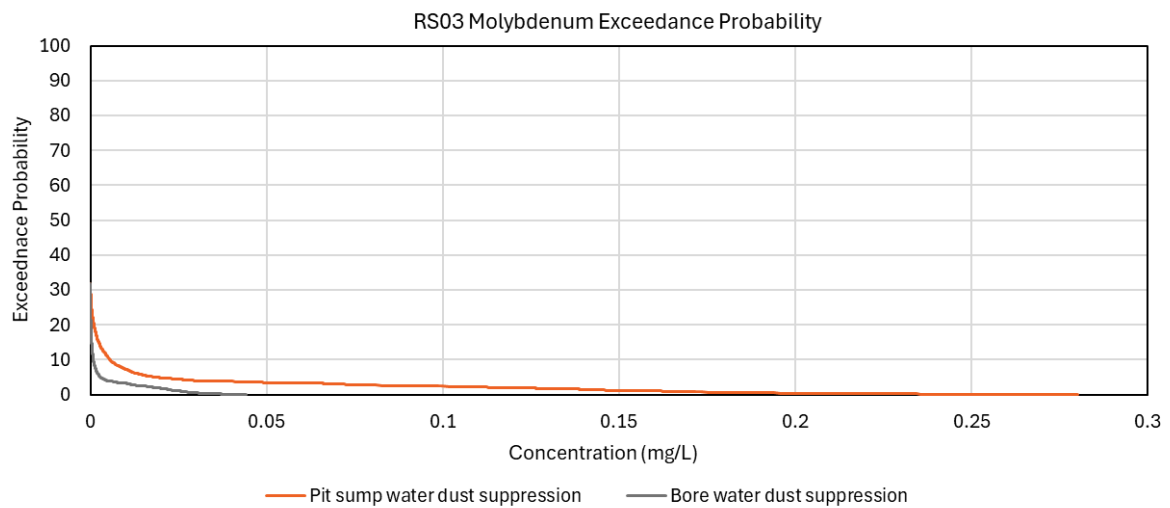


Figure 95: RS03 exceedance probability - molybdenum.

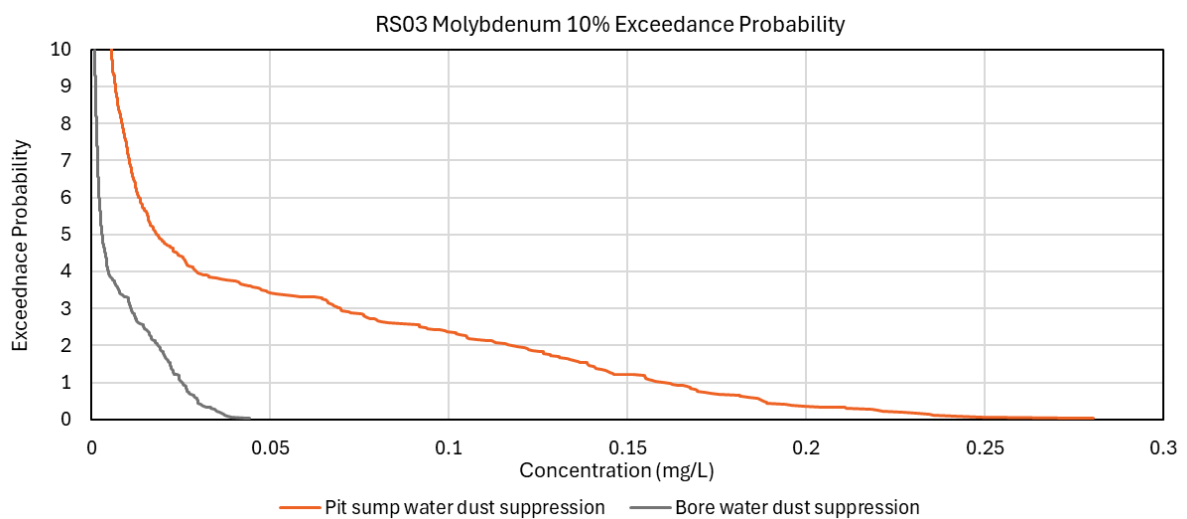


Figure 96: RS03 10% exceedance probability - molybdenum.

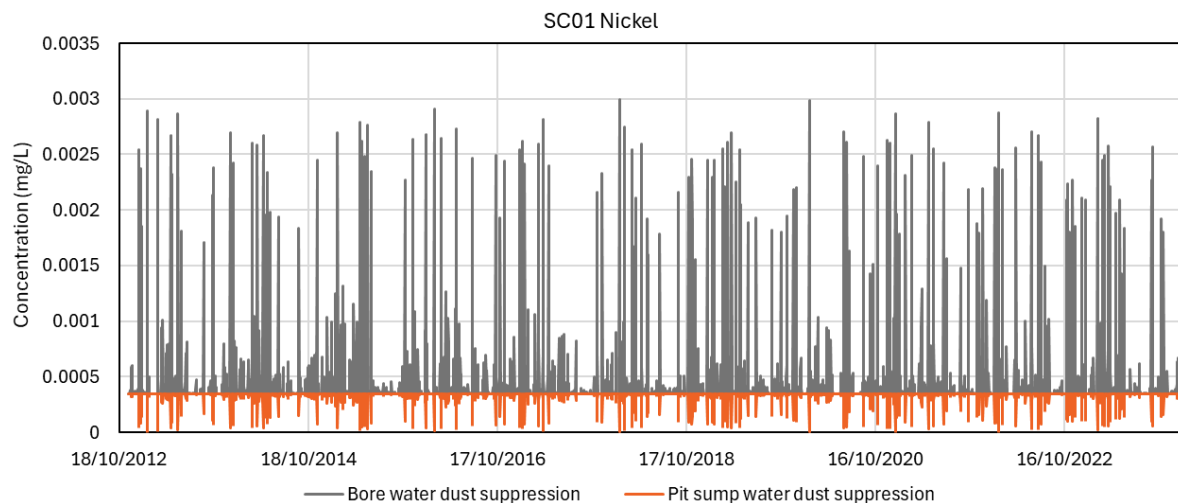


Figure 97: Modelled nickel concentrations in SC01 over time.

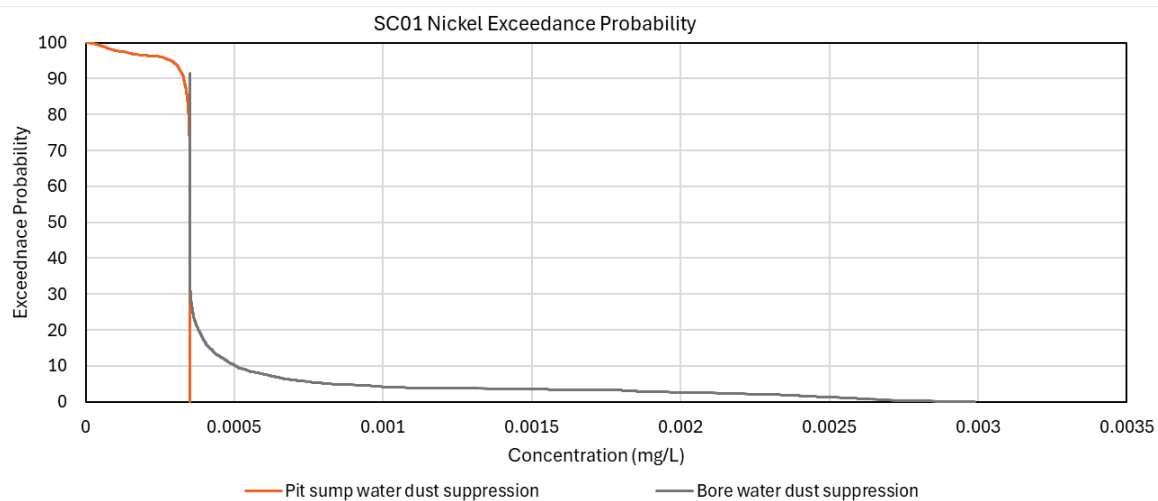


Figure 98: SC01 exceedance probability - nickel.

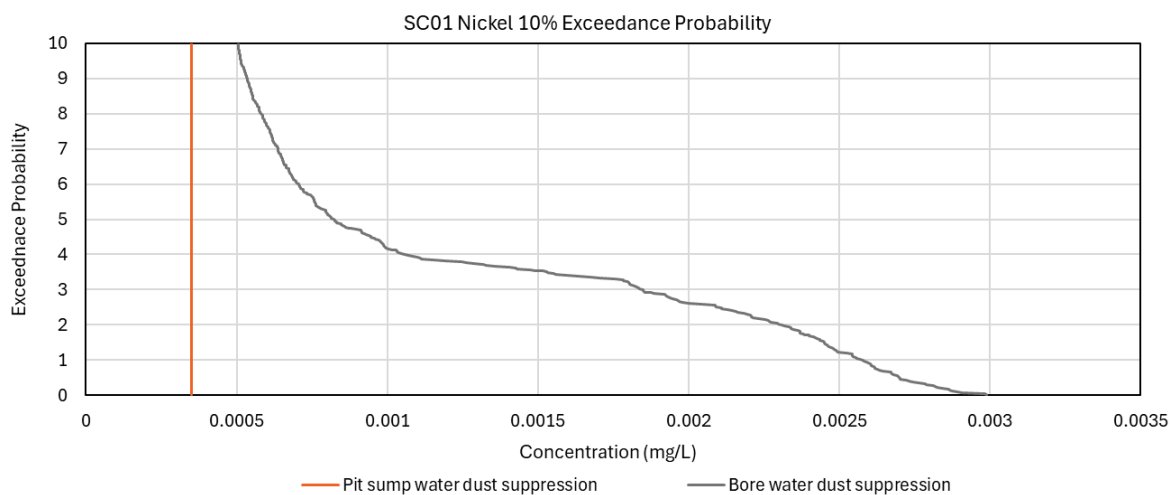


Figure 99: SC01 10% exceedance probability - nickel.

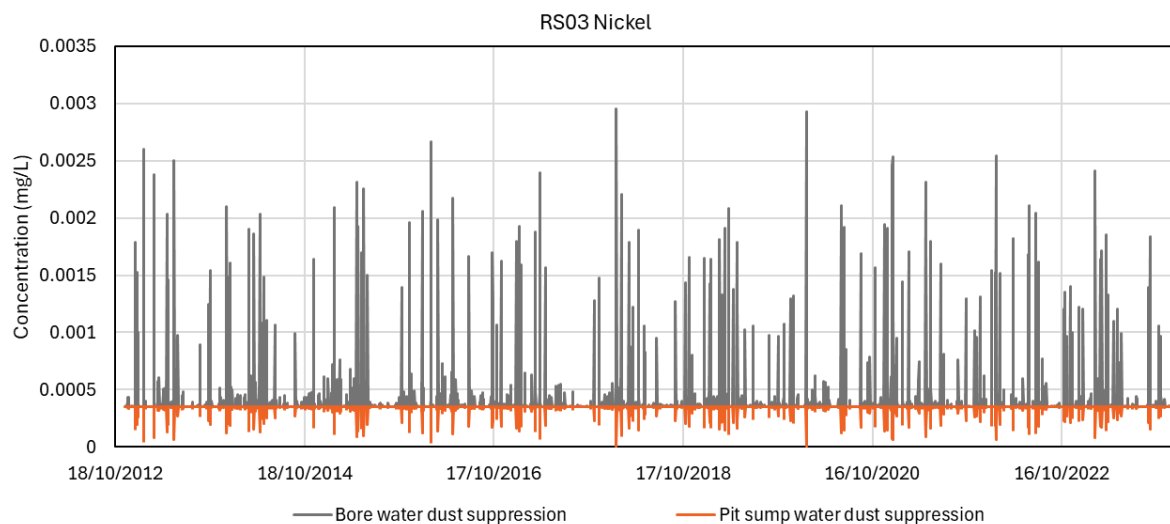


Figure 100: Modelled nickel concentrations in RS03 over time.

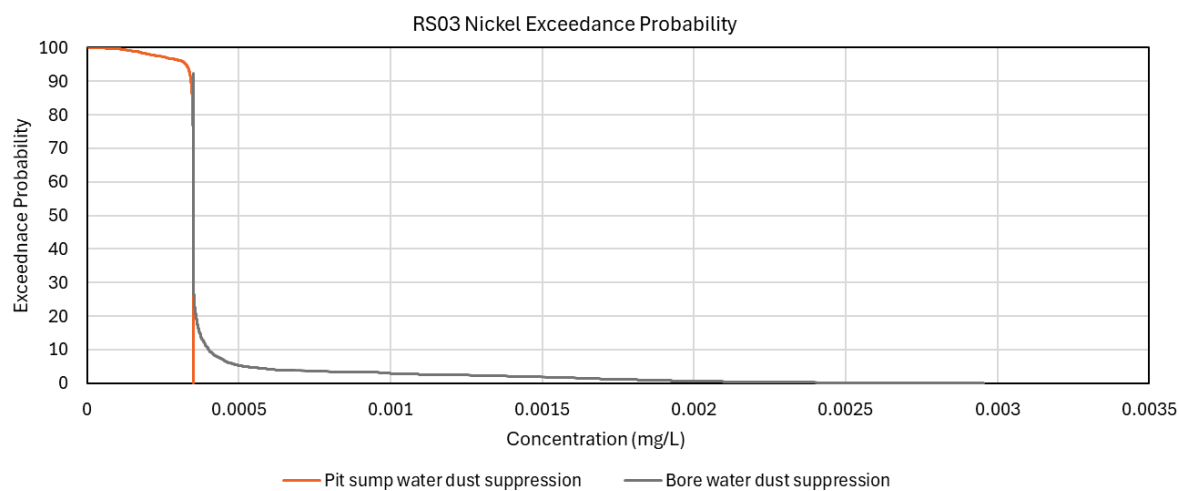


Figure 101: RS03 exceedance probability - nickel.

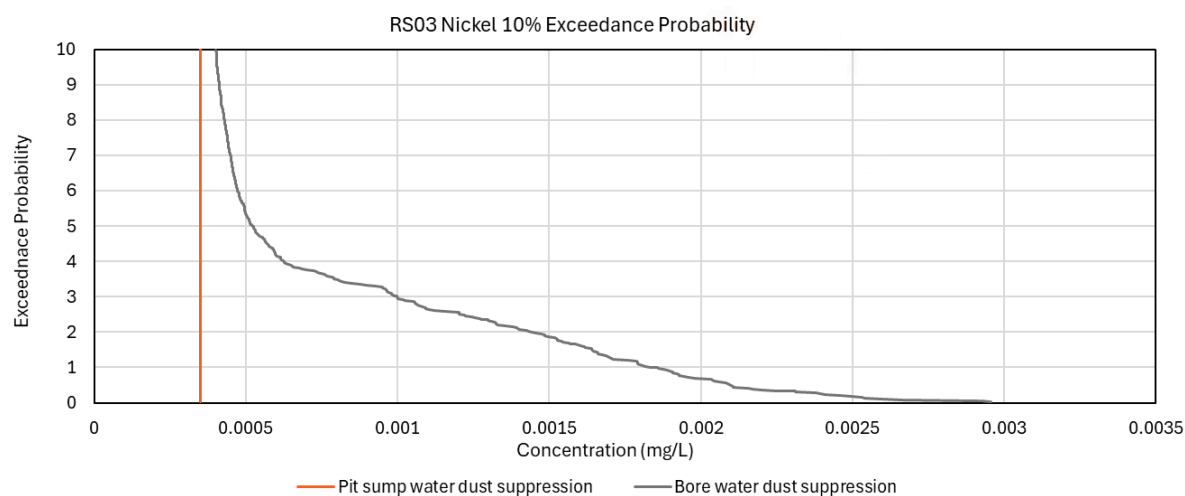


Figure 102: RS03 10% exceedance probability - nickel.

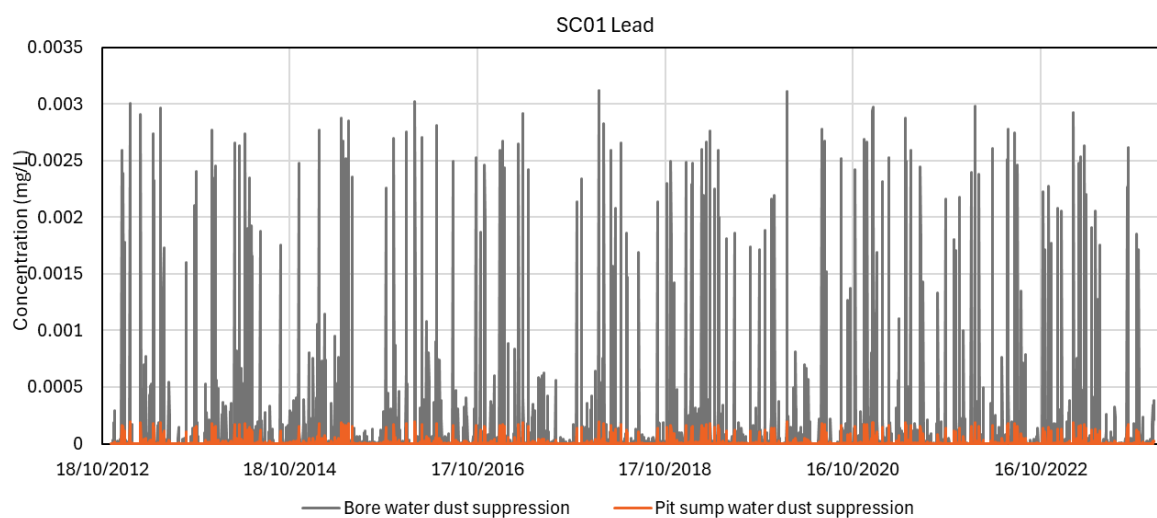


Figure 103: Modelled lead concentrations in SC01 over time.

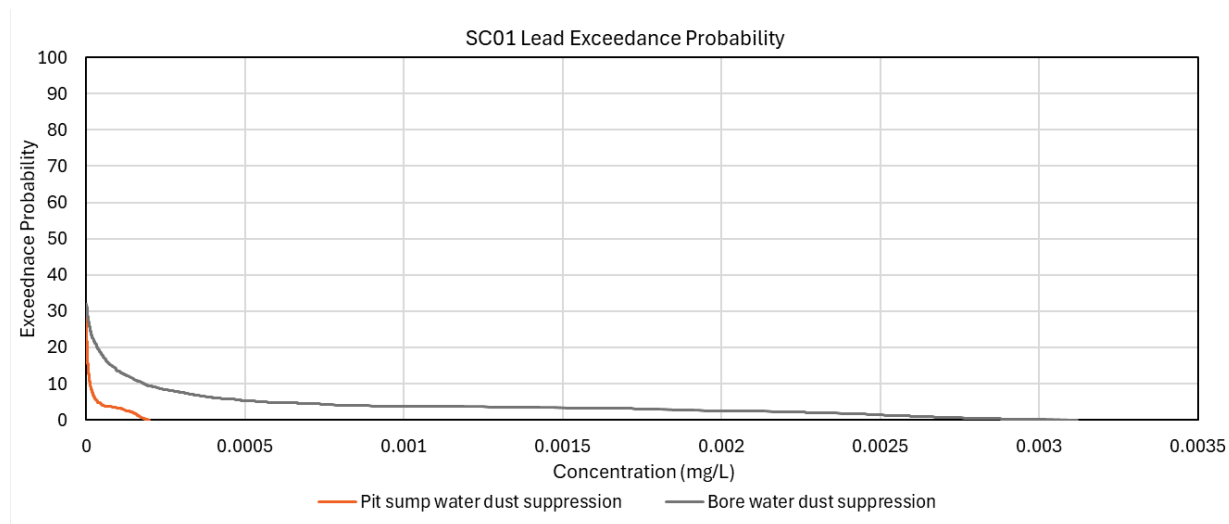


Figure 104: SC01 exceedance probability - lead.

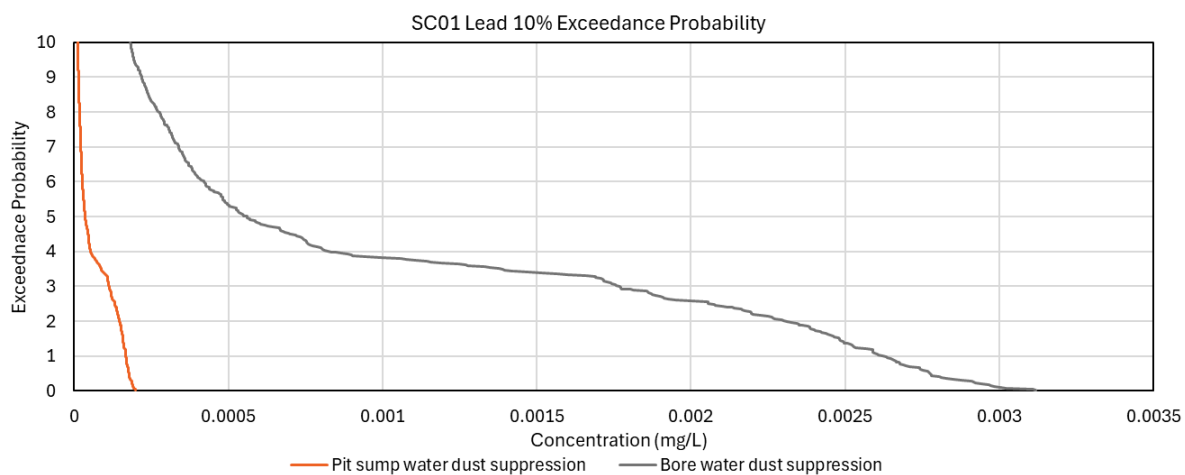


Figure 105: SC01 10% exceedance probability - lead.

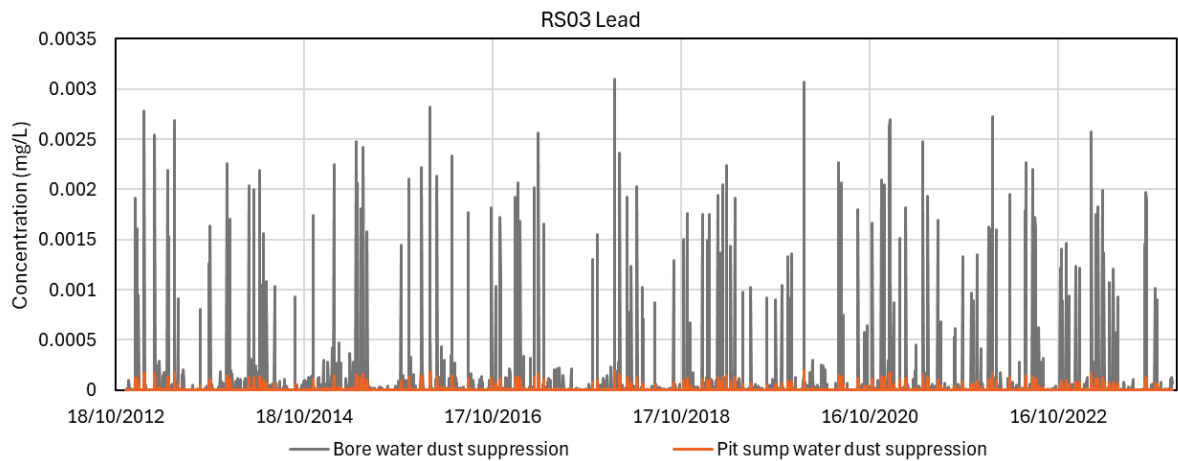


Figure 106: Modelled lead concentrations in RS03 over time.

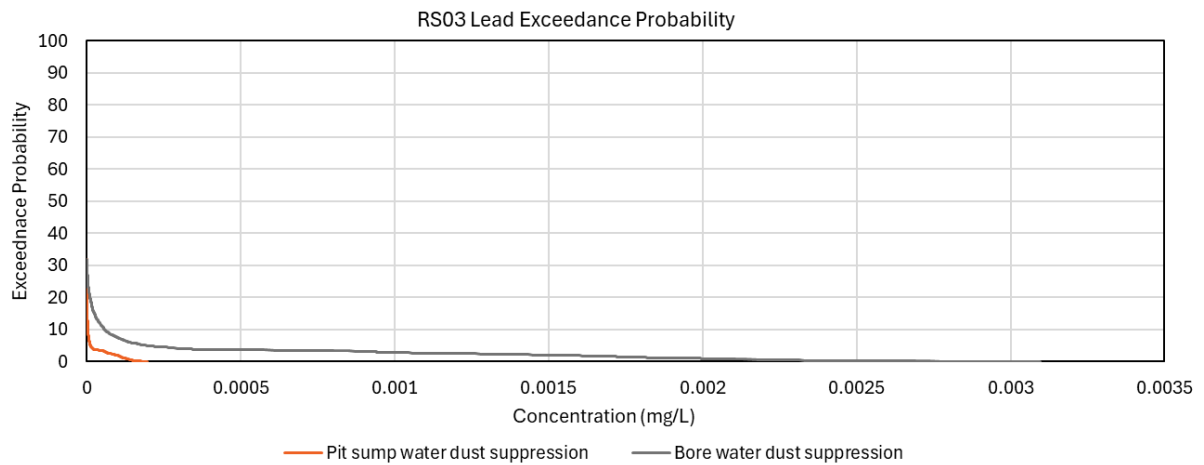


Figure 107: RS03 exceedance probability - lead.

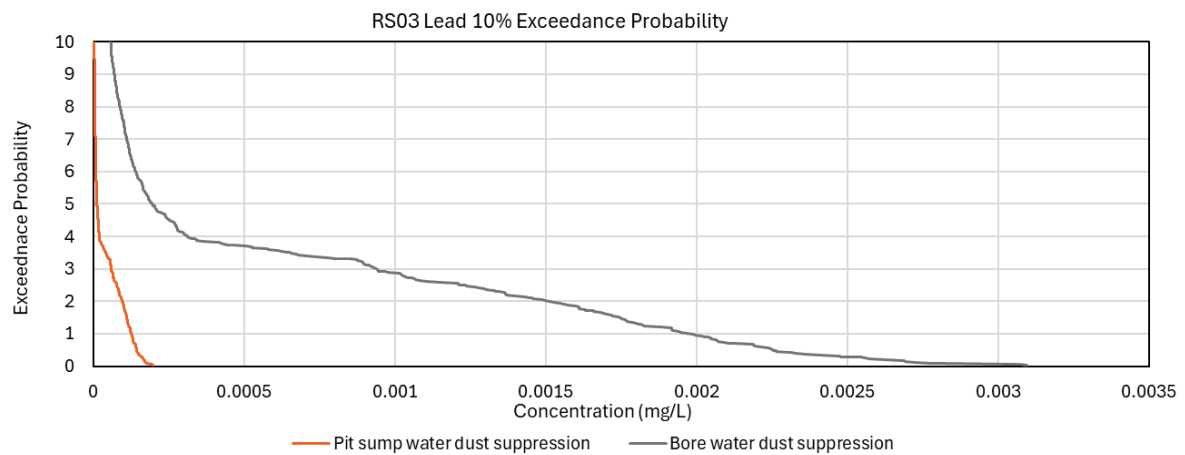


Figure 108: RS03 10% exceedance probability - lead.

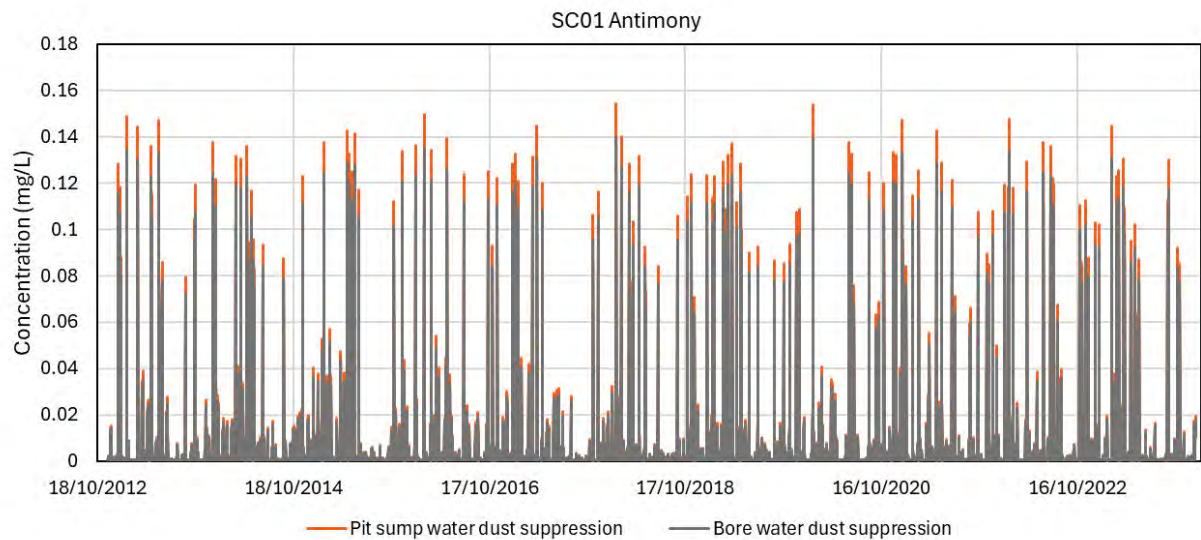


Figure 109: Modelled antimony concentrations in SC01 over time.

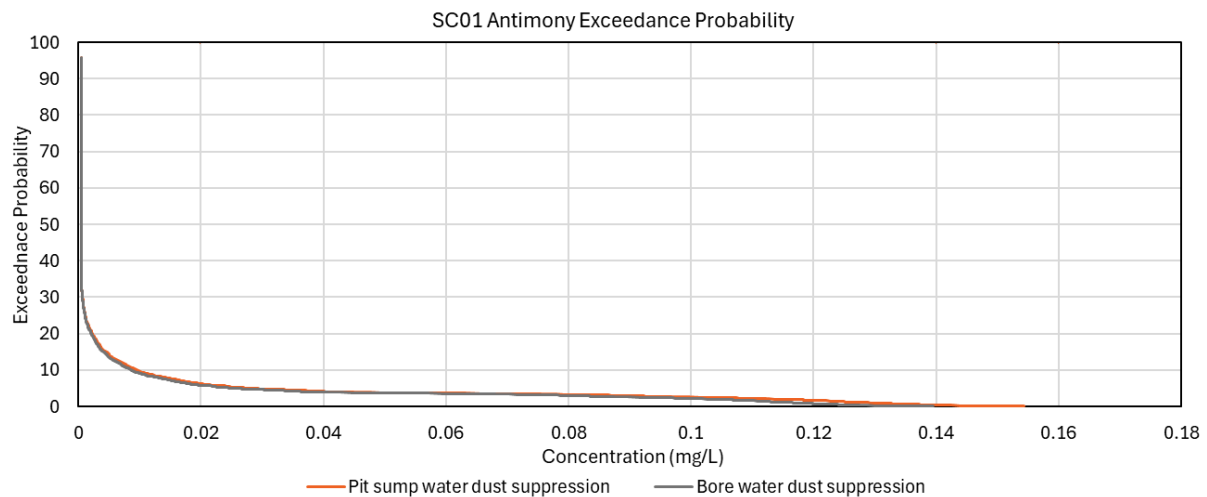


Figure 110: SC01 exceedance probability - antimony.

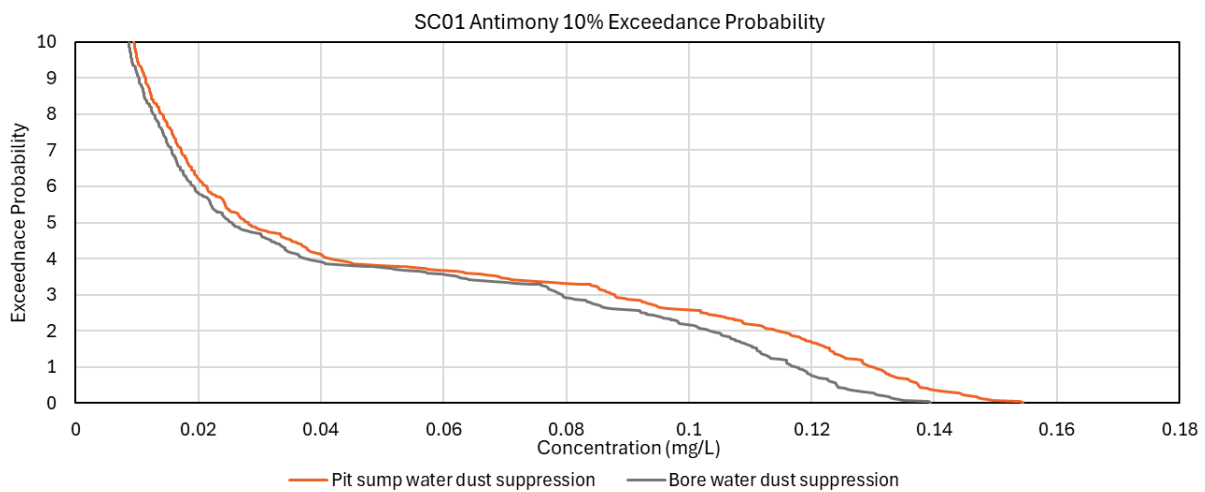


Figure 111: SC01 10% exceedance probability - antimony.

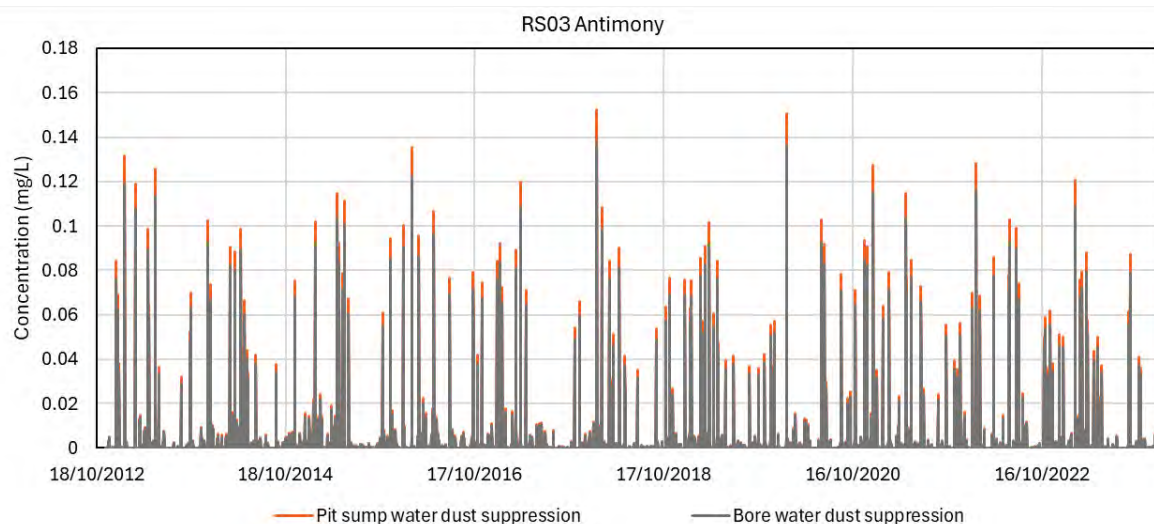


Figure 112: Modelled antimony concentrations in RS03 over time.

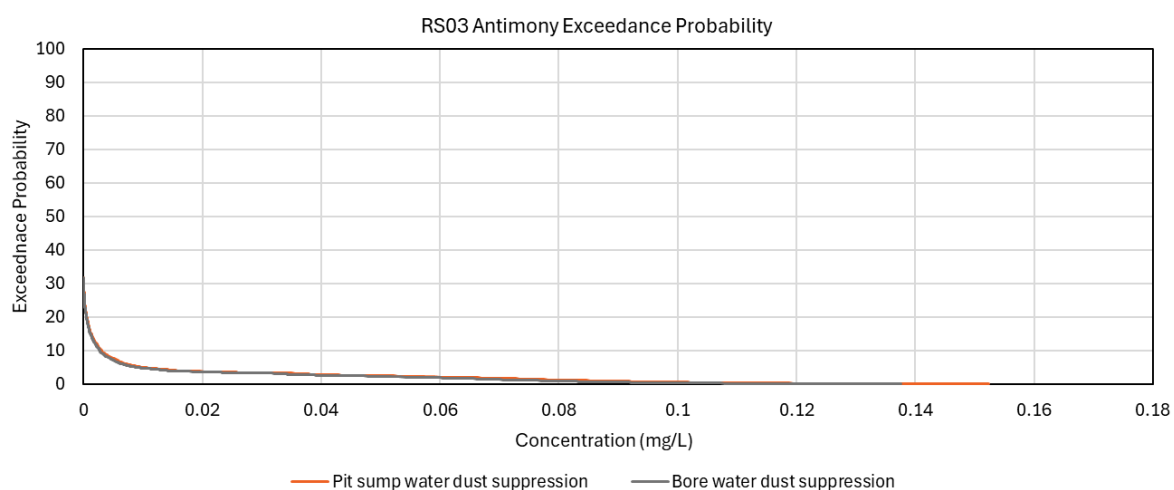


Figure 113: RS03 exceedance probability - antimony.

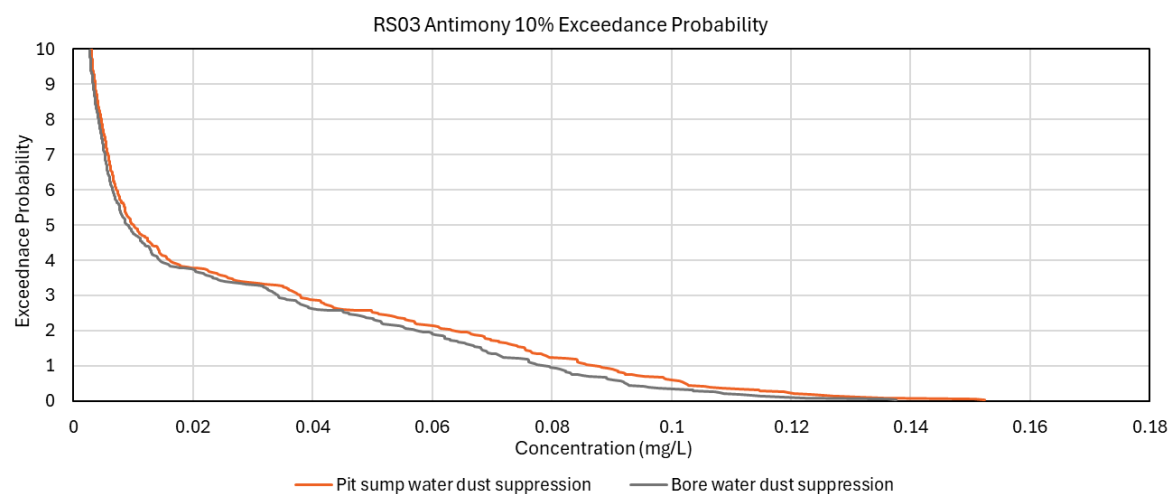


Figure 114: RS03 10% exceedance probability - antimony.

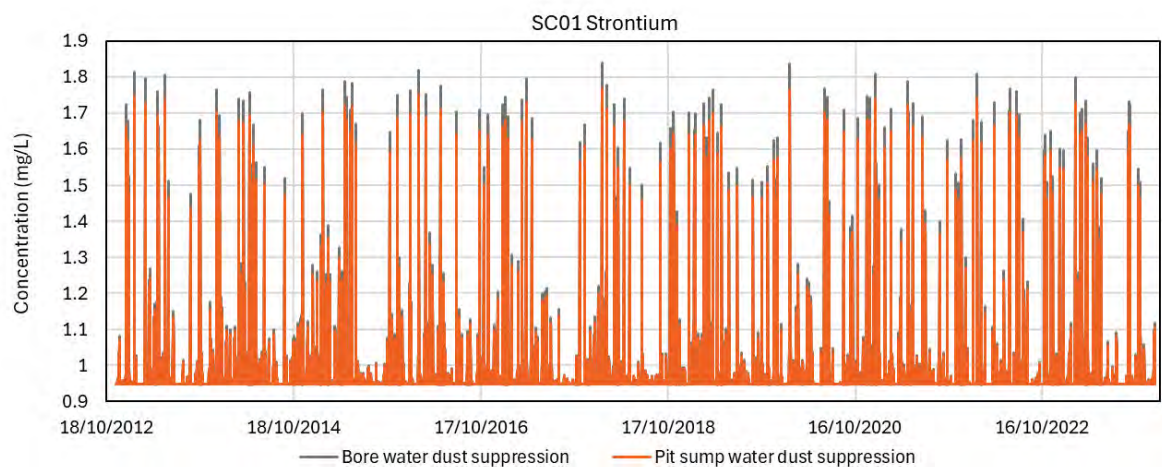


Figure 115: Modelled strontium concentrations in SC01 over time.

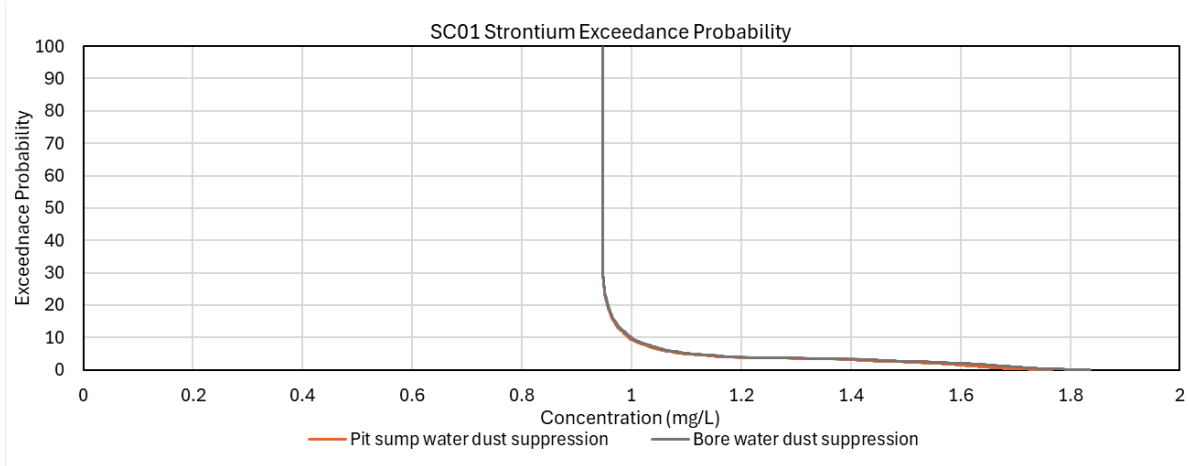


Figure 116: SC01 exceedance probability - strontium.

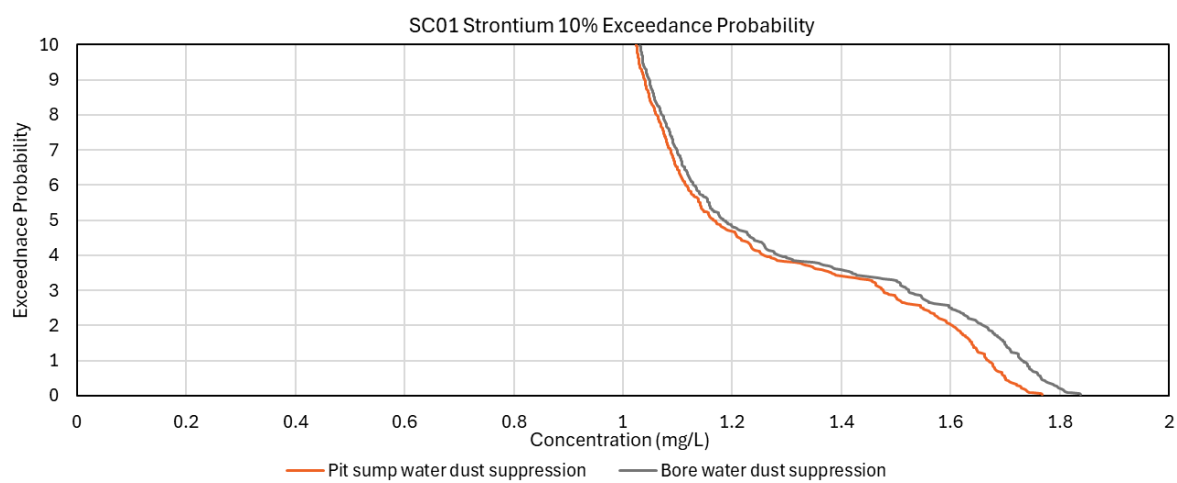


Figure 117: SC01 10% exceedance probability - strontium.

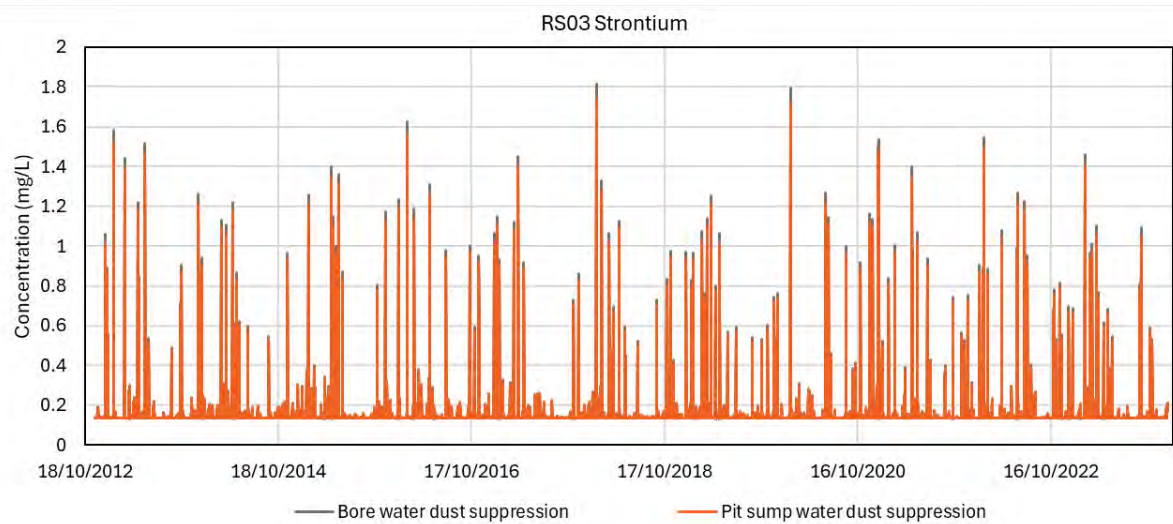


Figure 118: Modelled strontium concentrations in RS03 over time.

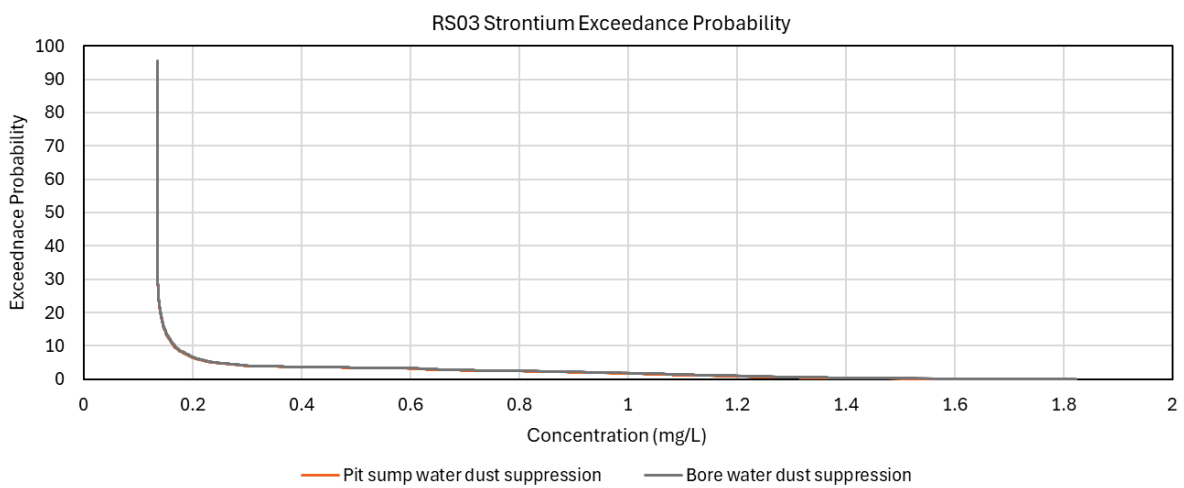


Figure 119: RS03 exceedance probability - strontium.

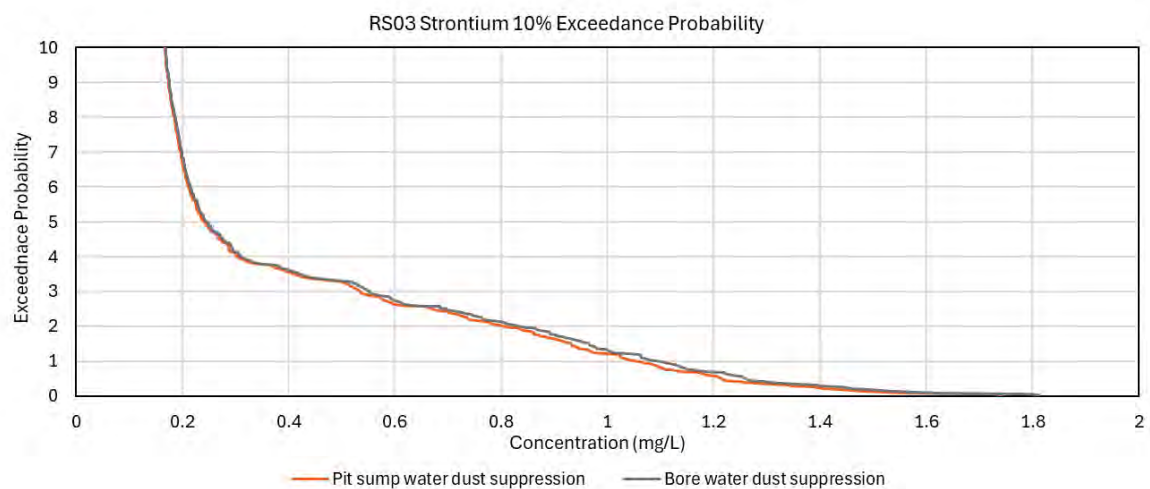


Figure 120: RS03 10% exceedance probability - strontium.

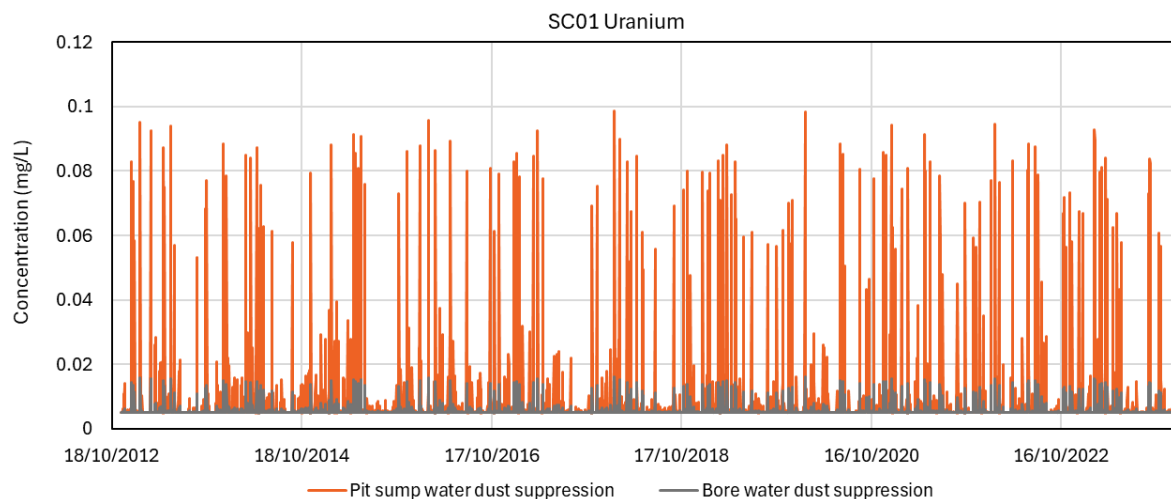


Figure 121: Modelled uranium concentrations in SC01 over time.

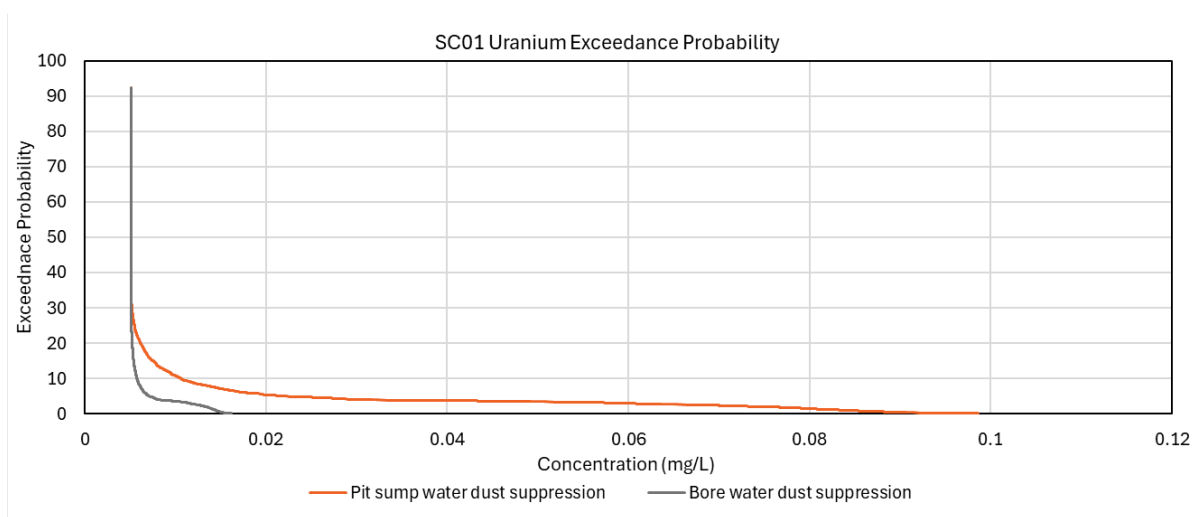


Figure 122: SC01 exceedance probability - uranium.

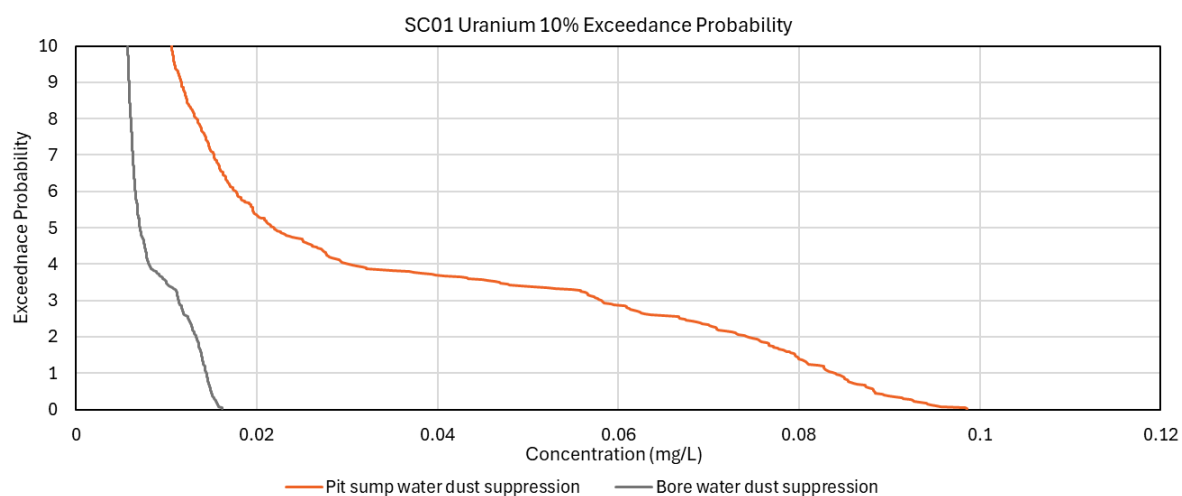


Figure 123: SC01 10% exceedance probability - uranium.

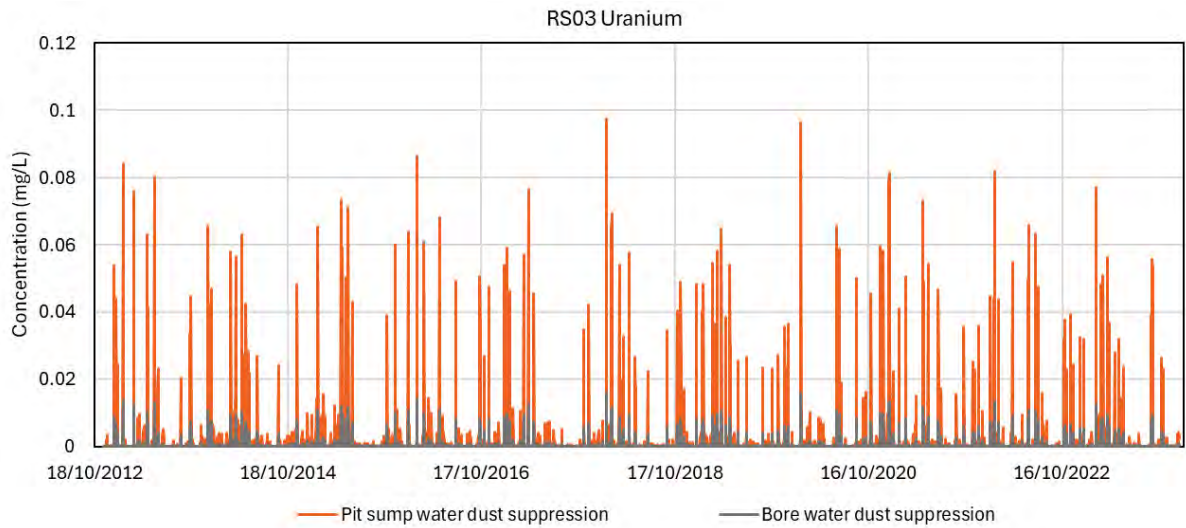


Figure 124: Modelled uranium concentrations in RS03 over time.

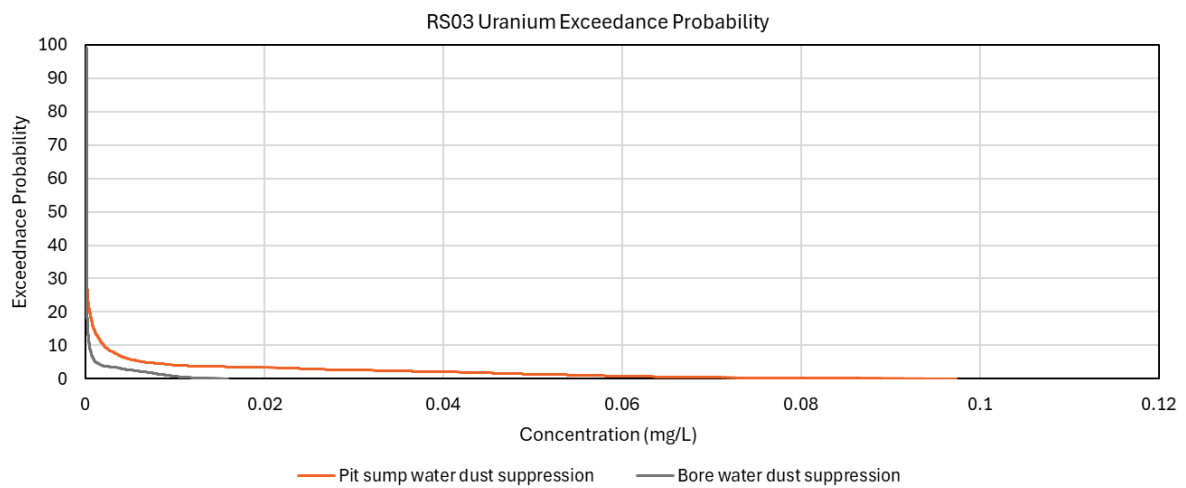


Figure 125: RS03 exceedance probability - uranium.

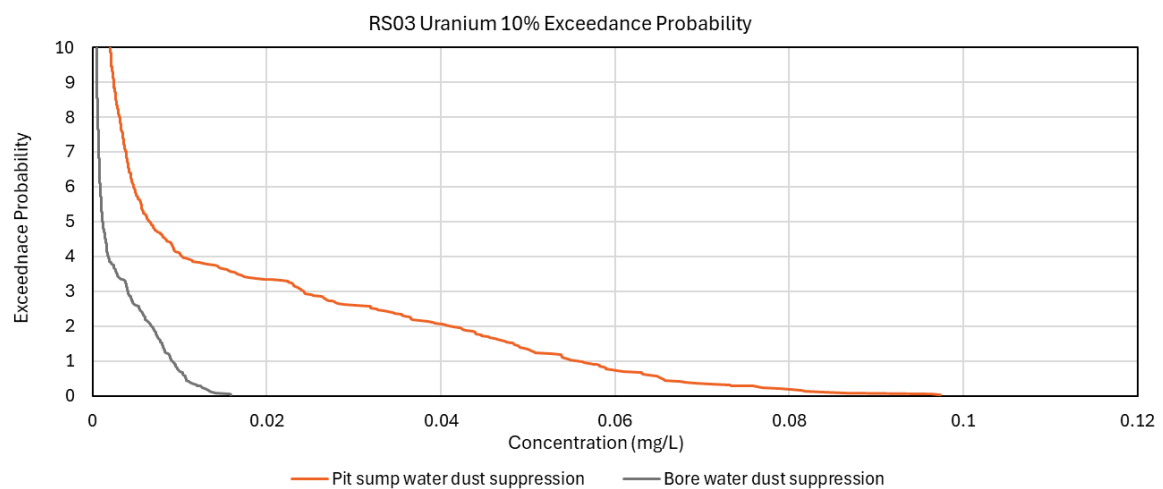


Figure 126: RS03 10% exceedance probability - uranium.

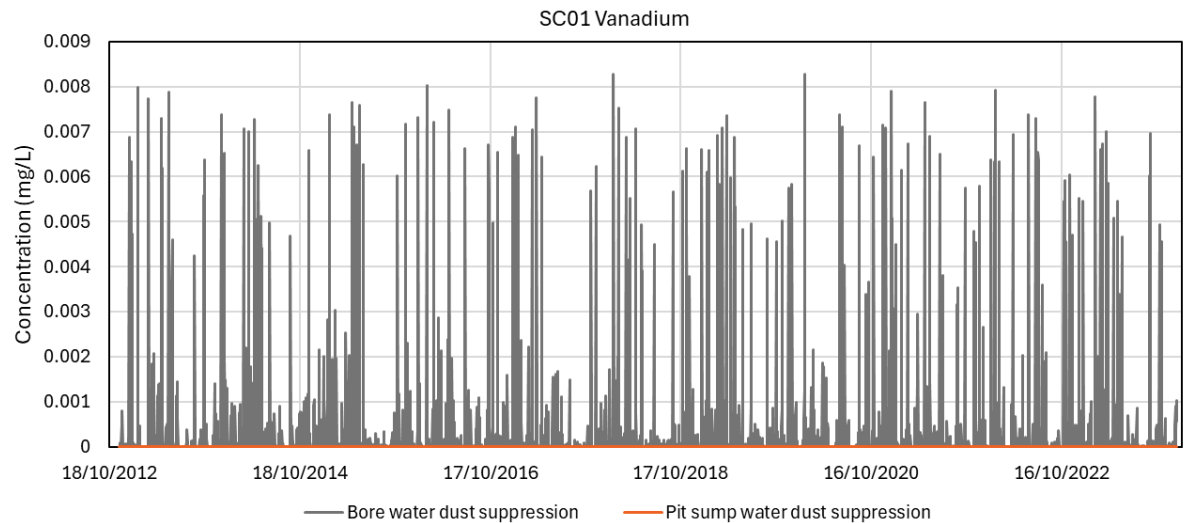


Figure 127: Modelled vanadium concentrations in SC01 over time.

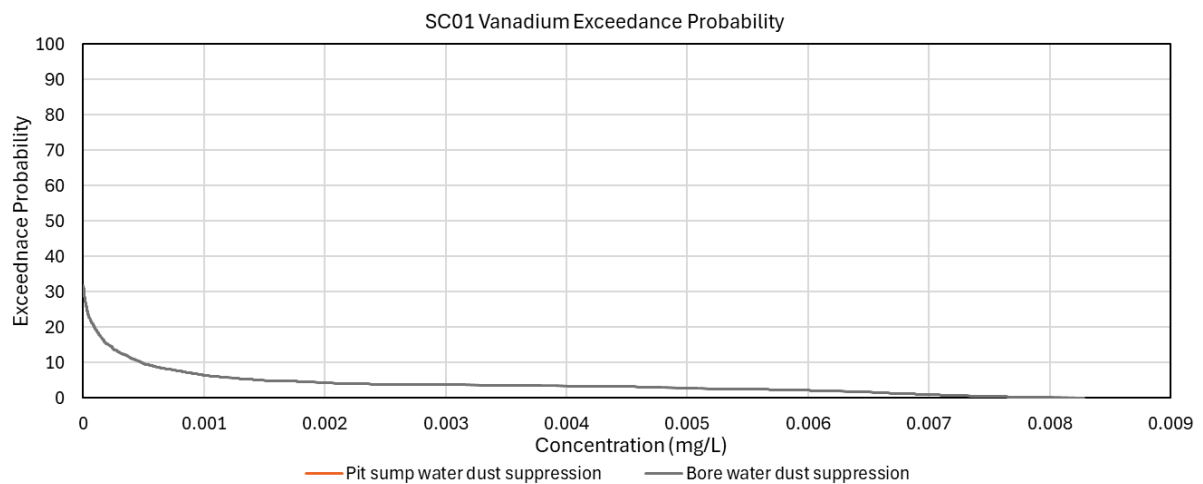


Figure 128: SC01 exceedance probability - vanadium.

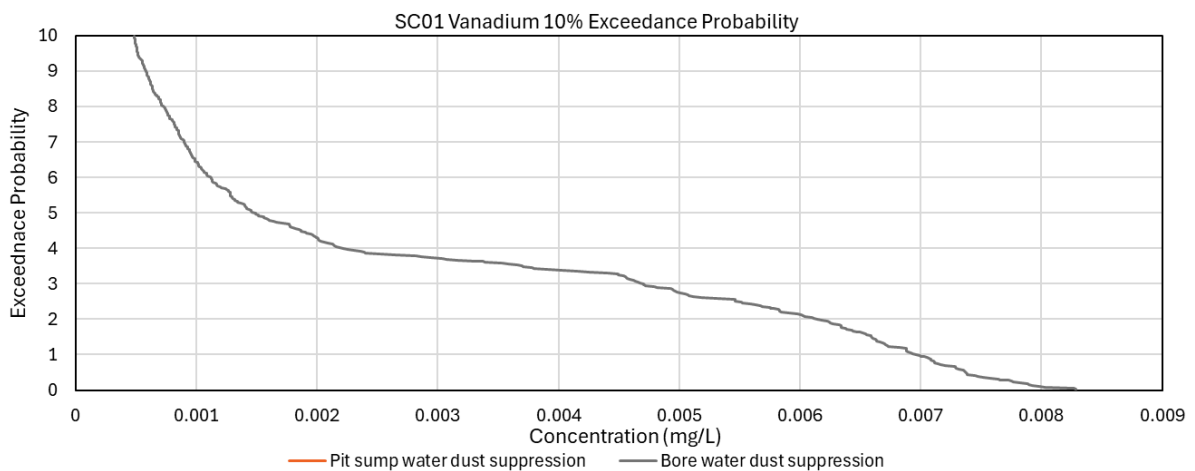


Figure 129: SC01 10% exceedance probability - vanadium.

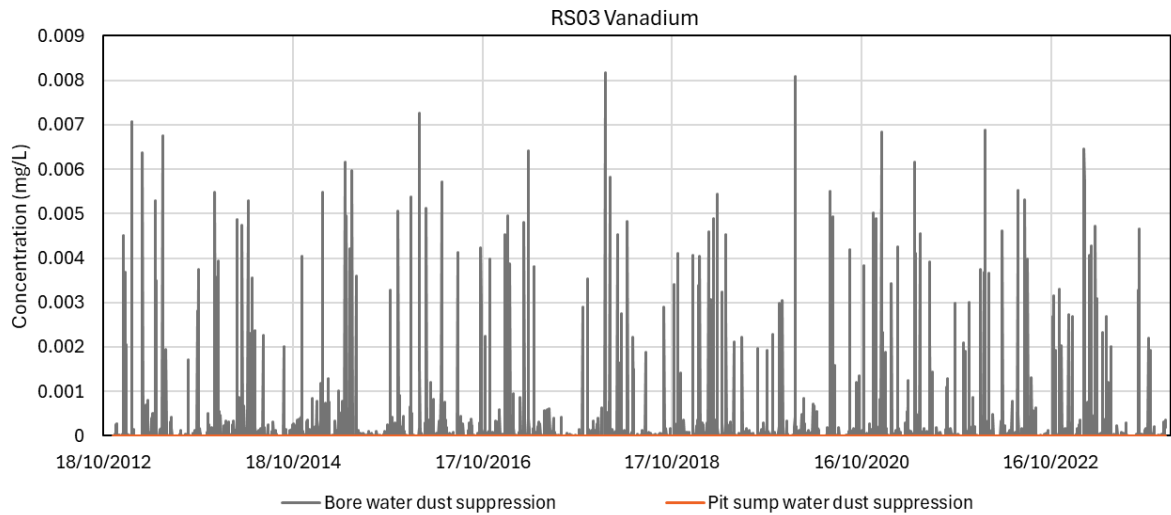


Figure 130: Modelled vanadium concentrations in RS03 over time.

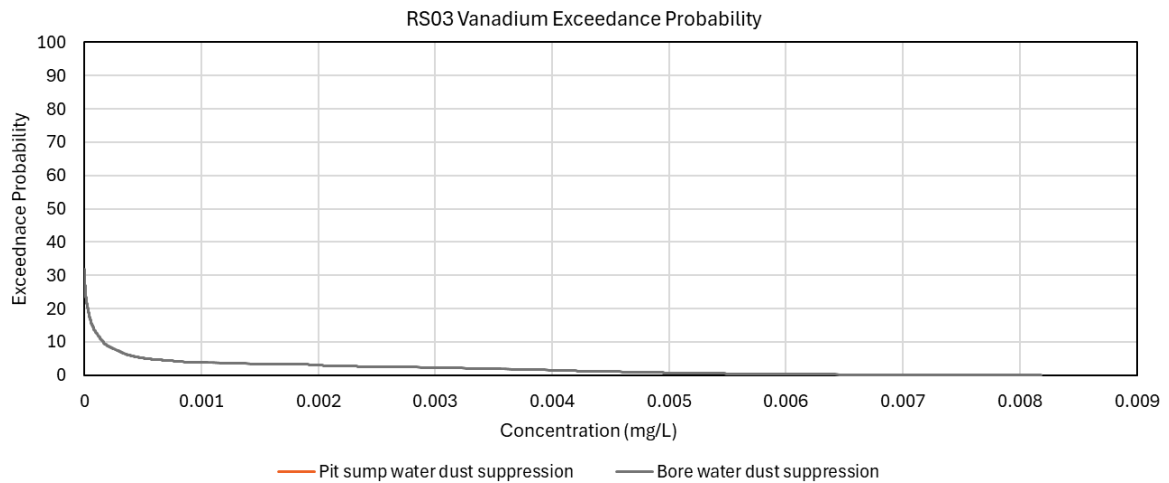


Figure 131: RS03 exceedance probability - vanadium.

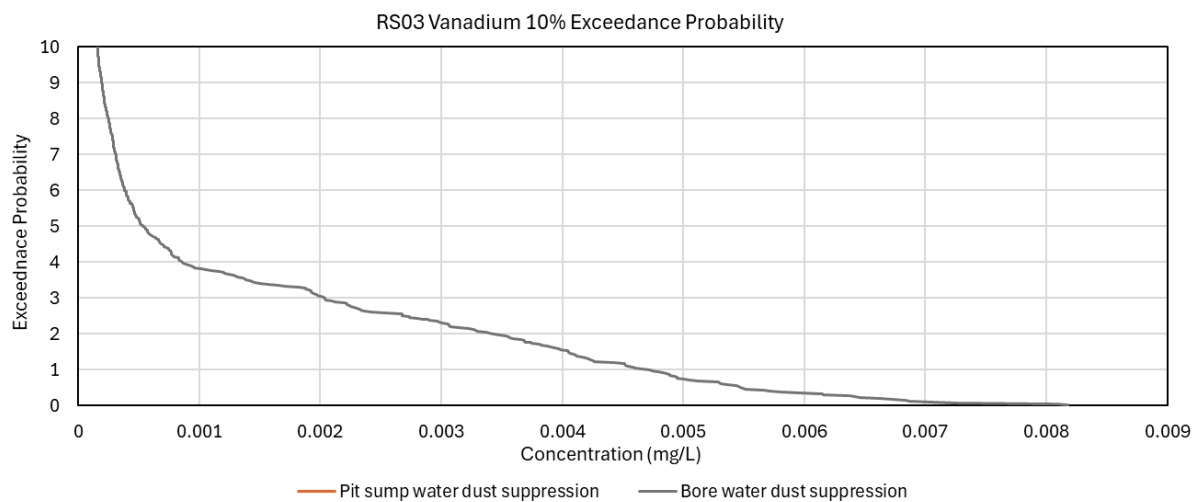


Figure 132: RS03 10% exceedance probability - vanadium.

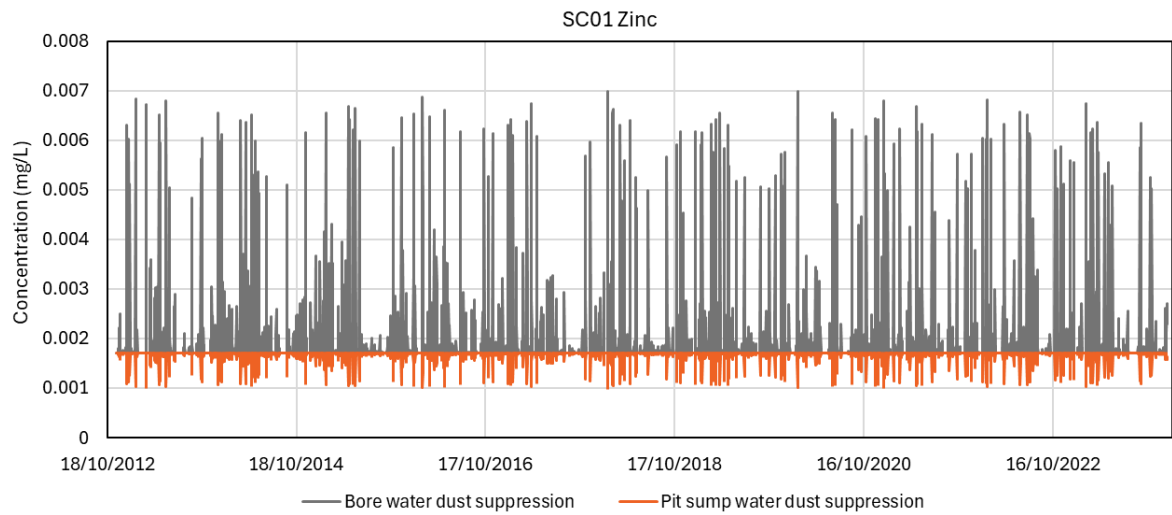


Figure 133: Modelled zinc concentrations in SC01 over time.

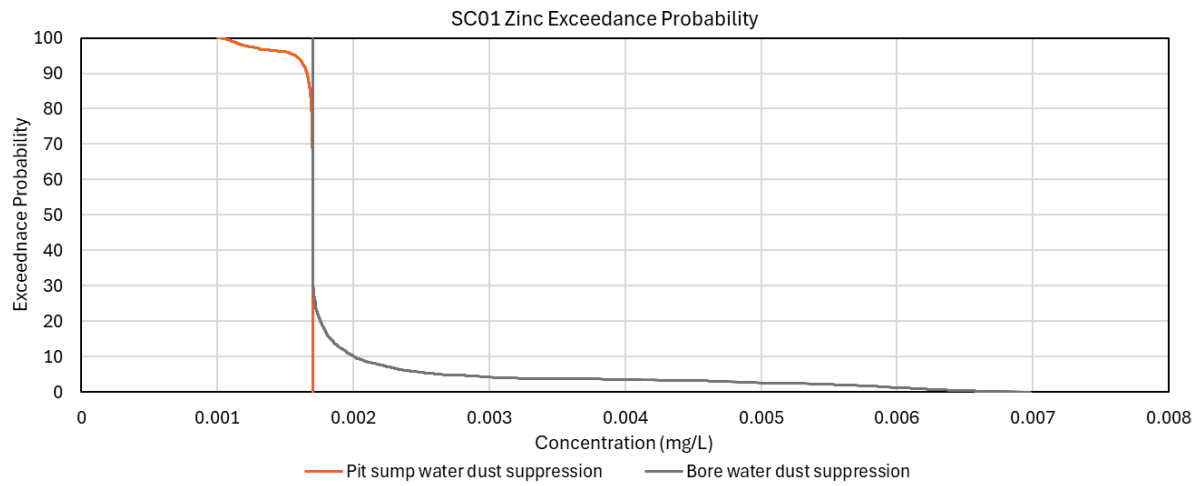


Figure 134: SC01 exceedance probability - zinc.

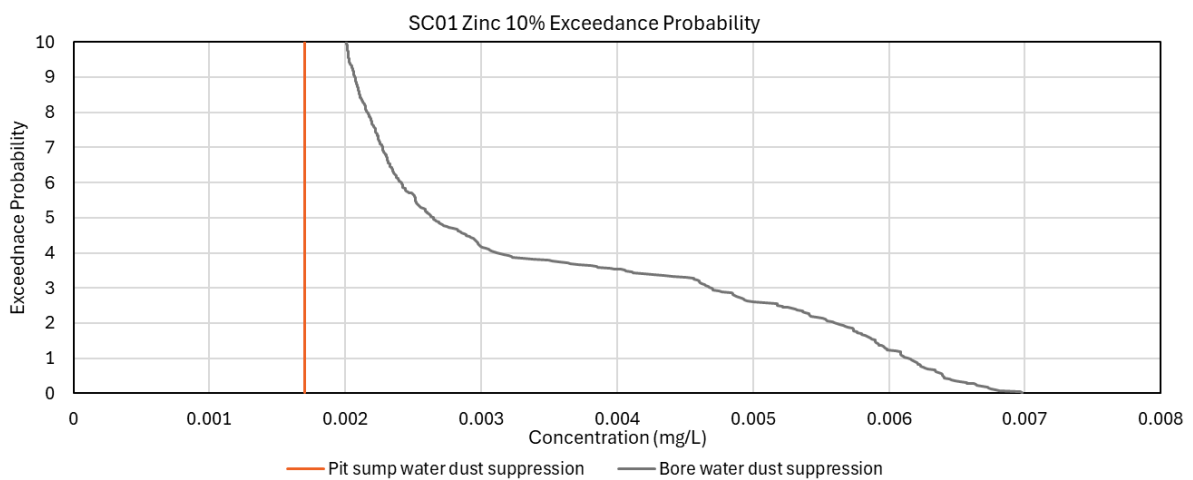


Figure 135: SC01 10% exceedance probability - zinc.

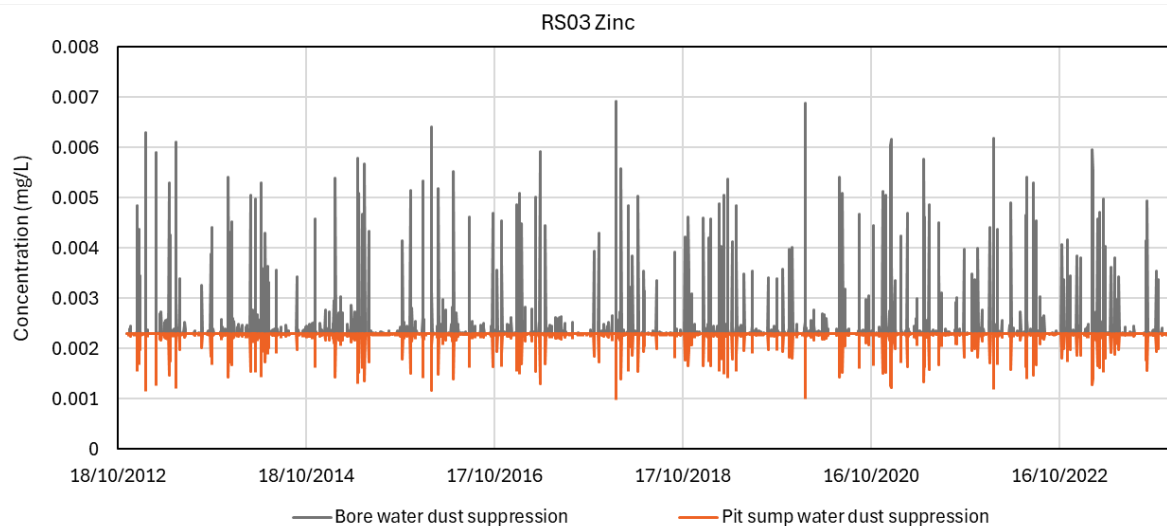


Figure 136: Modelled zinc concentrations in RS03 over time.

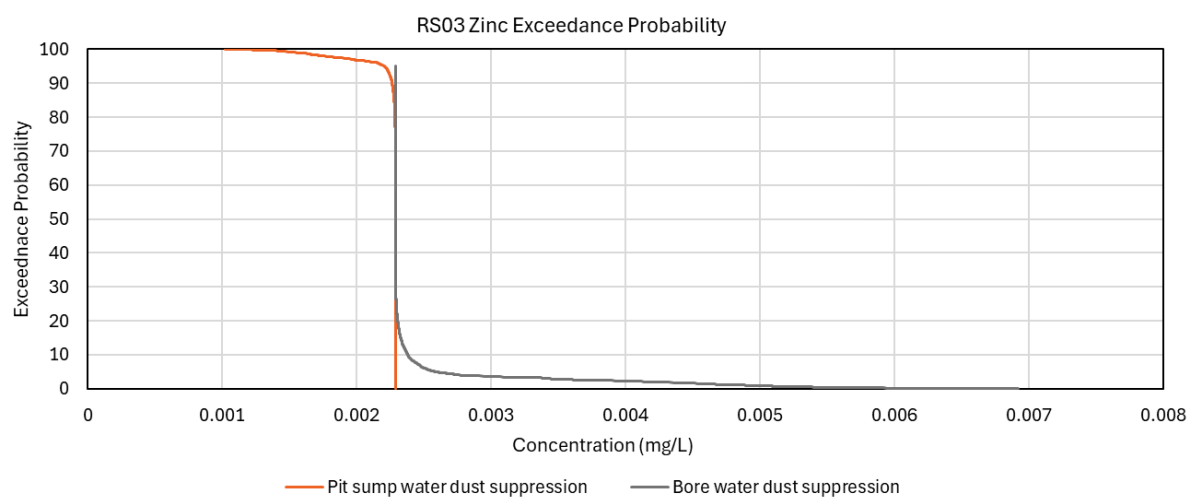


Figure 137: RS03 exceedance probability - zinc.

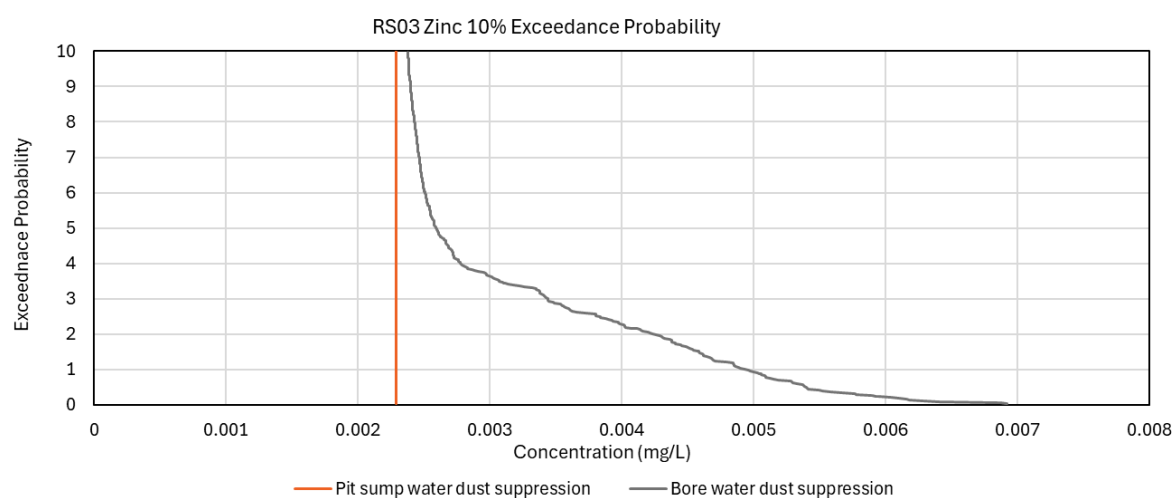


Figure 138: RS03 10% exceedance probability - zinc.

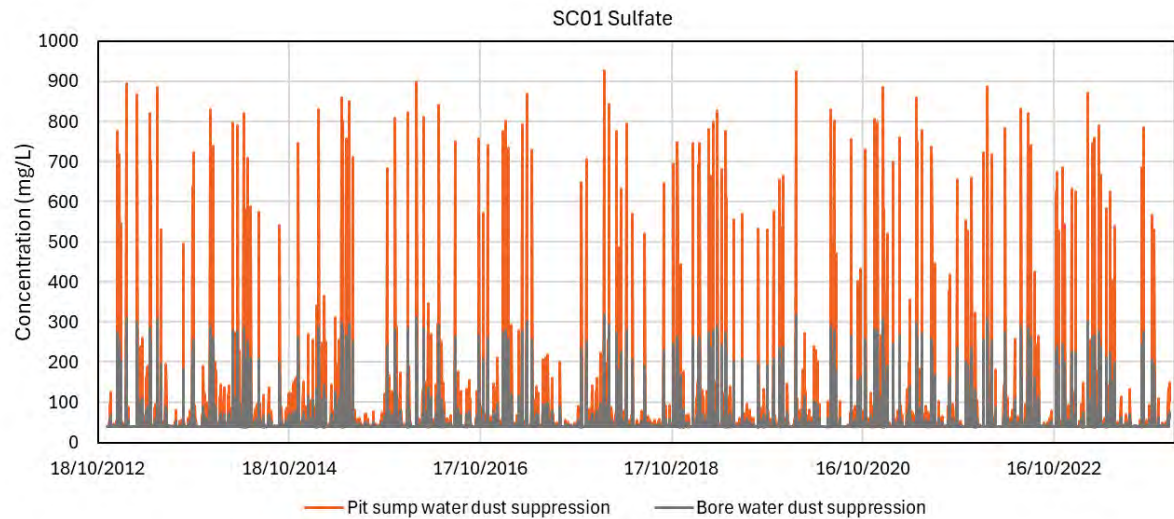


Figure 139: Modelled sulfate concentrations in SC01 over time.

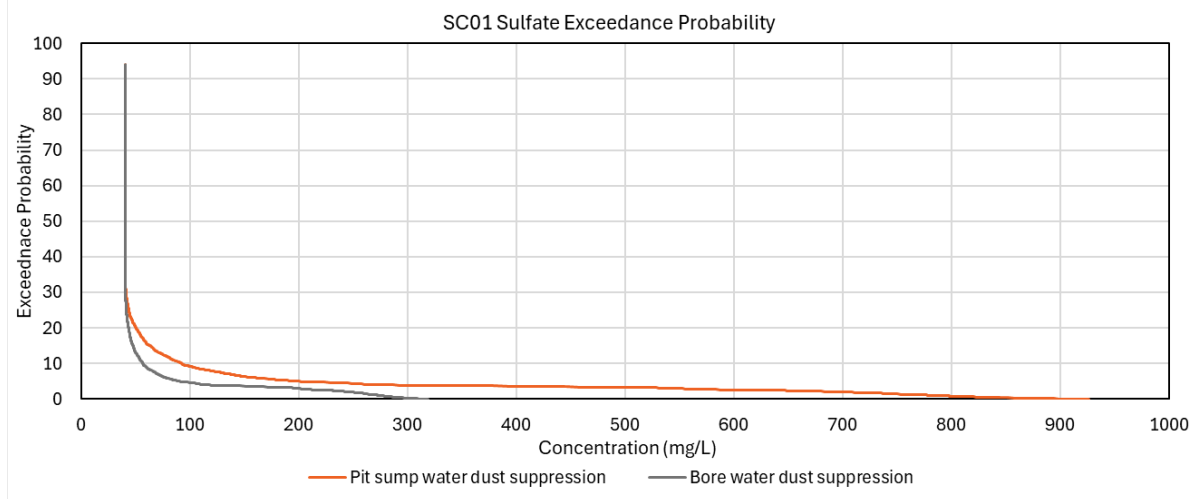


Figure 140: SC01 exceedance probability - sulfate.

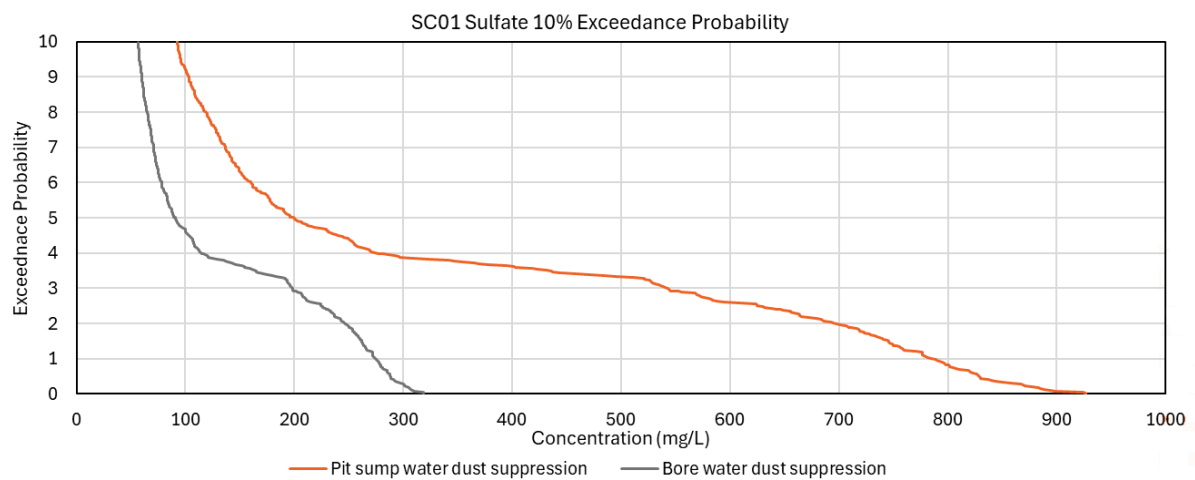


Figure 141: SC01 10% exceedance probability - sulfate.

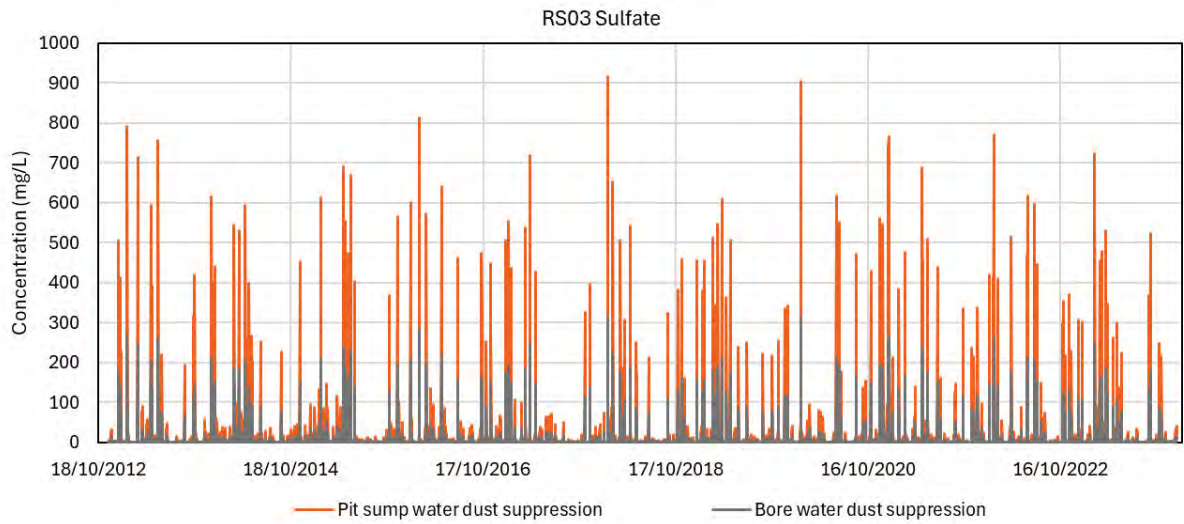


Figure 142: Modelled sulfate concentrations in RS03 over time.

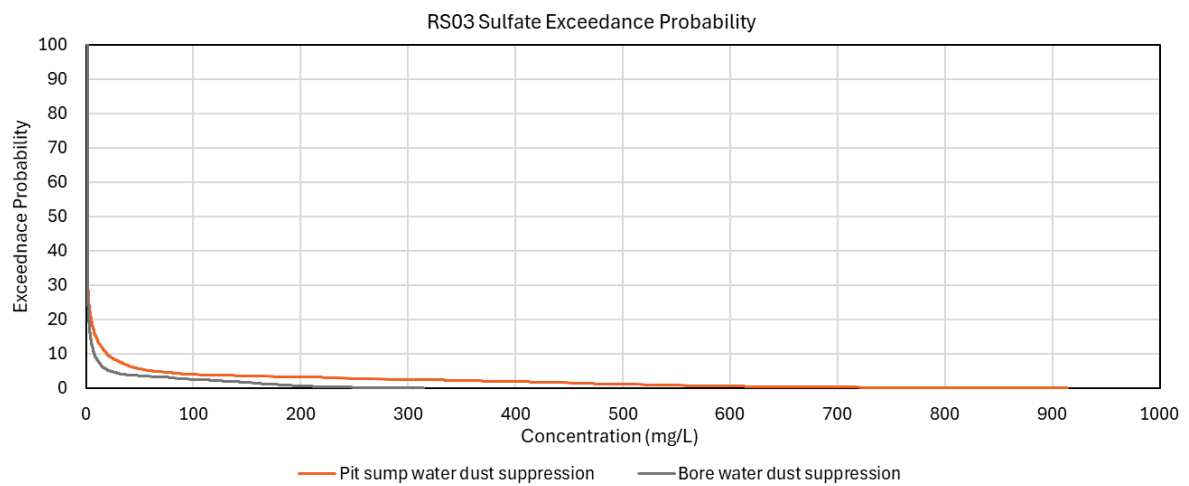


Figure 143: RS03 exceedance probability - sulfate.

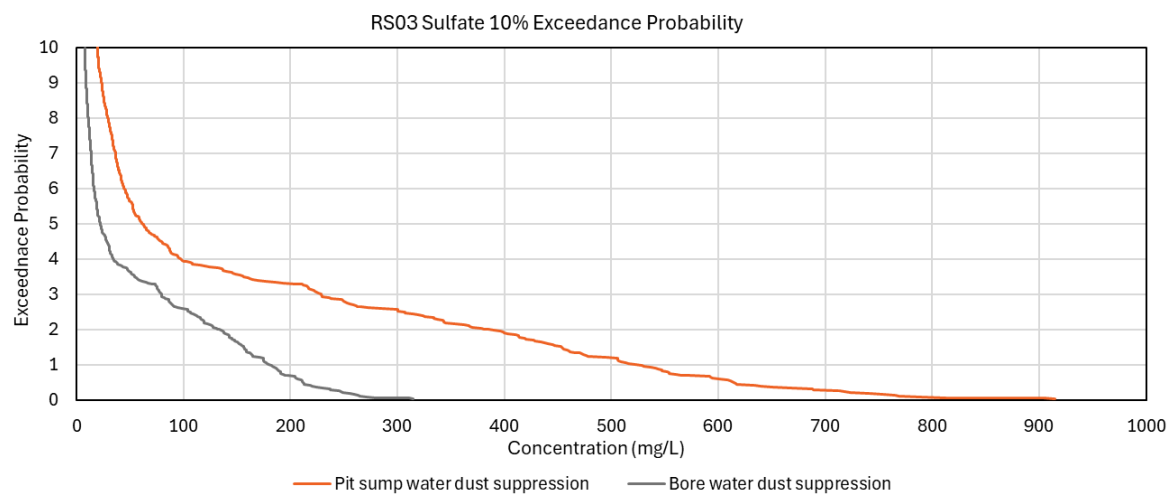


Figure 144: RS03 10% exceedance probability - sulfate.

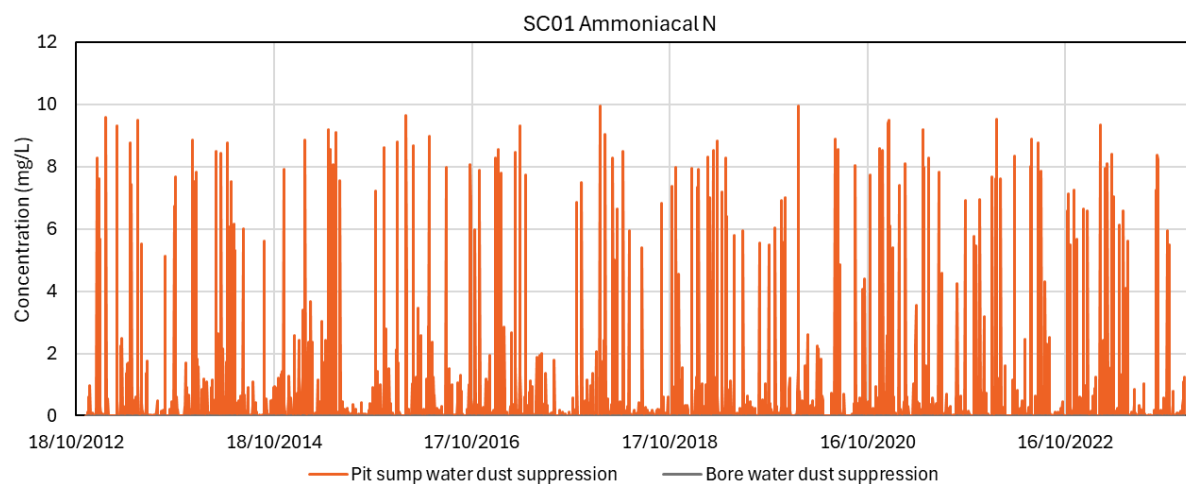


Figure 145: Modelled ammoniacal N concentrations in SC01 over time.

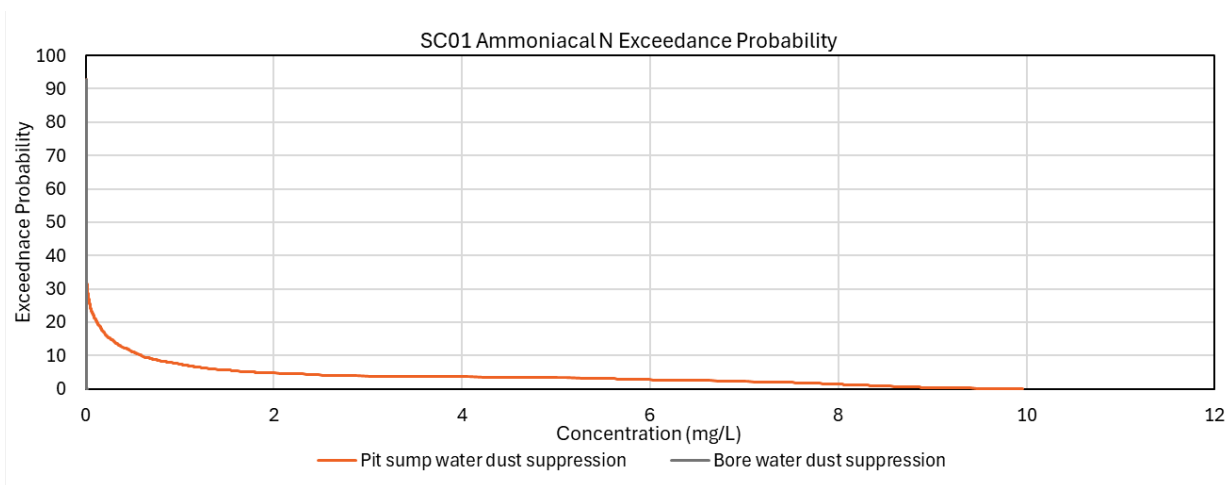


Figure 146: SC01 exceedance probability - ammoniacal N.

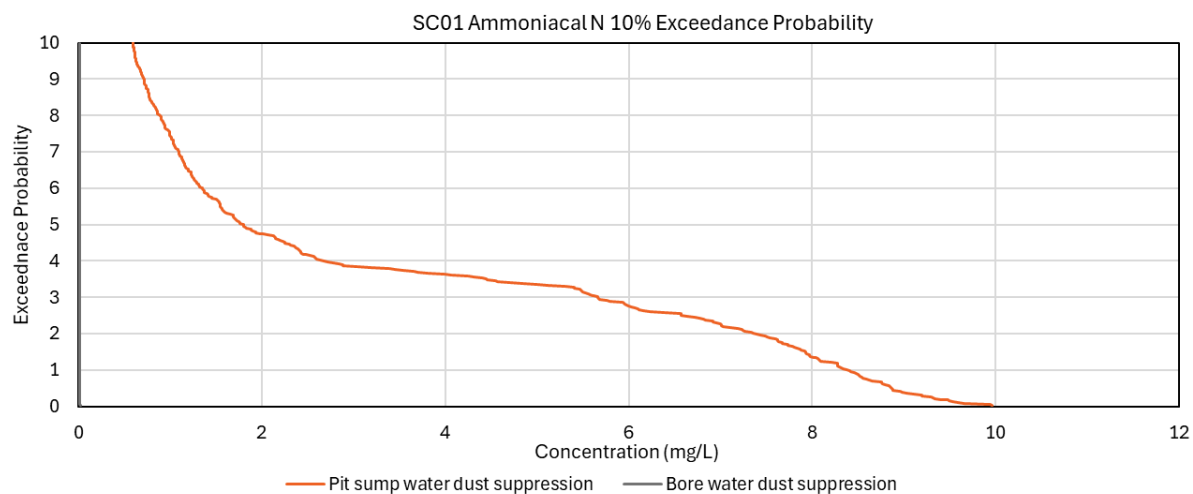


Figure 147: SC01 10% exceedance probability - ammoniacal N.

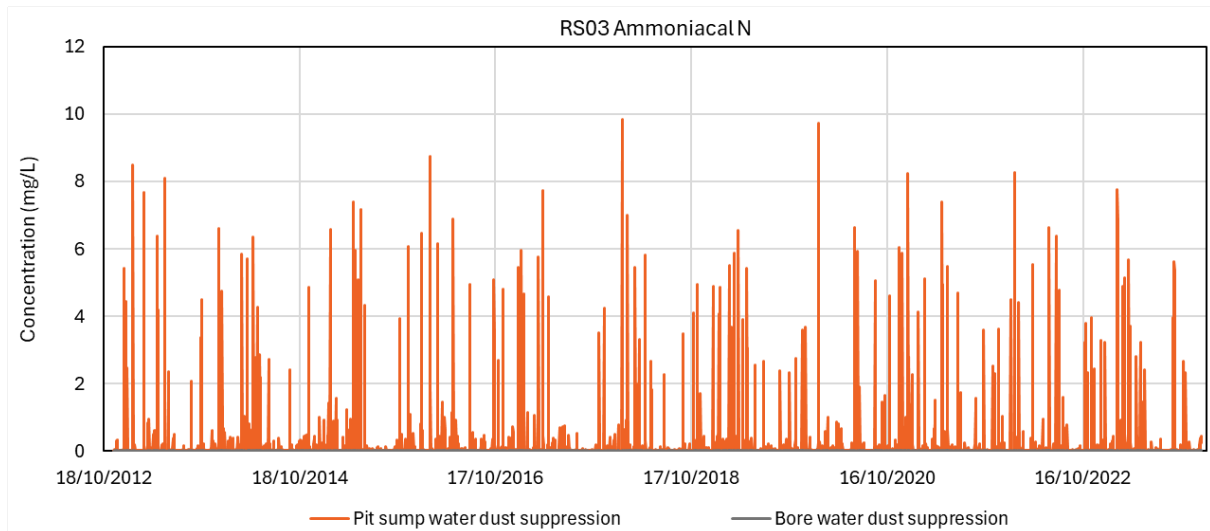


Figure 148: Modelled ammoniacal N concentrations in RS03 over time.

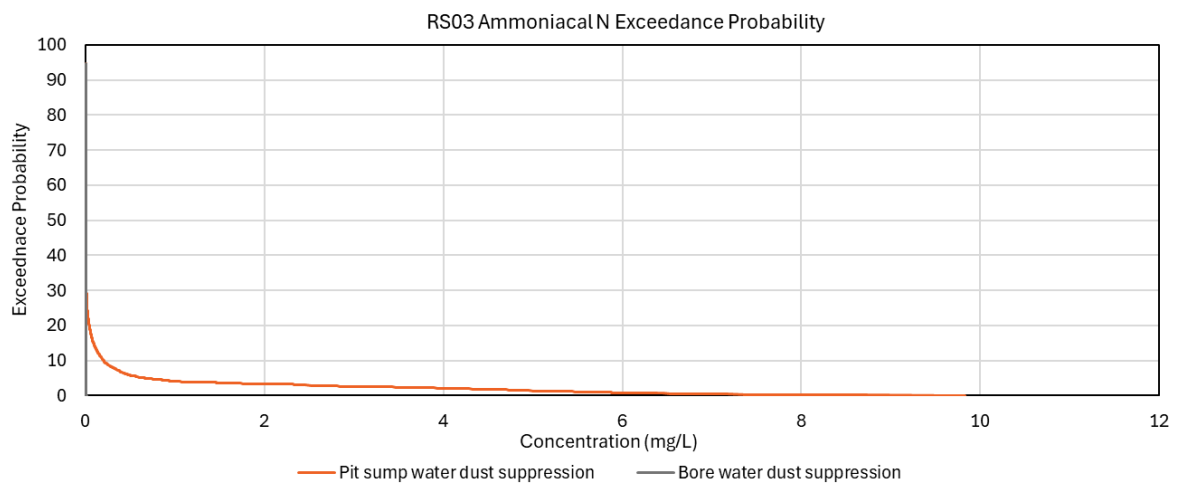


Figure 149: RS03 exceedance probability - ammoniacal N.

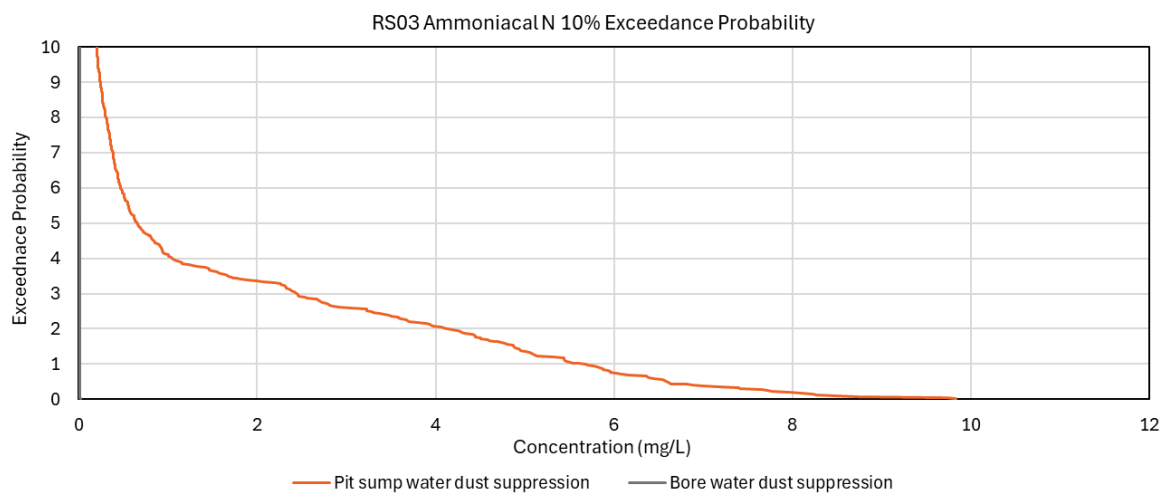


Figure 150: RS03 10% exceedance probability - ammoniacal N.

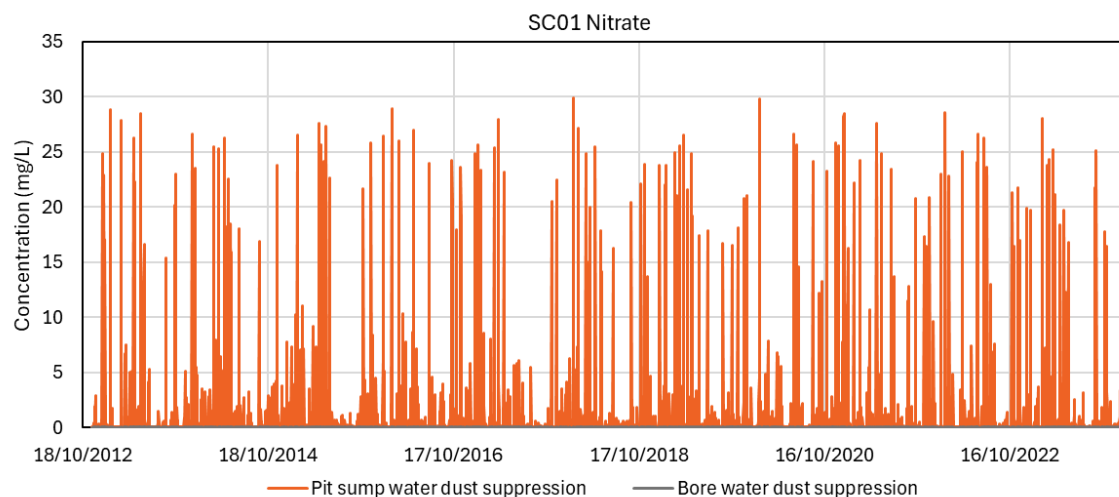


Figure 151: Modelled nitrate concentrations in SC01 over time.

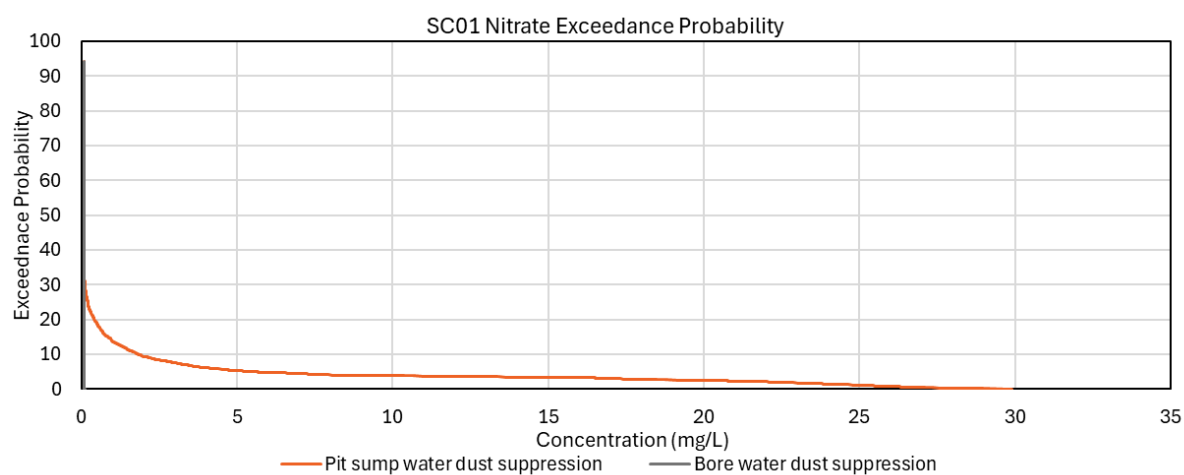


Figure 152: SC01 exceedance probability - nitrate.

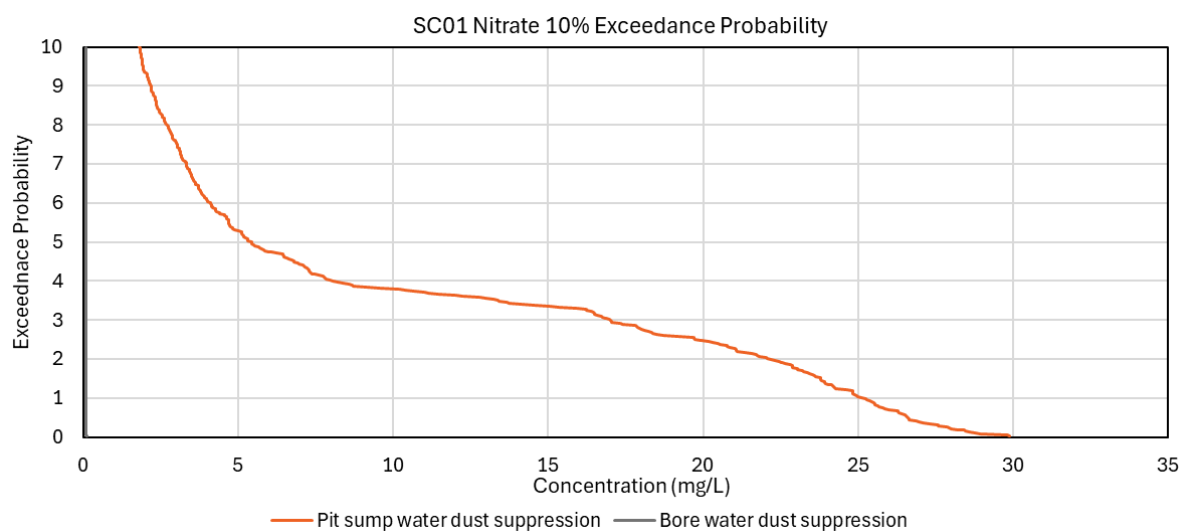


Figure 153: SC01 10% exceedance probability - nitrate.

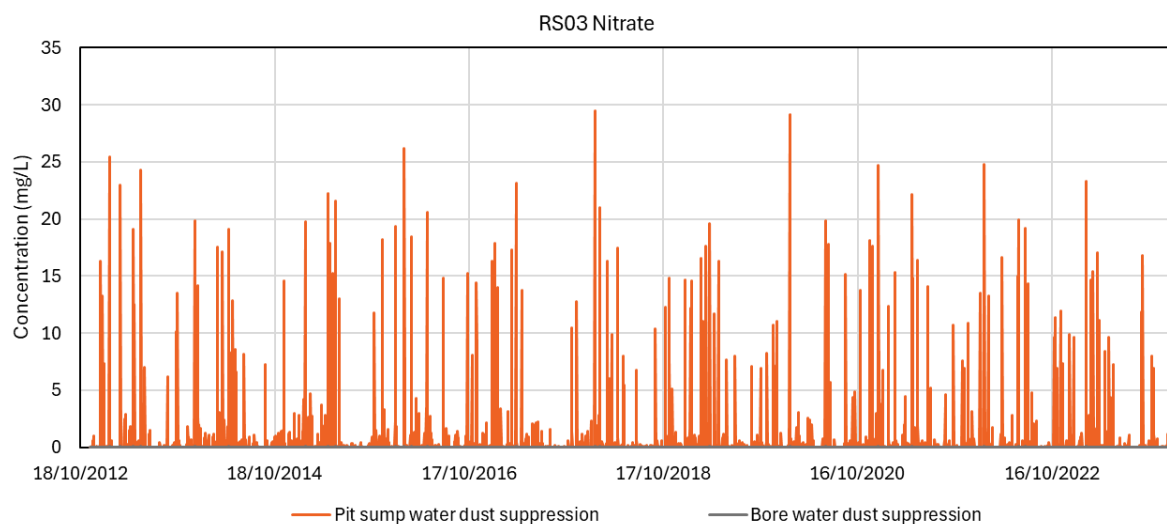


Figure 154: Modelled nitrate concentrations in RS03 over time.

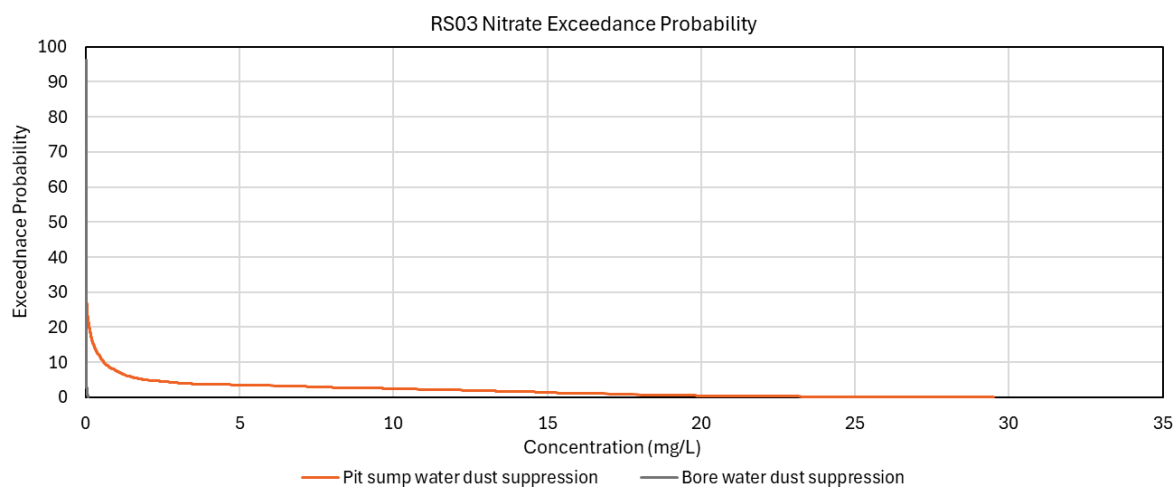


Figure 155: RS03 exceedance probability - nitrate.

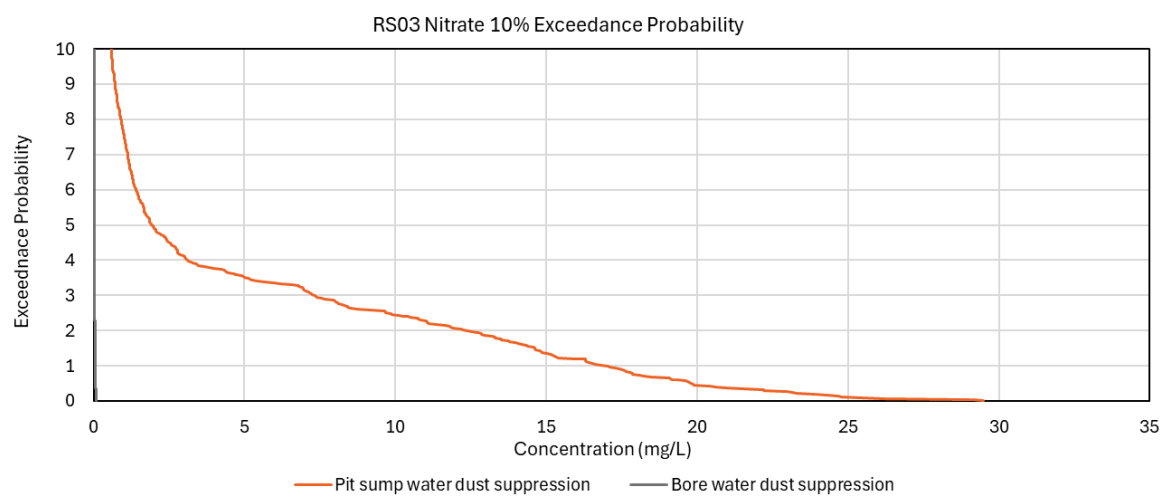


Figure 156: RS03 10% exceedance probability - nitrate.

APPENDIX D CLOSURE MODEL RESULTS AT SC01 AND RS03

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
0	MW-to-RAS_PL-NP20	SC01 Untreated	29.88	7.92	156	0.00	145.8	0.0164	0.0372	0.0696	39.7	0.00009	9.7	0.00981	0.00054	0.00049	1.66	1.08	1.36	0.00023	116.4	13.9	0.14	0.1287	4.14	164.2	0.00074	0.00026	0.55442	0.03058	199	2.89	0.0002	1.5570	0.0000	0.0461	0.0210	0.0021
1	MW-to-RAS_PL-NP20	SC01 Untreated	13.25	7.91	160	0.00	146.0	0.0117	0.0377	0.0674	40.5	0.00009	9.7	0.00960	0.00054	0.00047	1.64	1.10	1.40	0.00023	118.0	14.2	0.14	0.1258	4.05	165.7	0.00072	0.00026	0.56176	0.03110	186	2.96	0.0002	1.5869	0.0000	0.0450	0.0210	0.0021
2	MW-to-RAS_PL-NP20	SC01 Untreated	13.61	7.91	149	0.00	141.9	0.0148	0.0222	0.0503	39.7	0.00010	6.6	0.00560	0.00057	0.00052	1.80	0.67	0.80	0.00025	66.2	12.1	0.08	0.0751	2.24	107.1	0.00072	0.00027	0.31285	0.01839	126	1.96	0.0002	1.5899	0.0000	0.0276	0.0210	0.0018
3	MW-to-RAS_PL-NP20	SC01 Untreated	12.77	7.91	151	0.00	142.2	0.0133	0.0238	0.0505	40.5	0.00010	6.6	0.00543	0.00057	0.00051	1.78	0.72	0.87	0.00025	70.9	12.4	0.08	0.0765	2.31	112.3	0.00066	0.00027	0.33511	0.01865	127	2.00	0.0002	1.7152	0.0000	0.0287	0.0210	0.0018
4	MW-to-RAS_PL-NP20	SC01 Untreated	16.15	7.92	150	0.00	146.6	0.0147	0.0254	0.0517	39.5	0.00010	6.8	0.00460	0.00056	0.00050	1.66	0.67	0.85	0.00024	61.2	12.6	0.07	0.0728	1.93	101.8	0.00060	0.00026	0.35444	0.01865	118	1.93	0.0002	1.5767	0.0000	0.0257	0.0100	0.0017
5	MW-to-RAS_PL-NP20	SC01 Untreated	25.40	7.92	151	0.00	147.4	0.0133	0.0249	0.0514	39.7	0.00010	6.7	0.00415	0.00056	0.00049	1.63	0.65	0.82	0.00024	56.2	12.6	0.07	0.0679	1.72	96.5	0.00062	0.00026	0.26006	0.01556	107	1.86	0.0002	1.5656	0.0000	0.0235	0.0100	0.0017
6	MW-to-RAS_PL-NP20	SC01 Untreated	16.25	7.92	153	0.00	148.3	0.0124	0.0275	0.0539	39.8	0.00009	7.1	0.00445	0.00055	0.00048	1.60	0.71	0.92	0.00024	62.1	13.0	0.07	0.0742	1.81	102.9	0.00066	0.00026	0.26699	0.01631	111	2.03	0.0002	1.5370	0.0000	0.0252	0.0110	0.0017
7	MW-to-RAS_PL-NP20	SC01 Untreated	21.23	7.92	151	0.00	147.4	0.0133	0.0255	0.0527	39.7	0.00009	6.7	0.00395	0.00056	0.00049	1.63	0.67	0.85	0.00024	56.4	12.7	0.07	0.0692	1.58	96.4	0.00064	0.00026	0.25935	0.01550	106	1.92	0.0002	1.5604	0.0000	0.0235	0.0099	0.0016
8	MW-to-RAS_PL-NP20	SC01 Untreated	15.57	7.92	154	0.00	148.6	0.0122	0.0269	0.0548	39.9	0.00009	7.2	0.00437	0.00055	0.00047	1.58	0.75	0.97	0.00024	64.7	13.1	0.08	0.0776	1.72	105.3	0.00066	0.00026	0.29802	0.01746	113	2.14	0.0002	1.5230	0.0000	0.0260	0.0113	0.0017
9	MW-to-RAS_PL-NP20	SC01 Untreated	17.93	7.92	151	0.00	147.6	0.0131	0.0259	0.0522	39.7	0.00009	6.6	0.00431	0.00055	0.00049	1.62	0.68	0.86	0.00024	55.7	12.7	0.07	0.0691	1.43	96.4	0.00066	0.00026	0.25505	0.01527	104	1.95	0.0002	1.5522	0.0000	0.0231	0.0097	0.0016
10	MW-to-RAS_PL-NP20	SC01 Untreated	11.28	7.93	155	0.00	150.4	0.0118	0.0314	0.0569	39.9	0.00009	7.5	0.00431	0.00054	0.00046	1.52	0.80	1.05	0.00023	67.0	13.4	0.08	0.0814	1.62	107.7	0.00072	0.00025	0.30708	0.01786	114	2.25	0.0002	1.4645	0.0000	0.0266	0.0116	0.0016
11	MW-to-RAS_PL-NP20	SC01 Untreated	17.46	7.93	151	0.00	147.5	0.0114	0.0263	0.0513	39.5	0.00009	6.6	0.00352	0.00054	0.00049	1.62	0.69	0.87	0.00024	56.1	12.6	0.07	0.0701	1.33	95.2	0.00064	0.00026	0.25708	0.01533	107	2.00	0.0002	1.5438	0.0000	0.0235	0.0098	0.0016
12	MW-to-RAS_PL-NP20	SC01 Untreated	15.36	7.93	154	0.00	149.2	0.0129	0.0308	0.0541	39.8	0.00009	7.2	0.00400	0.00054	0.00047	1.55	0.79	1.04	0.00023	66.2	13.2	0.08	0.0803	1.50	106.1	0.00068	0.00026	0.30459	0.01772	117	2.26	0.0002	1.4888	0.0000	0.0265	0.0115	0.0016
13	MW-to-RAS_PL-NP20	SC01 Untreated	27.37	7.39	180	0.02	147.5	0.0163	0.0371	0.0846	45.8	0.00010	23.7	0.00672	0.00066	0.00059	1.51	0.80	1.61	0.00023	63.5	15.8	0.09	0.0839	1.85	120.7	0.01441	0.00094	0.28060	0.01628	134	2.29	0.0002	1.4465	0.0070	0.0265	0.0108	0.0024
14	MW-to-RAS_PL-NP20	SC01 Untreated	30.55	7.33	235	0.06	148.5	0.0260	0.1673	0.1583	57.7	0.00010	58.6	0.01377	0.00088	0.00082	1.26	1.01	3.07	0.00019	77.3	22.0	0.12	0.1170	3.00	171.9	0.04230	0.00231	0.32011	0.01763	203	2.76	0.0002	1.1911	0.0211	0.0342	0.0127	0.0040
15	MW-to-RAS_PL-NP20	SC01 Untreated	25.60	6.52	291	0.10	152.4	0.0307	0.2577	0.2348	69.2	0.00010	91.2	0.02159	0.00077	0.00100	0.95	1.34	4.62	0.00015	105.6	28.7	0.17	0.1632	4.26	267.2	0.06745	0.00355	0.42804	0.02259	273	3.56	0.0002	0.8992	0.0337	0.0456	0.0171	0.0055
16	MW-to-RAS_PL-NP20	SC01 Untreated	27.75	6.50	296	0.11	152.5	0.0308	0.2644	0.2448	70.5	0.00010	94.2	0.02258	0.00109	0.00103	0.94	1.34	4.71	0.00015	105.7	29.2	0.18	0.1656	4.06	241.1	0.06987	0.00367	0.42448	0.02241	273	3.54	0.0002	0.9013	0.0349	0.0458	0.0171	0.0057
17	MW-to-RAS_PL-NP20	SC01 Untreated	26.49	6.49	298	0.12	153.0	0.0311	0.2653	0.2435	70.8	0.00010	94.8	0.02307	0.00110	0.00104	0.94	1.34	4.73	0.00015	106.8	29.4	0.18	0.1654	3.92	243.5	0.07034	0.00370	0.42804	0.02259	273	3.54	0.0002	0.9034	0.0350	0.0464	0.0171	0.0058
18	MW-to-RAS_PL-NP20	SC01 Untreated	29.68	6.50	294	0.11	152.2	0.0306	0.2419	0.2325	67.8	0.00010	86.4	0.02146	0.00105	0.00100	1.02	1.27	4.36	0.00016	102.6	29.7	0.17	0.1609	3.44	230.3	0.06354	0.00338	0.41347	0.02198	265	3.38	0.0002	0.9047	0.0316	0.0448	0.0167	0.0054
19	MW-to-RAS_PL-NP20	SC01 Untreated	29.07	6.46	290	0.12	153.0	0.0315	0.2511	0.2438	69.1	0.00010	89.8	0.02266	0.00107	0.00103	0.99	1.31	4.54	0.00015	107.4	28.6	0.18	0.1659	3.49	239.9	0.06605	0.00351	0.43238	0.02238	275	3.48	0.0002	0.9425	0.0329	0.0468	0.0175	0.0056
20	MW-to-RAS_PL-NP20	SC01 Untreated	31.30	6.45	288	0.12	153.1	0.0315	0.2464	0.2422	68.5	0.00010	88.0	0.02260	0.00105	0.00103	1.00	1.32	4.51	0.00015	109.3	28.4	0.18	0.1708	3.45	239.6	0.06648	0.00344	0.44184	0.02239	276	3.50	0.0002	0.9508	0.0321	0.0475	0.0178	0.0055
21	MW-to-RAS_PL-NP20	SC01 Untreated	28.81	6.43	299	0.13	154.3	0.0328	0.2631	0.2596	70.7	0.00010	94.3	0.02437	0.00109	0.00107	0.94	1.38	4.79	0.00015	115.3	29.7	0.19	0.1815	3.47	253.5	0.06924	0.00368	0.46385	0.02441	291	3.64	0.0002	0.9975	0.0344	0.0501	0.0188	0.0058
22	MW-to-RAS_PL-NP20	SC01 Untreated	28.89	6.42	296	0.13	154.6	0.0327	0.2581	0.2563	70.1	0.00010	92.4	0.02407	0.00108	0.00106	0.96	1.37	4.73	0.00015	115.8	29.4	0.19	0.1814	3.29	252.5	0.06768	0.00361	0.46720	0.02460	290	3.63	0.0002	0.9075	0.0336	0.0502	0.0189	0.0058
23	MW-to-RAS_PL-NP20	SC01 Untreated	31.47	6.44	290	0.13	154.2	0.0315	0.2467	0.2467	68.8	0.00010	86.2	0.02314	0.00105	0.00104	0.99	1.34	4.57	0.00015	114.0	28.7	0.18	0.1767	3.12	245.5	0.06432	0.00345	0.46159	0.02440	281	3.58	0.0002	0.9475	0.0320	0.0491	0.0186	0.0056
24	MW-to-RAS_PL-NP20	SC01 Untreated	24.79	6.38	305	0.15	156.1	0.0332	0.2689	0.2678	71.8	0.00010	96.3	0.02531	0.00110	0.00109	0.91	1.44	4.96	0.00014	122.8	30.5	0.20	0.1910	3.19	263.8	0.07042	0.00376	0.49607	0.02602	302	3.79	0.0002	0.8691	0.0300	0.0527	0.0200	0.0060
25	MW-to-RAS_PL-NP20	SC01 Untreated	32.27	6.44	279	0.13	153.7	0.0314	0.2279	0.2303	66.5	0.00010	81.3	0.02145	0.00101	0.00101	1.06	1.28	4.27	0.00016	109.4	27.4	0.17	0.1687	2.76	232.9	0.05892	0.00320	0.44533	0.02366	270	3.45	0.0002	1.0009	0.0292	0.0473	0.0179	0.0052
26	MW-to-RAS_PL-NP20	SC01 Untreated	36.06	6.42	277	0.13	153.3	0.0321	0.2249	0.2278	66.0	0.00010	80.0	0.02122	0.00100	0.00101	1.06	1.29	4.27	0.00016	110.8	27.3	0.17	0.1699	2.90	232.7	0.05870	0.00315	0.45266	0.02402	272	3.48	0.0002	0.9988	0.0287	0.0478	0.0181	0.0052
27	MW-to-RAS_PL-NP20	SC01 Untreated	34.50	6.37	296	0.15	155.1	0.0343	0.2547	0.2552	69.8	0.00010	90.7	0.02407	0.00106	0.00108	0.95	1.42	4.83	0.00015	123.7	29.7	0.19	0.1896	3.24	257.7	0.06896	0.00356	0.50369	0.02643	301	3.79	0.0002	0.8914	0.0327	0.0529	0.0201	0.0057
28	MW-to-RAS_PL-NP20	SC01 Untreated	26.21	6.31	310	0.17	156.5	0.0343	0.2734	0.2711	72.5	0.00010	97.4	0.02573	0.00119	0.00112	0.97	1.50	5.18	0.00014	132.2	31.3	0.21	0.2008	3.32	273.8	0.07696	0.00378	0.52696	0.02678	313	4.15	0.0002	0.8339	0.0352	0.0540	0.0215	0.0059
29	MW-to-RAS_PL-NP20	SC01 Untreated	29.10	6.33	298	0.17	156.5																															

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
86	MW-to-RAS_PL-NP20	SC01 Untreated	30.73	6.21	304	0.22	156.0	0.0379	0.2684	0.1344	71.1	0.00010	86.6	0.00890	0.01006	0.00119	0.83	1.39	5.47	0.00013	92.7	30.7	0.15	0.1110	1.93	194.6	0.06524	0.00374	0.38651	0.02004	254	3.80	0.0002	0.7825	0.0332	0.0343	0.0138	0.0044
87	MW-to-RAS_PL-NP20	SC01 Untreated	37.91	6.29	279	0.19	153.0	0.0356	0.2298	0.1183	66.2	0.00010	74.3	0.00752	0.00909	0.00110	1.00	1.20	4.68	0.00015	78.6	27.9	0.13	0.0961	1.63	170.3	0.05579	0.00323	0.32751	0.01731	225	3.34	0.0002	0.9375	0.0284	0.0301	0.0118	0.0039
88	MW-to-RAS_PL-NP20	SC01 Untreated	33.91	6.26	284	0.20	153.4	0.0348	0.2207	0.1198	67.3	0.00010	76.6	0.00762	0.00903	0.00111	0.97	1.22	4.82	0.00015	80.1	28.1	0.13	0.0961	1.66	173.5	0.05761	0.00333	0.33324	0.01759	225	3.41	0.0002	0.9157	0.0294	0.0308	0.0119	0.0040
89	MW-to-RAS_PL-NP20	SC01 Untreated	38.12	6.24	297	0.21	154.8	0.0363	0.2678	0.1272	68.8	0.00010	83.3	0.00817	0.01004	0.00116	0.98	1.30	5.22	0.00014	85.4	29.7	0.14	0.1020	1.71	184.2	0.05890	0.00361	0.36582	0.01853	240	3.65	0.0002	0.8356	0.0321	0.0317	0.0127	0.0042
90	MW-to-RAS_PL-NP20	SC01 Untreated	36.38	6.31	271	0.18	152.2	0.0336	0.2183	0.1110	64.3	0.00010	70.5	0.00682	0.00897	0.00107	1.05	1.12	4.43	0.00015	72.4	26.6	0.12	0.0977	1.44	160.6	0.05296	0.00308	0.30099	0.01608	210	3.17	0.0002	0.9894	0.0270	0.0277	0.0108	0.0038
91	MW-to-RAS_PL-NP20	SC01 Untreated	25.97	6.21	299	0.22	155.2	0.0359	0.2624	0.1264	70.3	0.00010	84.4	0.00805	0.01005	0.00116	0.85	1.30	5.32	0.00014	85.6	30.1	0.14	0.1008	1.69	184.8	0.05631	0.00366	0.36002	0.01857	238	3.66	0.0002	0.8142	0.0326	0.0313	0.0127	0.0042
92	MW-to-RAS_PL-NP20	SC01 Untreated	22.72	6.20	302	0.22	155.9	0.0372	0.2678	0.1283	70.9	0.00010	86.3	0.00813	0.01006	0.00118	0.84	1.31	5.40	0.00013	85.7	30.4	0.14	0.1018	1.61	176.5	0.05637	0.00373	0.36605	0.01850	244	3.67	0.0002	0.7912	0.0334	0.0317	0.0127	0.0043
93	MW-to-RAS_PL-NP20	SC01 Untreated	23.03	6.24	292	0.21	155.3	0.0358	0.2505	0.1213	68.9	0.00010	80.8	0.00783	0.01003	0.00113	0.91	1.22	5.04	0.00014	79.5	29.0	0.13	0.0949	1.41	175.9	0.05611	0.00350	0.32982	0.01731	230	3.47	0.0002	0.8634	0.0312	0.0297	0.0118	0.0041
94	MW-to-RAS_PL-NP20	SC01 Untreated	35.74	6.34	261	0.17	151.8	0.0320	0.2023	0.1015	62.7	0.00010	64.6	0.00596	0.00893	0.00102	1.10	1.03	4.15	0.00016	66.1	25.3	0.11	0.0797	1.29	148.7	0.04844	0.00284	0.27468	0.01486	195	3.02	0.0002	1.0381	0.0247	0.0254	0.0098	0.0035
95	MW-to-RAS_PL-NP20	SC01 Untreated	37.37	6.31	276	0.19	153.2	0.0338	0.2267	0.1102	65.8	0.00010	72.6	0.00661	0.00908	0.00108	1.00	1.12	4.63	0.00015	72.2	27.2	0.12	0.0859	1.47	161.2	0.05472	0.00318	0.29943	0.01594	211	3.25	0.0002	0.9056	0.0279	0.0272	0.0107	0.0038
96	MW-to-RAS_PL-NP20	SC01 Untreated	31.33	6.27	288	0.20	154.7	0.0357	0.2461	0.1171	68.2	0.00010	76.9	0.00710	0.01002	0.00113	0.93	1.18	4.99	0.00014	76.6	28.7	0.13	0.0909	1.53	170.7	0.05475	0.00344	0.31692	0.01668	224	3.42	0.0002	0.8779	0.0305	0.0286	0.0113	0.0040
97	MW-to-RAS_PL-NP20	SC01 Untreated	30.73	6.30	275	0.18	153.4	0.0339	0.2243	0.1084	65.6	0.00010	71.9	0.00640	0.00908	0.00108	1.02	1.09	4.56	0.00016	69.7	27.0	0.12	0.0832	1.38	158.1	0.05297	0.00315	0.28824	0.01539	207	3.18	0.0002	0.9655	0.0277	0.0264	0.0103	0.0038
98	MW-to-RAS_PL-NP20	SC01 Untreated	23.98	6.22	296	0.21	155.9	0.0358	0.2575	0.1193	69.7	0.00010	82.2	0.00722	0.01004	0.00115	0.87	1.22	5.23	0.00014	78.9	29.6	0.13	0.0923	1.57	175.4	0.05635	0.00358	0.32658	0.01709	228	3.54	0.0002	0.8314	0.0318	0.0290	0.0116	0.0041
99	MW-to-RAS_PL-NP20	SC01 Untreated	25.61	6.25	292	0.21	155.6	0.0345	0.2508	0.1166	69.1	0.00010	80.4	0.00699	0.01003	0.00113	0.91	1.17	5.07	0.00014	75.6	29.1	0.13	0.0880	1.45	170.8	0.05695	0.00350	0.31215	0.01645	220	3.43	0.0002	0.8310	0.0311	0.0277	0.0111	0.0041
100	MW-to-RAS_PL-NP20	SC01 Untreated	42.56	6.40	255	0.16	151.5	0.0336	0.1946	0.0998	61.6	0.00010	62.3	0.00538	0.00903	0.00101	1.15	0.95	3.96	0.00017	59.3	24.5	0.10	0.0735	1.18	139.6	0.04681	0.00275	0.24448	0.01333	190	2.83	0.0002	1.0596	0.0239	0.0238	0.0087	0.0034
101	MW-to-RAS_PL-NP20	SC01 Untreated	26.58	6.22	299	0.22	156.3	0.0362	0.2637	0.1190	70.3	0.00010	83.7	0.00713	0.01004	0.00117	0.84	1.22	5.59	0.00013	79.2	30.1	0.14	0.0917	1.66	176.2	0.05637	0.00365	0.32728	0.01707	230	3.61	0.0002	0.9988	0.0325	0.0298	0.0116	0.0042
102	MW-to-RAS_PL-NP20	SC01 Untreated	26.70	6.24	286	0.20	154.7	0.0366	0.2438	0.1125	67.6	0.00010	77.6	0.00655	0.01001	0.00113	0.94	1.13	4.96	0.00014	72.1	28.4	0.12	0.0860	1.51	164.3	0.05591	0.00340	0.29725	0.01565	220	3.35	0.0002	0.8742	0.0301	0.0273	0.0105	0.0039
103	MW-to-RAS_PL-NP20	SC01 Untreated	26.38	6.21	294	0.21	155.6	0.0371	0.2575	0.1161	69.2	0.00010	81.7	0.00682	0.01003	0.00116	0.87	1.18	5.26	0.00014	75.7	29.5	0.13	0.0890	1.64	170.8	0.05609	0.00357	0.31222	0.01631	227	3.51	0.0002	0.8149	0.0317	0.0288	0.0110	0.0041
104	MW-to-RAS_PL-NP20	SC01 Untreated	28.47	6.25	286	0.20	154.6	0.0367	0.2447	0.1116	67.7	0.00010	77.8	0.00644	0.01001	0.00113	0.93	1.11	4.98	0.00014	71.0	28.4	0.12	0.0844	1.54	163.0	0.05591	0.00341	0.29184	0.01536	219	3.34	0.0002	0.8703	0.0302	0.0288	0.0103	0.0039
105	MW-to-RAS_PL-NP20	SC01 Untreated	38.06	6.32	273	0.18	152.9	0.0338	0.2219	0.1032	65.1	0.00010	70.7	0.00580	0.00902	0.00108	1.03	1.01	4.52	0.00016	64.0	26.7	0.11	0.0759	1.42	150.4	0.05354	0.00312	0.26250	0.01409	199	3.09	0.0002	0.9752	0.0273	0.0243	0.0093	0.0037
106	MW-to-RAS_PL-NP20	SC01 Untreated	28.37	6.24	288	0.21	154.6	0.0356	0.2469	0.1110	68.1	0.00010	78.4	0.00536	0.01002	0.00113	0.92	1.10	5.03	0.00014	70.2	28.8	0.12	0.0821	1.57	162.5	0.05593	0.00344	0.28797	0.01519	215	3.35	0.0002	0.8732	0.0305	0.0261	0.0102	0.0040
107	MW-to-RAS_PL-NP20	SC01 Untreated	33.28	6.30	276	0.19	153.3	0.0344	0.2276	0.1044	65.8	0.00010	72.4	0.00583	0.00909	0.00109	1.01	1.01	4.63	0.00015	64.0	27.1	0.11	0.0759	1.42	151.7	0.05500	0.00319	0.26207	0.01402	201	3.12	0.0002	0.9545	0.0281	0.0243	0.0093	0.0038
108	MW-to-RAS_PL-NP20	SC01 Untreated	27.35	6.24	289	0.21	154.8	0.0355	0.2489	0.1106	68.3	0.00010	78.9	0.00628	0.01002	0.00114	0.91	1.09	5.08	0.00014	69.5	28.8	0.12	0.0808	1.56	161.9	0.05606	0.00346	0.28442	0.01500	214	3.36	0.0002	0.8653	0.0307	0.0257	0.0101	0.0040
109	MW-to-RAS_PL-NP20	SC01 Untreated	29.20	6.28	279	0.19	153.8	0.0346	0.2330	0.1056	65.5	0.00010	74.2	0.00588	0.00900	0.00110	0.99	1.01	4.72	0.00015	64.0	27.5	0.11	0.0755	1.40	153.0	0.05545	0.00327	0.26108	0.01393	203	3.15	0.0002	0.9378	0.0288	0.0242	0.0092	0.0038
110	MW-to-RAS_PL-NP20	SC01 Untreated	21.36	6.20	303	0.22	156.9	0.0372	0.2712	0.1178	71.2	0.00010	86.1	0.00676	0.01007	0.00119	0.83	1.15	5.48	0.00013	73.1	30.4	0.13	0.0846	1.53	171.5	0.05688	0.00377	0.29857	0.01555	226	3.53	0.0002	0.7848	0.0337	0.0267	0.0105	0.0042
111	MW-to-RAS_PL-NP20	SC01 Untreated	27.83	6.29	275	0.19	154.0	0.0348	0.2277	0.1028	65.5	0.00010	72.1	0.00562	0.00908	0.00108	1.00	0.99	4.63	0.00015	62.0	27.0	0.11	0.0739	1.31	149.1	0.05477	0.00317	0.25339	0.01355	200	3.11	0.0002	0.9411	0.0280	0.0238	0.0089	0.0037
112	MW-to-RAS_PL-NP20	SC01 Untreated	26.07	6.25	285	0.20	155.2	0.0355	0.2435	0.1173	67.5	0.00010	76.9	0.00595	0.01001	0.00112	0.93	1.04	4.96	0.00014	65.7	28.3	0.12	0.0770	1.43	156.4	0.05589	0.00338	0.26814	0.01419	208	3.27	0.0002	0.8806	0.0300	0.0246	0.0104	0.0039
113	MW-to-RAS_PL-NP20	SC01 Untreated	37.76	6.33	267	0.18	152.7	0.0326	0.2139	0.0971	64.1	0.00010	67.6	0.00521	0.00906	0.00105	1.06	0.92	4.38	0.00016	57.6	26.0	0.10	0.0678	1.33	141.1	0.05132	0.00300	0.23454	0.01274	178	2.96	0.0002	1.0090	0.0262	0.0220	0.0083	0.0036
114	MW-to-RAS_PL-NP20	SC01 Untreated	37.55	6.32	265	0.18	152.2	0.0342	0.2119	0.0965	63.5	0.00010	66.9	0.00523	0.00904	0.00105	1.07	0.91	4.34	0.00015	56.6	25.8	0.10	0.0662	1.39	139.2	0.05079	0.00298	0.23010	0.01247	159	2.93	0.0002	1.0025	0.0259	0.0215	0.0078	0.0038
115	MW-to-RAS_PL-NP20	SC01 Untreated	30.08	6.22																																		

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
172	MW-to-RAS_PL-NP20	SC01 Untreated	23.42	6.21	290	0.22	153.9	0.0372	0.2614	0.1041	68.4	0.00010	80.8	0.00524	0.00101	0.00117	0.86	0.69	5.32	0.00013	41.1	28.9	0.09	0.0499	1.53	132.9	0.06295	0.00362	0.15027	0.00801	183	2.72	0.0002	0.8048	0.0323	0.0163	0.0051	0.0040
173	MW-to-RAS_PL-NP20	SC01 Untreated	28.20	6.29	272	0.20	152.1	0.0346	0.2307	0.0955	67.1	0.00010	71.7	0.00466	0.00097	0.00109	1.00	0.62	4.68	0.00015	36.1	26.6	0.08	0.0448	1.32	121.2	0.05962	0.00322	0.13119	0.00731	166	2.45	0.0002	0.8409	0.0285	0.0149	0.0045	0.0037
174	MW-to-RAS_PL-NP20	SC01 Untreated	23.80	6.25	262	0.20	153.5	0.0358	0.2473	0.1005	67.0	0.00010	76.7	0.00497	0.00100	0.00113	0.92	0.65	5.01	0.00014	38.3	27.8	0.09	0.0469	1.36	127.2	0.05966	0.00344	0.13891	0.00757	174	2.56	0.0002	0.8719	0.0304	0.0154	0.0048	0.0038
175	MW-to-RAS_PL-NP20	SC01 Untreated	26.42	6.22	290	0.21	154.5	0.0351	0.2593	0.1032	68.6	0.00010	80.2	0.00519	0.00102	0.00115	0.88	0.66	5.23	0.00014	39.5	28.8	0.09	0.0467	1.36	131.3	0.05948	0.00358	0.14275	0.00773	175	2.63	0.0002	0.8411	0.0320	0.0152	0.0049	0.0040
176	MW-to-RAS_PL-NP20	SC01 Untreated	29.33	6.35	260	0.17	151.7	0.0319	0.2092	0.0892	62.9	0.00010	65.2	0.00424	0.00094	0.00104	1.09	0.56	4.23	0.00017	32.1	25.1	0.07	0.0400	1.08	112.7	0.05842	0.00294	0.11567	0.00673	151	2.24	0.0002	0.1363	0.0259	0.0135	0.0040	0.0035
177	MW-to-RAS_PL-NP20	SC01 Untreated	36.22	6.35	256	0.17	151.0	0.0324	0.2046	0.0870	61.8	0.00010	63.1	0.00410	0.00092	0.00103	1.09	0.55	4.20	0.00016	31.9	24.7	0.07	0.0403	1.20	110.2	0.04867	0.00296	0.11519	0.00670	151	2.23	0.0002	0.1331	0.0249	0.0136	0.0040	0.0034
178	MW-to-RAS_PL-NP20	SC01 Untreated	36.33	6.31	260	0.18	150.8	0.0335	0.2114	0.0892	62.6	0.00010	65.3	0.00424	0.00093	0.00105	1.07	0.56	4.35	0.00016	32.6	25.2	0.07	0.0413	1.35	112.5	0.05047	0.00296	0.11711	0.00672	156	2.26	0.0002	0.1082	0.0258	0.0139	0.0041	0.0035
179	MW-to-RAS_PL-NP20	SC01 Untreated	28.50	6.24	283	0.21	153.0	0.0369	0.2495	0.1009	67.2	0.00010	77.3	0.00500	0.00102	0.00115	0.92	0.63	5.08	0.00014	37.4	28.0	0.08	0.0464	1.54	126.5	0.06020	0.00348	0.13382	0.00727	176	2.50	0.0002	0.8629	0.0308	0.0153	0.0046	0.0039
180	MW-to-RAS_PL-NP20	SC01 Untreated	30.63	6.27	273	0.19	151.9	0.0352	0.2328	0.0960	65.2	0.00010	72.2	0.00468	0.00097	0.00111	0.99	0.59	4.74	0.00015	34.8	26.7	0.08	0.0435	1.43	120.1	0.05611	0.00326	0.12402	0.00691	166	2.36	0.0002	0.9327	0.0287	0.0145	0.0043	0.0037
181	MW-to-RAS_PL-NP20	SC01 Untreated	32.28	6.26	278	0.20	152.2	0.0359	0.2420	0.0981	66.1	0.00010	74.6	0.00483	0.00098	0.00113	0.94	0.61	4.96	0.00014	36.0	27.4	0.08	0.0447	1.54	122.8	0.05806	0.00337	0.12839	0.00705	170	2.42	0.0002	0.8838	0.0297	0.0148	0.0044	0.0038
182	MW-to-RAS_PL-NP20	SC01 Untreated	37.66	6.29	268	0.19	151.0	0.0353	0.2265	0.0940	64.2	0.00010	70.1	0.00454	0.00096	0.00109	1.01	0.58	4.63	0.00015	33.5	26.2	0.08	0.0427	1.47	117.0	0.05443	0.00317	0.11894	0.00668	163	2.29	0.0002	0.9484	0.0279	0.0143	0.0041	0.0036
183	MW-to-RAS_PL-NP20	SC01 Untreated	30.58	6.24	283	0.21	152.2	0.0360	0.2498	0.1004	67.1	0.00010	77.2	0.00499	0.00100	0.00115	0.91	0.61	5.10	0.00014	36.3	28.0	0.08	0.0445	1.61	125.2	0.06019	0.00348	0.12869	0.00702	172	2.44	0.0002	0.8626	0.0308	0.0146	0.0044	0.0039
184	MW-to-RAS_PL-NP20	SC01 Untreated	36.22	6.29	272	0.19	151.0	0.0337	0.2312	0.0951	65.2	0.00010	71.8	0.00464	0.00097	0.00110	1.00	0.57	4.71	0.00015	33.4	26.6	0.08	0.0409	1.46	118.4	0.05582	0.00324	0.11750	0.00664	159	2.28	0.0002	0.9513	0.0286	0.0136	0.0040	0.0037
185	MW-to-RAS_PL-NP20	SC01 Untreated	51.53	6.37	254	0.17	149.1	0.0343	0.2037	0.0872	61.3	0.00010	62.9	0.00408	0.00091	0.00104	1.10	0.52	4.18	0.00016	29.8	24.4	0.07	0.0398	1.39	107.6	0.04868	0.00287	0.10500	0.00611	153	2.09	0.0002	1.0279	0.0249	0.0135	0.0040	0.0034
186	MW-to-RAS_PL-NP20	SC01 Untreated	30.73	6.20	293	0.23	152.3	0.0379	0.2679	0.1056	68.9	0.00010	82.7	0.00533	0.00102	0.00119	0.83	0.63	5.48	0.00013	37.9	29.2	0.09	0.0464	1.82	130.6	0.06453	0.00372	0.13328	0.00708	181	2.50	0.0002	0.7824	0.0331	0.0151	0.0045	0.0040
187	MW-to-RAS_PL-NP20	SC01 Untreated	37.91	6.28	269	0.19	149.9	0.0356	0.2294	0.0948	64.4	0.00010	71.0	0.00460	0.00096	0.00110	1.00	0.56	4.68	0.00015	32.5	26.3	0.08	0.0418	1.54	116.5	0.05500	0.00322	0.11359	0.00637	164	2.22	0.0002	0.9356	0.0283	0.0140	0.0039	0.0037
188	MW-to-RAS_PL-NP20	SC01 Untreated	33.91	6.26	274	0.20	150.1	0.0348	0.2366	0.0966	65.4	0.00010	73.3	0.00474	0.00097	0.00111	0.97	0.57	4.83	0.00015	33.1	26.9	0.08	0.0412	1.57	119.0	0.05713	0.00331	0.11539	0.00645	163	2.25	0.0002	0.9175	0.0293	0.0137	0.0039	0.0037
189	MW-to-RAS_PL-NP20	SC01 Untreated	30.12	6.23	286	0.22	151.4	0.0365	0.2514	0.1029	67.3	0.00010	78.8	0.00515	0.00101	0.00116	0.88	0.60	5.22	0.00014	35.4	28.4	0.08	0.0437	1.62	126.3	0.06039	0.00339	0.12326	0.00668	174	2.36	0.0002	0.8355	0.0320	0.0143	0.0042	0.0039
190	MW-to-RAS_PL-NP20	SC01 Untreated	35.38	6.31	263	0.18	149.4	0.0336	0.2180	0.0913	63.2	0.00010	67.6	0.00438	0.00094	0.00107	1.05	0.53	4.44	0.00016	30.2	25.5	0.07	0.0388	1.37	111.9	0.05256	0.00306	0.10504	0.00606	154	2.10	0.0002	0.9393	0.0269	0.0131	0.0036	0.0035
191	MW-to-RAS_PL-NP20	SC01 Untreated	25.97	6.21	289	0.22	151.7	0.0359	0.2620	0.1036	68.3	0.00010	81.0	0.00521	0.00101	0.00116	0.85	0.60	5.33	0.00014	35.7	28.6	0.08	0.0431	1.61	127.4	0.06334	0.00364	0.12395	0.00670	172	2.38	0.0002	0.8142	0.0325	0.0140	0.0042	0.0040
192	MW-to-RAS_PL-NP20	SC01 Untreated	22.72	6.20	292	0.22	152.5	0.0372	0.2675	0.1058	69.0	0.00010	82.9	0.00534	0.00103	0.00118	0.84	0.61	5.40	0.00013	36.0	29.1	0.09	0.0444	1.53	129.3	0.06491	0.00371	0.12474	0.00667	178	2.38	0.0002	0.7912	0.0333	0.0145	0.0042	0.0040
193	MW-to-RAS_PL-NP20	SC01 Untreated	23.03	6.24	282	0.21	152.0	0.0358	0.2502	0.1010	67.1	0.00010	77.7	0.00501	0.00100	0.00113	0.91	0.58	5.04	0.00014	33.6	27.8	0.08	0.0420	1.34	123.2	0.06070	0.00348	0.11607	0.00638	169	2.26	0.0002	0.8624	0.0311	0.0138	0.0040	0.0039
194	MW-to-RAS_PL-NP20	SC01 Untreated	35.74	6.34	253	0.17	149.1	0.0320	0.2021	0.0859	61.2	0.00010	62.1	0.00402	0.00091	0.00102	1.10	0.50	4.15	0.00016	28.0	24.3	0.07	0.0364	1.24	105.4	0.04813	0.00283	0.09708	0.00578	144	1.98	0.0002	1.0380	0.0246	0.0124	0.0034	0.0034
195	MW-to-RAS_PL-NP20	SC01 Untreated	37.37	6.31	268	0.19	150.3	0.0338	0.2265	0.0933	64.2	0.00010	69.9	0.00451	0.00095	0.00108	1.00	0.53	4.63	0.00015	33.0	26.2	0.07	0.0388	1.41	114.1	0.05438	0.00316	0.10623	0.00606	156	2.12	0.0002	0.9504	0.0279	0.0130	0.0037	0.0036
196	MW-to-RAS_PL-NP20	SC01 Untreated	31.33	6.27	279	0.20	151.6	0.0337	0.2458	0.0994	66.5	0.00010	76.1	0.00490	0.00099	0.00113	0.93	0.57	4.99	0.00014	32.8	27.5	0.08	0.0413	1.47	121.0	0.05940	0.00343	0.11305	0.00625	167	2.22	0.0002	0.8779	0.0304	0.0136	0.0038	0.0038
197	MW-to-RAS_PL-NP20	SC01 Untreated	30.73	6.30	267	0.19	150.6	0.0339	0.2241	0.0930	64.0	0.00010	69.3	0.00448	0.00095	0.00108	1.02	0.53	4.56	0.00016	30.1	26.0	0.07	0.0385	1.33	113.2	0.05396	0.00314	0.10343	0.00594	155	2.28	0.0002	0.9654	0.0276	0.0129	0.0036	0.0036
198	MW-to-RAS_PL-NP20	SC01 Untreated	23.98	6.22	287	0.21	152.6	0.0358	0.2573	0.1022	67.9	0.00010	79.3	0.00510	0.00101	0.00115	0.87	0.58	5.24	0.00014	34.1	28.4	0.08	0.0419	1.51	124.7	0.06201	0.00357	0.11736	0.00640	169	2.28	0.0002	0.8313	0.0318	0.0137	0.0040	0.0039
199	MW-to-RAS_PL-NP20	SC01 Untreated	25.61	6.22	284	0.21	152.5	0.0345	0.2506	0.1005	67.4	0.00010	77.8	0.00500	0.00100	0.00113	0.91	0.57	5.07	0.00014	32.9	28.0	0.08	0.0400	1.40	122.5	0.06064	0.00349	0.11275	0.00626	164	2.22	0.0002	0.8730	0.0311	0.0132	0.0038	0.0039
0	MW-to-RAS_PL-NP20	SC01 Treated	29.88	7.92	163	0.00	145.8	0.0169	0.0234	0.0696	43.1	0.00009	57.7	0.00334	0.00046	0.00047	1.66	1.08	0.94	0.00023	116.4	13.4	0.02	0.0132	1.08	164.2	0.00057	0.00029	0.00894	0.00235	152	0.64	0.0002	1.4465	0.0007	0.0095	0.0014	0.0011
1	MW-to-RAS_PL-NP20	SC01 Treated	13.25</																																			

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
58	MW-to-RAS_PL-NP20	SC01 Treated	29.69	6.24	351	0.21	156.3	0.0124	0.0037	0.1784	93.8	0.00010	86.6	0.00036	0.00027	0.00026	0.87	1.49	0.06	0.00014	116.2	28.3	0.03	0.0081	0.09	228.8	0.00149	0.00019	0.01189	0.00163	205	0.36	0.0002	0.8278	0.0032	0.0136	0.0020	0.0006
59	MW-to-RAS_PL-NP20	SC01 Treated	27.36	6.31	326	0.18	154.1	0.0142	0.0036	0.1596	87.3	0.00010	76.9	0.00035	0.00021	0.00030	1.00	1.34	0.06	0.00015	102.5	26.1	0.02	0.0096	0.10	205.4	0.00136	0.00020	0.01136	0.00173	190	0.40	0.0002	0.9377	0.0028	0.0131	0.0018	0.0007
60	MW-to-RAS_PL-NP20	SC01 Treated	37.91	6.22	354	0.21	156.3	0.0131	0.0038	0.1762	94.6	0.00010	76.9	0.00035	0.00027	0.00026	0.85	1.51	0.06	0.00013	115.9	28.6	0.03	0.0087	0.09	228.5	0.00151	0.00019	0.01206	0.00159	206	0.36	0.0002	0.8038	0.0033	0.0137	0.0020	0.0006
61	MW-to-RAS_PL-NP20	SC01 Treated	27.83	6.23	357	0.21	156.4	0.0110	0.0035	0.1749	94.8	0.00010	86.7	0.00035	0.00027	0.00025	0.85	1.50	0.06	0.00014	114.5	28.8	0.03	0.0086	0.09	227.7	0.00153	0.00019	0.01129	0.00162	201	0.36	0.0002	0.8216	0.0033	0.0128	0.0020	0.0006
62	MW-to-RAS_PL-NP20	SC01 Treated	21.52	6.19	373	0.23	158.4	0.0118	0.0038	0.1852	99.8	0.00010	86.7	0.00035	0.00024	0.00024	1.78	1.59	0.07	0.00013	126.7	30.2	0.03	0.0074	0.08	240.3	0.00163	0.00018	0.01206	0.00152	214	0.33	0.0002	0.7364	0.0036	0.0136	0.0021	0.0005
63	MW-to-RAS_PL-NP20	SC01 Treated	32.01	6.34	318	0.17	154.0	0.0135	0.0035	0.1466	85.4	0.00010	73.4	0.00033	0.00032	0.00031	1.05	1.27	0.06	0.00016	93.8	25.3	0.02	0.0088	0.10	192.3	0.00132	0.00020	0.01047	0.00177	177	0.41	0.0002	0.9902	0.0027	0.0120	0.0017	0.0007
64	MW-to-RAS_PL-NP20	SC01 Treated	30.64	6.30	331	0.19	155.2	0.0111	0.0033	0.1512	88.8	0.00010	77.7	0.00033	0.00030	0.00028	0.97	1.36	0.06	0.00015	101.1	26.6	0.02	0.0065	0.09	202.8	0.00137	0.00020	0.01029	0.00172	180	0.39	0.0002	0.9308	0.0029	0.0117	0.0018	0.0007
65	MW-to-RAS_PL-NP20	SC01 Treated	33.00	6.31	313	0.17	153.4	0.0137	0.0035	0.1394	84.2	0.00010	71.0	0.00032	0.00032	0.00032	1.05	1.27	0.06	0.00016	92.4	25.0	0.02	0.0090	0.10	187.4	0.00128	0.00020	0.01039	0.00176	174	0.41	0.0002	0.9913	0.0026	0.0119	0.0017	0.0008
66	MW-to-RAS_PL-NP20	SC01 Treated	26.89	6.24	348	0.21	156.3	0.0118	0.0036	0.1596	93.3	0.00010	84.7	0.00033	0.00028	0.00027	0.89	1.45	0.06	0.00014	106.1	28.0	0.02	0.0071	0.09	213.6	0.00147	0.00019	0.01064	0.00163	192	0.37	0.0002	0.8531	0.0032	0.0123	0.0018	0.0006
67	MW-to-RAS_PL-NP20	SC01 Treated	30.07	6.29	331	0.19	155.0	0.0122	0.0034	0.1470	88.9	0.00010	77.9	0.00032	0.00030	0.00029	0.98	1.35	0.06	0.00015	97.5	26.5	0.02	0.0074	0.09	196.3	0.00138	0.00020	0.01029	0.00170	180	0.39	0.0002	0.9317	0.0029	0.0117	0.0017	0.0007
68	MW-to-RAS_PL-NP20	SC01 Treated	32.44	6.30	331	0.19	155.0	0.0123	0.0034	0.1451	88.8	0.00010	77.7	0.00032	0.00030	0.00029	0.98	1.35	0.06	0.00015	96.7	26.5	0.02	0.0075	0.09	197.0	0.00138	0.00020	0.01024	0.00170	179	0.39	0.0002	0.9302	0.0029	0.0116	0.0017	0.0007
69	MW-to-RAS_PL-NP20	SC01 Treated	19.24	6.17	381	0.24	159.8	0.0111	0.0038	0.1735	101.8	0.00010	87.2	0.00032	0.00023	0.00022	0.73	1.63	0.07	0.00012	117.8	30.7	0.03	0.0066	0.08	235.4	0.00165	0.00018	0.01158	0.00145	211	0.32	0.0002	0.6978	0.0037	0.0129	0.0020	0.0005
70	MW-to-RAS_PL-NP20	SC01 Treated	27.85	6.30	326	0.18	155.3	0.0124	0.0034	0.1395	87.7	0.00010	75.7	0.00031	0.00031	0.00030	1.00	1.31	0.06	0.00016	92.2	26.0	0.02	0.0076	0.10	190.4	0.00135	0.00020	0.00996	0.00171	174	0.39	0.0002	0.9559	0.0028	0.0113	0.0017	0.0007
71	MW-to-RAS_PL-NP20	SC01 Treated	36.69	6.37	301	0.16	153.0	0.0145	0.0035	0.1239	81.1	0.00010	65.9	0.00031	0.00034	0.00034	1.12	1.18	0.06	0.00017	81.7	23.9	0.02	0.0095	0.11	170.5	0.00122	0.00021	0.00977	0.00180	163	0.43	0.0002	1.0459	0.0025	0.0112	0.0015	0.0008
72	MW-to-RAS_PL-NP20	SC01 Treated	23.42	6.22	353	0.21	157.8	0.0130	0.0038	0.1522	94.6	0.00010	86.1	0.00030	0.00027	0.00026	0.86	1.48	0.06	0.00013	104.3	28.4	0.02	0.0082	0.09	210.5	0.00150	0.00019	0.01105	0.00154	195	0.35	0.0002	0.8051	0.0033	0.0123	0.0018	0.0006
73	MW-to-RAS_PL-NP20	SC01 Treated	28.20	6.29	328	0.19	155.5	0.0133	0.0036	0.1565	88.1	0.00010	76.2	0.00030	0.00031	0.00030	1.00	1.31	0.06	0.00015	91.0	26.2	0.02	0.0083	0.10	188.5	0.00136	0.00020	0.01008	0.00168	176	0.39	0.0002	0.9408	0.0029	0.0114	0.0016	0.0007
74	MW-to-RAS_PL-NP20	SC01 Treated	23.80	6.25	342	0.20	157.1	0.0130	0.0037	0.1429	91.7	0.00010	81.5	0.00030	0.00029	0.00028	0.92	1.39	0.06	0.00014	96.4	27.4	0.02	0.0090	0.09	196.3	0.00144	0.00019	0.01042	0.00160	154	0.37	0.0002	0.8721	0.0031	0.0117	0.0017	0.0007
75	MW-to-RAS_PL-NP20	SC01 Treated	20.42	6.23	352	0.21	158.3	0.0113	0.0035	0.1465	94.4	0.00010	85.1	0.00029	0.00027	0.00026	0.88	1.43	0.06	0.00014	99.4	28.2	0.02	0.0064	0.08	204.3	0.00148	0.00019	0.01012	0.00158	185	0.36	0.0002	0.8413	0.0032	0.0113	0.0017	0.0006
76	MW-to-RAS_PL-NP20	SC01 Treated	29.33	6.36	311	0.17	154.7	0.0127	0.0033	0.1231	83.8	0.00010	69.1	0.00029	0.00034	0.00032	1.09	1.18	0.06	0.00017	80.3	24.6	0.02	0.0076	0.10	171.2	0.00127	0.00021	0.00906	0.00178	159	0.42	0.0002	1.0385	0.0026	0.0103	0.0015	0.0008
77	MW-to-RAS_PL-NP20	SC01 Treated	36.22	6.36	306	0.17	154.1	0.0135	0.0034	0.1187	82.3	0.00010	66.8	0.00029	0.00034	0.00032	1.09	1.18	0.06	0.00017	80.0	24.3	0.02	0.0084	0.10	168.1	0.00123	0.00020	0.00927	0.00177	159	0.42	0.0002	1.0332	0.0025	0.0105	0.0015	0.0008
78	MW-to-RAS_PL-NP20	SC01 Treated	36.33	6.32	311	0.17	153.9	0.0138	0.0034	0.1208	83.7	0.00010	69.0	0.00029	0.00033	0.00032	1.07	1.20	0.06	0.00016	81.3	24.7	0.02	0.0086	0.10	170.9	0.00126	0.00020	0.00939	0.00173	163	0.41	0.0002	1.0083	0.0026	0.0107	0.0015	0.0008
79	MW-to-RAS_PL-NP20	SC01 Treated	28.50	6.24	342	0.21	156.6	0.0136	0.0037	0.1370	91.9	0.00010	81.6	0.00029	0.00028	0.00028	0.92	1.37	0.06	0.00014	92.9	27.4	0.02	0.0084	0.09	193.2	0.00144	0.00019	0.01021	0.00157	183	0.37	0.0002	0.8631	0.0031	0.0114	0.0016	0.0007
80	MW-to-RAS_PL-NP20	SC01 Treated	30.63	6.28	328	0.19	155.2	0.0135	0.0036	0.1283	89.3	0.00010	76.1	0.00028	0.00031	0.00030	0.99	1.28	0.06	0.00015	86.1	26.2	0.02	0.0083	0.10	181.5	0.00137	0.00020	0.00964	0.00164	172	0.39	0.0002	0.9329	0.0029	0.0109	0.0015	0.0007
81	MW-to-RAS_PL-NP20	SC01 Treated	32.28	6.26	335	0.20	155.7	0.0133	0.0036	0.1301	90.0	0.00010	76.6	0.00028	0.00029	0.00028	0.94	1.32	0.06	0.00014	89.2	26.8	0.02	0.0082	0.09	186.1	0.00140	0.00019	0.00964	0.00159	176	0.37	0.0002	0.8839	0.0030	0.0110	0.0016	0.0007
82	MW-to-RAS_PL-NP20	SC01 Treated	37.66	6.30	322	0.19	154.2	0.0141	0.0036	0.1228	86.6	0.00010	73.7	0.00028	0.00031	0.00031	1.01	1.24	0.06	0.00015	82.5	25.7	0.02	0.0088	0.10	175.0	0.00134	0.00020	0.00953	0.00165	169	0.39	0.0002	0.9485	0.0028	0.0107	0.0015	0.0007
83	MW-to-RAS_PL-NP20	SC01 Treated	30.58	6.24	342	0.21	155.7	0.0126	0.0036	0.1310	91.7	0.00010	81.1	0.00027	0.00028	0.00027	0.91	1.33	0.06	0.00014	89.5	27.4	0.02	0.0074	0.09	188.0	0.00144	0.00019	0.00960	0.00156	177	0.37	0.0002	0.8628	0.0031	0.0107	0.0016	0.0006
84	MW-to-RAS_PL-NP20	SC01 Treated	36.22	6.29	327	0.19	154.2	0.0122	0.0034	0.1223	87.9	0.00010	75.3	0.00027	0.00030	0.00030	1.00	1.23	0.06	0.00015	81.8	26.0	0.02	0.0068	0.10	175.4	0.00136	0.00020	0.00883	0.00166	163	0.39	0.0002	0.9514	0.0029	0.0100	0.0015	0.0007
85	MW-to-RAS_PL-NP20	SC01 Treated	51.53	6.37	301	0.17	151.9	0.0153	0.0036	0.1099	81.3	0.00010	65.9	0.00028	0.00034	0.00033	1.10	1.11	0.06	0.00016	72.6	23.9	0.02	0.0099	0.11	157.7	0.00123	0.00020	0.00912	0.00172	157	0.42	0.0002	1.0280	0.0025	0.0104	0.0013	0.0008
86	MW-to-RAS_PL-NP20	SC01 Treated	36.73	6.21	355	0.22	156.0	0.0127	0.0038	0.1344	95.2	0.00010	86.6	0.00026	0.00026	0.00027	0.83	1.39	0.06	0.00013	92.7	28.5	0.02	0.0058	0.09	184.6	0.00152	0.00019	0.00992	0.00165	194	0.34	0.0002	0.7825	0.0033	0.0089	0.0013	0.

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
144	MW-to-RAS_PL-NP20	SC01 Treated	32.34	6.27	316	0.19	151.7	0.0128	0.0035	0.0961	85.2	0.00010	71.7	0.00022	0.00030	0.00029	0.98	0.76	0.06	0.00015	46.2	25.0	0.01	0.0066	0.09	131.1	0.00133	0.00020	0.00569	0.00146	131	0.37	0.0002	0.9336	0.0028	0.0068	0.0008	0.0007
145	MW-to-RAS_PL-NP20	SC01 Treated	24.04	6.18	358	0.24	155.2	0.0118	0.0038	0.1126	96.4	0.00010	68.7	0.00021	0.00024	0.00023	1.07	0.89	0.07	0.00015	55.0	28.6	0.02	0.0054	0.08	153.2	0.00158	0.00018	0.00590	0.00010	120	0.31	0.0002	0.7339	0.0035	0.0069	0.0009	0.0005
146	MW-to-RAS_PL-NP20	SC01 Treated	35.26	6.31	299	0.18	150.5	0.0147	0.0036	0.0906	80.9	0.00010	65.7	0.00023	0.00031	0.00032	1.07	0.70	0.06	0.00016	41.8	23.6	0.01	0.0085	0.10	122.2	0.00125	0.00020	0.00599	0.00015	126	0.40	0.0002	0.0005	0.0026	0.0072	0.0008	0.0008
147	MW-to-RAS_PL-NP20	SC01 Treated	35.23	6.30	316	0.19	151.6	0.0144	0.0034	0.0960	85.2	0.00010	71.7	0.00022	0.00031	0.00030	1.08	0.74	0.06	0.00015	44.5	25.0	0.01	0.0092	0.09	129.7	0.00134	0.00020	0.00541	0.00148	128	0.38	0.0002	0.9517	0.0028	0.0065	0.0008	0.0007
148	MW-to-RAS_PL-NP20	SC01 Treated	32.28	6.25	322	0.20	152.2	0.0134	0.0036	0.0997	86.5	0.00010	74.5	0.00022	0.00029	0.00029	0.94	0.76	0.06	0.00014	46.3	25.6	0.01	0.0071	0.09	133.2	0.00137	0.00019	0.00563	0.00139	135	0.36	0.0002	0.8890	0.0029	0.0070	0.0009	0.0007
149	MW-to-RAS_PL-NP20	SC01 Treated	35.34	6.29	305	0.18	150.6	0.0146	0.0036	0.0929	82.3	0.00010	68.2	0.00023	0.00032	0.00032	1.04	0.70	0.06	0.00015	42.0	24.1	0.01	0.0084	0.10	124.2	0.00129	0.00020	0.00594	0.00149	130	0.39	0.0002	0.9714	0.0027	0.0072	0.0008	0.0007
150	MW-to-RAS_PL-NP20	SC01 Treated	30.10	6.24	326	0.20	151.9	0.0131	0.0036	0.1000	87.8	0.00010	76.0	0.00022	0.00029	0.00028	0.93	0.76	0.06	0.00014	46.0	25.8	0.01	0.0068	0.09	134.1	0.00140	0.00019	0.00567	0.00137	135	0.38	0.0002	0.8795	0.0030	0.0068	0.0008	0.0007
151	MW-to-RAS_PL-NP20	SC01 Treated	39.52	6.30	316	0.19	151.2	0.0137	0.0036	0.0966	85.3	0.00010	72.4	0.00022	0.00030	0.00030	0.99	0.72	0.06	0.00015	43.4	25.0	0.01	0.0074	0.10	128.8	0.00135	0.00020	0.00569	0.00143	132	0.37	0.0002	0.9264	0.0029	0.0069	0.0008	0.0007
152	MW-to-RAS_PL-NP20	SC01 Treated	36.08	6.28	319	0.20	151.2	0.0138	0.0036	0.0977	86.0	0.00010	73.6	0.00022	0.00030	0.00029	0.97	0.73	0.06	0.00015	43.9	25.2	0.01	0.0075	0.10	130.0	0.00137	0.00019	0.00575	0.00140	134	0.37	0.0002	0.9050	0.0029	0.0068	0.0008	0.0007
153	MW-to-RAS_PL-NP20	SC01 Treated	34.37	6.28	319	0.20	151.1	0.0135	0.0036	0.0977	86.1	0.00010	73.6	0.00022	0.00030	0.00029	0.97	0.72	0.06	0.00015	43.3	25.2	0.01	0.0071	0.10	129.6	0.00137	0.00020	0.00558	0.00141	132	0.37	0.0002	0.9129	0.0029	0.0068	0.0008	0.0007
154	MW-to-RAS_PL-NP20	SC01 Treated	33.78	6.28	315	0.19	150.9	0.0135	0.0036	0.0961	85.1	0.00010	72.1	0.00022	0.00030	0.00030	0.98	0.70	0.06	0.00015	42.3	24.9	0.01	0.0072	0.10	127.4	0.00134	0.00020	0.00555	0.00142	130	0.37	0.0002	0.9248	0.0029	0.0067	0.0008	0.0007
155	MW-to-RAS_PL-NP20	SC01 Treated	29.77	6.25	324	0.20	151.5	0.0130	0.0036	0.0992	87.3	0.00010	75.4	0.00022	0.00029	0.00028	0.94	0.72	0.06	0.00014	43.8	25.7	0.01	0.0066	0.09	131.4	0.00139	0.00019	0.00544	0.00137	133	0.36	0.0002	0.8836	0.0030	0.0066	0.0008	0.0007
156	MW-to-RAS_PL-NP20	SC01 Treated	36.60	6.29	314	0.19	150.9	0.0134	0.0036	0.0957	84.9	0.00010	71.8	0.00022	0.00030	0.00030	0.98	0.69	0.06	0.00015	41.6	24.9	0.01	0.0071	0.10	126.4	0.00134	0.00020	0.00545	0.00142	129	0.37	0.0002	0.9273	0.0028	0.0067	0.0008	0.0007
157	MW-to-RAS_PL-NP20	SC01 Treated	31.63	6.26	319	0.20	151.1	0.0136	0.0036	0.0973	86.0	0.00010	73.6	0.00022	0.00030	0.00029	0.96	0.70	0.06	0.00014	42.3	25.3	0.01	0.0073	0.09	128.3	0.00136	0.00019	0.00553	0.00138	132	0.36	0.0002	0.8982	0.0029	0.0067	0.0008	0.0007
158	MW-to-RAS_PL-NP20	SC01 Treated	29.92	6.22	335	0.22	152.1	0.0124	0.0036	0.1028	90.1	0.00010	79.6	0.00021	0.00027	0.00026	0.87	0.74	0.06	0.00014	45.1	26.6	0.01	0.0060	0.09	135.6	0.00145	0.00019	0.00530	0.00129	136	0.34	0.0002	0.8267	0.0032	0.0068	0.0008	0.0006
159	MW-to-RAS_PL-NP20	SC01 Treated	37.61	6.29	311	0.19	150.4	0.0142	0.0036	0.0949	84.1	0.00010	70.8	0.00022	0.00031	0.00030	1.00	0.67	0.06	0.00015	39.9	24.6	0.01	0.0079	0.10	123.9	0.00133	0.00020	0.00555	0.00143	129	0.37	0.0002	0.9067	0.0026	0.0068	0.0007	0.0007
160	MW-to-RAS_PL-NP20	SC01 Treated	28.08	6.21	338	0.22	152.1	0.0131	0.0036	0.1044	90.9	0.00010	81.1	0.00021	0.00027	0.00026	0.85	0.74	0.06	0.00013	45.1	26.8	0.01	0.0067	0.09	136.7	0.00147	0.00019	0.00549	0.00125	139	0.33	0.0002	0.8016	0.0032	0.0066	0.0008	0.0006
161	MW-to-RAS_PL-NP20	SC01 Treated	28.00	6.22	340	0.22	152.1	0.0111	0.0035	0.1048	91.7	0.00010	82.0	0.00021	0.00027	0.00025	0.85	0.73	0.06	0.00014	44.6	27.1	0.01	0.0047	0.08	137.2	0.00149	0.00019	0.00549	0.00128	133	0.33	0.0002	0.8205	0.0033	0.0065	0.0008	0.0006
162	MW-to-RAS_PL-NP20	SC01 Treated	21.62	6.18	357	0.24	154.0	0.0118	0.0038	0.1117	96.0	0.00010	88.8	0.00020	0.00024	0.00024	0.77	0.77	0.07	0.00013	47.2	28.4	0.02	0.0054	0.08	145.2	0.00159	0.00018	0.00518	0.00116	143	0.31	0.0002	0.7350	0.0036	0.0063	0.0008	0.0005
163	MW-to-RAS_PL-NP20	SC01 Treated	32.10	6.33	305	0.18	150.5	0.0135	0.0035	0.0922	82.4	0.00010	68.1	0.00022	0.00032	0.00031	1.05	0.63	0.06	0.00016	36.8	24.0	0.01	0.0072	0.10	119.2	0.00129	0.00020	0.00510	0.00149	122	0.39	0.0002	0.9889	0.0027	0.0064	0.0007	0.0007
164	MW-to-RAS_PL-NP20	SC01 Treated	30.69	6.28	317	0.19	151.4	0.0111	0.0033	0.0951	85.6	0.00010	72.1	0.00021	0.00030	0.00028	0.97	0.66	0.06	0.00015	39.3	25.1	0.01	0.0048	0.09	124.4	0.00134	0.00019	0.00549	0.00142	120	0.38	0.0002	0.9298	0.0029	0.0067	0.0007	0.0007
165	MW-to-RAS_PL-NP20	SC01 Treated	33.03	6.30	300	0.18	150.0	0.0137	0.0035	0.0999	81.2	0.00010	66.1	0.00022	0.00032	0.00032	1.05	0.61	0.06	0.00016	36.1	23.7	0.01	0.0074	0.10	116.5	0.00126	0.00020	0.00512	0.00149	120	0.39	0.0002	0.9902	0.0026	0.0064	0.0007	0.0007
166	MW-to-RAS_PL-NP20	SC01 Treated	26.90	6.23	333	0.21	152.4	0.0118	0.0035	0.1021	89.8	0.00010	79.0	0.00021	0.00028	0.00027	0.89	0.69	0.06	0.00014	41.6	26.4	0.01	0.0054	0.09	132.0	0.00145	0.00019	0.00519	0.00147	131	0.30	0.0002	0.8523	0.0031	0.0060	0.0007	0.0006
167	MW-to-RAS_PL-NP20	SC01 Treated	30.08	6.28	317	0.19	151.4	0.0122	0.0034	0.0961	85.7	0.00010	72.7	0.00022	0.00030	0.00029	0.98	0.64	0.06	0.00015	38.2	25.1	0.01	0.0058	0.09	124.0	0.00135	0.00020	0.00472	0.00142	123	0.36	0.0002	0.9311	0.0029	0.0059	0.0007	0.0007
168	MW-to-RAS_PL-NP20	SC01 Treated	32.44	6.29	317	0.19	151.4	0.0123	0.0034	0.0959	85.6	0.00010	72.6	0.00022	0.00030	0.00029	0.98	0.64	0.06	0.00015	38.0	25.1	0.01	0.0059	0.09	123.6	0.00135	0.00020	0.00471	0.00141	123	0.36	0.0002	0.9297	0.0029	0.0059	0.0007	0.0007
169	MW-to-RAS_PL-NP20	SC01 Treated	19.24	6.16	364	0.24	155.4	0.0111	0.0038	0.1136	97.9	0.00010	91.0	0.00020	0.00023	0.00022	0.73	0.76	0.07	0.00012	46.3	29.0	0.02	0.0046	0.07	146.0	0.00162	0.00018	0.00482	0.00110	142	0.29	0.0002	0.6973	0.0036	0.0059	0.0007	0.0005
170	MW-to-RAS_PL-NP20	SC01 Treated	27.85	6.29	313	0.19	151.8	0.0124	0.0034	0.0945	84.7	0.00010	70.9	0.00022	0.00031	0.00030	1.00	0.62	0.06	0.00016	36.4	24.7	0.01	0.0061	0.09	121.0	0.00133	0.00020	0.00467	0.00144	121	0.37	0.0002	0.9556	0.0028	0.0059	0.0007	0.0007
171	MW-to-RAS_PL-NP20	SC01 Treated	36.69	6.36	299	0.16	150.0	0.0145	0.0035	0.0861	78.4	0.00010	61.8	0.00023	0.00034	0.00034	1.12	0.56	0.06	0.00017	32.3	22.7	0.01	0.0082	0.11	109.7	0.00120	0.00021	0.00510	0.00156	116	0.41	0.0002	1.0494	0.0024	0.0064	0.0007	0.0008
172	MW-to-RAS_PL-NP20	SC01 Treated	23.42	6.21	338	0.22	153.9	0.0132	0.0036	0.1044	91.1	0.00010	80.9	0.00021	0.00026	0.00026	0.86	0.69	0.06	0.00013	41.1	26.9	0.01	0.0065	0.09	132.9	0.00147	0.00019	0.00549	0.00123	135	0.37	0.0002	0.8049	0.0032	0.0063	0.0007	0.0007
173	MW-to-RAS_PL-NP20	SC01 Treated	28.																																			

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
30	MW-to-RAS PL-NP20	RS03 Untreated	17.98	6.58	104	0.08	106.0	0.0166	0.0202	0.0248	25.9	0.00007	5.2	0.00044	0.00045	0.00072	1.40	0.23	0.85	0.00017	12.3	9.7	0.02	0.0127	2.18	28.5	0.00051	0.00041	0.04339	0.00357	31	0.55	0.0002	1.3750	0.0000	0.0045	0.0020	0.0016
31	MW-to-RAS PL-NP20	RS03 Untreated	20.10	6.57	104	0.09	105.1	0.0171	0.0202	0.0247	25.7	0.00007	5.1	0.00043	0.00045	0.00073	1.41	0.23	0.86	0.00017	12.4	9.6	0.02	0.0131	2.24	28.3	0.00051	0.00042	0.04367	0.00357	32	0.56	0.0002	1.3856	0.0000	0.0046	0.0020	0.0016
32	MW-to-RAS PL-NP20	RS03 Untreated	19.95	6.54	103	0.09	103.0	0.0175	0.0207	0.0244	25.5	0.00007	5.0	0.00043	0.00044	0.00075	1.41	0.24	0.93	0.00016	13.0	9.6	0.02	0.0135	2.46	28.2	0.00051	0.00044	0.04364	0.00357	33	0.59	0.0002	1.3856	0.0000	0.0048	0.0020	0.0016
33	MW-to-RAS PL-NP20	RS03 Untreated	20.61	6.53	102	0.10	100.1	0.0185	0.0209	0.0239	25.1	0.00007	4.9	0.00043	0.00044	0.00075	1.42	0.24	0.96	0.00016	13.3	9.5	0.02	0.0138	2.55	27.7	0.00051	0.00044	0.04360	0.00357	34	0.60	0.0002	1.3977	0.0000	0.0048	0.0021	0.0016
34	MW-to-RAS PL-NP20	RS03 Untreated	13.90	6.50	112	0.10	112.2	0.0180	0.0240	0.0257	27.3	0.00007	5.6	0.00047	0.00044	0.00075	1.31	0.27	1.05	0.00016	15.3	10.7	0.02	0.0157	2.63	32.3	0.00051	0.00047	0.05571	0.00414	37	0.69	0.0002	1.2925	0.0000	0.0055	0.0024	0.0016
35	MW-to-RAS PL-NP20	RS03 Untreated	21.02	6.54	111	0.10	112.2	0.0171	0.0228	0.0254	27.2	0.00007	5.5	0.00043	0.00045	0.00074	1.33	0.25	0.97	0.00017	13.9	10.5	0.02	0.0138	2.42	31.0	0.00051	0.00045	0.04949	0.00367	33	0.62	0.0002	1.3174	0.0000	0.0049	0.0022	0.0016
36	MW-to-RAS PL-NP20	RS03 Untreated	14.56	6.56	114	0.09	116.7	0.0162	0.0230	0.0255	28.0	0.00007	5.7	0.00042	0.00045	0.00072	1.33	0.25	0.93	0.00017	13.5	10.8	0.02	0.0131	2.25	31.7	0.00050	0.00043	0.04846	0.00364	31	0.62	0.0002	1.3163	0.0000	0.0047	0.0021	0.0016
37	MW-to-RAS PL-NP20	RS03 Untreated	14.68	6.60	115	0.08	119.3	0.0159	0.0221	0.0257	28.2	0.00007	5.1	0.00039	0.00046	0.00071	1.33	0.24	0.84	0.00017	12.1	10.8	0.02	0.0119	2.01	31.1	0.00050	0.00041	0.04266	0.00359	29	0.56	0.0002	1.3157	0.0000	0.0043	0.0019	0.0016
38	MW-to-RAS PL-NP20	RS03 Untreated	18.61	6.59	105	0.08	108.0	0.0165	0.0197	0.0243	26.1	0.00007	5.1	0.00035	0.00045	0.00072	1.40	0.21	0.80	0.00017	10.6	9.7	0.01	0.0109	2.05	27.2	0.00050	0.00040	0.03666	0.00322	29	0.51	0.0002	1.3761	0.0000	0.0040	0.0017	0.0016
39	MW-to-RAS PL-NP20	RS03 Untreated	21.77	6.59	107	0.08	109.2	0.0162	0.0204	0.0243	26.5	0.00007	5.2	0.00036	0.00045	0.00072	1.40	0.22	0.83	0.00017	11.2	9.9	0.01	0.0111	2.09	28.0	0.00050	0.00041	0.03884	0.00337	28	0.54	0.0002	1.3808	0.0000	0.0040	0.0018	0.0016
40	MW-to-RAS PL-NP20	RS03 Untreated	26.22	6.55	96	0.09	94.3	0.0176	0.0185	0.0225	23.9	0.00007	4.5	0.00033	0.00043	0.00075	1.49	0.20	0.87	0.00016	10.7	8.7	0.01	0.0112	2.40	23.8	0.00051	0.00042	0.03589	0.00312	30	0.53	0.0002	1.4645	0.0000	0.0041	0.0017	0.0015
41	MW-to-RAS PL-NP20	RS03 Untreated	16.77	6.54	110	0.10	110.4	0.0170	0.0231	0.0223	27.1	0.00007	5.4	0.00039	0.00044	0.00075	1.38	0.25	1.00	0.00016	14.1	10.4	0.02	0.0138	2.43	30.4	0.00050	0.00044	0.05066	0.00389	33	0.67	0.0002	1.3641	0.0000	0.0049	0.0022	0.0016
42	MW-to-RAS PL-NP20	RS03 Untreated	21.51	6.60	104	0.08	105.6	0.0163	0.0202	0.0230	25.8	0.00007	5.0	0.00034	0.00044	0.00072	1.42	0.22	0.84	0.00017	11.3	9.6	0.01	0.0114	2.06	27.2	0.00050	0.00040	0.03967	0.00336	29	0.56	0.0002	1.4032	0.0000	0.0042	0.0018	0.0016
43	MW-to-RAS PL-NP20	RS03 Untreated	14.39	6.51	115	0.10	115.3	0.0177	0.0238	0.0250	27.9	0.00007	5.6	0.00036	0.00045	0.00075	1.32	0.25	1.03	0.00016	13.4	10.9	0.02	0.0131	2.62	30.7	0.00049	0.00047	0.04656	0.00368	33	0.63	0.0002	1.2981	0.0000	0.0048	0.0020	0.0016
44	MW-to-RAS PL-NP20	RS03 Untreated	18.51	6.52	105	0.10	104.2	0.0176	0.0214	0.0237	25.7	0.00007	5.1	0.00034	0.00044	0.00075	1.37	0.22	0.96	0.00017	12.0	9.8	0.01	0.0118	2.52	27.3	0.00050	0.00045	0.04087	0.00340	31	0.58	0.0002	1.3477	0.0000	0.0043	0.0018	0.0016
45	MW-to-RAS PL-NP20	RS03 Untreated	13.04	6.53	120	0.10	122.3	0.0172	0.0253	0.0258	29.0	0.00007	6.0	0.00036	0.00045	0.00073	1.26	0.26	1.04	0.00017	13.9	11.5	0.02	0.0134	2.45	33.0	0.00049	0.00046	0.04937	0.00367	33	0.66	0.0002	1.2411	0.0000	0.0049	0.0022	0.0016
46	MW-to-RAS PL-NP20	RS03 Untreated	21.09	6.55	101	0.09	101.4	0.0175	0.0199	0.0233	25.0	0.00007	4.8	0.00031	0.00044	0.00074	1.41	0.20	0.88	0.00017	10.7	9.4	0.01	0.0110	2.31	25.5	0.00050	0.00043	0.03569	0.00315	30	0.53	0.0002	1.3795	0.0000	0.0041	0.0017	0.0016
47	MW-to-RAS PL-NP20	RS03 Untreated	21.62	6.57	106	0.09	106.5	0.0167	0.0211	0.0236	26.1	0.00007	5.1	0.00032	0.00045	0.00073	1.40	0.22	0.90	0.00017	11.6	9.8	0.01	0.0113	2.21	27.4	0.00050	0.00042	0.04004	0.00339	29	0.58	0.0002	1.3675	0.0000	0.0041	0.0018	0.0016
48	MW-to-RAS PL-NP20	RS03 Untreated	18.13	6.54	104	0.09	103.8	0.0174	0.0209	0.0232	25.7	0.00007	5.0	0.00031	0.00044	0.00075	1.42	0.21	0.93	0.00016	11.4	9.7	0.01	0.0114	2.40	26.4	0.00049	0.00044	0.03873	0.00328	30	0.58	0.0002	1.3953	0.0000	0.0042	0.0018	0.0016
49	MW-to-RAS PL-NP20	RS03 Untreated	20.66	6.55	101	0.09	101.0	0.0175	0.0202	0.0230	25.0	0.00007	4.8	0.00030	0.00044	0.00074	1.42	0.21	0.90	0.00016	11.0	9.3	0.01	0.0113	2.29	25.6	0.00049	0.00042	0.03743	0.00322	30	0.56	0.0002	1.3962	0.0000	0.0042	0.0017	0.0015
50	MW-to-RAS PL-NP20	RS03 Untreated	16.92	6.54	106	0.09	105.8	0.0173	0.0217	0.0234	26.0	0.00007	5.1	0.00031	0.00044	0.00074	1.38	0.22	0.95	0.00016	11.8	9.9	0.01	0.0116	2.38	27.3	0.00049	0.00044	0.04051	0.00338	31	0.60	0.0002	1.3602	0.0000	0.0043	0.0018	0.0016
51	MW-to-RAS PL-NP20	RS03 Untreated	24.18	6.56	104	0.09	104.9	0.0172	0.0209	0.0232	25.8	0.00007	5.0	0.00030	0.00044	0.00074	1.41	0.21	0.91	0.00017	11.1	9.7	0.01	0.0111	2.27	26.4	0.00049	0.00043	0.03754	0.00324	30	0.57	0.0002	1.3924	0.0000	0.0041	0.0017	0.0016
52	MW-to-RAS PL-NP20	RS03 Untreated	21.53	6.56	103	0.09	103.6	0.0171	0.0206	0.0229	25.6	0.00007	4.9	0.00029	0.00044	0.00074	1.43	0.21	0.90	0.00016	11.0	9.5	0.01	0.0110	2.26	25.9	0.00049	0.00042	0.03722	0.00321	30	0.57	0.0002	1.4091	0.0000	0.0041	0.0017	0.0015
53	MW-to-RAS PL-NP20	RS03 Untreated	20.60	6.57	104	0.09	104.7	0.0168	0.0206	0.0230	25.7	0.00007	4.9	0.00029	0.00044	0.00074	1.43	0.21	0.89	0.00017	10.8	9.6	0.01	0.0107	2.20	26.0	0.00049	0.00042	0.03658	0.00319	29	0.57	0.0002	1.4054	0.0000	0.0040	0.0017	0.0016
54	MW-to-RAS PL-NP20	RS03 Untreated	19.75	6.56	102	0.09	102.8	0.0170	0.0203	0.0228	25.4	0.00007	4.8	0.00028	0.00044	0.00074	1.44	0.20	0.89	0.00017	10.5	9.4	0.01	0.0104	2.28	25.3	0.00049	0.00042	0.03482	0.00310	29	0.55	0.0002	1.4158	0.0000	0.0039	0.0016	0.0016
55	MW-to-RAS PL-NP20	RS03 Untreated	16.93	6.54	106	0.09	106.7	0.0173	0.0217	0.0234	26.2	0.00007	5.1	0.00028	0.00044	0.00074	1.39	0.21	0.95	0.00017	11.1	9.9	0.01	0.0108	2.39	26.7	0.00049	0.00044	0.03723	0.00322	30	0.58	0.0002	1.3667	0.0000	0.0040	0.0017	0.0016
56	MW-to-RAS PL-NP20	RS03 Untreated	22.05	6.55	105	0.09	104.9	0.0175	0.0212	0.0232	25.8	0.00007	5.0	0.00028	0.00044	0.00075	1.40	0.20	0.94	0.00017	10.8	9.8	0.01	0.0106	2.38	26.0	0.00049	0.00044	0.03587	0.00315	30	0.57	0.0002	1.3800	0.0000	0.0040	0.0017	0.0016
57	MW-to-RAS PL-NP20	RS03 Untreated	18.28	6.53	104	0.09	103.7	0.0175	0.0211	0.0229	25.7	0.00007	4.9	0.00027	0.00044	0.00075	1.42	0.20	0.95	0.00016	10.8	9.7	0.01	0.0106	2.41	25.6	0.00049	0.00044	0.03556	0.00313	30	0.57	0.0002	1.3955	0.0000	0.0040	0.0017	0.0016
58	MW-to-RAS PL-NP20	RS03 Untreated	22.69	6.54	104	0.09	103.2	0.0177	0.0229	0.0235	25.5	0.00007	5.2	0.00027	0.00044	0.00075	1.35	0.22	1.02	0.00016	11.7	10.3	0.01	0.0111	2.55	27.4	0.00049	0.00041	0.03555	0.00315	31	0.61	0.0002	1.3343	0.0000	0.0042	0.0018	0.0016
59	MW-to-RAS PL-NP20	RS03 Untreated	13.25	6.53	112	0.10	104.6	0.0173	0.0213	0.0231	25.7	0.00007	5.0	0.00027	0.00044	0.00075																						

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
116	MW-to-RAS_PL-NP20	RS03 Untreated	18.65	6.56	110	0.09	112.6	0.0168	0.0228	0.0232	27.1	0.00007	5.2	0.00021	0.00044	0.00073	1.34	0.16	0.95	0.00017	7.5	10.4	0.01	0.0066	2.27	24.1	0.00047	0.00044	0.02003	0.00236	24	0.45	0.0002	1.3269	0.0000	0.0028	0.0011	0.0016
117	MW-to-RAS_PL-NP20	RS03 Untreated	17.76	6.58	111	0.09	114.4	0.0164	0.0223	0.0234	27.4	0.00007	5.2	0.00021	0.00044	0.00073	1.35	0.16	0.90	0.00017	7.1	10.4	0.01	0.0063	2.13	24.3	0.00047	0.00042	0.01872	0.00232	23	0.43	0.0002	1.3399	0.0000	0.0026	0.0011	0.0016
118	MW-to-RAS_PL-NP20	RS03 Untreated	19.63	6.57	102	0.09	104.1	0.0167	0.0200	0.0223	25.5	0.00007	4.7	0.00020	0.00044	0.00073	1.42	0.14	0.86	0.00017	6.5	9.4	0.01	0.0060	2.17	21.5	0.00048	0.00042	0.01622	0.00217	23	0.40	0.0002	1.4007	0.0000	0.0025	0.0010	0.0016
119	MW-to-RAS_PL-NP20	RS03 Untreated	19.12	6.57	106	0.09	107.0	0.0167	0.0210	0.0226	26.0	0.00007	4.9	0.00020	0.00044	0.00073	1.40	0.15	0.89	0.00017	6.9	9.7	0.01	0.0062	2.17	22.4	0.00048	0.00042	0.01763	0.00224	23	0.41	0.0002	1.3797	0.0000	0.0026	0.0010	0.0016
120	MW-to-RAS_PL-NP20	RS03 Untreated	20.08	6.55	102	0.09	102.7	0.0171	0.0204	0.0221	25.3	0.00007	4.7	0.00020	0.00044	0.00074	1.42	0.14	0.90	0.00017	6.7	9.4	0.01	0.0062	2.29	21.3	0.00048	0.00043	0.01689	0.00218	24	0.41	0.0002	1.4031	0.0000	0.0026	0.0010	0.0015
121	MW-to-RAS_PL-NP20	RS03 Untreated	18.74	6.57	109	0.09	111.6	0.0166	0.0220	0.0231	26.9	0.00007	5.1	0.00020	0.00044	0.00073	1.38	0.15	0.91	0.00017	7.0	10.1	0.01	0.0064	2.13	23.4	0.00047	0.00042	0.01822	0.00228	24	0.42	0.0002	1.3611	0.0000	0.0027	0.0011	0.0016
122	MW-to-RAS_PL-NP20	RS03 Untreated	18.74	6.58	107	0.09	109.4	0.0166	0.0211	0.0229	26.8	0.00007	5.0	0.00020	0.00044	0.00073	1.39	0.15	0.87	0.00017	6.6	9.9	0.01	0.0061	2.12	22.8	0.00048	0.00042	0.01674	0.00221	23	0.40	0.0002	1.3710	0.0000	0.0026	0.0010	0.0016
123	MW-to-RAS_PL-NP20	RS03 Untreated	20.67	6.57	105	0.09	106.2	0.0167	0.0207	0.0225	25.9	0.00007	4.8	0.00020	0.00044	0.00074	1.41	0.14	0.89	0.00017	6.5	9.7	0.01	0.0059	2.22	21.9	0.00048	0.00042	0.01614	0.00217	23	0.38	0.0002	1.3898	0.0000	0.0025	0.0010	0.0016
124	MW-to-RAS_PL-NP20	RS03 Untreated	15.77	6.58	113	0.09	116.4	0.0164	0.0226	0.0236	27.7	0.00007	5.3	0.00021	0.00045	0.00073	1.35	0.15	0.90	0.00017	6.8	10.6	0.01	0.0061	2.11	24.4	0.00047	0.00042	0.01759	0.00227	23	0.41	0.0002	1.3354	0.0000	0.0026	0.0010	0.0016
125	MW-to-RAS_PL-NP20	RS03 Untreated	21.05	6.56	102	0.09	102.8	0.0171	0.0200	0.0223	25.2	0.00007	4.7	0.00020	0.00044	0.00074	1.42	0.14	0.88	0.00017	6.3	9.4	0.01	0.0060	2.27	21.0	0.00048	0.00043	0.01507	0.00210	23	0.38	0.0002	1.3951	0.0000	0.0025	0.0009	0.0016
126	MW-to-RAS_PL-NP20	RS03 Untreated	22.20	6.53	97	0.09	96.1	0.0177	0.0197	0.0215	24.2	0.00007	4.4	0.00020	0.00043	0.00075	1.45	0.14	0.92	0.00016	6.5	8.9	0.01	0.0063	2.42	19.6	0.00049	0.00044	0.01587	0.00210	24	0.40	0.0002	1.4297	0.0000	0.0026	0.0009	0.0015
127	MW-to-RAS_PL-NP20	RS03 Untreated	21.16	6.54	104	0.10	104.3	0.0177	0.0222	0.0225	25.7	0.00007	4.8	0.00020	0.00043	0.00075	1.39	0.15	0.90	0.00016	7.2	9.7	0.01	0.0068	2.44	19.8	0.00048	0.00045	0.01845	0.00223	25	0.43	0.0002	1.3732	0.0000	0.0026	0.0010	0.0015
128	MW-to-RAS_PL-NP20	RS03 Untreated	14.99	6.53	107	0.10	108.1	0.0171	0.0224	0.0227	26.3	0.00007	4.9	0.00020	0.00044	0.00074	1.37	0.15	0.97	0.00017	7.0	10.0	0.01	0.0062	2.36	22.6	0.00048	0.00044	0.01778	0.00223	24	0.42	0.0002	1.3500	0.0000	0.0026	0.0010	0.0015
129	MW-to-RAS_PL-NP20	RS03 Untreated	18.01	6.55	109	0.09	111.6	0.0168	0.0224	0.0232	26.9	0.00007	5.1	0.00020	0.00044	0.00073	1.34	0.15	0.94	0.00017	6.8	10.3	0.01	0.0060	2.24	23.3	0.00047	0.00043	0.01687	0.00221	23	0.40	0.0002	1.3288	0.0000	0.0026	0.0010	0.0016
130	MW-to-RAS_PL-NP20	RS03 Untreated	18.49	6.57	102	0.09	104.3	0.0168	0.0201	0.0224	25.4	0.00007	4.7	0.00020	0.00044	0.00073	1.41	0.14	0.85	0.00017	6.1	9.4	0.01	0.0058	2.12	21.3	0.00048	0.00041	0.01462	0.00209	23	0.37	0.0002	1.3859	0.0000	0.0025	0.0009	0.0016
131	MW-to-RAS_PL-NP20	RS03 Untreated	20.66	6.57	102	0.09	103.5	0.0172	0.0202	0.0224	25.3	0.00007	4.7	0.00020	0.00044	0.00073	1.42	0.14	0.87	0.00017	6.2	9.4	0.01	0.0061	2.17	21.1	0.00048	0.00042	0.01479	0.00209	24	0.37	0.0002	1.3979	0.0000	0.0025	0.0009	0.0016
132	MW-to-RAS_PL-NP20	RS03 Untreated	20.49	6.54	101	0.09	101.4	0.0177	0.0207	0.0221	25.1	0.00007	4.6	0.00020	0.00043	0.00075	1.42	0.14	0.93	0.00016	6.5	9.4	0.01	0.0063	2.39	20.7	0.00048	0.00044	0.01545	0.00209	24	0.39	0.0002	1.3953	0.0000	0.0026	0.0009	0.0015
133	MW-to-RAS_PL-NP20	RS03 Untreated	21.17	6.52	100	0.10	101.4	0.0177	0.0207	0.0217	24.7	0.00007	4.5	0.00020	0.00043	0.00076	1.43	0.14	0.96	0.00016	6.6	9.2	0.01	0.0062	2.48	20.1	0.00048	0.00044	0.01577	0.00209	24	0.39	0.0002	1.4066	0.0000	0.0026	0.0009	0.0015
134	MW-to-RAS_PL-NP20	RS03 Untreated	14.20	6.50	110	0.10	110.6	0.0181	0.0240	0.0231	26.9	0.00007	5.1	0.00021	0.00044	0.00075	1.33	0.15	0.96	0.00016	7.4	10.4	0.01	0.0069	2.55	23.2	0.00047	0.00047	0.01853	0.00223	26	0.43	0.0002	1.3029	0.0000	0.0029	0.0010	0.0015
135	MW-to-RAS_PL-NP20	RS03 Untreated	21.53	6.54	109	0.10	110.6	0.0173	0.0228	0.0231	26.7	0.00007	5.1	0.00021	0.00044	0.00074	1.34	0.15	0.98	0.00017	6.8	10.3	0.01	0.0060	2.36	23.0	0.00048	0.00045	0.01652	0.00218	24	0.40	0.0002	1.3268	0.0000	0.0026	0.0010	0.0016
136	MW-to-RAS_PL-NP20	RS03 Untreated	14.87	6.56	112	0.09	115.1	0.0163	0.0229	0.0233	27.6	0.00007	5.3	0.00020	0.00044	0.00073	1.34	0.15	0.94	0.00017	6.6	10.6	0.01	0.0054	2.20	23.8	0.00047	0.00043	0.01603	0.00218	22	0.39	0.0002	1.3270	0.0000	0.0024	0.0010	0.0016
137	MW-to-RAS_PL-NP20	RS03 Untreated	14.97	6.59	113	0.08	117.7	0.0160	0.0221	0.0239	27.8	0.00007	5.3	0.00021	0.00045	0.00071	1.34	0.15	0.85	0.00017	6.0	10.5	0.01	0.0052	1.97	24.2	0.00047	0.00041	0.01427	0.00214	22	0.36	0.0002	1.3263	0.0000	0.0023	0.0009	0.0016
138	MW-to-RAS_PL-NP20	RS03 Untreated	19.03	6.59	103	0.08	106.6	0.0166	0.0196	0.0228	25.7	0.00007	4.8	0.00020	0.00045	0.00072	1.41	0.13	0.80	0.00017	5.5	9.5	0.01	0.0054	2.01	21.4	0.00048	0.00040	0.01242	0.00201	22	0.33	0.0002	1.3849	0.0000	0.0023	0.0009	0.0016
139	MW-to-RAS_PL-NP20	RS03 Untreated	21.62	6.59	105	0.08	107.9	0.0163	0.0204	0.0228	26.1	0.00007	4.9	0.00020	0.00045	0.00072	1.41	0.14	0.84	0.00017	5.8	9.7	0.01	0.0051	2.06	21.8	0.00048	0.00041	0.01318	0.00205	21	0.35	0.0002	1.3891	0.0000	0.0022	0.0009	0.0016
140	MW-to-RAS_PL-NP20	RS03 Untreated	26.78	6.55	94	0.09	93.1	0.0176	0.0184	0.0211	23.6	0.00007	4.2	0.00020	0.00043	0.00075	1.50	0.12	0.87	0.00016	5.7	8.5	0.01	0.0058	2.36	18.2	0.00049	0.00042	0.01254	0.00192	23	0.35	0.0002	1.4715	0.0000	0.0024	0.0008	0.0015
141	MW-to-RAS_PL-NP20	RS03 Untreated	17.08	6.54	106	0.10	109.0	0.0171	0.0231	0.0225	26.7	0.00007	4.9	0.00020	0.00043	0.00075	1.39	0.15	1.01	0.00016	6.9	10.1	0.01	0.0060	2.37	22.3	0.00047	0.00044	0.01663	0.00216	24	0.41	0.0002	1.3720	0.0000	0.0026	0.0010	0.0015
142	MW-to-RAS_PL-NP20	RS03 Untreated	21.92	6.59	102	0.08	104.4	0.0164	0.0201	0.0223	25.4	0.00007	4.7	0.00020	0.00044	0.00072	1.43	0.13	0.84	0.00017	5.8	9.4	0.01	0.0054	2.02	20.9	0.00048	0.00040	0.01344	0.00204	22	0.35	0.0002	1.4104	0.0000	0.0023	0.0009	0.0016
143	MW-to-RAS_PL-NP20	RS03 Untreated	14.61	6.51	113	0.10	113.9	0.0178	0.0238	0.0234	27.7	0.00007	5.2	0.00021	0.00044	0.00075	1.32	0.15	1.03	0.00016	6.8	10.7	0.01	0.0061	2.58	23.4	0.00047	0.00047	0.01576	0.00211	25	0.39	0.0002	1.3054	0.0000	0.0026	0.0009	0.0016
144	MW-to-RAS_PL-NP20	RS03 Untreated	18.82	6.52	103	0.10	103.0	0.0175	0.0214	0.0224	25.3	0.00007	4.7	0.00020	0.00043	0.00075	1.37	0.14	0.97	0.00016	6.3	9.6	0.01	0.0057	2.48	20.9	0.00048	0.00044	0.01544	0.00209	24	0.39	0.0002	1.3952	0.0000	0.0026	0.0009	0.0015
145	MW-to-RAS_PL-NP20	RS03 Untreated	13.22	6.52	118	0.10	120.7	0.0173	0.0253	0.0242	28.3	0.00007	5.6	0.00021	0.00045	0.00074</																						

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
2	MW-to-RAS_PL-NP20	RS03 Treated	14.78	6.56	137	0.09	112.4	0.0029	0.0002	0.0322	38.5	0.00007	5.9	0.00002	0.00001	0.00001	1.32	0.28	0.01	0.00017	17.1	9.7	0.00	0.0004	0.03	36.3	0.00001	0.00001	0.00126	0.00009	27	0.01	0.0002	1.3019	0.0000	0.0017	0.0003	0.0000
3	MW-to-RAS_PL-NP20	RS03 Treated	13.99	6.50	142	0.10	115.2	0.0030	0.0002	0.0339	39.5	0.00007	6.2	0.00002	0.00001	0.00001	1.27	0.31	0.01	0.00017	18.5	10.2	0.00	0.0005	0.03	39.1	0.00001	0.00001	0.00145	0.00010	29	0.01	0.0002	1.2557	0.0000	0.0019	0.0003	0.0000
4	MW-to-RAS_PL-NP20	RS03 Treated	15.81	6.53	140	0.10	114.4	0.0030	0.0002	0.0336	39.5	0.00007	6.1	0.00002	0.00001	0.00001	1.29	0.31	0.01	0.00017	18.8	10.0	0.00	0.0004	0.03	38.3	0.00001	0.00001	0.00141	0.00010	29	0.01	0.0002	1.2699	0.0000	0.0018	0.0003	0.0000
5	MW-to-RAS_PL-NP20	RS03 Treated	22.92	6.57	131	0.09	106.8	0.0028	0.0002	0.0304	37.4	0.00007	5.6	0.00002	0.00001	0.00001	1.38	0.28	0.01	0.00017	16.6	9.1	0.00	0.0004	0.02	34.2	0.00001	0.00001	0.00123	0.00009	26	0.01	0.0002	1.3636	0.0000	0.0016	0.0003	0.0000
6	MW-to-RAS_PL-NP20	RS03 Treated	15.66	6.55	134	0.09	109.0	0.0029	0.0002	0.0306	38.3	0.00007	5.7	0.00002	0.00001	0.00001	1.39	0.29	0.01	0.00017	17.2	9.4	0.00	0.0004	0.03	35.1	0.00001	0.00001	0.00129	0.00009	26	0.01	0.0002	1.3703	0.0000	0.0017	0.0003	0.0000
7	MW-to-RAS_PL-NP20	RS03 Treated	19.79	6.57	133	0.09	109.4	0.0028	0.0002	0.0301	38.1	0.00007	5.7	0.00002	0.00001	0.00001	1.38	0.28	0.01	0.00017	16.3	9.3	0.00	0.0004	0.02	34.4	0.00001	0.00001	0.00121	0.00009	25	0.01	0.0002	1.3648	0.0000	0.0016	0.0003	0.0000
8	MW-to-RAS_PL-NP20	RS03 Treated	15.21	6.54	137	0.09	111.3	0.0029	0.0002	0.0303	38.9	0.00007	5.8	0.00002	0.00001	0.00001	1.36	0.30	0.01	0.00017	17.2	9.6	0.00	0.0004	0.03	35.4	0.00001	0.00001	0.00127	0.00009	26	0.01	0.0002	1.3424	0.0000	0.0016	0.0003	0.0000
9	MW-to-RAS_PL-NP20	RS03 Treated	17.17	6.58	136	0.08	112.1	0.0027	0.0002	0.0297	38.7	0.00007	5.7	0.00001	0.00001	0.00001	1.36	0.28	0.01	0.00017	15.9	9.5	0.00	0.0004	0.02	34.5	0.00001	0.00001	0.00118	0.00009	25	0.01	0.0002	1.3420	0.0000	0.0015	0.0003	0.0000
10	MW-to-RAS_PL-NP20	RS03 Treated	11.91	6.56	148	0.09	123.8	0.0028	0.0002	0.0314	41.9	0.00007	6.4	0.00002	0.00001	0.00001	1.27	0.31	0.01	0.00017	17.4	10.6	0.00	0.0004	0.02	38.4	0.00001	0.00001	0.00130	0.00009	26	0.01	0.0002	1.2601	0.0000	0.0016	0.0003	0.0000
11	MW-to-RAS_PL-NP20	RS03 Treated	16.41	6.55	138	0.09	114.8	0.0029	0.0002	0.0295	39.3	0.00007	5.9	0.00001	0.00001	0.00001	1.31	0.28	0.01	0.00017	15.1	9.8	0.00	0.0003	0.02	34.2	0.00001	0.00001	0.00110	0.00008	25	0.01	0.0002	1.2914	0.0000	0.0015	0.0002	0.0000
12	MW-to-RAS_PL-NP20	RS03 Treated	14.97	6.53	142	0.10	116.4	0.0029	0.0002	0.0300	40.1	0.00007	6.0	0.00001	0.00001	0.00001	1.30	0.30	0.01	0.00017	16.9	10.1	0.00	0.0004	0.03	36.0	0.00001	0.00001	0.00124	0.00009	26	0.01	0.0002	1.2783	0.0000	0.0016	0.0003	0.0000
13	MW-to-RAS_PL-NP20	RS03 Treated	23.17	6.56	129	0.09	104.3	0.0028	0.0002	0.0274	36.9	0.00007	5.3	0.00001	0.00001	0.00001	1.40	0.27	0.01	0.00017	14.8	8.9	0.00	0.0003	0.02	31.2	0.00001	0.00001	0.00108	0.00008	24	0.01	0.0002	1.3816	0.0000	0.0014	0.0002	0.0000
14	MW-to-RAS_PL-NP20	RS03 Treated	21.90	6.57	125	0.09	100.4	0.0029	0.0002	0.0267	35.9	0.00007	5.1	0.00001	0.00001	0.00001	1.45	0.27	0.01	0.00016	14.7	8.5	0.00	0.0003	0.02	30.1	0.00001	0.00001	0.00108	0.00008	24	0.01	0.0002	1.4231	0.0000	0.0014	0.0002	0.0000
15	MW-to-RAS_PL-NP20	RS03 Treated	16.50	6.52	138	0.10	111.8	0.0029	0.0002	0.0288	39.3	0.00007	5.8	0.00001	0.00001	0.00001	1.34	0.32	0.01	0.00016	17.8	9.8	0.00	0.0004	0.03	35.4	0.00001	0.00001	0.00133	0.00009	27	0.01	0.0002	1.3280	0.0000	0.0017	0.0003	0.0000
16	MW-to-RAS_PL-NP20	RS03 Treated	17.93	6.56	140	0.09	114.9	0.0028	0.0002	0.0286	39.7	0.00007	5.9	0.00001	0.00001	0.00001	1.33	0.30	0.01	0.00017	16.5	9.9	0.00	0.0004	0.02	35.1	0.00001	0.00001	0.00123	0.00009	25	0.01	0.0002	1.3118	0.0000	0.0015	0.0003	0.0000
17	MW-to-RAS_PL-NP20	RS03 Treated	17.10	6.58	141	0.09	116.6	0.0027	0.0002	0.0283	40.0	0.00007	5.9	0.00001	0.00001	0.00001	1.34	0.29	0.01	0.00017	15.5	9.9	0.00	0.0003	0.02	34.5	0.00001	0.00001	0.00115	0.00009	24	0.01	0.0002	1.3229	0.0000	0.0014	0.0002	0.0000
18	MW-to-RAS_PL-NP20	RS03 Treated	18.87	6.57	130	0.09	106.3	0.0028	0.0002	0.0263	37.3	0.00007	5.3	0.00001	0.00001	0.00001	1.40	0.25	0.01	0.00017	13.6	9.0	0.00	0.0003	0.02	30.2	0.00001	0.00001	0.00098	0.00008	22	0.01	0.0002	1.3860	0.0000	0.0013	0.0002	0.0000
19	MW-to-RAS_PL-NP20	RS03 Treated	18.44	6.57	133	0.09	109.2	0.0029	0.0002	0.0269	38.1	0.00007	5.5	0.00001	0.00001	0.00001	1.38	0.27	0.01	0.00017	14.6	9.3	0.00	0.0003	0.02	31.8	0.00001	0.00001	0.00106	0.00008	23	0.01	0.0002	1.3644	0.0000	0.0014	0.0002	0.0000
20	MW-to-RAS_PL-NP20	RS03 Treated	19.36	6.55	129	0.09	104.8	0.0028	0.0002	0.0260	37.0	0.00007	5.2	0.00001	0.00001	0.00001	1.41	0.26	0.01	0.00017	14.1	9.0	0.00	0.0003	0.02	30.2	0.00001	0.00001	0.00102	0.00008	23	0.01	0.0002	1.3888	0.0000	0.0013	0.0002	0.0000
21	MW-to-RAS_PL-NP20	RS03 Treated	18.10	6.58	138	0.09	113.7	0.0027	0.0002	0.0272	39.3	0.00007	5.7	0.00001	0.00001	0.00001	1.36	0.28	0.01	0.00017	15.0	9.6	0.00	0.0003	0.02	33.1	0.00001	0.00001	0.00111	0.00008	24	0.01	0.0002	1.3469	0.0000	0.0014	0.0002	0.0000
22	MW-to-RAS_PL-NP20	RS03 Treated	18.11	6.58	135	0.08	113.7	0.0027	0.0002	0.0265	38.6	0.00007	5.5	0.00001	0.00001	0.00001	1.37	0.26	0.01	0.00017	13.9	9.4	0.00	0.0003	0.02	31.5	0.00001	0.00001	0.00101	0.00008	23	0.01	0.0002	1.3568	0.0000	0.0013	0.0002	0.0000
23	MW-to-RAS_PL-NP20	RS03 Treated	19.98	6.57	132	0.09	108.2	0.0028	0.0002	0.0259	37.9	0.00007	5.3	0.00001	0.00001	0.00001	1.39	0.25	0.01	0.00017	13.5	9.2	0.00	0.0003	0.02	30.3	0.00001	0.00001	0.00097	0.00008	22	0.01	0.0002	1.3767	0.0000	0.0013	0.0002	0.0000
24	MW-to-RAS_PL-NP20	RS03 Treated	15.30	6.58	142	0.09	118.4	0.0027	0.0002	0.0272	40.5	0.00007	5.9	0.00001	0.00001	0.00001	1.34	0.27	0.01	0.00017	14.6	10.0	0.00	0.0003	0.02	33.6	0.00001	0.00001	0.00107	0.00008	23	0.01	0.0002	1.3211	0.0000	0.0014	0.0002	0.0000
25	MW-to-RAS_PL-NP20	RS03 Treated	20.36	6.56	128	0.09	104.6	0.0028	0.0002	0.0252	36.8	0.00007	5.1	0.00001	0.00001	0.00001	1.40	0.24	0.01	0.00017	12.7	8.9	0.00	0.0003	0.02	28.6	0.00001	0.00001	0.00089	0.00007	22	0.01	0.0002	1.3831	0.0000	0.0012	0.0002	0.0000
26	MW-to-RAS_PL-NP20	RS03 Treated	21.51	6.53	123	0.09	97.9	0.0029	0.0002	0.0244	35.3	0.00007	4.8	0.00001	0.00001	0.00002	1.44	0.24	0.01	0.00016	13.3	8.5	0.00	0.0003	0.03	27.5	0.00001	0.00001	0.00094	0.00007	23	0.01	0.0002	1.4185	0.0000	0.0013	0.0002	0.0000
27	MW-to-RAS_PL-NP20	RS03 Treated	20.52	6.54	132	0.10	106.1	0.0029	0.0002	0.0255	37.6	0.00007	5.3	0.00001	0.00001	0.00001	1.38	0.27	0.01	0.00016	15.2	9.2	0.00	0.0003	0.03	31.1	0.00001	0.00001	0.00111	0.00008	25	0.01	0.0002	1.3620	0.0000	0.0014	0.0002	0.0000
28	MW-to-RAS_PL-NP20	RS03 Treated	14.59	6.54	135	0.09	110.0	0.0028	0.0002	0.0258	38.5	0.00007	5.5	0.00001	0.00001	0.00001	1.35	0.27	0.01	0.00017	14.8	9.5	0.00	0.0003	0.02	31.7	0.00001	0.00001	0.00108	0.00008	24	0.01	0.0002	1.3379	0.0000	0.0014	0.0002	0.0000
29	MW-to-RAS_PL-NP20	RS03 Treated	17.52	6.56	138	0.09	113.5	0.0028	0.0002	0.0260	39.2	0.00007	5.6	0.00001	0.00001	0.00001	1.33	0.26	0.01	0.00017	14.1	9.7	0.00	0.0003	0.02	31.8	0.00001	0.00001	0.00102	0.00008	23	0.01	0.0002	1.3165	0.0000	0.0013	0.0002	0.0000
30	MW-to-RAS_PL-NP20	RS03 Treated	17.98	6.58	128	0.08	106.0	0.0028	0.0002	0.0248	37.0	0.00007	5.2	0.00001	0.00001	0.00001	1.42	0.23	0.01	0.00017	12.3	8.9	0.00	0.0003	0.02	28.5	0.00001	0.00001	0.00093	0.00007	21	0.01	0.0002	1.3750	0.0000	0.0012	0.0002	0.0000
31	MW-to-RAS_PL-NP20	RS03 Treated	20.10	6.57	128	0.09	105.1	0.0029	0.0002	0.0247	36.9	0.00007	5.1	0.00001	0.00001	0.00001	1.41																					

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
88	MW-to-RAS PL-NP20	RS03 Treated	19.56	6.56	125	0.09	101.6	0.0028	0.0002	0.0220	36.0	0.00007	4.7	0.00000	0.00001	0.00001	1.43	0.17	0.01	0.00016	8.3	8.6	0.00	0.0002	0.02	22.7	0.00001	0.00001	0.00049	0.00005	18	0.01	0.0002	1.4124	0.0000	0.0008	0.0001	0.0000
89	MW-to-RAS PL-NP20	RS03 Treated	17.40	6.56	134	0.09	110.7	0.0028	0.0002	0.0231	36.3	0.00007	5.1	0.00000	0.00001	0.00001	1.37	0.18	0.01	0.00017	8.8	9.4	0.00	0.0002	0.02	25.0	0.00001	0.00001	0.00053	0.00005	18	0.01	0.0002	1.3473	0.0000	0.0008	0.0001	0.0000
90	MW-to-RAS PL-NP20	RS03 Treated	21.95	6.58	125	0.08	102.6	0.0028	0.0002	0.0222	36.0	0.00007	4.7	0.00000	0.00001	0.00001	1.43	0.16	0.01	0.00017	7.6	8.5	0.00	0.0001	0.02	22.4	0.00001	0.00001	0.00044	0.00005	17	0.01	0.0002	1.4072	0.0000	0.0008	0.0001	0.0000
91	MW-to-RAS PL-NP20	RS03 Treated	14.21	6.54	133	0.09	109.3	0.0028	0.0002	0.0228	38.0	0.00007	5.1	0.00000	0.00001	0.00001	1.36	0.17	0.01	0.00017	8.5	9.3	0.00	0.0002	0.02	24.5	0.00001	0.00001	0.00050	0.00005	18	0.01	0.0002	1.3474	0.0000	0.0008	0.0001	0.0000
92	MW-to-RAS PL-NP20	RS03 Treated	12.97	6.54	143	0.09	119.9	0.0028	0.0002	0.0243	40.5	0.00007	5.6	0.00000	0.00001	0.00001	1.28	0.19	0.01	0.00017	8.7	10.1	0.00	0.0002	0.02	27.2	0.00001	0.00001	0.00052	0.00005	19	0.01	0.0002	1.2624	0.0000	0.0008	0.0001	0.0000
93	MW-to-RAS PL-NP20	RS03 Treated	13.89	6.58	143	0.09	121.3	0.0027	0.0002	0.0246	40.6	0.00007	5.6	0.00000	0.00001	0.00001	1.28	0.18	0.01	0.00017	8.1	10.1	0.00	0.0001	0.02	27.2	0.00001	0.00001	0.00047	0.00005	18	0.01	0.0002	1.2588	0.0000	0.0008	0.0001	0.0000
94	MW-to-RAS PL-NP20	RS03 Treated	22.05	6.55	123	0.09	100.2	0.0029	0.0002	0.0222	35.4	0.00007	4.6	0.00000	0.00001	0.00001	1.42	0.15	0.01	0.00017	7.3	8.4	0.00	0.0001	0.02	21.6	0.00001	0.00001	0.00040	0.00005	17	0.01	0.0002	1.3996	0.0000	0.0007	0.0001	0.0000
95	MW-to-RAS PL-NP20	RS03 Treated	23.39	6.56	127	0.09	103.1	0.0028	0.0002	0.0222	36.4	0.00007	4.7	0.00000	0.00001	0.00001	1.43	0.16	0.01	0.00017	8.0	8.7	0.00	0.0002	0.02	22.7	0.00001	0.00001	0.00046	0.00005	17	0.01	0.0002	1.4068	0.0000	0.0008	0.0001	0.0000
96	MW-to-RAS PL-NP20	RS03 Treated	19.21	6.59	131	0.08	108.6	0.0027	0.0002	0.0227	37.8	0.00007	4.9	0.00000	0.00001	0.00001	1.43	0.17	0.01	0.00017	7.8	9.0	0.00	0.0001	0.02	23.7	0.00001	0.00001	0.00046	0.00005	17	0.01	0.0002	1.4155	0.0000	0.0008	0.0001	0.0000
97	MW-to-RAS PL-NP20	RS03 Treated	19.21	6.58	130	0.08	107.7	0.0028	0.0002	0.0228	37.5	0.00007	4.9	0.00000	0.00001	0.00001	1.42	0.16	0.01	0.00017	7.5	8.9	0.00	0.0001	0.02	23.3	0.00001	0.00001	0.00042	0.00005	17	0.01	0.0002	1.4052	0.0000	0.0007	0.0001	0.0000
98	MW-to-RAS PL-NP20	RS03 Treated	13.90	6.53	137	0.09	112.8	0.0028	0.0002	0.0233	39.0	0.00007	5.2	0.00000	0.00001	0.00001	1.35	0.17	0.01	0.00017	8.3	9.6	0.00	0.0001	0.02	24.9	0.00001	0.00001	0.00047	0.00005	18	0.01	0.0002	1.3348	0.0000	0.0008	0.0001	0.0000
99	MW-to-RAS PL-NP20	RS03 Treated	15.49	6.57	138	0.09	115.0	0.0027	0.0002	0.0236	39.2	0.00007	5.3	0.00000	0.00001	0.00001	1.33	0.17	0.01	0.00017	7.8	9.6	0.00	0.0001	0.02	25.3	0.00001	0.00001	0.00044	0.00005	17	0.01	0.0002	1.3152	0.0000	0.0007	0.0001	0.0000
100	MW-to-RAS PL-NP20	RS03 Treated	28.74	6.60	126	0.08	104.1	0.0028	0.0002	0.0226	36.2	0.00007	4.7	0.00000	0.00001	0.00001	1.43	0.15	0.01	0.00017	6.9	8.5	0.00	0.0001	0.02	22.1	0.00001	0.00001	0.00038	0.00005	18	0.01	0.0002	1.4044	0.0000	0.0008	0.0001	0.0000
101	MW-to-RAS PL-NP20	RS03 Treated	15.05	6.52	137	0.10	110.9	0.0029	0.0002	0.0229	38.8	0.00007	5.2	0.00000	0.00001	0.00002	1.36	0.17	0.01	0.00016	8.6	9.6	0.00	0.0002	0.03	24.5	0.00001	0.00001	0.00049	0.00005	18	0.01	0.0002	1.3444	0.0000	0.0008	0.0001	0.0000
102	MW-to-RAS PL-NP20	RS03 Treated	15.49	6.53	133	0.09	109.3	0.0029	0.0002	0.0231	37.9	0.00007	5.1	0.00000	0.00001	0.00001	1.35	0.16	0.01	0.00017	7.9	9.3	0.00	0.0002	0.02	24.0	0.00001	0.00001	0.00045	0.00005	18	0.01	0.0002	1.3307	0.0000	0.0008	0.0001	0.0000
103	MW-to-RAS PL-NP20	RS03 Treated	14.64	6.49	137	0.11	112.0	0.0030	0.0002	0.0235	38.5	0.00007	5.3	0.00000	0.00001	0.00002	1.30	0.17	0.01	0.00017	8.6	9.8	0.00	0.0002	0.03	25.0	0.00001	0.00001	0.00048	0.00005	19	0.01	0.0002	1.2785	0.0000	0.0008	0.0001	0.0000
104	MW-to-RAS PL-NP20	RS03 Treated	16.55	6.52	135	0.10	111.4	0.0030	0.0002	0.0235	38.4	0.00007	5.2	0.00000	0.00001	0.00001	1.31	0.17	0.01	0.00017	9.2	9.6	0.00	0.0002	0.02	24.7	0.00001	0.00001	0.00046	0.00005	19	0.01	0.0002	1.2910	0.0000	0.0008	0.0001	0.0000
105	MW-to-RAS PL-NP20	RS03 Treated	24.10	6.56	127	0.09	104.1	0.0028	0.0002	0.0225	36.5	0.00007	4.8	0.00000	0.00001	0.00001	1.40	0.15	0.01	0.00017	7.3	8.8	0.00	0.0001	0.02	22.4	0.00001	0.00001	0.00040	0.00005	17	0.01	0.0002	1.3830	0.0000	0.0007	0.0001	0.0000
106	MW-to-RAS PL-NP20	RS03 Treated	16.37	6.55	130	0.09	106.1	0.0028	0.0002	0.0225	37.2	0.00007	4.9	0.00000	0.00001	0.00001	1.41	0.16	0.01	0.00017	7.6	9.0	0.00	0.0001	0.02	22.8	0.00001	0.00001	0.00042	0.00005	17	0.01	0.0002	1.3912	0.0000	0.0007	0.0001	0.0000
107	MW-to-RAS PL-NP20	RS03 Treated	20.75	6.57	130	0.09	106.7	0.0028	0.0002	0.0227	37.2	0.00007	4.9	0.00000	0.00001	0.00001	1.40	0.16	0.01	0.00017	7.3	8.9	0.00	0.0001	0.02	22.8	0.00001	0.00001	0.00040	0.00005	17	0.01	0.0002	1.3833	0.0000	0.0007	0.0001	0.0000
108	MW-to-RAS PL-NP20	RS03 Treated	15.87	6.53	133	0.10	108.5	0.0029	0.0002	0.0229	37.9	0.00007	5.0	0.00000	0.00001	0.00001	1.38	0.16	0.01	0.00017	7.7	9.3	0.00	0.0001	0.02	23.4	0.00001	0.00001	0.00041	0.00005	17	0.01	0.0002	1.3618	0.0000	0.0007	0.0001	0.0000
109	MW-to-RAS PL-NP20	RS03 Treated	17.94	6.57	132	0.09	109.5	0.0028	0.0002	0.0230	37.8	0.00007	5.0	0.00000	0.00001	0.00001	1.38	0.16	0.01	0.00017	7.1	9.1	0.00	0.0001	0.02	23.4	0.00001	0.00001	0.00039	0.00005	17	0.01	0.0002	1.3607	0.0000	0.0007	0.0001	0.0000
110	MW-to-RAS PL-NP20	RS03 Treated	12.35	6.55	144	0.09	121.0	0.0028	0.0002	0.0243	40.9	0.00007	5.6	0.00000	0.00001	0.00001	1.30	0.17	0.01	0.00017	7.7	10.2	0.00	0.0001	0.02	26.3	0.00001	0.00001	0.00042	0.00005	17	0.01	0.0002	1.2814	0.0000	0.0007	0.0001	0.0000
111	MW-to-RAS PL-NP20	RS03 Treated	17.09	6.55	135	0.09	112.3	0.0029	0.0002	0.0237	38.4	0.00007	5.2	0.00000	0.00001	0.00001	1.33	0.15	0.01	0.00017	7.0	9.4	0.00	0.0001	0.02	24.0	0.00001	0.00001	0.00036	0.00005	18	0.01	0.0002	1.3094	0.0000	0.0007	0.0001	0.0000
112	MW-to-RAS PL-NP20	RS03 Treated	15.56	6.52	138	0.10	113.8	0.0029	0.0002	0.0237	39.1	0.00007	5.3	0.00000	0.00001	0.00001	1.32	0.16	0.01	0.00017	7.7	9.8	0.00	0.0001	0.02	24.6	0.00001	0.00001	0.00041	0.00005	18	0.01	0.0002	1.2962	0.0000	0.0008	0.0001	0.0000
113	MW-to-RAS PL-NP20	RS03 Treated	24.20	6.55	125	0.09	101.9	0.0028	0.0002	0.0221	36.0	0.00007	4.7	0.00000	0.00001	0.00001	1.42	0.15	0.01	0.00017	6.9	8.6	0.00	0.0001	0.02	21.4	0.00001	0.00001	0.00036	0.00004	16	0.01	0.0002	1.3977	0.0000	0.0007	0.0001	0.0000
114	MW-to-RAS PL-NP20	RS03 Treated	22.85	6.56	121	0.09	98.3	0.0029	0.0002	0.0217	35.1	0.00007	4.4	0.00000	0.00001	0.00001	1.46	0.14	0.01	0.00016	6.8	8.2	0.00	0.0001	0.02	20.4	0.00001	0.00001	0.00036	0.00004	17	0.01	0.0002	1.4383	0.0000	0.0007	0.0001	0.0000
115	MW-to-RAS PL-NP20	RS03 Treated	17.14	6.52	135	0.10	109.4	0.0029	0.0002	0.0226	38.3	0.00007	5.0	0.00000	0.00001	0.00002	1.36	0.16	0.01	0.00016	8.0	9.5	0.00	0.0001	0.03	23.5	0.00001	0.00001	0.00043	0.00005	18	0.01	0.0002	1.3442	0.0000	0.0008	0.0001	0.0000
116	MW-to-RAS PL-NP20	RS03 Treated	18.61	6.55	136	0.09	112.6	0.0028	0.0002	0.0232	38.5	0.00007	5.2	0.00000	0.00001	0.00001	1.34	0.16	0.01	0.00017	7.5	9.6	0.00	0.0001	0.02	24.1	0.00001	0.00001	0.00034	0.00005	17	0.01	0.0002	1.3269	0.0000	0.0007	0.0001	0.0000
117	MW-to-RAS PL-NP20	RS03 Treated	17.76	6.57	137	0.09	114.4	0.0027	0.0002	0.0234	39.2	0.00007	5.2	0.00000	0.00001	0.00001	1.35	0.16</																				

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
174	MW-to-RAS_PL-NP20	RS03 Treated	14.50	6.56	139	0.09	116.4	0.0028	0.0002	0.0239	39.6	0.00007	5.3	0.00000	0.00001	0.00001	1.33	0.13	0.01	0.00017	5.4	9.7	0.00	0.0001	0.02	23.1	0.00001	0.00001	0.00021	0.00004	16	0.01	0.0002	1.3126	0.0000	0.0006	0.0001	0.0000
175	MW-to-RAS_PL-NP20	RS03 Treated	12.36	6.56	143	0.09	120.7	0.0027	0.0002	0.0243	40.6	0.00007	5.5	0.00000	0.00001	0.00001	1.28	0.14	0.01	0.00017	5.4	9.2	0.00	0.0001	0.02	24.1	0.00001	0.00001	0.00021	0.00004	15	0.01	0.0002	1.2696	0.0000	0.0005	0.0001	0.0000
176	MW-to-RAS_PL-NP20	RS03 Treated	20.08	6.62	134	0.08	113.6	0.0026	0.0002	0.0236	38.4	0.00007	5.1	0.00000	0.00001	0.00001	1.37	0.13	0.01	0.00018	4.7	9.1	0.00	0.0001	0.02	22.3	0.00001	0.00001	0.00017	0.00004	14	0.01	0.0002	1.2479	0.0000	0.0005	0.0001	0.0000
177	MW-to-RAS_PL-NP20	RS03 Treated	23.27	6.56	120	0.09	99.3	0.0028	0.0002	0.0218	35.9	0.00007	4.4	0.00000	0.00001	0.00001	1.45	0.12	0.01	0.00017	4.9	8.3	0.00	0.0001	0.02	18.9	0.00001	0.00001	0.00017	0.00004	15	0.01	0.0002	1.4294	0.0000	0.0005	0.0001	0.0000
178	MW-to-RAS_PL-NP20	RS03 Treated	22.12	6.56	119	0.09	95.8	0.0029	0.0002	0.0213	34.4	0.00007	4.2	0.00000	0.00001	0.00001	1.47	0.12	0.01	0.00016	5.1	8.0	0.00	0.0001	0.02	18.1	0.00001	0.00001	0.00019	0.00004	15	0.01	0.0002	1.4454	0.0000	0.0006	0.0001	0.0000
179	MW-to-RAS_PL-NP20	RS03 Treated	16.39	6.55	131	0.09	107.8	0.0029	0.0002	0.0226	37.5	0.00007	4.8	0.00000	0.00001	0.00001	1.38	0.13	0.01	0.00017	5.5	9.1	0.00	0.0001	0.02	21.0	0.00001	0.00001	0.00022	0.00004	16	0.01	0.0002	1.3600	0.0000	0.0006	0.0001	0.0000
180	MW-to-RAS_PL-NP20	RS03 Treated	18.30	6.56	128	0.09	105.7	0.0029	0.0002	0.0226	36.8	0.00007	4.7	0.00000	0.00001	0.00001	1.38	0.12	0.01	0.00017	5.2	8.9	0.00	0.0001	0.02	20.5	0.00001	0.00001	0.00020	0.00004	15	0.01	0.0002	1.3634	0.0000	0.0006	0.0001	0.0000
181	MW-to-RAS_PL-NP20	RS03 Treated	18.55	6.52	128	0.10	104.3	0.0030	0.0002	0.0224	36.7	0.00007	4.7	0.00000	0.00001	0.00002	1.38	0.12	0.01	0.00016	5.5	8.9	0.00	0.0001	0.02	20.2	0.00001	0.00001	0.00020	0.00004	16	0.01	0.0002	1.3603	0.0000	0.0006	0.0001	0.0000
182	MW-to-RAS_PL-NP20	RS03 Treated	22.87	6.55	126	0.09	102.7	0.0029	0.0002	0.0222	36.1	0.00007	4.6	0.00000	0.00001	0.00001	1.40	0.12	0.01	0.00016	5.3	8.7	0.00	0.0001	0.02	19.8	0.00001	0.00001	0.00020	0.00004	16	0.01	0.0002	1.3602	0.0000	0.0006	0.0001	0.0000
183	MW-to-RAS_PL-NP20	RS03 Treated	17.56	6.53	130	0.10	105.9	0.0029	0.0002	0.0225	37.2	0.00007	4.8	0.00000	0.00001	0.00001	1.39	0.12	0.01	0.00016	5.5	9.0	0.00	0.0001	0.02	20.5	0.00001	0.00001	0.00020	0.00004	16	0.01	0.0002	1.3685	0.0000	0.0006	0.0001	0.0000
184	MW-to-RAS_PL-NP20	RS03 Treated	22.28	6.57	125	0.09	102.6	0.0028	0.0002	0.0220	36.1	0.00007	4.6	0.00000	0.00001	0.00001	1.43	0.12	0.01	0.00017	5.0	8.6	0.00	0.0001	0.02	19.6	0.00001	0.00001	0.00018	0.00004	14	0.01	0.0002	1.4122	0.0000	0.0005	0.0001	0.0000
185	MW-to-RAS_PL-NP20	RS03 Treated	32.87	6.58	116	0.08	93.7	0.0029	0.0002	0.0210	33.9	0.00007	4.1	0.00000	0.00001	0.00001	1.52	0.11	0.01	0.00016	4.8	7.7	0.00	0.0001	0.02	17.3	0.00001	0.00001	0.00017	0.00003	16	0.01	0.0002	1.4941	0.0000	0.0006	0.0001	0.0000
186	MW-to-RAS_PL-NP20	RS03 Treated	16.91	6.54	132	0.10	106.9	0.0029	0.0002	0.0222	37.7	0.00007	4.8	0.00000	0.00001	0.00002	1.41	0.13	0.01	0.00016	5.7	9.1	0.00	0.0001	0.02	20.5	0.00001	0.00001	0.00022	0.00004	16	0.01	0.0002	1.3896	0.0000	0.0006	0.0001	0.0000
187	MW-to-RAS_PL-NP20	RS03 Treated	22.62	6.56	123	0.09	100.0	0.0029	0.0002	0.0218	35.4	0.00007	4.4	0.00000	0.00001	0.00001	1.44	0.12	0.01	0.00016	5.0	8.4	0.00	0.0001	0.02	19.0	0.00001	0.00001	0.00018	0.00004	15	0.01	0.0002	1.4187	0.0000	0.0006	0.0001	0.0000
188	MW-to-RAS_PL-NP20	RS03 Treated	19.56	6.56	124	0.09	101.2	0.0028	0.0002	0.0218	35.8	0.00007	4.5	0.00000	0.00001	0.00001	1.43	0.12	0.01	0.00016	5.0	8.5	0.00	0.0001	0.02	19.2	0.00001	0.00001	0.00018	0.00004	15	0.01	0.0002	1.4124	0.0000	0.0006	0.0001	0.0000
189	MW-to-RAS_PL-NP20	RS03 Treated	17.40	6.56	134	0.09	110.3	0.0028	0.0002	0.0229	38.0	0.00007	5.0	0.00000	0.00001	0.00001	1.37	0.13	0.01	0.00017	5.3	9.3	0.00	0.0001	0.02	21.4	0.00001	0.00001	0.00019	0.00004	15	0.01	0.0002	1.4373	0.0000	0.0006	0.0001	0.0000
190	MW-to-RAS_PL-NP20	RS03 Treated	21.95	6.58	125	0.08	102.2	0.0028	0.0002	0.0221	35.9	0.00007	4.6	0.00000	0.00001	0.00001	1.43	0.12	0.01	0.00017	4.8	8.5	0.00	0.0001	0.02	19.5	0.00001	0.00001	0.00017	0.00004	15	0.01	0.0002	1.4072	0.0000	0.0005	0.0001	0.0000
191	MW-to-RAS_PL-NP20	RS03 Treated	14.21	6.54	133	0.09	108.9	0.0028	0.0002	0.0227	37.8	0.00007	4.9	0.00000	0.00001	0.00001	1.36	0.12	0.01	0.00017	5.3	9.2	0.00	0.0001	0.02	21.1	0.00001	0.00001	0.00019	0.00004	15	0.01	0.0002	1.3474	0.0000	0.0005	0.0001	0.0000
192	MW-to-RAS_PL-NP20	RS03 Treated	12.97	6.54	142	0.09	119.5	0.0028	0.0002	0.0242	40.3	0.00007	5.4	0.00000	0.00001	0.00001	1.28	0.13	0.01	0.00017	5.3	10.1	0.00	0.0001	0.02	23.7	0.00001	0.00001	0.00020	0.00004	16	0.01	0.0002	1.2624	0.0000	0.0006	0.0001	0.0000
193	MW-to-RAS_PL-NP20	RS03 Treated	13.89	6.58	142	0.09	121.0	0.0027	0.0002	0.0245	40.4	0.00007	5.5	0.00000	0.00001	0.00001	1.28	0.13	0.01	0.00017	5.0	10.0	0.00	0.0001	0.02	24.0	0.00001	0.00001	0.00018	0.00004	15	0.01	0.0002	1.2588	0.0000	0.0005	0.0001	0.0000
194	MW-to-RAS_PL-NP20	RS03 Treated	22.05	6.55	123	0.09	99.9	0.0029	0.0002	0.0221	35.3	0.00007	4.5	0.00000	0.00001	0.00001	1.42	0.12	0.01	0.00017	4.8	8.4	0.00	0.0001	0.02	19.1	0.00001	0.00001	0.00016	0.00004	15	0.01	0.0002	1.3996	0.0000	0.0005	0.0001	0.0000
195	MW-to-RAS_PL-NP20	RS03 Treated	23.39	6.56	126	0.09	102.7	0.0028	0.0002	0.0221	36.2	0.00007	4.6	0.00000	0.00001	0.00001	1.43	0.12	0.01	0.00017	5.1	8.6	0.00	0.0001	0.02	19.6	0.00001	0.00001	0.00018	0.00004	15	0.01	0.0002	1.4068	0.0000	0.0005	0.0001	0.0000
196	MW-to-RAS_PL-NP20	RS03 Treated	19.21	6.59	131	0.08	108.2	0.0027	0.0002	0.0226	37.6	0.00007	4.8	0.00000	0.00001	0.00001	1.43	0.12	0.01	0.00017	4.9	8.9	0.00	0.0001	0.02	20.6	0.00001	0.00001	0.00018	0.00004	15	0.01	0.0002	1.4155	0.0000	0.0005	0.0001	0.0000
197	MW-to-RAS_PL-NP20	RS03 Treated	19.21	6.58	130	0.08	107.4	0.0028	0.0002	0.0227	37.3	0.00007	4.8	0.00000	0.00001	0.00001	1.42	0.12	0.01	0.00017	4.8	8.9	0.00	0.0001	0.02	20.6	0.00001	0.00001	0.00017	0.00004	15	0.01	0.0002	1.4052	0.0000	0.0005	0.0001	0.0000
198	MW-to-RAS_PL-NP20	RS03 Treated	13.90	6.53	136	0.09	112.4	0.0028	0.0002	0.0237	38.8	0.00007	5.1	0.00000	0.00001	0.00001	1.35	0.13	0.01	0.00017	5.3	9.5	0.00	0.0001	0.02	21.9	0.00001	0.00001	0.00019	0.00004	15	0.01	0.0002	1.3348	0.0000	0.0005	0.0001	0.0000
199	MW-to-RAS_PL-NP20	RS03 Treated	15.49	6.57	137	0.09	114.7	0.0027	0.0002	0.0235	39.1	0.00007	5.2	0.00000	0.00001	0.00001	1.33	0.13	0.01	0.00017	5.0	9.6	0.00	0.0001	0.02	22.4	0.00001	0.00001	0.00018	0.00004	14	0.01	0.0002	1.3152	0.0000	0.0005	0.0001	0.0000
0	Base Case (NP20)	SC01 Untreated	46.83	6.98	437	0.00	125.7	0.0142	0.6308	0.3133	111.0	0.0011	23.8	0.0242	0.0022	0.0056	0.95	1.36	0.22	0.0013	72.6	38.9	0.24	0.1251	4.80	333.0	0.1947	0.00796	0.31134	0.01541	379	3.81	0.0001	0.8786	0.0988	0.0434	0.0117	0.0099
1	Base Case (NP20)	SC01 Untreated	23.41	6.93	462	0.00	126.0	0.0110	0.6743	0.3513	116.7	0.0011	25.0	0.0280	0.00223	0.0055	0.86	1.62	0.69	0.0012	87.4	41.4	0.27	0.1476	6.23	368.2	0.20563	0.0849	0.37369	0.01850	407	4.58	0.0001	0.8193	0.1054	0.0399	0.0143	0.0107
2	Base Case (NP20)	SC01 Untreated	23.24	7.26	307	0.00	131.5	0.0134	0.4632	0.2951	94.7	0.0010	18.0	0.02519	0.00174	0.0063	1.08	1.56	5.19	0.0015	85.8	33.4	0.22	0.1454	6.44	384.4	0.14757	0.06015	0.36727	0.01894	339	4.30	0.0001	0.8753	0.0407	0.0144	0.0094	
3	Base Case (NP20)	SC01 Untreated	19.58	7.12	344	0.00	136.1	0.0121	0.4277	0.3075	96.7	0.0010	15.6	0.02870	0.0015	0.0049	1.07	1.91	4.97	0.0015																		

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
60	Base Case (NP20)	SC01 Untreated	27.85	6.31	295	0.17	153.9	0.0363	0.2567	0.1316	69.4	0.00010	83.7	0.00877	0.00103	0.00113	0.86	1.44	5.15	0.00013	97.8	29.6	0.16	0.1168	2.81	197.8	0.06273	0.00358	0.41433	0.02153	257	3.80	0.0002	0.8070	0.0320	0.0361	0.0148	0.0042
61	Base Case (NP20)	SC01 Untreated	27.16	6.31	295	0.17	153.7	0.0344	0.2535	0.1282	69.6	0.00010	83.0	0.00838	0.00104	0.00114	0.88	1.38	5.07	0.00014	92.3	29.5	0.15	0.1082	2.61	191.5	0.06327	0.00357	0.38828	0.02030	243	3.65	0.0002	0.8431	0.0318	0.0335	0.0139	0.0042
62	Base Case (NP20)	SC01 Untreated	20.09	6.28	304	0.18	154.8	0.0366	0.2675	0.1320	71.4	0.00010	88.1	0.00848	0.00107	0.00118	0.83	1.37	5.27	0.00013	90.5	30.4	0.15	0.1069	2.47	193.7	0.06658	0.00379	0.37601	0.01964	250	3.62	0.0002	0.7885	0.0340	0.0331	0.0135	0.0044
63	Base Case (NP20)	SC01 Untreated	31.75	6.44	266	0.13	151.3	0.0314	0.2121	0.1107	63.9	0.00010	69.1	0.00693	0.00096	0.00102	0.96	1.23	4.30	0.00016	79.7	25.9	0.13	0.0868	2.03	167.6	0.05163	0.00286	0.33871	0.01807	216	3.29	0.0002	1.0094	0.0263	0.0302	0.0122	0.0037
64	Base Case (NP20)	SC01 Untreated	31.37	6.39	281	0.15	152.8	0.0306	0.2341	0.1180	65.5	0.00009	75.4	0.00767	0.00098	0.00102	0.94	1.42	4.71	0.00015	92.7	27.8	0.13	0.1078	2.30	185.4	0.05623	0.00319	0.39694	0.02091	233	3.74	0.0002	0.9094	0.0286	0.0336	0.0142	0.0039
65	Base Case (NP20)	SC01 Untreated	34.28	6.39	270	0.14	151.7	0.0323	0.2196	0.1118	64.5	0.00010	70.6	0.00706	0.00096	0.00101	1.01	1.34	4.44	0.00015	86.1	26.6	0.14	0.1023	2.16	174.4	0.05263	0.00301	0.36800	0.01947	226	3.52	0.0002	0.9530	0.0268	0.0332	0.0132	0.0037
66	Base Case (NP20)	SC01 Untreated	26.45	6.32	292	0.17	153.3	0.0341	0.2504	0.1217	69.0	0.00010	81.8	0.00760	0.00104	0.00111	0.91	1.34	4.94	0.00014	85.7	28.9	0.14	0.1003	2.19	173.2	0.06180	0.00351	0.36044	0.01960	235	3.54	0.0002	0.8692	0.0315	0.0314	0.0128	0.0041
67	Base Case (NP20)	SC01 Untreated	30.12	6.37	280	0.15	152.4	0.0323	0.2330	0.1145	66.6	0.00010	75.6	0.00708	0.00099	0.00105	0.97	1.32	4.63	0.00015	83.2	27.5	0.14	0.0975	2.03	175.5	0.05686	0.00323	0.35227	0.01862	225	3.48	0.0002	0.9287	0.0290	0.0306	0.0126	0.0039
68	Base Case (NP20)	SC01 Untreated	32.55	6.38	279	0.15	152.4	0.0326	0.2323	0.1133	66.5	0.00010	75.2	0.00695	0.00099	0.00105	0.97	1.32	4.63	0.00015	82.6	27.5	0.13	0.0966	1.99	174.3	0.05652	0.00322	0.34963	0.01848	224	3.47	0.0002	0.9275	0.0288	0.0304	0.0125	0.0039
69	Base Case (NP20)	SC01 Untreated	18.25	6.25	312	0.19	155.8	0.0365	0.2638	0.1309	73.2	0.00010	92.7	0.00811	0.00110	0.00119	0.77	1.45	5.55	0.00013	90.7	31.4	0.16	0.1047	2.16	196.4	0.07049	0.00396	0.37909	0.01959	253	3.78	0.0002	0.7375	0.0360	0.0325	0.0134	0.0045
70	Base Case (NP20)	SC01 Untreated	27.73	6.39	275	0.15	152.2	0.0314	0.2269	0.1097	65.7	0.00010	73.6	0.00657	0.00099	0.00102	1.01	1.26	4.46	0.00016	77.9	26.9	0.13	0.0914	1.75	168.3	0.05544	0.00314	0.32975	0.01752	216	3.36	0.0002	0.9577	0.0283	0.0289	0.0117	0.0038
71	Base Case (NP20)	SC01 Untreated	37.84	6.45	261	0.13	150.9	0.0310	0.2070	0.1021	62.7	0.00010	66.3	0.00604	0.00094	0.00097	1.08	1.24	4.13	0.00016	76.2	25.3	0.12	0.0909	1.68	160.3	0.04960	0.00282	0.32563	0.01741	210	3.31	0.0002	1.0132	0.0253	0.0290	0.0116	0.0035
72	Base Case (NP20)	SC01 Untreated	23.41	6.30	296	0.17	154.3	0.0354	0.2622	0.1209	69.8	0.00010	84.6	0.00734	0.00105	0.00111	0.86	1.40	5.17	0.00013	87.5	29.6	0.15	0.1020	1.97	186.1	0.06415	0.00361	0.36943	0.01922	243	3.73	0.0002	0.8080	0.0328	0.0320	0.0131	0.0042
73	Base Case (NP20)	SC01 Untreated	28.01	6.38	276	0.15	152.3	0.0329	0.2300	0.1090	66.0	0.00010	74.5	0.00638	0.00099	0.00104	1.00	1.23	4.52	0.00015	75.7	27.1	0.13	0.0891	1.67	166.3	0.05632	0.00319	0.31888	0.01692	217	3.33	0.0002	0.9464	0.0288	0.0283	0.0113	0.0038
74	Base Case (NP20)	SC01 Untreated	23.52	6.34	286	0.16	153.5	0.0338	0.2457	0.1137	67.9	0.00010	79.5	0.00670	0.00102	0.00107	0.93	1.28	4.82	0.00015	79.5	28.2	0.13	0.0930	1.71	174.0	0.06023	0.00339	0.33495	0.01761	227	3.48	0.0002	0.8818	0.0308	0.0294	0.0118	0.0040
75	Base Case (NP20)	SC01 Untreated	19.92	6.31	292	0.17	154.3	0.0329	0.2538	0.1156	69.2	0.00010	82.2	0.00681	0.00104	0.00109	0.90	1.29	4.96	0.00014	79.9	28.9	0.14	0.0918	1.68	176.6	0.06242	0.00351	0.33558	0.01764	226	3.52	0.0002	0.8629	0.0319	0.0289	0.0119	0.0041
76	Base Case (NP20)	SC01 Untreated	29.18	6.45	263	0.13	151.1	0.0296	0.2100	0.1002	63.6	0.00010	69.2	0.00584	0.00096	0.00097	1.10	1.10	4.06	0.00017	67.1	25.4	0.11	0.0799	1.35	159.2	0.05151	0.00291	0.29296	0.01530	196	3.08	0.0002	1.0439	0.0263	0.0253	0.0101	0.0036
77	Base Case (NP20)	SC01 Untreated	38.04	6.42	265	0.14	152.0	0.0311	0.2141	0.1002	63.5	0.00010	67.7	0.00575	0.00094	0.00098	1.04	1.23	4.34	0.00016	76.3	25.9	0.12	0.0888	1.52	160.4	0.05074	0.00290	0.29547	0.01735	209	3.42	0.0002	0.9778	0.0259	0.0284	0.0115	0.0035
78	Base Case (NP20)	SC01 Untreated	37.91	6.37	270	0.15	152.1	0.0329	0.2193	0.1019	64.4	0.00010	69.8	0.00577	0.00096	0.00103	1.02	1.19	4.46	0.00015	73.7	26.4	0.12	0.0860	1.58	159.2	0.05251	0.00303	0.31079	0.01654	210	3.33	0.0002	0.9638	0.0268	0.0276	0.0110	0.0036
79	Base Case (NP20)	SC01 Untreated	28.46	6.29	289	0.18	153.9	0.0365	0.2473	0.1116	68.3	0.00010	79.7	0.00632	0.00103	0.00114	0.92	1.20	4.96	0.00014	74.5	28.6	0.13	0.0870	1.67	168.0	0.06054	0.00348	0.30900	0.01623	224	3.36	0.0002	0.8656	0.0309	0.0277	0.0109	0.0040
80	Base Case (NP20)	SC01 Untreated	30.64	6.33	277	0.17	152.9	0.0345	0.2288	0.1045	65.9	0.00010	73.3	0.00582	0.00099	0.00109	0.99	1.14	4.62	0.00015	70.7	27.2	0.12	0.0825	1.54	158.9	0.05548	0.00321	0.29430	0.01563	211	3.24	0.0002	0.9333	0.0283	0.0265	0.0104	0.0038
81	Base Case (NP20)	SC01 Untreated	33.17	6.31	285	0.18	153.8	0.0355	0.2423	0.1079	67.2	0.00010	76.9	0.00610	0.00100	0.00111	0.91	1.23	4.96	0.00014	77.1	28.3	0.13	0.0890	1.66	167.6	0.05814	0.00336	0.32275	0.01695	223	3.50	0.0002	0.8596	0.0297	0.0264	0.0113	0.0039
82	Base Case (NP20)	SC01 Untreated	38.17	6.35	274	0.17	152.4	0.0349	0.2258	0.1024	65.3	0.00010	72.0	0.00564	0.00098	0.00108	1.00	1.12	4.60	0.00015	69.8	27.0	0.12	0.0817	1.53	156.5	0.05443	0.00316	0.29059	0.01543	210	3.24	0.0002	0.8949	0.0278	0.0263	0.0102	0.0037
83	Base Case (NP20)	SC01 Untreated	30.61	6.29	288	0.18	153.7	0.0355	0.2461	0.1085	68.0	0.00010	76.6	0.00606	0.00102	0.00113	0.91	1.18	5.00	0.00014	73.7	28.6	0.13	0.0845	1.62	165.5	0.05967	0.00344	0.30544	0.01606	219	3.40	0.0002	0.8638	0.0305	0.0270	0.0107	0.0039
84	Base Case (NP20)	SC01 Untreated	36.09	6.35	276	0.17	152.3	0.0332	0.2264	0.1017	65.8	0.00010	72.5	0.00554	0.00099	0.00108	1.00	1.08	4.59	0.00015	66.8	27.1	0.11	0.0766	1.45	154.0	0.05497	0.00319	0.27582	0.01474	201	3.16	0.0002	0.9528	0.0281	0.0247	0.0097	0.0037
85	Base Case (NP20)	SC01 Untreated	53.41	6.41	262	0.15	151.0	0.0341	0.2099	0.0954	62.8	0.00010	66.0	0.00510	0.00094	0.00103	1.06	1.06	4.29	0.00016	65.4	25.5	0.11	0.0776	1.41	146.9	0.04978	0.00290	0.27320	0.01454	200	3.12	0.0002	0.9895	0.0254	0.0252	0.0096	0.0035
86	Base Case (NP20)	SC01 Untreated	30.51	6.25	299	0.20	154.3	0.0380	0.2639	0.1134	70.2	0.00010	84.3	0.00630	0.00105	0.00119	0.84	1.18	5.35	0.00013	74.3	29.9	0.13	0.0851	1.71	170.2	0.06439	0.00371	0.30517	0.01588	228	3.47	0.0002	0.7931	0.0330	0.0221	0.0106	0.0041
87	Base Case (NP20)	SC01 Untreated	38.08	6.32	274	0.17	152.0	0.0358	0.2253	0.1005	65.2	0.00010	71.7	0.00536	0.00098	0.00111	1.00	1.05	4.62	0.00015	65.0	27.0	0.11	0.0762	1.46	150.8	0.05436	0.00319	0.26697	0.01421	205	3.13	0.0002	0.9321	0.0278	0.0247	0.0094	0.0037
88	Base Case (NP20)	SC01 Untreated	33.74	6.31	278	0.18	152.3	0.0348	0.2304	0.1015	66.1	0.00010	73.4	0.00584	0.00099	0.00111	0.97	1.05	4.72	0.00015	65.5	27.4	0.11	0.0752	1.47	152.0	0.05672	0.00328	0.26840	0.01428	203	3.16	0.0002	0.9230	0.0265	0.0245	0.0096	0.0037
89	Base Case (NP20)	SC01 Untreated	29.28	6.28	286	0.19	153.3	0.0365	0.2456	0.1069	65.8	0.00010	70.8	0.00576	0.																							

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
146	Base Case (NP20)	SC01 Untreated	36.23	6.33	259	0.17	150.1	0.0342	0.2131	0.0889	62.2	0.00010	65.4	0.00423	0.00092	0.00105	1.04	0.64	4.41	0.00015	38.1	25.2	0.08	0.0475	0.95	117.5	0.05045	0.00295	0.14384	0.00801	164	2.69	0.0002	0.9718	0.0258	0.0159	0.0050	0.0034
147	Base Case (NP20)	SC01 Untreated	35.15	6.32	271	0.18	150.7	0.0337	0.2281	0.0946	64.9	0.00010	71.3	0.00461	0.00097	0.00109	1.00	0.64	4.62	0.00015	37.9	26.4	0.08	0.0456	1.00	122.7	0.05029	0.00321	0.13999	0.00779	165	2.65	0.0002	0.9547	0.0283	0.0151	0.0048	0.0037
148	Base Case (NP20)	SC01 Untreated	32.97	6.27	277	0.19	151.6	0.0358	0.2422	0.0978	65.9	0.00010	74.8	0.00462	0.00097	0.00112	0.92	0.69	4.96	0.00014	41.1	27.4	0.09	0.0498	1.07	127.9	0.05806	0.00336	0.15342	0.00830	176	2.84	0.0002	0.9652	0.0297	0.0164	0.0053	0.0038
149	Base Case (NP20)	SC01 Untreated	35.94	6.31	264	0.18	150.2	0.0353	0.2205	0.0920	63.4	0.00010	69.3	0.00441	0.00094	0.00109	1.02	0.63	4.53	0.00015	37.2	25.8	0.09	0.0467	1.01	119.1	0.05094	0.00309	0.13792	0.00765	167	2.61	0.0002	0.9542	0.0271	0.0158	0.0047	0.0035
150	Base Case (NP20)	SC01 Untreated	30.11	6.26	278	0.20	151.5	0.0363	0.2410	0.0982	66.2	0.00010	70.0	0.00483	0.00098	0.00114	0.93	0.66	4.94	0.00014	39.4	27.5	0.09	0.0477	1.11	126.3	0.05917	0.00339	0.14395	0.00783	174	2.70	0.0002	0.9513	0.0289	0.0157	0.0049	0.0038
151	Base Case (NP20)	SC01 Untreated	39.80	6.32	272	0.19	150.8	0.0355	0.2309	0.0953	64.8	0.00010	71.8	0.00463	0.00096	0.00111	0.98	0.63	4.72	0.00015	37.6	26.6	0.08	0.0464	1.05	122.2	0.05567	0.00325	0.13758	0.00758	170	2.61	0.0002	0.9215	0.0285	0.0154	0.0047	0.0037
152	Base Case (NP20)	SC01 Untreated	36.26	6.29	273	0.19	151.0	0.0362	0.2342	0.0961	65.1	0.00010	72.7	0.00468	0.00097	0.00112	0.96	0.64	4.81	0.00015	38.0	26.9	0.08	0.0469	1.07	123.1	0.05635	0.00329	0.13875	0.00760	172	2.62	0.0002	0.9105	0.0289	0.0156	0.0048	0.0037
153	Base Case (NP20)	SC01 Untreated	34.19	6.29	273	0.19	150.8	0.0357	0.2319	0.0958	65.1	0.00010	72.3	0.00466	0.00097	0.00112	0.98	0.62	4.74	0.00015	36.9	26.8	0.08	0.0455	1.05	121.9	0.05606	0.00328	0.13347	0.00737	169	2.58	0.0002	0.9190	0.0287	0.0151	0.0046	0.0037
154	Base Case (NP20)	SC01 Untreated	34.03	6.30	271	0.18	150.5	0.0350	0.2311	0.0947	64.6	0.00010	71.5	0.00461	0.00096	0.00110	0.98	0.63	4.73	0.00015	37.2	26.5	0.08	0.0459	1.03	121.5	0.05549	0.00322	0.13630	0.00752	168	2.59	0.0002	0.9181	0.0284	0.0152	0.0047	0.0037
155	Base Case (NP20)	SC01 Untreated	29.80	6.27	277	0.19	151.0	0.0354	0.2411	0.0978	65.9	0.00010	74.8	0.00461	0.00098	0.00112	0.94	0.64	4.92	0.00014	38.1	27.3	0.08	0.0464	1.07	125.0	0.05612	0.00336	0.13860	0.00758	172	2.63	0.0002	0.9834	0.0296	0.0153	0.0048	0.0038
156	Base Case (NP20)	SC01 Untreated	36.84	6.32	270	0.18	150.2	0.0346	0.2315	0.0947	64.6	0.00010	71.6	0.00462	0.00096	0.00109	0.98	0.62	4.71	0.00015	36.7	26.5	0.08	0.0454	1.03	121.2	0.05563	0.00322	0.13431	0.00743	167	2.56	0.0002	0.9218	0.0285	0.0151	0.0046	0.0037
157	Base Case (NP20)	SC01 Untreated	32.20	6.28	275	0.19	150.7	0.0356	0.2398	0.0971	65.4	0.00010	74.1	0.00477	0.00097	0.00111	0.94	0.64	4.89	0.00014	37.8	27.1	0.08	0.0467	1.07	124.0	0.05760	0.00333	0.13795	0.00753	172	2.61	0.0002	0.9828	0.0296	0.0154	0.0047	0.0037
158	Base Case (NP20)	SC01 Untreated	30.09	6.24	286	0.20	151.6	0.0364	0.2568	0.1022	67.7	0.00010	79.6	0.00511	0.00100	0.00116	0.87	0.66	5.23	0.00014	39.4	28.4	0.09	0.0474	1.15	129.8	0.06022	0.00357	0.14241	0.00765	178	2.68	0.0002	0.8232	0.0318	0.0155	0.0049	0.0039
159	Base Case (NP20)	SC01 Untreated	38.04	6.31	269	0.18	150.0	0.0354	0.2293	0.0945	64.3	0.00010	71.0	0.00458	0.00096	0.00109	0.99	0.60	4.67	0.00015	35.4	26.3	0.08	0.0447	1.04	119.4	0.05519	0.00320	0.12787	0.00709	167	2.46	0.0002	0.9263	0.0283	0.0149	0.0044	0.0036
160	Base Case (NP20)	SC01 Untreated	28.00	6.22	287	0.21	151.8	0.0378	0.2582	0.1034	67.9	0.00010	80.1	0.00514	0.00101	0.00118	0.86	0.65	5.29	0.00013	38.9	28.6	0.09	0.0474	1.18	129.5	0.06239	0.00361	0.13871	0.00741	180	2.62	0.0002	0.8063	0.0320	0.0155	0.0047	0.0039
161	Base Case (NP20)	SC01 Untreated	27.32	6.23	288	0.21	151.9	0.0386	0.2548	0.1020	68.2	0.00010	79.6	0.00511	0.00101	0.00118	0.86	0.62	5.20	0.00014	37.2	28.6	0.09	0.0439	1.14	127.9	0.06203	0.00361	0.13056	0.00709	172	2.51	0.0002	0.8425	0.0318	0.0144	0.0045	0.0040
162	Base Case (NP20)	SC01 Untreated	20.17	6.20	297	0.22	153.1	0.0382	0.2690	0.1082	70.0	0.00010	84.9	0.00544	0.00105	0.00123	0.83	0.57	4.90	0.00014	32.9	27.3	0.09	0.0451	1.11	132.6	0.06362	0.00383	0.12888	0.00686	181	2.49	0.0002	0.7977	0.0340	0.0147	0.0044	0.0041
163	Base Case (NP20)	SC01 Untreated	31.82	6.37	259	0.16	149.4	0.0328	0.2132	0.0897	62.3	0.00010	66.2	0.00427	0.00093	0.00103	1.06	0.55	4.30	0.00016	31.7	25.0	0.07	0.0403	0.94	112.5	0.05138	0.00286	0.11378	0.00655	154	2.25	0.0002	0.9897	0.0253	0.0136	0.0039	0.0035
164	Base Case (NP20)	SC01 Untreated	31.42	6.31	272	0.18	149.4	0.0319	0.2352	0.0940	64.8	0.00010	71.9	0.00462	0.00095	0.00106	0.94	0.61	4.81	0.00015	36.0	26.7	0.08	0.0426	0.93	120.6	0.05594	0.00321	0.13136	0.00731	159	2.51	0.0002	0.9088	0.0287	0.0141	0.0045	0.0036
165	Base Case (NP20)	SC01 Untreated	34.29	6.32	262	0.17	149.5	0.0334	0.2206	0.0905	62.9	0.00010	67.5	0.00435	0.00093	0.00105	1.01	0.58	4.53	0.00015	33.8	25.6	0.08	0.0426	0.94	114.8	0.05237	0.00304	0.12268	0.00691	159	2.38	0.0002	0.9523	0.0286	0.0142	0.0042	0.0035
166	Base Case (NP20)	SC01 Untreated	26.45	6.25	284	0.20	151.3	0.0354	0.2515	0.1018	67.6	0.00010	78.8	0.00506	0.00101	0.00115	0.91	0.60	5.05	0.00014	35.1	28.0	0.08	0.0426	1.05	125.7	0.06154	0.00354	0.12242	0.00672	170	2.39	0.0002	0.8656	0.0315	0.0140	0.0042	0.0039
167	Base Case (NP20)	SC01 Untreated	30.13	6.30	272	0.18	150.3	0.0334	0.2340	0.0956	65.1	0.00010	72.7	0.00468	0.00097	0.00108	0.97	0.58	4.72	0.00015	33.5	26.6	0.08	0.0412	0.95	119.2	0.05561	0.00326	0.11882	0.00667	160	2.33	0.0002	0.9283	0.0290	0.0137	0.0041	0.0037
168	Base Case (NP20)	SC01 Untreated	32.55	6.31	272	0.18	150.3	0.0335	0.2332	0.0952	65.0	0.00010	72.3	0.00465	0.00097	0.00109	0.97	0.57	4.73	0.00015	33.4	26.6	0.08	0.0410	0.96	118.6	0.05527	0.00325	0.11803	0.00663	160	2.32	0.0002	0.9272	0.0288	0.0136	0.0041	0.0037
169	Base Case (NP20)	SC01 Untreated	18.25	6.19	304	0.23	153.7	0.0378	0.2849	0.1122	71.7	0.00010	89.6	0.00574	0.00107	0.00123	0.77	0.64	5.66	0.00013	37.8	30.5	0.09	0.0452	1.10	136.8	0.07024	0.00400	0.12994	0.00685	185	2.49	0.0002	0.7371	0.0360	0.0146	0.0044	0.0043
170	Base Case (NP20)	SC01 Untreated	27.73	6.33	268	0.17	150.1	0.0324	0.2277	0.0939	64.3	0.00010	70.9	0.00457	0.00096	0.00105	1.01	0.55	4.54	0.00016	31.6	26.0	0.07	0.0396	0.84	116.4	0.05523	0.00316	0.11188	0.00638	156	2.22	0.0002	0.9574	0.0283	0.0132	0.0039	0.0036
171	Base Case (NP20)	SC01 Untreated	37.84	6.39	253	0.15	148.7	0.0321	0.2077	0.0870	61.2	0.00010	63.6	0.00411	0.00091	0.00099	1.08	0.54	4.20	0.00016	30.3	24.4	0.07	0.0398	0.81	108.9	0.04939	0.00284	0.10967	0.00636	151	2.18	0.0002	0.1029	0.0253	0.0135	0.0038	0.0034
172	Base Case (NP20)	SC01 Untreated	23.41	6.24	288	0.20	152.0	0.0365	0.2631	0.1044	68.2	0.00010	81.7	0.00524	0.00102	0.00115	0.86	0.61	5.26	0.00013	35.8	28.6	0.09	0.0447	1.02	128.4	0.06393	0.00363	0.12586	0.00677	177	2.42	0.0002	0.8077	0.0328	0.0146	0.0043	0.0040
173	Base Case (NP20)	SC01 Untreated	28.01	6.32	269	0.17	150.2	0.0338	0.2308	0.0953	64.5	0.00010	72.0	0.00464	0.00097	0.00107	1.00	0.55	4.60	0.00015	31.2	26.2	0.08	0.0401	0.99	116.8	0.05613	0.00321	0.10920	0.00619	160	2.19	0.0002	0.9462	0.0286	0.0133	0.0037	0.0037
174	Base Case (NP20)	SC01 Untreated	23.52	6.28	278	0.19	151.3	0.0345	0.2465	0.0998	66.4	0.00010	76.8	0.00489	0.00095	0.00113	0.80	0.50	4.67	0.00015	28.6	26.2	0.07	0.0378	1.07	111.4	0.05429	0.00320	0.09431	0.00538	158	1.95	0.0002	0.9319	0.0278	0.0127	0.0038	0.0036
175	Base Case (NP20)	SC01 Untreated	19.20	6.28	285	0.19	152.1	0.0352	0.2545	0.1022	67.7	0.000																										

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
32	Base Case (NP20)	SC01 Treated	33.41	6.55	320	0.10	152.4	0.0132	0.0036	0.2011	85.7	0.00009	78.5	0.00044	0.00031	0.00038	0.99	1.47	0.06	0.00015	130.4	25.8	0.03	0.0102	0.15	244.6	0.00136	0.00019	0.01386	0.00186	214	0.40	0.0002	0.9336	0.0028	0.0160	0.0024	0.0007
33	Base Case (NP20)	SC01 Treated	36.84	6.50	328	0.11	153.0	0.0122	0.0035	0.2009	87.7	0.00009	80.7	0.00043	0.00029	0.00037	0.95	1.51	0.06	0.00015	132.6	26.6	0.03	0.0092	0.15	247.7	0.00138	0.00019	0.01365	0.00182	215	0.39	0.0002	0.9784	0.0029	0.0158	0.0024	0.0007
34	Base Case (NP20)	SC01 Treated	26.14	6.41	353	0.13	154.6	0.0122	0.0038	0.2009	84.3	0.00009	81.1	0.00042	0.00026	0.00036	0.93	1.56	0.06	0.00013	135.0	26.6	0.03	0.0098	0.14	257.4	0.00154	0.00018	0.01403	0.00163	228	0.35	0.0002	0.7716	0.0033	0.0160	0.0024	0.0006
35	Base Case (NP20)	SC01 Treated	34.37	6.49	336	0.12	153.2	0.0114	0.0034	0.1993	90.0	0.00010	83.4	0.00040	0.00029	0.00037	0.93	1.44	0.06	0.00015	123.0	27.1	0.03	0.0078	0.14	237.3	0.00144	0.00019	0.01251	0.00176	205	0.36	0.0002	0.8865	0.0030	0.0143	0.0022	0.0007
36	Base Case (NP20)	SC01 Treated	24.08	6.43	350	0.13	154.3	0.0103	0.0034	0.1913	93.7	0.00010	88.7	0.00039	0.00027	0.00036	0.96	1.47	0.06	0.00014	123.8	28.2	0.03	0.0066	0.13	241.6	0.00151	0.00019	0.01221	0.00169	207	0.36	0.0002	0.8327	0.0033	0.0139	0.0022	0.0006
37	Base Case (NP20)	SC01 Treated	22.80	6.47	334	0.12	153.2	0.0114	0.0035	0.1770	89.7	0.00010	82.8	0.00037	0.00029	0.00037	0.95	1.38	0.06	0.00015	114.1	26.7	0.03	0.0077	0.13	225.7	0.00144	0.00019	0.01188	0.00175	197	0.38	0.0002	0.9057	0.0031	0.0134	0.0020	0.0007
38	Base Case (NP20)	SC01 Treated	29.29	6.54	307	0.10	151.9	0.0132	0.0035	0.1629	82.6	0.00010	71.7	0.00038	0.00033	0.00039	1.06	1.35	0.06	0.00016	111.1	24.6	0.02	0.0096	0.14	212.8	0.00128	0.00020	0.01231	0.00186	190	0.42	0.0002	0.9958	0.0026	0.0139	0.0020	0.0008
39	Base Case (NP20)	SC01 Treated	32.07	6.55	313	0.10	151.9	0.0115	0.0033	0.1613	84.0	0.00010	73.7	0.00037	0.00032	0.00039	1.05	1.35	0.06	0.00016	110.0	24.9	0.02	0.0078	0.13	212.8	0.00131	0.00020	0.01163	0.00188	185	0.41	0.0002	1.0026	0.0027	0.0132	0.0020	0.0008
40	Base Case (NP20)	SC01 Treated	43.89	6.54	302	0.10	151.6	0.0139	0.0035	0.1576	80.9	0.00009	68.7	0.00037	0.00030	0.00040	1.07	1.40	0.06	0.00016	114.6	24.2	0.02	0.0104	0.14	212.7	0.00123	0.00020	0.01278	0.00188	193	0.42	0.0002	0.9998	0.0025	0.0144	0.0021	0.0008
41	Base Case (NP20)	SC01 Treated	28.60	6.40	350	0.14	154.4	0.0115	0.0036	0.1760	93.8	0.00010	86.3	0.00035	0.00027	0.00036	0.96	1.49	0.06	0.00014	120.5	28.2	0.03	0.0076	0.12	234.3	0.00152	0.00019	0.01228	0.00165	207	0.36	0.0002	0.8199	0.0033	0.0137	0.0021	0.0006
42	Base Case (NP20)	SC01 Treated	34.23	6.48	319	0.12	152.1	0.0128	0.0034	0.1520	85.7	0.00010	75.4	0.00034	0.00032	0.00040	1.02	1.30	0.06	0.00016	102.5	25.4	0.02	0.0085	0.13	203.6	0.00134	0.00020	0.01119	0.00178	184	0.40	0.0002	0.9691	0.0028	0.0126	0.0018	0.0007
43	Base Case (NP20)	SC01 Treated	25.90	6.37	353	0.15	155.4	0.0122	0.0037	0.1737	94.3	0.00009	88.5	0.00034	0.00025	0.00036	0.92	1.56	0.06	0.00013	124.5	28.5	0.03	0.0084	0.12	237.4	0.00151	0.00018	0.01289	0.00159	213	0.35	0.0002	0.7728	0.0033	0.0142	0.0022	0.0006
44	Base Case (NP20)	SC01 Treated	32.42	6.43	324	0.13	153.1	0.0123	0.0034	0.1542	86.8	0.00009	76.4	0.00034	0.00030	0.00038	0.96	1.43	0.06	0.00015	112.8	26.1	0.02	0.0083	0.12	214.4	0.00134	0.00019	0.01195	0.00175	193	0.39	0.0002	0.9127	0.0028	0.0133	0.0020	0.0007
45	Base Case (NP20)	SC01 Treated	22.66	6.34	361	0.16	155.6	0.0114	0.0037	0.1675	96.7	0.00010	91.7	0.00032	0.00025	0.00036	0.80	1.49	0.06	0.00013	115.6	29.0	0.03	0.0071	0.11	229.2	0.00157	0.00018	0.01176	0.00154	205	0.34	0.0002	0.7642	0.0035	0.0129	0.0020	0.0006
46	Base Case (NP20)	SC01 Treated	35.54	6.47	308	0.12	152.0	0.0141	0.0035	0.1402	82.7	0.00010	70.1	0.00033	0.00032	0.00040	1.04	1.35	0.06	0.00015	103.4	24.6	0.02	0.0100	0.13	198.1	0.00126	0.00020	0.01179	0.00179	185	0.41	0.0002	0.9222	0.0026	0.0131	0.0019	0.0007
47	Base Case (NP20)	SC01 Treated	34.49	6.45	321	0.13	152.3	0.0120	0.0034	0.1421	86.1	0.00010	75.8	0.00032	0.00031	0.00039	1.00	1.33	0.06	0.00015	100.5	25.6	0.02	0.0077	0.12	196.4	0.00135	0.00020	0.01078	0.00176	180	0.40	0.0002	0.9522	0.0026	0.0120	0.0018	0.0007
48	Base Case (NP20)	SC01 Treated	32.41	6.40	332	0.14	153.5	0.0129	0.0036	0.1483	89.0	0.00009	79.6	0.00032	0.00029	0.00038	0.93	1.45	0.06	0.00013	110.0	26.6	0.02	0.0098	0.12	211.9	0.00139	0.00019	0.01199	0.00167	194	0.38	0.0002	0.8696	0.0030	0.0131	0.0019	0.0007
49	Base Case (NP20)	SC01 Treated	35.37	6.43	314	0.13	152.0	0.0143	0.0035	0.1354	84.4	0.00010	72.5	0.00031	0.00031	0.00040	1.02	1.32	0.06	0.00015	98.4	25.1	0.02	0.0098	0.12	193.4	0.00130	0.00020	0.01130	0.00167	182	0.40	0.0002	0.9546	0.0027	0.0125	0.0018	0.0007
50	Base Case (NP20)	SC01 Treated	29.66	6.37	332	0.15	153.2	0.0128	0.0036	0.1417	89.1	0.00010	79.3	0.00030	0.00029	0.00038	0.93	1.39	0.06	0.00014	102.8	26.6	0.02	0.0083	0.11	203.0	0.00140	0.00019	0.01113	0.00165	187	0.38	0.0002	0.8817	0.0030	0.0123	0.0018	0.0007
51	Base Case (NP20)	SC01 Treated	39.24	6.43	323	0.14	152.5	0.0134	0.0036	0.1352	86.8	0.00010	75.9	0.00030	0.00030	0.00039	0.98	1.34	0.06	0.00015	98.0	25.8	0.02	0.0088	0.11	194.9	0.00135	0.00019	0.01095	0.00169	182	0.39	0.0002	0.9220	0.0028	0.0121	0.0017	0.0007
52	Base Case (NP20)	SC01 Treated	35.76	6.40	326	0.14	152.7	0.0135	0.0036	0.1349	87.5	0.00010	76.7	0.00030	0.00030	0.00039	0.96	1.36	0.06	0.00015	98.7	26.0	0.02	0.0089	0.11	195.9	0.00136	0.00019	0.01103	0.00166	184	0.38	0.0002	0.9023	0.0029	0.0121	0.0017	0.0007
53	Base Case (NP20)	SC01 Treated	33.78	6.40	324	0.14	152.5	0.0133	0.0035	0.1316	87.1	0.00010	76.1	0.00029	0.00030	0.00039	0.98	1.32	0.06	0.00015	94.8	25.9	0.02	0.0085	0.11	191.0	0.00136	0.00019	0.01059	0.00167	179	0.39	0.0002	0.9195	0.0029	0.0117	0.0017	0.0007
54	Base Case (NP20)	SC01 Treated	33.65	6.40	322	0.14	152.4	0.0132	0.0035	0.1303	86.7	0.00010	75.4	0.00029	0.00030	0.00039	0.98	1.36	0.06	0.00015	96.8	25.7	0.02	0.0086	0.11	192.2	0.00135	0.00019	0.01081	0.00168	180	0.39	0.0002	0.9196	0.0028	0.0118	0.0017	0.0007
55	Base Case (NP20)	SC01 Treated	29.48	6.37	331	0.15	153.0	0.0126	0.0036	0.1327	88.9	0.00010	78.8	0.00029	0.00029	0.00038	0.93	1.39	0.06	0.00014	98.6	26.4	0.02	0.0080	0.11	196.5	0.00139	0.00019	0.01072	0.00164	182	0.38	0.0002	0.8828	0.0030	0.0117	0.0017	0.0007
56	Base Case (NP20)	SC01 Treated	36.47	6.41	322	0.14	152.2	0.0131	0.0035	0.1237	86.7	0.00010	75.4	0.00028	0.00030	0.00039	0.98	1.36	0.06	0.00015	95.1	25.7	0.02	0.0084	0.11	190.0	0.00135	0.00019	0.01062	0.00168	178	0.39	0.0002	0.9225	0.0028	0.0116	0.0017	0.0007
57	Base Case (NP20)	SC01 Treated	31.94	6.37	329	0.15	152.8	0.0133	0.0036	0.1293	88.3	0.00010	77.9	0.00028	0.00029	0.00038	0.94	1.40	0.06	0.00014	97.5	26.2	0.02	0.0086	0.11	194.0	0.00138	0.00019	0.01086	0.00163	183	0.38	0.0002	0.8834	0.0029	0.0118	0.0017	0.0007
58	Base Case (NP20)	SC01 Treated	29.87	6.33	343	0.16	153.7	0.0121	0.0036	0.1411	92.2	0.00009	83.4	0.00027	0.00027	0.00037	0.87	1.46	0.06	0.00014	100.8	27.5	0.02	0.0074	0.10	204.5	0.00146	0.00019	0.01071	0.00156	187	0.36	0.0002	0.8239	0.0032	0.0116	0.0017	0.0006
59	Base Case (NP20)	SC01 Treated	37.60	6.39	320	0.15	151.9	0.0140	0.0036	0.1219	86.1	0.00010	74.5	0.00028	0.00031	0.00039	0.99	1.33	0.06	0.00015	90.0	25.4	0.02	0.0091	0.11	183.0	0.00134	0.00020	0.01042	0.00166	175	0.39	0.0002	0.9269	0.0028	0.0114	0.0016	0.0007
60	Base Case (NP20)	SC01 Treated	27.05	6.31	345	0.17	153.9	0.0119	0.0037	0.1316	92.5	0.00010	83.7	0.00027	0.00027	0.00037	0.86	1.44	0.06	0.00013	97.8	27.6	0.02	0.0080	0.10	197.8	0.00147	0.00019	0.01054	0.00162	187	0.37	0.0002	0.8070	0.0032	0.0115	0.0016	0.0006
61	Base Case (NP20)	SC01 Treated	27.16	6.31	344	0.17																																

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
118	Base Case (NP20)	SC01 Treated	32.63	6.32	313	0.17	151.9	0.0130	0.0035	0.0943	84.5	0.00010	70.6	0.00022	0.00031	0.00039	0.99	0.82	0.06	0.00015	50.2	24.8	0.01	0.0069	0.09	134.2	0.00131	0.00019	0.00623	0.00148	134	0.38	0.0002	0.9360	0.0028	0.0072	0.0009	0.0007
119	Base Case (NP20)	SC01 Treated	30.94	6.31	318	0.18	152.1	0.0127	0.0035	0.0967	86.0	0.00010	72.9	0.00022	0.00030	0.00039	0.98	0.81	0.06	0.00015	49.5	25.2	0.01	0.0066	0.09	135.6	0.00135	0.00020	0.00603	0.00147	134	0.37	0.0002	0.9282	0.0029	0.0071	0.0009	0.0007
120	Base Case (NP20)	SC01 Treated	33.80	6.31	317	0.18	152.0	0.0127	0.0035	0.0965	85.5	0.00010	72.1	0.00022	0.00030	0.00039	0.97	0.82	0.06	0.00015	50.4	25.1	0.01	0.0067	0.09	135.5	0.00133	0.00019	0.00614	0.00146	135	0.37	0.0002	0.9213	0.0028	0.0072	0.0009	0.0007
121	Base Case (NP20)	SC01 Treated	29.98	6.30	326	0.19	152.6	0.0129	0.0036	0.0984	88.2	0.00010	76.5	0.00022	0.00029	0.00039	0.96	0.80	0.06	0.00015	48.5	25.8	0.01	0.0066	0.09	137.7	0.00141	0.00020	0.00591	0.00142	137	0.34	0.0002	0.9027	0.0030	0.0070	0.0009	0.0007
122	Base Case (NP20)	SC01 Treated	30.16	6.31	322	0.18	152.4	0.0129	0.0036	0.0981	86.8	0.00010	74.3	0.00022	0.00030	0.00039	0.96	0.80	0.06	0.00015	48.4	25.4	0.01	0.0066	0.09	136.6	0.00137	0.00019	0.00598	0.00143	136	0.37	0.0002	0.9111	0.0029	0.0070	0.0009	0.0007
123	Base Case (NP20)	SC01 Treated	33.34	6.33	316	0.17	151.9	0.0123	0.0034	0.0950	85.2	0.00010	71.7	0.00022	0.00030	0.00039	0.98	0.79	0.06	0.00015	48.2	25.0	0.01	0.0063	0.09	133.2	0.00133	0.00020	0.00582	0.00147	131	0.37	0.0002	0.9351	0.0028	0.0069	0.0009	0.0007
124	Base Case (NP20)	SC01 Treated	25.31	6.29	331	0.19	153.0	0.0121	0.0035	0.1021	89.5	0.00010	78.6	0.00022	0.00029	0.00038	0.93	0.79	0.06	0.00015	48.1	26.2	0.01	0.0058	0.08	139.1	0.00144	0.00019	0.00562	0.00140	136	0.36	0.0002	0.8860	0.0031	0.0067	0.0008	0.0007
125	Base Case (NP20)	SC01 Treated	34.67	6.35	304	0.16	151.1	0.0132	0.0034	0.0904	82.0	0.00010	67.0	0.00022	0.00032	0.00040	1.03	0.77	0.06	0.00016	46.4	24.0	0.01	0.0072	0.09	127.5	0.00126	0.00020	0.00602	0.00152	128	0.39	0.0002	0.9736	0.0026	0.0071	0.0009	0.0007
126	Base Case (NP20)	SC01 Treated	39.39	6.33	307	0.17	151.1	0.0136	0.0035	0.0916	82.8	0.00010	66.2	0.00022	0.00031	0.00040	1.01	0.78	0.06	0.00015	47.4	24.3	0.01	0.0076	0.09	129.1	0.00128	0.00020	0.00620	0.00148	132	0.38	0.0002	0.9479	0.0027	0.0073	0.0009	0.0007
127	Base Case (NP20)	SC01 Treated	36.37	6.28	325	0.19	152.4	0.0135	0.0036	0.0992	87.7	0.00010	75.5	0.00022	0.00029	0.00039	0.94	0.78	0.06	0.00014	47.8	25.8	0.01	0.0072	0.09	136.4	0.00139	0.00019	0.00599	0.00148	138	0.36	0.0002	0.9804	0.0030	0.0071	0.0008	0.0007
128	Base Case (NP20)	SC01 Treated	26.95	6.23	337	0.21	153.3	0.0120	0.0035	0.1029	90.8	0.00010	79.6	0.00021	0.00028	0.00038	0.89	0.79	0.06	0.00014	46.6	26.8	0.01	0.0055	0.08	139.4	0.00145	0.00019	0.00547	0.00134	137	0.34	0.0002	0.8455	0.0032	0.0065	0.0008	0.0006
129	Base Case (NP20)	SC01 Treated	29.55	6.26	332	0.20	153.1	0.0123	0.0035	0.1014	89.6	0.00010	77.9	0.00021	0.00028	0.00039	0.91	0.77	0.06	0.00014	46.7	26.4	0.01	0.0058	0.08	136.4	0.00142	0.00019	0.00543	0.00136	135	0.35	0.0002	0.8675	0.0031	0.0065	0.0008	0.0006
130	Base Case (NP20)	SC01 Treated	30.80	6.31	309	0.18	151.3	0.0135	0.0035	0.0927	83.4	0.00010	69.0	0.00022	0.00031	0.00040	1.02	0.72	0.06	0.00015	43.4	24.4	0.01	0.0073	0.09	126.0	0.00129	0.00020	0.00572	0.00148	129	0.38	0.0002	0.9572	0.0027	0.0069	0.0008	0.0007
131	Base Case (NP20)	SC01 Treated	34.11	6.33	305	0.17	150.9	0.0144	0.0036	0.0920	82.5	0.00010	68.0	0.00022	0.00032	0.00041	1.03	0.72	0.06	0.00015	43.0	24.1	0.01	0.0082	0.10	125.0	0.00129	0.00020	0.00601	0.00148	130	0.39	0.0002	0.9631	0.0027	0.0072	0.0008	0.0007
132	Base Case (NP20)	SC01 Treated	34.92	6.31	311	0.18	151.2	0.0139	0.0036	0.0936	84.0	0.00010	72.0	0.00022	0.00030	0.00040	0.99	0.74	0.06	0.00015	44.9	24.6	0.01	0.0078	0.09	128.1	0.00131	0.00019	0.00600	0.00144	132	0.38	0.0002	0.9256	0.0028	0.0071	0.0008	0.0007
133	Base Case (NP20)	SC01 Treated	38.37	6.29	319	0.19	151.6	0.0130	0.0035	0.0958	85.9	0.00010	72.7	0.00021	0.00029	0.00039	0.95	0.76	0.06	0.00014	46.1	25.3	0.01	0.0068	0.09	131.1	0.00134	0.00019	0.00574	0.00140	133	0.36	0.0002	0.9334	0.0029	0.0068	0.0008	0.0007
134	Base Case (NP20)	SC01 Treated	27.08	6.30	345	0.22	153.7	0.0139	0.0039	0.1070	92.9	0.00010	83.5	0.00021	0.00026	0.00038	0.83	0.79	0.07	0.00013	48.6	27.5	0.02	0.0073	0.08	142.0	0.00151	0.00018	0.00597	0.00147	146	0.32	0.0002	0.7684	0.0033	0.0071	0.0008	0.0006
135	Base Case (NP20)	SC01 Treated	35.50	6.29	328	0.20	153.4	0.0128	0.0035	0.0998	88.5	0.00010	76.7	0.00021	0.00029	0.00039	0.93	0.73	0.06	0.00015	44.3	26.0	0.01	0.0056	0.09	132.9	0.00141	0.00019	0.00515	0.00138	131	0.35	0.0002	0.8849	0.0030	0.0063	0.0008	0.0007
136	Base Case (NP20)	SC01 Treated	24.83	6.23	343	0.21	153.4	0.0109	0.0035	0.1052	92.4	0.00010	82.2	0.00021	0.00027	0.00037	0.86	0.74	0.06	0.00014	45.3	27.2	0.01	0.0044	0.08	136.5	0.00149	0.00019	0.00478	0.00130	133	0.33	0.0002	0.8132	0.0033	0.0059	0.0008	0.0006
137	Base Case (NP20)	SC01 Treated	23.46	6.29	327	0.19	152.2	0.0119	0.0035	0.1003	88.4	0.00010	77.0	0.00022	0.00029	0.00039	0.95	0.70	0.06	0.00015	41.8	25.8	0.01	0.0055	0.09	131.5	0.00142	0.00020	0.00497	0.00139	129	0.36	0.0002	0.9051	0.0031	0.0061	0.0007	0.0007
138	Base Case (NP20)	SC01 Treated	20.29	6.36	299	0.16	150.2	0.0137	0.0035	0.0894	80.8	0.00010	66.0	0.00022	0.00032	0.00041	1.06	0.67	0.06	0.00016	39.6	23.5	0.01	0.0077	0.10	120.2	0.00126	0.00020	0.00559	0.00152	123	0.40	0.0002	0.9502	0.0026	0.0067	0.0008	0.0008
139	Base Case (NP20)	SC01 Treated	32.95	6.37	304	0.16	150.2	0.0119	0.0033	0.0911	82.3	0.00010	66.2	0.00022	0.00033	0.00040	1.05	0.67	0.06	0.00016	39.4	23.9	0.01	0.0059	0.09	122.1	0.00129	0.00020	0.00497	0.00153	119	0.39	0.0002	0.9025	0.0027	0.0061	0.0008	0.0008
140	Base Case (NP20)	SC01 Treated	44.59	6.38	292	0.15	149.5	0.0143	0.0035	0.0860	78.9	0.00010	62.9	0.00022	0.00030	0.00041	1.07	0.68	0.06	0.00016	40.4	23.0	0.01	0.0083	0.10	117.8	0.00121	0.00020	0.00586	0.00153	123	0.40	0.0002	0.9996	0.0025	0.0070	0.0008	0.0008
141	Base Case (NP20)	SC01 Treated	29.55	6.24	342	0.21	153.0	0.0121	0.0036	0.1055	92.1	0.00010	82.5	0.00021	0.00027	0.00038	0.86	0.74	0.06	0.00014	44.7	27.1	0.01	0.0056	0.08	137.9	0.00150	0.00019	0.00509	0.00128	137	0.33	0.0002	0.8182	0.0033	0.0063	0.0008	0.0006
142	Base Case (NP20)	SC01 Treated	35.06	6.33	311	0.18	150.8	0.0132	0.0035	0.0943	84.2	0.00010	70.6	0.00022	0.00032	0.00041	1.02	0.65	0.06	0.00016	38.3	24.5	0.01	0.0068	0.09	122.5	0.00133	0.00020	0.00512	0.00147	124	0.38	0.0002	0.9689	0.0028	0.0063	0.0007	0.0007
143	Base Case (NP20)	SC01 Treated	26.49	6.22	343	0.21	153.7	0.0127	0.0037	0.1054	92.3	0.00010	82.7	0.00020	0.00025	0.00037	0.82	0.75	0.06	0.00013	46.0	27.3	0.01	0.0063	0.08	136.8	0.00149	0.00018	0.00544	0.00121	140	0.32	0.0002	0.7722	0.0033	0.0065	0.0008	0.0006
144	Base Case (NP20)	SC01 Treated	33.13	6.29	315	0.18	151.3	0.0127	0.0035	0.0940	84.9	0.00010	71.0	0.00021	0.00030	0.00039	0.96	0.69	0.06	0.00015	41.4	25.0	0.01	0.0064	0.09	125.2	0.00132	0.00019	0.00520	0.00140	126	0.37	0.0002	0.9122	0.0028	0.0064	0.0007	0.0007
145	Base Case (NP20)	SC01 Treated	23.13	6.20	353	0.23	154.2	0.0120	0.0037	0.1096	95.0	0.00010	86.6	0.00020	0.00025	0.00037	0.80	0.73	0.07	0.00013	44.2	28.0	0.01	0.0053	0.08	140.6	0.00156	0.00018	0.00491	0.00119	139	0.31	0.0002	0.7638	0.0035	0.0061	0.0007	0.0006
146	Base Case (NP20)	SC01 Treated	36.23	6.33	299	0.17	150.1	0.0145	0.0036	0.0889	80.7	0.00010	65.4	0.00022	0.00032	0.00041	1.04	0.64	0.06	0.00015	38.1	23.6	0.01	0.0083	0.10	117.5	0.00124	0.00020	0.00551	0.00119	124	0.37	0.0002	0.9719	0.0025	0.0068	0.0007	0.0007
147	Base Case (NP20)	SC01 Treated	36.15	6.32	313	0.18	150.7	0.0124	0.0037	0.0946	84.7	0.000																										

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
4	Base Case (NP20)	RS03 Untreated	15.81	6.53	114	0.10	114.4	0.0177	0.0232	0.0329	27.6	0.00007	6.1	0.00120	0.00045	0.00073	1.29	0.31	0.98	0.00017	18.8	10.9	0.02	0.0222	2.76	36.3	0.00061	0.00046	0.07039	0.00494	41	0.67	0.0002	1.2699	0.0000	0.0071	0.0030	0.0016
5	Base Case (NP20)	RS03 Untreated	22.92	6.57	106	0.09	106.8	0.0169	0.0208	0.0304	26.1	0.00007	5.6	0.00104	0.00045	0.00073	1.38	0.28	0.88	0.00017	16.6	9.9	0.02	0.0193	2.49	34.2	0.00059	0.00043	0.06148	0.00449	37	0.61	0.0002	1.3535	0.0000	0.0062	0.0027	0.0016
6	Base Case (NP20)	RS03 Untreated	15.66	6.55	109	0.09	109.0	0.0168	0.0214	0.0306	26.1	0.00007	5.7	0.00105	0.00045	0.00074	1.39	0.29	0.91	0.00017	17.2	10.2	0.02	0.0198	2.56	35.1	0.00059	0.00043	0.06427	0.00462	37	0.64	0.0002	1.3703	0.0000	0.0064	0.0028	0.0016
7	Base Case (NP20)	RS03 Untreated	15.79	6.57	108	0.09	109.4	0.0168	0.0210	0.0301	25.8	0.00007	5.7	0.00097	0.00045	0.00073	1.38	0.28	0.88	0.00017	16.3	10.1	0.02	0.0188	2.42	34.4	0.00058	0.00042	0.06069	0.00446	36	0.61	0.0002	1.3648	0.0000	0.0061	0.0026	0.0016
8	Base Case (NP20)	RS03 Untreated	15.21	6.54	111	0.09	111.3	0.0171	0.0221	0.0303	27.2	0.00007	5.8	0.00098	0.00045	0.00074	1.36	0.30	0.95	0.00017	17.2	10.5	0.02	0.0193	2.65	35.4	0.00059	0.00045	0.06370	0.00459	37	0.64	0.0002	1.3424	0.0000	0.0063	0.0027	0.0016
9	Base Case (NP20)	RS03 Untreated	17.17	6.58	110	0.08	112.1	0.0165	0.0213	0.0297	27.0	0.00007	5.7	0.00090	0.00045	0.00072	1.36	0.28	0.86	0.00017	15.9	10.3	0.02	0.0180	2.30	34.5	0.00057	0.00042	0.05911	0.00440	35	0.60	0.0002	1.3420	0.0000	0.0059	0.0026	0.0016
10	Base Case (NP20)	RS03 Untreated	11.91	6.56	120	0.09	123.8	0.0165	0.0238	0.0314	29.3	0.00007	6.4	0.00095	0.00046	0.00072	1.27	0.31	0.93	0.00017	17.4	11.5	0.02	0.0192	2.43	36.4	0.00057	0.00044	0.06481	0.00470	37	0.65	0.0002	1.2601	0.0000	0.0063	0.0028	0.0016
11	Base Case (NP20)	RS03 Untreated	16.41	6.55	112	0.09	114.8	0.0171	0.0218	0.0298	27.5	0.00007	5.9	0.00081	0.00046	0.00072	1.31	0.28	0.88	0.00017	15.1	10.6	0.02	0.0171	2.44	34.2	0.00056	0.00044	0.05503	0.00419	36	0.58	0.0002	1.2914	0.0000	0.0057	0.0024	0.0016
12	Base Case (NP20)	RS03 Untreated	14.97	6.53	115	0.10	116.4	0.0174	0.0232	0.0300	28.0	0.00007	6.0	0.00096	0.00046	0.00074	1.30	0.30	0.97	0.00017	16.9	11.0	0.02	0.0186	2.64	36.0	0.00056	0.00046	0.06208	0.00453	38	0.64	0.0002	1.2783	0.0000	0.0062	0.0027	0.0016
13	Base Case (NP20)	RS03 Untreated	23.17	6.56	104	0.09	104.3	0.0169	0.0203	0.0270	25.7	0.00007	5.3	0.00075	0.00044	0.00073	1.40	0.27	0.89	0.00017	14.8	9.7	0.02	0.0163	2.45	31.2	0.00055	0.00043	0.05405	0.00410	34	0.59	0.0002	1.3816	0.0000	0.0054	0.0024	0.0016
14	Base Case (NP20)	RS03 Untreated	21.90	6.57	101	0.09	100.4	0.0172	0.0197	0.0267	25.1	0.00007	5.1	0.00073	0.00044	0.00074	1.45	0.27	0.87	0.00016	14.7	9.3	0.02	0.0166	2.41	30.1	0.00055	0.00042	0.05397	0.00406	35	0.60	0.0002	1.4231	0.0000	0.0056	0.0024	0.0016
15	Base Case (NP20)	RS03 Untreated	16.50	6.52	112	0.10	111.8	0.0174	0.0233	0.0288	27.1	0.00007	5.8	0.00083	0.00044	0.00075	1.34	0.32	1.02	0.00016	17.8	10.7	0.02	0.0193	2.73	35.4	0.00056	0.00046	0.06631	0.00468	39	0.69	0.0002	1.3280	0.0000	0.0064	0.0028	0.0016
16	Base Case (NP20)	RS03 Untreated	17.93	6.56	113	0.09	114.9	0.0166	0.0229	0.0286	27.7	0.00007	5.9	0.00077	0.00045	0.00073	1.33	0.30	0.94	0.00017	16.5	10.7	0.02	0.0177	2.44	35.1	0.00055	0.00044	0.06146	0.00449	36	0.65	0.0002	1.3118	0.0000	0.0059	0.0026	0.0016
17	Base Case (NP20)	RS03 Untreated	17.10	6.58	114	0.09	116.6	0.0162	0.0224	0.0283	27.9	0.00007	5.9	0.00071	0.00045	0.00072	1.34	0.29	0.89	0.00017	15.5	10.7	0.02	0.0165	2.28	34.5	0.00054	0.00042	0.05727	0.00430	34	0.62	0.0002	1.3219	0.0000	0.0056	0.0025	0.0016
18	Base Case (NP20)	RS03 Untreated	18.87	6.57	105	0.09	106.3	0.0165	0.0201	0.0263	26.0	0.00007	5.3	0.00062	0.00045	0.00073	1.40	0.25	0.85	0.00017	13.6	9.8	0.02	0.0145	2.30	30.2	0.00053	0.00042	0.04892	0.00385	32	0.56	0.0002	1.3860	0.0000	0.0050	0.0022	0.0016
19	Base Case (NP20)	RS03 Untreated	18.44	6.57	108	0.09	109.2	0.0166	0.0211	0.0269	26.8	0.00007	5.5	0.00064	0.00045	0.00073	1.38	0.27	0.88	0.00017	14.6	10.1	0.02	0.0155	2.31	31.8	0.00054	0.00042	0.05324	0.00407	33	0.60	0.0002	1.3650	0.0000	0.0053	0.0023	0.0016
20	Base Case (NP20)	RS03 Untreated	19.36	6.55	105	0.09	104.8	0.0169	0.0205	0.0260	25.9	0.00007	5.2	0.00060	0.00044	0.00074	1.41	0.26	0.89	0.00017	14.1	9.7	0.02	0.0150	2.41	30.2	0.00053	0.00043	0.05096	0.00393	33	0.59	0.0002	1.3856	0.0000	0.0051	0.0022	0.0016
21	Base Case (NP20)	RS03 Untreated	18.10	6.58	112	0.09	113.7	0.0164	0.0221	0.0272	27.4	0.00007	5.7	0.00063	0.00045	0.00072	1.36	0.28	0.89	0.00017	15.0	10.5	0.02	0.0159	2.26	33.1	0.00053	0.00042	0.05549	0.00419	34	0.62	0.0002	1.3469	0.0000	0.0054	0.0024	0.0016
22	Base Case (NP20)	RS03 Untreated	18.11	6.58	109	0.09	111.5	0.0164	0.0212	0.0265	27.0	0.00007	5.6	0.00059	0.00045	0.00072	1.37	0.26	0.86	0.00017	13.9	10.2	0.02	0.0147	2.33	31.5	0.00052	0.00042	0.05062	0.00394	32	0.59	0.0002	1.3568	0.0000	0.0051	0.0022	0.0016
23	Base Case (NP20)	RS03 Untreated	19.98	6.57	107	0.09	108.2	0.0165	0.0208	0.0259	26.4	0.00007	5.3	0.00055	0.00045	0.00073	1.39	0.25	0.88	0.00017	13.5	10.0	0.02	0.0140	2.32	30.3	0.00052	0.00042	0.04857	0.00383	32	0.58	0.0002	1.3767	0.0000	0.0049	0.0022	0.0016
24	Base Case (NP20)	RS03 Untreated	15.30	6.58	115	0.09	118.4	0.0163	0.0226	0.0272	28.3	0.00007	5.9	0.00057	0.00045	0.00072	1.34	0.27	0.89	0.00017	14.6	10.9	0.02	0.0151	2.21	33.6	0.00052	0.00042	0.05340	0.00410	33	0.61	0.0002	1.3211	0.0000	0.0052	0.0023	0.0016
25	Base Case (NP20)	RS03 Untreated	20.36	6.56	104	0.09	104.6	0.0170	0.0201	0.0252	25.7	0.00007	5.1	0.00049	0.00044	0.00073	1.40	0.24	0.87	0.00017	12.7	9.6	0.02	0.0133	2.35	28.6	0.00052	0.00043	0.04467	0.00362	31	0.55	0.0002	1.3831	0.0000	0.0047	0.0020	0.0016
26	Base Case (NP20)	RS03 Untreated	21.51	6.53	99	0.09	97.9	0.0176	0.0198	0.0244	24.6	0.00007	4.8	0.00050	0.00044	0.00075	1.44	0.24	0.92	0.00016	13.3	9.2	0.02	0.0141	2.51	27.5	0.00052	0.00044	0.04713	0.00370	33	0.58	0.0002	1.4185	0.0000	0.0049	0.0021	0.0016
27	Base Case (NP20)	RS03 Untreated	20.52	6.54	107	0.10	106.1	0.0175	0.0222	0.0255	26.2	0.00007	5.3	0.00054	0.00044	0.00075	1.38	0.27	0.99	0.00016	15.2	10.0	0.02	0.0159	2.54	31.1	0.00052	0.00045	0.05569	0.00413	35	0.66	0.0002	1.3620	0.0000	0.0055	0.0024	0.0016
28	Base Case (NP20)	RS03 Untreated	14.59	6.54	110	0.09	110.0	0.0169	0.0225	0.0258	26.9	0.00007	5.5	0.00052	0.00045	0.00074	1.35	0.27	0.97	0.00017	14.8	10.4	0.02	0.0150	2.45	31.7	0.00052	0.00044	0.05395	0.00409	34	0.64	0.0002	1.3739	0.0000	0.0052	0.0023	0.0016
29	Base Case (NP20)	RS03 Untreated	17.52	6.56	112	0.09	113.5	0.0167	0.0225	0.0260	27.4	0.00007	5.6	0.00050	0.00045	0.00073	1.33	0.26	0.93	0.00017	14.1	10.6	0.02	0.0143	2.32	31.8	0.00051	0.00043	0.05095	0.00396	33	0.61	0.0002	1.3165	0.0000	0.0050	0.0022	0.0016
30	Base Case (NP20)	RS03 Untreated	17.98	6.58	104	0.08	106.0	0.0166	0.0202	0.0248	25.9	0.00007	5.2	0.00044	0.00045	0.00072	1.40	0.23	0.85	0.00017	12.3	9.7	0.02	0.0127	2.18	28.5	0.00051	0.00041	0.04339	0.00357	31	0.55	0.0002	1.3750	0.0000	0.0045	0.0020	0.0016
31	Base Case (NP20)	RS03 Untreated	20.10	6.57	104	0.09	105.1	0.0171	0.0202	0.0247	25.7	0.00007	5.1	0.00043	0.00045	0.00073	1.41	0.23	0.86	0.00017	12.4	9.6	0.02	0.0131	2.24	28.3	0.00051	0.00042	0.04367	0.00357	32	0.58	0.0002	1.3868	0.0000	0.0046	0.0020	0.0016
32	Base Case (NP20)	RS03 Untreated	19.95	6.54	103	0.09	103.0	0.0175	0.0207	0.0244	25.0	0.00007	5.0	0.00043	0.00044	0.00075	1.41	0.24	0.93	0.00016	13.0	9.6	0.02	0.0135	2.46	29.2	0.00051	0.00045	0.04537	0.00367	33	0.65	0.0002	1.3554	0.0000	0.0049	0.0022	0.0016
33	Base Case (NP20)	RS03 Untreated	20.10	6.57	102	0.10	100.1	0.0176	0.0208	0.0239	25.1	0.00007	4.9	0.00043	0.00044	0.00075	1.42	0.24	0.96	0.00016	13.7	9.5	0.02	0.0135	2.58													

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
90	Base Case (NP20)	RS03 Untreated	21.95	6.58	101	0.08	102.6	0.0168	0.0197	0.0222	25.2	0.00007	4.7	0.00021	0.00044	0.00073	1.43	0.16	0.85	0.00017	7.6	9.3	0.01	0.0074	2.14	22.4	0.00048	0.00041	0.02192	0.00246	25	0.48	0.0002	1.4072	0.0000	0.0029	0.0012	0.0016
91	Base Case (NP20)	RS03 Untreated	14.21	6.54	108	0.09	109.3	0.0168	0.0221	0.0228	26.4	0.00007	5.1	0.00022	0.00044	0.00074	1.36	0.17	0.95	0.00017	8.5	10.1	0.01	0.0077	2.32	24.5	0.00047	0.00044	0.02510	0.00261	27	0.53	0.0002	1.3474	0.0000	0.0031	0.0013	0.0015
92	Base Case (NP20)	RS03 Untreated	12.97	6.54	116	0.09	119.9	0.0169	0.0238	0.0243	26.3	0.00007	5.6	0.00022	0.00045	0.00072	1.28	0.18	0.95	0.00017	8.7	11.0	0.01	0.0086	2.32	27.2	0.00047	0.00044	0.02591	0.00270	27	0.53	0.0002	1.2634	0.0000	0.0032	0.0013	0.0016
93	Base Case (NP20)	RS03 Untreated	13.89	6.58	116	0.09	121.3	0.0165	0.0230	0.0246	26.3	0.00007	5.6	0.00022	0.00046	0.00071	1.28	0.18	0.98	0.00017	9.1	11.0	0.01	0.0075	2.03	27.2	0.00047	0.00042	0.02347	0.00261	25	0.49	0.0002	1.2588	0.0000	0.0031	0.0012	0.0016
94	Base Case (NP20)	RS03 Untreated	22.05	6.55	100	0.09	100.2	0.0173	0.0195	0.0222	24.7	0.00007	4.6	0.00021	0.00044	0.00074	1.42	0.15	0.87	0.00017	7.3	9.2	0.01	0.0071	2.30	21.6	0.00048	0.00043	0.01997	0.00236	25	0.45	0.0002	1.3986	0.0000	0.0029	0.0011	0.0016
95	Base Case (NP20)	RS03 Untreated	23.39	6.56	102	0.09	103.1	0.0169	0.0207	0.0222	25.4	0.00007	4.7	0.00021	0.00044	0.00074	1.43	0.16	0.91	0.00017	8.0	9.5	0.01	0.0075	2.22	22.7	0.00048	0.00042	0.02319	0.00251	25	0.50	0.0002	1.4068	0.0000	0.0030	0.0012	0.0015
96	Base Case (NP20)	RS03 Untreated	19.21	6.59	106	0.08	108.6	0.0164	0.0210	0.0227	26.4	0.00007	4.9	0.00021	0.00044	0.00073	1.43	0.17	0.87	0.00017	7.8	9.8	0.01	0.0074	2.04	23.7	0.00048	0.00041	0.02288	0.00251	24	0.50	0.0002	1.4155	0.0000	0.0030	0.0012	0.0016
97	Base Case (NP20)	RS03 Untreated	19.21	6.58	105	0.08	107.7	0.0167	0.0205	0.0228	26.2	0.00007	4.9	0.00021	0.00043	0.00073	1.42	0.16	0.86	0.00017	7.5	9.7	0.01	0.0070	2.11	23.3	0.00048	0.00041	0.02101	0.00244	24	0.47	0.0002	1.4052	0.0000	0.0029	0.0012	0.0016
98	Base Case (NP20)	RS03 Untreated	13.90	6.53	111	0.09	112.8	0.0170	0.0226	0.0233	27.2	0.00007	5.2	0.00021	0.00044	0.00074	1.35	0.17	0.96	0.00017	8.3	10.4	0.01	0.0074	2.35	24.9	0.00048	0.00044	0.02348	0.00254	25	0.50	0.0002	1.3348	0.0000	0.0030	0.0012	0.0016
99	Base Case (NP20)	RS03 Untreated	15.49	6.57	111	0.09	115.0	0.0163	0.0222	0.0236	27.1	0.00007	5.3	0.00021	0.00045	0.00072	1.33	0.17	0.89	0.00017	7.8	10.5	0.01	0.0069	2.11	25.3	0.00047	0.00042	0.02201	0.00251	24	0.47	0.0002	1.3152	0.0000	0.0030	0.0012	0.0016
100	Base Case (NP20)	RS03 Untreated	28.74	6.60	101	0.08	104.1	0.0170	0.0194	0.0226	25.3	0.00007	4.7	0.00021	0.00044	0.00073	1.43	0.15	0.81	0.00017	6.9	9.3	0.01	0.0071	2.03	22.1	0.00048	0.00040	0.01882	0.00231	25	0.43	0.0002	1.4044	0.0000	0.0029	0.0011	0.0016
101	Base Case (NP20)	RS03 Untreated	15.05	6.52	111	0.10	110.9	0.0175	0.0233	0.0229	27.1	0.00007	5.2	0.00021	0.00043	0.00076	1.36	0.17	0.84	0.00016	8.6	10.5	0.01	0.0076	2.06	24.5	0.00048	0.00046	0.02442	0.00254	26	0.52	0.0002	1.3444	0.0000	0.0031	0.0013	0.0015
102	Base Case (NP20)	RS03 Untreated	15.49	6.53	106	0.09	109.3	0.0174	0.0221	0.0231	26.4	0.00007	5.1	0.00021	0.00044	0.00074	1.35	0.16	0.95	0.00017	7.9	10.1	0.01	0.0076	2.33	24.0	0.00048	0.00044	0.02227	0.00246	25	0.48	0.0002	1.3307	0.0000	0.0031	0.0012	0.0016
103	Base Case (NP20)	RS03 Untreated	14.64	6.49	111	0.11	112.0	0.0182	0.0238	0.0235	27.1	0.00007	5.3	0.00021	0.00044	0.00075	1.30	0.17	1.05	0.00017	8.6	10.6	0.01	0.0080	2.65	25.0	0.00047	0.00048	0.02399	0.00253	28	0.51	0.0002	1.2785	0.0000	0.0032	0.0012	0.0016
104	Base Case (NP20)	RS03 Untreated	16.55	6.52	110	0.10	111.4	0.0179	0.0232	0.0235	26.8	0.00007	5.2	0.00021	0.00045	0.00074	1.31	0.17	1.00	0.00017	8.2	10.4	0.01	0.0078	2.44	24.7	0.00048	0.00046	0.02301	0.00250	27	0.49	0.0002	1.2910	0.0000	0.0032	0.0012	0.0016
105	Base Case (NP20)	RS03 Untreated	24.10	6.56	103	0.09	104.1	0.0171	0.0207	0.0225	25.5	0.00007	4.8	0.00021	0.00044	0.00074	1.40	0.15	0.90	0.00017	7.3	9.5	0.01	0.0069	2.22	22.4	0.00048	0.00043	0.02031	0.00236	24	0.45	0.0002	1.3830	0.0000	0.0028	0.0011	0.0016
106	Base Case (NP20)	RS03 Untreated	16.37	6.55	105	0.09	106.1	0.0170	0.0213	0.0225	26.0	0.00007	4.9	0.00021	0.00044	0.00074	1.41	0.16	0.92	0.00017	7.6	9.8	0.01	0.0070	2.28	22.8	0.00048	0.00043	0.02077	0.00239	25	0.47	0.0002	1.3912	0.0000	0.0028	0.0011	0.0016
107	Base Case (NP20)	RS03 Untreated	20.75	6.57	105	0.09	106.7	0.0170	0.0209	0.0227	26.0	0.00007	4.9	0.00021	0.00044	0.00073	1.40	0.16	0.89	0.00017	7.3	9.7	0.01	0.0069	2.18	22.8	0.00048	0.00042	0.01976	0.00236	24	0.45	0.0002	1.3833	0.0000	0.0028	0.0011	0.0016
108	Base Case (NP20)	RS03 Untreated	15.87	6.53	108	0.10	108.5	0.0173	0.0220	0.0229	26.5	0.00007	5.0	0.00021	0.00044	0.00075	1.38	0.16	0.96	0.00017	7.7	10.1	0.01	0.0069	2.40	23.4	0.00048	0.00045	0.02068	0.00238	25	0.46	0.0002	1.3618	0.0000	0.0028	0.0011	0.0016
109	Base Case (NP20)	RS03 Untreated	17.94	6.57	107	0.09	109.5	0.0166	0.0212	0.0230	26.4	0.00007	5.0	0.00021	0.00045	0.00072	1.38	0.16	0.87	0.00017	7.1	9.9	0.01	0.0066	2.09	23.4	0.00048	0.00042	0.01925	0.00235	24	0.44	0.0002	1.3607	0.0000	0.0027	0.0011	0.0016
110	Base Case (NP20)	RS03 Untreated	12.35	6.55	117	0.09	121.0	0.0167	0.0237	0.0243	28.5	0.00007	5.6	0.00021	0.00045	0.00073	1.30	0.17	0.94	0.00017	7.1	11.1	0.01	0.0068	2.20	26.3	0.00047	0.00044	0.02100	0.00245	25	0.46	0.0002	1.2814	0.0000	0.0029	0.0012	0.0016
111	Base Case (NP20)	RS03 Untreated	17.09	6.55	109	0.09	112.3	0.0173	0.0217	0.0237	26.8	0.00007	5.2	0.00021	0.00045	0.00073	1.33	0.15	0.90	0.00017	7.0	10.3	0.01	0.0067	2.27	24.0	0.00048	0.00044	0.01822	0.00230	25	0.42	0.0002	1.3094	0.0000	0.0028	0.0010	0.0016
112	Base Case (NP20)	RS03 Untreated	15.56	6.52	112	0.10	113.8	0.0176	0.0232	0.0237	27.3	0.00007	5.3	0.00021	0.00045	0.00074	1.32	0.16	0.99	0.00017	7.7	10.6	0.01	0.0070	2.45	24.6	0.00048	0.00046	0.02038	0.00238	26	0.45	0.0002	1.2962	0.0000	0.0029	0.0011	0.0016
113	Base Case (NP20)	RS03 Untreated	24.20	6.55	101	0.09	101.9	0.0170	0.0202	0.0221	25.1	0.00007	4.7	0.00021	0.00044	0.00074	1.42	0.15	0.90	0.00017	6.9	9.4	0.01	0.0064	2.28	21.4	0.00048	0.00043	0.01779	0.00224	24	0.42	0.0002	1.3977	0.0000	0.0026	0.0010	0.0015
114	Base Case (NP20)	RS03 Untreated	22.85	6.56	98	0.09	98.3	0.0174	0.0196	0.0217	24.5	0.00007	4.4	0.00020	0.00043	0.00074	1.46	0.14	0.88	0.00016	6.8	9.0	0.01	0.0068	2.24	20.4	0.00048	0.00042	0.01783	0.00221	25	0.42	0.0002	1.4383	0.0000	0.0028	0.0010	0.0015
115	Base Case (NP20)	RS03 Untreated	17.14	6.52	109	0.10	109.4	0.0176	0.0233	0.0238	26.8	0.00007	5.0	0.00021	0.00043	0.00076	1.36	0.16	1.03	0.00016	8.0	10.3	0.01	0.0072	2.53	23.5	0.00047	0.00046	0.02158	0.00239	26	0.48	0.0002	1.3442	0.0000	0.0030	0.0012	0.0015
116	Base Case (NP20)	RS03 Untreated	18.65	6.56	110	0.09	112.6	0.0168	0.0228	0.0232	27.1	0.00007	5.2	0.00021	0.00044	0.00073	1.34	0.16	0.95	0.00017	7.5	10.4	0.01	0.0066	2.27	24.1	0.00047	0.00044	0.02003	0.00236	24	0.45	0.0002	1.3299	0.0000	0.0028	0.0011	0.0016
117	Base Case (NP20)	RS03 Untreated	17.76	6.58	111	0.09	114.4	0.0164	0.0223	0.0234	27.4	0.00007	5.2	0.00021	0.00045	0.00073	1.35	0.16	0.90	0.00017	7.1	10.4	0.01	0.0063	2.13	24.3	0.00047	0.00042	0.01872	0.00232	23	0.43	0.0002	1.3399	0.0000	0.0026	0.0010	0.0016
118	Base Case (NP20)	RS03 Untreated	19.63	6.57	102	0.09	104.1	0.0167	0.0200	0.0223	25.5	0.00007	4.7	0.00020	0.00044	0.00073	1.42	0.14	0.96	0.00017	6.5	9.4	0.01	0.0066	2.17	21.5	0.00048	0.00042	0.01622	0.00217	23	0.41	0.0002	1.4607	0.0000	0.0025	0.0009	0.0016
119	Base Case (NP20)	RS03 Untreated	19.12	6.57	105	0.09	107.0	0.0167	0.0210	0.0226	26.0	0.00007	4.8	0.00020	0.00044	0.00073	1.40	0.15	0.89	0.00017	6.8	9.7	0.01	0.0063	2.10	22.4												

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
176	Base Case (NP20)	RS03 Untreated	20.08	6.62	106	0.08	113.6	0.0159	0.0204	0.0236	26.8	0.00007	5.1	0.00020	0.00046	0.00070	1.37	0.13	0.77	0.00018	4.7	10.0	0.01	0.0042	1.82	22.3	0.00048	0.00039	0.00867	0.00187	20	0.27	0.0002	1.3479	0.0000	0.0020	0.0007	0.0016
177	Base Case (NP20)	RS03 Untreated	23.27	6.56	96	0.09	99.3	0.0170	0.0190	0.0218	24.6	0.00007	4.4	0.00020	0.00043	0.00074	1.45	0.12	0.85	0.00017	4.9	9.0	0.01	0.0046	2.23	18.9	0.00048	0.00042	0.00874	0.00177	21	0.29	0.0002	1.4294	0.0000	0.0021	0.0007	0.0015
178	Base Case (NP20)	RS03 Untreated	22.12	6.56	96	0.09	96.8	0.0171	0.0192	0.0213	24.0	0.00007	4.2	0.00020	0.00043	0.00074	1.47	0.12	0.88	0.00016	5.1	8.7	0.01	0.0049	2.24	18.1	0.00048	0.00042	0.00853	0.00179	22	0.30	0.0002	1.4454	0.0000	0.0021	0.0007	0.0015
179	Base Case (NP20)	RS03 Untreated	16.39	6.55	104	0.09	107.8	0.0171	0.0222	0.0226	26.3	0.00007	4.9	0.00020	0.00044	0.00074	1.38	0.13	0.95	0.00017	5.5	9.9	0.01	0.0051	2.24	21.0	0.00047	0.00043	0.01084	0.00187	23	0.31	0.0002	1.3600	0.0000	0.0023	0.0008	0.0015
180	Base Case (NP20)	RS03 Untreated	18.30	6.56	104	0.09	105.7	0.0171	0.0211	0.0226	25.7	0.00007	4.7	0.00020	0.00044	0.00073	1.38	0.12	0.91	0.00017	5.2	9.7	0.01	0.0049	2.22	20.5	0.00048	0.00043	0.00984	0.00184	22	0.30	0.0002	1.3634	0.0000	0.0022	0.0008	0.0016
181	Base Case (NP20)	RS03 Untreated	18.55	6.52	104	0.10	104.3	0.0177	0.0216	0.0224	25.8	0.00007	4.7	0.00020	0.00043	0.00075	1.38	0.12	0.98	0.00016	5.5	9.7	0.01	0.0050	2.48	20.2	0.00048	0.00045	0.01014	0.00182	23	0.30	0.0002	1.3603	0.0000	0.0022	0.0008	0.0015
182	Base Case (NP20)	RS03 Untreated	22.87	6.55	102	0.09	102.7	0.0176	0.0211	0.0222	25.3	0.00007	4.6	0.00020	0.00044	0.00074	1.40	0.12	0.94	0.00016	5.3	9.5	0.01	0.0051	2.33	19.8	0.00048	0.00043	0.00999	0.00182	23	0.30	0.0002	1.3802	0.0000	0.0023	0.0007	0.0015
183	Base Case (NP20)	RS03 Untreated	17.56	6.53	105	0.10	105.9	0.0173	0.0220	0.0225	26.0	0.00007	4.8	0.00020	0.00044	0.00075	1.39	0.12	0.97	0.00016	5.5	9.8	0.01	0.0048	2.40	20.5	0.00048	0.00044	0.01024	0.00184	22	0.31	0.0002	1.3685	0.0000	0.0022	0.0008	0.0015
184	Base Case (NP20)	RS03 Untreated	22.28	6.57	101	0.09	102.6	0.0165	0.0202	0.0220	25.3	0.00007	4.6	0.00020	0.00044	0.00073	1.43	0.12	0.87	0.00017	5.0	9.3	0.01	0.0043	2.13	19.6	0.00048	0.00041	0.00903	0.00181	20	0.29	0.0002	1.4122	0.0000	0.0020	0.0007	0.0016
185	Base Case (NP20)	RS03 Untreated	32.87	6.58	94	0.08	93.7	0.0173	0.0182	0.0210	23.7	0.00007	4.1	0.00020	0.00043	0.00075	1.52	0.11	0.84	0.00016	4.8	8.4	0.01	0.0050	2.18	17.3	0.00049	0.00040	0.00853	0.00172	22	0.29	0.0002	1.4941	0.0000	0.0022	0.0007	0.0015
186	Base Case (NP20)	RS03 Untreated	16.91	6.54	107	0.10	106.9	0.0173	0.0230	0.0222	26.3	0.00007	4.8	0.00020	0.00043	0.00075	1.41	0.13	1.02	0.00016	5.7	9.9	0.01	0.0050	2.41	20.5	0.00047	0.00044	0.01110	0.00184	23	0.32	0.0002	1.3896	0.0000	0.0022	0.0008	0.0015
187	Base Case (NP20)	RS03 Untreated	22.62	6.56	99	0.09	100.0	0.0171	0.0200	0.0218	24.7	0.00007	4.4	0.00020	0.00043	0.00074	1.44	0.12	0.89	0.00016	5.0	9.1	0.01	0.0049	2.20	19.0	0.00048	0.00042	0.01014	0.00177	22	0.29	0.0002	1.4187	0.0000	0.0022	0.0007	0.0015
188	Base Case (NP20)	RS03 Untreated	19.56	6.56	100	0.09	101.2	0.0168	0.0204	0.0218	25.0	0.00007	4.5	0.00020	0.00043	0.00074	1.43	0.12	0.90	0.00016	5.0	9.2	0.01	0.0045	2.21	19.2	0.00048	0.00042	0.00908	0.00176	21	0.29	0.0002	1.4124	0.0000	0.0020	0.0007	0.0015
189	Base Case (NP20)	RS03 Untreated	17.40	6.56	108	0.09	110.3	0.0169	0.0223	0.0229	26.5	0.00007	5.0	0.00020	0.00044	0.00073	1.37	0.13	0.94	0.00017	5.3	10.1	0.01	0.0046	2.25	21.4	0.00047	0.00043	0.00968	0.00183	22	0.29	0.0002	1.3473	0.0000	0.0021	0.0007	0.0016
190	Base Case (NP20)	RS03 Untreated	21.95	6.58	101	0.08	102.2	0.0168	0.0197	0.0221	25.1	0.00007	4.6	0.00020	0.00044	0.00073	1.43	0.12	0.85	0.00017	4.8	9.2	0.01	0.0045	2.13	19.5	0.00048	0.00041	0.00937	0.00177	21	0.28	0.0002	1.4072	0.0000	0.0020	0.0007	0.0016
191	Base Case (NP20)	RS03 Untreated	14.21	6.54	107	0.09	108.9	0.0168	0.0221	0.0227	26.4	0.00007	4.9	0.00020	0.00044	0.00074	1.36	0.12	0.95	0.00017	5.3	10.0	0.01	0.0044	2.32	21.1	0.00047	0.00044	0.00942	0.00181	21	0.29	0.0002	1.3474	0.0000	0.0020	0.0007	0.0015
192	Base Case (NP20)	RS03 Untreated	12.97	6.54	115	0.09	119.5	0.0169	0.0238	0.0242	28.1	0.00007	5.4	0.00021	0.00045	0.00072	1.28	0.13	0.95	0.00017	5.3	10.9	0.01	0.0046	2.22	23.7	0.00047	0.00044	0.00978	0.00187	22	0.29	0.0002	1.2624	0.0000	0.0022	0.0008	0.0016
193	Base Case (NP20)	RS03 Untreated	13.89	6.58	115	0.09	121.0	0.0165	0.0230	0.0245	28.2	0.00007	5.5	0.00021	0.00046	0.00071	1.28	0.13	0.88	0.00017	5.0	10.9	0.01	0.0044	2.03	24.0	0.00047	0.00042	0.00962	0.00188	22	0.27	0.0002	1.2588	0.0000	0.0021	0.0007	0.0016
194	Base Case (NP20)	RS03 Untreated	22.05	6.55	99	0.09	99.9	0.0173	0.0195	0.0221	24.8	0.00007	4.5	0.00020	0.00044	0.00074	1.42	0.12	0.87	0.00017	4.8	9.1	0.01	0.0046	2.29	19.1	0.00048	0.00043	0.00814	0.00175	22	0.27	0.0002	1.3986	0.0000	0.0021	0.0007	0.0016
195	Base Case (NP20)	RS03 Untreated	23.39	6.56	102	0.09	102.7	0.0169	0.0207	0.0221	25.3	0.00007	4.6	0.00020	0.00044	0.00074	1.43	0.12	0.91	0.00017	5.1	9.4	0.01	0.0046	2.21	19.6	0.00048	0.00042	0.00917	0.00180	21	0.29	0.0002	1.4058	0.0000	0.0021	0.0007	0.0015
196	Base Case (NP20)	RS03 Untreated	19.21	6.59	106	0.08	108.2	0.0164	0.0210	0.0226	26.3	0.00007	4.8	0.00020	0.00044	0.00073	1.43	0.12	0.87	0.00017	4.9	9.7	0.01	0.0045	2.04	20.6	0.00048	0.00041	0.00906	0.00181	21	0.29	0.0002	1.4156	0.0000	0.0020	0.0007	0.0016
197	Base Case (NP20)	RS03 Untreated	19.21	6.58	105	0.08	107.4	0.0167	0.0205	0.0222	26.1	0.00007	4.8	0.00020	0.00044	0.00073	1.42	0.12	0.86	0.00017	4.8	9.6	0.01	0.0045	2.11	20.6	0.00048	0.00041	0.00856	0.00180	21	0.28	0.0002	1.4052	0.0000	0.0020	0.0007	0.0016
198	Base Case (NP20)	RS03 Untreated	13.90	6.53	110	0.09	112.4	0.0170	0.0226	0.0237	27.1	0.00007	5.1	0.00020	0.00044	0.00074	1.35	0.13	0.96	0.00017	5.3	10.4	0.01	0.0045	2.35	21.9	0.00047	0.00044	0.00953	0.00183	22	0.29	0.0002	1.3348	0.0000	0.0021	0.0007	0.0016
199	Base Case (NP20)	RS03 Untreated	15.49	6.57	111	0.09	114.7	0.0162	0.0222	0.0235	27.3	0.00007	5.2	0.00020	0.00045	0.00072	1.33	0.13	0.89	0.00017	5.0	10.4	0.01	0.0041	2.10	22.4	0.00047	0.00042	0.00898	0.00185	20	0.28	0.0002	1.3152	0.0000	0.0020	0.0007	0.0016
0	Base Case (NP20)	RS03 Treated	23.45	6.57	77	0.02	64.6	0.0027	0.0001	0.0199	24.1	0.00007	2.6	0.00001	0.00001	0.00009	1.73	0.10	0.00	0.00017	3.7	4.1	0.00	0.0002	0.01	12.7	0.00001	0.00000	0.00022	0.00004	17	0.00	0.0001	1.6651	0.0000	0.0008	0.0001	0.0000
1	Base Case (NP20)	RS03 Treated	14.34	6.57	139	0.09	114.1	0.0028	0.0002	0.0318	39.5	0.00007	6.0	0.00002	0.00001	0.00011	1.31	0.27	0.01	0.00017	16.4	9.9	0.00	0.0004	0.03	35.7	0.00001	0.00001	0.00118	0.00009	25	0.01	0.0002	1.2939	0.0000	0.0016	0.0003	0.0000
2	Base Case (NP20)	RS03 Treated	14.78	6.56	137	0.09	112.4	0.0029	0.0002	0.0322	38.8	0.00007	5.9	0.00002	0.00001	0.00010	1.32	0.28	0.01	0.00017	17.1	9.7	0.00	0.0004	0.03	36.3	0.00001	0.00001	0.00126	0.00009	27	0.01	0.0002	1.3019	0.0000	0.0017	0.0003	0.0000
3	Base Case (NP20)	RS03 Treated	13.99	6.50	142	0.10	115.2	0.0030	0.0002	0.0336	39.9	0.00007	6.2	0.00002	0.00001	0.00011	1.27	0.31	0.01	0.00017	19.5	10.2	0.00	0.0005	0.03	39.1	0.00001	0.00001	0.00145	0.00010	29	0.01	0.0002	1.2557	0.0000	0.0019	0.0003	0.0000
4	Base Case (NP20)	RS03 Treated	15.81	6.53	140	0.10	114.4	0.0030	0.0002	0.0329	39.5	0.00007	6.1	0.00002	0.00001	0.00010	1.29	0.31	0.01	0.00017	18.8	10.0	0.00	0.0004	0.03	38.3	0.00001	0.00001	0.00141	0.00010	29	0.01	0.0002	1.2699	0.0000	0.0018	0.0003	0.0000
5	Base Case (NP20)	RS03 Treated	22.57	6.57	131	0.09	106.8	0.0029	0.0002	0.0304	37.4	0.00007	5.6	0.00002	0.00001	0.00010	1.38	0.28	0.01	0.00017	16.6	9.1	0.00	0.0004	0.02	34.2	0.00001											

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
62	Base Case (NP20)	RS03 Treated	12.19	6.56	148	0.09	125.1	0.0027	0.0002	0.0253	41.9	0.00007	6.0	0.00000	0.00001	0.00010	1.25	0.22	0.01	0.00017	11.1	10.6	0.00	0.0002	0.02	30.8	0.00001	0.00001	0.00074	0.00007	20	0.01	0.0002	1.2392	0.0000	0.0010	0.0002	0.0000
63	Base Case (NP20)	RS03 Treated	20.88	6.59	135	0.08	113.3	0.0028	0.0002	0.0241	38.6	0.00007	5.3	0.00000	0.00001	0.00010	1.35	0.19	0.01	0.00017	9.1	9.4	0.00	0.0002	0.02	26.6	0.00001	0.00001	0.00058	0.00006	19	0.01	0.0002	1.3251	0.0000	0.0009	0.0001	0.0000
64	Base Case (NP20)	RS03 Treated	18.98	6.55	132	0.09	107.0	0.0028	0.0002	0.0230	37.6	0.00007	5.1	0.00000	0.00001	0.00011	1.39	0.19	0.01	0.00017	9.8	9.1	0.00	0.0002	0.02	25.4	0.00001	0.00001	0.00062	0.00006	19	0.01	0.0002	1.3759	0.0000	0.0009	0.0001	0.0000
65	Base Case (NP20)	RS03 Treated	19.86	6.54	123	0.09	99.3	0.0029	0.0002	0.0222	34.8	0.00007	4.7	0.00000	0.00001	0.00011	1.43	0.18	0.01	0.00016	9.5	8.5	0.00	0.0002	0.02	23.5	0.00001	0.00001	0.00060	0.00006	19	0.01	0.0002	1.4104	0.0000	0.0009	0.0001	0.0000
66	Base Case (NP20)	RS03 Treated	15.98	6.55	137	0.09	112.3	0.0029	0.0002	0.0236	39.5	0.00007	5.3	0.00000	0.00001	0.00011	1.35	0.21	0.01	0.00017	10.7	9.6	0.00	0.0002	0.02	27.4	0.00001	0.00001	0.00071	0.00006	20	0.01	0.0002	1.3382	0.0000	0.0010	0.0002	0.0000
67	Base Case (NP20)	RS03 Treated	18.02	6.56	132	0.09	109.0	0.0028	0.0002	0.0233	37.8	0.00007	5.1	0.00000	0.00001	0.00011	1.38	0.19	0.01	0.00017	9.6	9.2	0.00	0.0002	0.02	25.8	0.00001	0.00001	0.00061	0.00006	19	0.01	0.0002	1.3605	0.0000	0.0009	0.0001	0.0000
68	Base Case (NP20)	RS03 Treated	20.42	6.56	132	0.09	108.2	0.0028	0.0002	0.0231	37.7	0.00007	5.1	0.00000	0.00001	0.00011	1.38	0.19	0.01	0.00017	9.7	9.2	0.00	0.0002	0.02	25.6	0.00001	0.00001	0.00062	0.00006	19	0.01	0.0002	1.3676	0.0000	0.0009	0.0001	0.0000
69	Base Case (NP20)	RS03 Treated	10.61	6.54	150	0.09	125.9	0.0028	0.0002	0.0251	42.4	0.00007	6.0	0.00000	0.00001	0.00010	1.27	0.22	0.01	0.00017	10.8	10.7	0.00	0.0002	0.02	30.5	0.00001	0.00001	0.00071	0.00006	20	0.01	0.0002	1.2533	0.0000	0.0010	0.0002	0.0000
70	Base Case (NP20)	RS03 Treated	17.26	6.59	136	0.08	113.8	0.0027	0.0002	0.0239	38.7	0.00007	5.3	0.00000	0.00001	0.00010	1.35	0.18	0.01	0.00017	8.8	9.4	0.00	0.0002	0.02	26.3	0.00001	0.00001	0.00055	0.00006	18	0.01	0.0002	1.3320	0.0000	0.0009	0.0001	0.0000
71	Base Case (NP20)	RS03 Treated	23.94	6.57	125	0.08	102.4	0.0029	0.0002	0.0226	36.0	0.00007	4.7	0.00000	0.00001	0.00011	1.44	0.17	0.01	0.00017	8.4	8.5	0.00	0.0002	0.02	23.3	0.00001	0.00001	0.00051	0.00005	19	0.01	0.0002	1.4146	0.0000	0.0009	0.0001	0.0000
72	Base Case (NP20)	RS03 Treated	13.25	6.53	138	0.10	114.0	0.0029	0.0002	0.0238	39.4	0.00007	5.4	0.00000	0.00001	0.00011	1.34	0.20	0.01	0.00017	10.3	9.8	0.00	0.0002	0.02	27.3	0.00001	0.00001	0.00066	0.00006	20	0.01	0.0002	1.3253	0.0000	0.0010	0.0002	0.0000
73	Base Case (NP20)	RS03 Treated	17.65	6.57	135	0.09	111.8	0.0028	0.0002	0.0236	38.4	0.00007	5.2	0.00000	0.00001	0.00010	1.36	0.19	0.01	0.00017	9.2	9.4	0.00	0.0002	0.02	26.1	0.00001	0.00001	0.00058	0.00006	19	0.01	0.0002	1.3403	0.0000	0.0009	0.0001	0.0000
74	Base Case (NP20)	RS03 Treated	14.50	6.56	140	0.09	116.8	0.0028	0.0002	0.0242	39.8	0.00007	5.5	0.00000	0.00001	0.00010	1.33	0.19	0.01	0.00017	9.4	9.8	0.00	0.0002	0.02	27.2	0.00001	0.00001	0.00059	0.00006	19	0.01	0.0002	1.3126	0.0000	0.0009	0.0001	0.0000
75	Base Case (NP20)	RS03 Treated	12.36	6.56	144	0.09	121.1	0.0027	0.0002	0.0246	40.8	0.00007	5.7	0.00000	0.00001	0.00010	1.28	0.19	0.01	0.00017	9.3	10.2	0.00	0.0002	0.02	28.3	0.00001	0.00001	0.00058	0.00006	18	0.01	0.0002	1.2686	0.0000	0.0009	0.0001	0.0000
76	Base Case (NP20)	RS03 Treated	20.08	6.62	135	0.08	113.9	0.0026	0.0002	0.0238	38.6	0.00007	5.3	0.00000	0.00001	0.00010	1.37	0.17	0.01	0.00018	7.9	9.3	0.00	0.0001	0.02	25.7	0.00001	0.00001	0.00048	0.00005	17	0.01	0.0002	1.4279	0.0000	0.0008	0.0001	0.0000
77	Base Case (NP20)	RS03 Treated	23.27	6.56	123	0.09	99.6	0.0028	0.0002	0.0220	35.4	0.00007	4.6	0.00000	0.00001	0.00011	1.45	0.16	0.01	0.00017	8.0	8.3	0.00	0.0002	0.02	22.1	0.00001	0.00001	0.00047	0.00005	18	0.01	0.0002	1.3494	0.0000	0.0008	0.0001	0.0000
78	Base Case (NP20)	RS03 Treated	22.12	6.56	120	0.09	96.1	0.0029	0.0002	0.0215	34.6	0.00007	4.4	0.00000	0.00001	0.00011	1.47	0.17	0.01	0.00017	8.5	8.1	0.00	0.0002	0.02	21.8	0.00001	0.00001	0.00052	0.00005	18	0.01	0.0002	1.4454	0.0000	0.0008	0.0001	0.0000
79	Base Case (NP20)	RS03 Treated	16.39	6.55	138	0.09	108.3	0.0029	0.0002	0.0229	37.7	0.00007	5.0	0.00000	0.00001	0.00011	1.38	0.19	0.01	0.00017	9.6	9.2	0.00	0.0002	0.02	25.3	0.00001	0.00001	0.00061	0.00006	19	0.01	0.0002	1.3600	0.0000	0.0009	0.0001	0.0000
80	Base Case (NP20)	RS03 Treated	18.30	6.56	129	0.09	106.1	0.0029	0.0002	0.0228	37.0	0.00007	4.9	0.00000	0.00001	0.00011	1.38	0.18	0.01	0.00017	8.8	9.0	0.00	0.0002	0.02	24.3	0.00001	0.00001	0.00054	0.00005	19	0.01	0.0002	1.3634	0.0000	0.0009	0.0001	0.0000
81	Base Case (NP20)	RS03 Treated	18.55	6.52	129	0.10	104.7	0.0030	0.0002	0.0226	36.9	0.00007	4.9	0.00000	0.00001	0.00011	1.38	0.18	0.01	0.00016	9.2	9.0	0.00	0.0002	0.02	24.1	0.00001	0.00001	0.00055	0.00005	19	0.01	0.0002	1.3603	0.0000	0.0009	0.0001	0.0000
82	Base Case (NP20)	RS03 Treated	22.87	6.55	127	0.09	103.1	0.0029	0.0002	0.0225	36.3	0.00007	4.8	0.00000	0.00001	0.00011	1.40	0.18	0.01	0.00016	8.9	8.8	0.00	0.0002	0.02	23.6	0.00001	0.00001	0.00055	0.00005	19	0.01	0.0002	1.3802	0.0000	0.0009	0.0001	0.0000
83	Base Case (NP20)	RS03 Treated	17.56	6.53	131	0.10	106.3	0.0029	0.0002	0.0227	37.4	0.00007	5.0	0.00000	0.00001	0.00011	1.39	0.18	0.01	0.00016	9.3	9.1	0.00	0.0002	0.02	24.5	0.00001	0.00001	0.00057	0.00006	19	0.01	0.0002	1.3685	0.0000	0.0009	0.0001	0.0000
84	Base Case (NP20)	RS03 Treated	22.28	6.57	126	0.09	102.9	0.0028	0.0002	0.0227	36.3	0.00007	4.7	0.00000	0.00001	0.00011	1.43	0.17	0.01	0.00017	8.3	8.6	0.00	0.0002	0.02	23.1	0.00001	0.00001	0.00050	0.00005	17	0.01	0.0002	1.4122	0.0000	0.0008	0.0001	0.0000
85	Base Case (NP20)	RS03 Treated	32.87	6.58	117	0.08	94.0	0.0029	0.0002	0.0212	34.0	0.00007	4.2	0.00000	0.00001	0.00011	1.52	0.16	0.01	0.00016	7.7	7.8	0.00	0.0002	0.02	20.4	0.00001	0.00001	0.00045	0.00005	18	0.01	0.0002	1.4941	0.0000	0.0008	0.0001	0.0000
86	Base Case (NP20)	RS03 Treated	16.91	6.54	133	0.10	107.4	0.0029	0.0002	0.0224	37.9	0.00007	5.0	0.00000	0.00001	0.00011	1.41	0.19	0.01	0.00016	9.9	9.2	0.00	0.0002	0.02	24.9	0.00001	0.00001	0.00062	0.00006	20	0.01	0.0002	1.3896	0.0000	0.0009	0.0001	0.0000
87	Base Case (NP20)	RS03 Treated	22.62	6.56	124	0.09	100.4	0.0029	0.0002	0.0219	35.6	0.00007	4.6	0.00000	0.00001	0.00011	1.44	0.17	0.01	0.00016	8.2	8.4	0.00	0.0002	0.02	22.4	0.00001	0.00001	0.00049	0.00005	18	0.01	0.0002	1.4187	0.0000	0.0008	0.0001	0.0000
88	Base Case (NP20)	RS03 Treated	19.56	6.56	125	0.09	101.6	0.0028	0.0002	0.0220	36.0	0.00007	4.7	0.00000	0.00001	0.00011	1.43	0.17	0.01	0.00016	8.3	8.6	0.00	0.0002	0.02	22.7	0.00001	0.00001	0.00049	0.00005	18	0.01	0.0002	1.4124	0.0000	0.0008	0.0001	0.0000
89	Base Case (NP20)	RS03 Treated	17.40	6.56	134	0.09	110.7	0.0028	0.0002	0.0231	38.3	0.00007	5.1	0.00000	0.00001	0.00011	1.37	0.18	0.01	0.00017	8.8	9.4	0.00	0.0002	0.02	25.0	0.00001	0.00001	0.00053	0.00005	18	0.01	0.0002	1.3473	0.0000	0.0008	0.0001	0.0000
90	Base Case (NP20)	RS03 Treated	21.95	6.58	125	0.08	102.6	0.0028	0.0002	0.0222	36.0	0.00007	4.7	0.00000	0.00001	0.00011	1.43	0.16	0.01	0.00017	7.6	8.5	0.00	0.0002	0.02	22.4	0.00001	0.00001	0.00048	0.00005	17	0.01	0.0002	1.4072	0.0000	0.0008	0.0001	0.0000
91	Base Case (NP20)	RS03 Treated	14.21	6.54	135	0.09	109.3	0.0029	0.0002	0.0228	38.0	0.00007	5.1	0.00000	0.00001	0.00011	1.36	0.17	0.01	0.00017	8.5	9.3	0.00	0.0002	0.02	24.5	0.00001	0.00001	0.00									

Year	Scenario	Station	Flow Rate (L/s)	pH	Hardness (mg CaCO ₃ /L)	Acidity (mg CaCO ₃ /L)	Alkalinity (mg CaCO ₃ /L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	DOC (mg/L)	F (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	NO ₃ -N (mg/L)	Na (mg/L)	Ni (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	TOC (mg/L)	CN (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
148	Base Case (NP20)	RS03 Treated	18.37	6.54	127	0.09	102.8	0.0029	0.0002	0.0221	36.3	0.00007	4.6	0.00000	0.00001	0.00011	1.42	0.13	0.01	0.00016	6.0	8.7	0.00	0.0001	0.02	20.5	0.00001	0.00001	0.00027	0.00004	16	0.01	0.0002	1.4010	0.0000	0.0006	0.0001	0.0000
149	Base Case (NP20)	RS03 Treated	20.92	6.55	123	0.09	100.0	0.0029	0.0002	0.0220	35.4	0.00007	4.5	0.00000	0.00001	0.00011	1.43	0.13	0.01	0.00016	5.8	8.4	0.00	0.0001	0.02	19.9	0.00001	0.00001	0.00026	0.00004	17	0.01	0.0002	1.4010	0.0000	0.0006	0.0001	0.0000
150	Base Case (NP20)	RS03 Treated	17.11	6.54	129	0.09	104.8	0.0029	0.0002	0.0224	36.8	0.00007	4.7	0.00000	0.00001	0.00011	1.38	0.14	0.01	0.00016	6.2	8.9	0.00	0.0001	0.02	21.1	0.00001	0.00001	0.00028	0.00004	16	0.01	0.0002	1.3651	0.0000	0.0006	0.0001	0.0000
151	Base Case (NP20)	RS03 Treated	24.47	6.56	127	0.09	103.9	0.0029	0.0002	0.0223	36.5	0.00007	4.7	0.00000	0.00001	0.00011	1.42	0.13	0.01	0.00017	5.9	8.7	0.00	0.0001	0.02	20.7	0.00001	0.00001	0.00026	0.00004	16	0.01	0.0002	1.3969	0.0000	0.0006	0.0001	0.0000
152	Base Case (NP20)	RS03 Treated	21.76	6.56	126	0.09	102.7	0.0029	0.0002	0.0220	36.3	0.00007	4.6	0.00000	0.00001	0.00011	1.44	0.13	0.01	0.00016	5.8	8.6	0.00	0.0001	0.02	20.3	0.00001	0.00001	0.00026	0.00004	16	0.01	0.0002	1.4132	0.0000	0.0006	0.0001	0.0000
153	Base Case (NP20)	RS03 Treated	20.80	6.57	127	0.09	103.8	0.0028	0.0002	0.0221	36.5	0.00007	4.6	0.00000	0.00001	0.00011	1.43	0.13	0.01	0.00017	5.7	8.7	0.00	0.0001	0.02	20.5	0.00001	0.00001	0.00025	0.00004	16	0.01	0.0002	1.4103	0.0000	0.0006	0.0001	0.0000
154	Base Case (NP20)	RS03 Treated	19.92	6.56	125	0.09	102.0	0.0029	0.0002	0.0221	36.0	0.00007	4.6	0.00000	0.00001	0.00011	1.44	0.13	0.01	0.00017	5.7	8.6	0.00	0.0001	0.02	20.0	0.00001	0.00001	0.00024	0.00004	16	0.01	0.0002	1.4193	0.0000	0.0006	0.0001	0.0000
155	Base Case (NP20)	RS03 Treated	17.06	6.54	130	0.09	105.9	0.0029	0.0002	0.0226	37.1	0.00007	4.8	0.00000	0.00001	0.00011	1.39	0.13	0.01	0.00017	6.0	9.0	0.00	0.0001	0.02	21.1	0.00001	0.00001	0.00026	0.00004	16	0.01	0.0002	1.3698	0.0000	0.0006	0.0001	0.0000
156	Base Case (NP20)	RS03 Treated	22.21	6.55	128	0.09	104.1	0.0029	0.0002	0.0224	36.6	0.00007	4.7	0.00000	0.00001	0.00011	1.40	0.13	0.01	0.00017	5.9	8.9	0.00	0.0001	0.02	20.7	0.00001	0.00001	0.00025	0.00004	16	0.01	0.0002	1.3827	0.0000	0.0006	0.0001	0.0000
157	Base Case (NP20)	RS03 Treated	18.39	6.53	127	0.09	103.0	0.0029	0.0002	0.0222	36.4	0.00007	4.6	0.00000	0.00001	0.00011	1.42	0.13	0.01	0.00016	5.9	8.8	0.00	0.0001	0.02	20.3	0.00001	0.00001	0.00025	0.00004	16	0.01	0.0002	1.3992	0.0000	0.0006	0.0001	0.0000
158	Base Case (NP20)	RS03 Treated	16.51	6.51	132	0.10	107.4	0.0030	0.0002	0.0228	37.6	0.00007	4.9	0.00000	0.00001	0.00011	1.35	0.14	0.01	0.00016	6.3	9.3	0.00	0.0001	0.03	21.6	0.00001	0.00001	0.00027	0.00004	17	0.01	0.0002	1.3366	0.0000	0.0006	0.0001	0.0000
159	Base Case (NP20)	RS03 Treated	22.81	6.54	127	0.09	103.9	0.0030	0.0002	0.0224	36.5	0.00007	4.7	0.00000	0.00001	0.00011	1.40	0.13	0.01	0.00017	5.8	8.8	0.00	0.0001	0.02	20.6	0.00001	0.00001	0.00025	0.00004	17	0.01	0.0002	1.3772	0.0000	0.0006	0.0001	0.0000
160	Base Case (NP20)	RS03 Treated	15.32	6.51	134	0.10	109.0	0.0030	0.0002	0.0228	38.0	0.00007	5.0	0.00000	0.00001	0.00011	1.35	0.14	0.01	0.00016	6.3	9.4	0.00	0.0001	0.02	21.9	0.00001	0.00001	0.00027	0.00004	17	0.01	0.0002	1.3258	0.0000	0.0006	0.0001	0.0000
161	Base Case (NP20)	RS03 Treated	16.09	6.54	137	0.10	112.8	0.0028	0.0002	0.0232	38.8	0.00007	5.2	0.00000	0.00001	0.00011	1.31	0.14	0.01	0.00017	6.1	9.7	0.00	0.0001	0.02	22.7	0.00001	0.00001	0.00026	0.00004	15	0.01	0.0002	1.3006	0.0000	0.0006	0.0001	0.0000
162	Base Case (NP20)	RS03 Treated	12.21	6.56	147	0.09	124.5	0.0027	0.0002	0.0247	41.6	0.00007	5.7	0.00000	0.00001	0.00010	1.25	0.14	0.01	0.00017	5.9	10.4	0.00	0.0001	0.02	25.4	0.00001	0.00001	0.00025	0.00004	16	0.01	0.0002	1.2405	0.0000	0.0006	0.0001	0.0000
163	Base Case (NP20)	RS03 Treated	20.91	6.59	134	0.08	112.8	0.0028	0.0002	0.0236	38.3	0.00007	5.1	0.00000	0.00001	0.00010	1.35	0.13	0.01	0.00017	5.2	9.3	0.00	0.0001	0.02	22.5	0.00001	0.00001	0.00020	0.00004	15	0.01	0.0002	1.3269	0.0000	0.0006	0.0001	0.0000
164	Base Case (NP20)	RS03 Treated	19.00	6.55	130	0.09	106.6	0.0028	0.0002	0.0225	37.5	0.00007	4.8	0.00000	0.00001	0.00011	1.39	0.13	0.01	0.00017	5.6	9.0	0.00	0.0001	0.02	20.9	0.00001	0.00001	0.00022	0.00004	15	0.01	0.0002	1.3759	0.0000	0.0006	0.0001	0.0000
165	Base Case (NP20)	RS03 Treated	19.86	6.54	122	0.09	99.0	0.0029	0.0002	0.0218	35.2	0.00007	4.4	0.00000	0.00001	0.00011	1.43	0.12	0.01	0.00016	5.4	8.4	0.00	0.0001	0.02	19.2	0.00001	0.00001	0.00021	0.00004	16	0.01	0.0002	1.4105	0.0000	0.0006	0.0001	0.0000
166	Base Case (NP20)	RS03 Treated	15.88	6.55	135	0.09	111.8	0.0028	0.0002	0.0231	38.8	0.00007	5.1	0.00000	0.00001	0.00011	1.35	0.13	0.01	0.00017	5.8	9.5	0.00	0.0001	0.02	22.2	0.00001	0.00001	0.00024	0.00004	15	0.01	0.0002	1.3382	0.0000	0.0006	0.0001	0.0000
167	Base Case (NP20)	RS03 Treated	18.02	6.56	131	0.09	108.6	0.0028	0.0002	0.0229	37.6	0.00007	4.9	0.00000	0.00001	0.00011	1.38	0.13	0.01	0.00017	5.4	9.1	0.00	0.0001	0.02	21.4	0.00001	0.00001	0.00022	0.00004	15	0.01	0.0002	1.3605	0.0000	0.0006	0.0001	0.0000
168	Base Case (NP20)	RS03 Treated	20.42	6.56	131	0.09	107.8	0.0028	0.0002	0.0227	37.5	0.00007	4.9	0.00000	0.00001	0.00011	1.38	0.13	0.01	0.00017	5.5	9.1	0.00	0.0001	0.02	21.2	0.00001	0.00001	0.00022	0.00004	15	0.01	0.0002	1.3676	0.0000	0.0006	0.0001	0.0000
169	Base Case (NP20)	RS03 Treated	10.61	6.54	149	0.09	125.4	0.0028	0.0002	0.0246	42.1	0.00007	5.7	0.00000	0.00001	0.00010	1.27	0.14	0.01	0.00017	5.9	10.6	0.00	0.0001	0.02	25.3	0.00001	0.00001	0.00024	0.00004	15	0.01	0.0002	1.2533	0.0000	0.0006	0.0001	0.0000
170	Base Case (NP20)	RS03 Treated	17.26	6.59	135	0.08	113.4	0.0027	0.0002	0.0236	38.5	0.00007	5.1	0.00000	0.00001	0.00010	1.35	0.13	0.01	0.00017	5.1	9.3	0.00	0.0001	0.02	22.4	0.00001	0.00001	0.00020	0.00004	15	0.01	0.0002	1.3320	0.0000	0.0006	0.0001	0.0000
171	Base Case (NP20)	RS03 Treated	23.94	6.57	124	0.08	102.1	0.0029	0.0002	0.0223	35.8	0.00007	4.6	0.00000	0.00001	0.00011	1.44	0.12	0.01	0.00017	5.0	8.4	0.00	0.0001	0.02	19.7	0.00001	0.00001	0.00019	0.00004	15	0.01	0.0002	1.4146	0.0000	0.0006	0.0001	0.0000
172	Base Case (NP20)	RS03 Treated	13.25	6.53	137	0.10	113.6	0.0029	0.0002	0.0234	39.1	0.00007	5.1	0.00000	0.00001	0.00011	1.34	0.13	0.01	0.00017	5.8	9.6	0.00	0.0001	0.02	22.5	0.00001	0.00001	0.00023	0.00004	16	0.01	0.0002	1.3253	0.0000	0.0006	0.0001	0.0000
173	Base Case (NP20)	RS03 Treated	17.65	6.57	134	0.09	111.4	0.0028	0.0002	0.0233	38.2	0.00007	5.0	0.00000	0.00001	0.00010	1.36	0.13	0.01	0.00017	5.3	9.3	0.00	0.0001	0.02	22.0	0.00001	0.00001	0.00021	0.00004	15	0.01	0.0002	1.3403	0.0000	0.0006	0.0001	0.0000
174	Base Case (NP20)	RS03 Treated	14.50	6.56	139	0.09	116.4	0.0028	0.0002	0.0239	39.6	0.00007	5.3	0.00000	0.00001	0.00010	1.33	0.13	0.01	0.00017	5.4	9.7	0.00	0.0001	0.02	23.1	0.00001	0.00001	0.00021	0.00004	16	0.01	0.0002	1.3126	0.0000	0.0006	0.0001	0.0000
175	Base Case (NP20)	RS03 Treated	12.36	6.56	143	0.09	120.7	0.0027	0.0002	0.0243	40.8	0.00007	5.5	0.00000	0.00001	0.00010	1.28	0.14	0.01	0.00017	5.4	10.1	0.00	0.0001	0.02	24.1	0.00001	0.00001	0.00021	0.00004	15	0.01	0.0002	1.2686	0.0000	0.0005	0.0001	0.0000
176	Base Case (NP20)	RS03 Treated	20.08	6.62	134	0.08	113.6	0.0026	0.0002	0.0236	38.1	0.00007	5.1	0.00000	0.00001	0.00010	1.37	0.13	0.01	0.00019	4.7	9.2	0.00	0.0001	0.02	22.3	0.00001	0.00001	0.00017	0.00004	14	0.01	0.0002	1.3479	0.0000	0.0005	0.0001	0.0000
177	Base Case (NP20)	RS03 Treated	23.27	6.56	122	0.09	99.3	0.0028	0.0002	0.0218	35.2	0.00007	4.4	0.00000	0.00001	0.00011	1.45	0.12	0.01	0.00017	4.9	8.3	0.00	0.0001	0.02	18.9												

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MINE WASTE MANAGEMENT

GREENROAD GROUP

APPENDIX O WATER QUALITY DATABASE QA/QC

MEMORANDUM

Recipient: Damian Spring – Matakanui Gold Limited

From: Paul Weber – Mine Waste Management

Date: 31 May 2025

Cc: Mary Askey – Matakanui Gold Limited

Document Number: J-NZ0233-011-M-Rev1

Document Title: Water Quality Database QA/QC

Mine Waste Management Limited (MWM) has provided this memorandum to Matakanui Gold Limited for the proposed Bendigo-Ophir Gold Project (BOGP Project). MWM has been engaged to provide advice regarding quality assurance / quality control (QA/QC) of water quality data loaded into the BOGP water quality database. It is recommended that the following issues are considered for QA/QC:

- Quality assurance (QA) of data is required.
- Quality control (QC) including duplicate samples, replicate testing, blanks, and water reference standards should be used.
- Quality assurance of data is required.
- Management of limits of reporting (LOR).
- Ensuring the LOR is appropriate for the potential constituents of concern (PCOC) to confirm whether they are elevated against recommended water quality guidelines.
- Analysis of data to confirm whether further ongoing testing is required if results are consistently lower than the recommended water quality guidelines.

BACKGROUND

An important aspect of ensuring data are suitable and meet the data quality objectives (DQOs) is to undertake QA/QC where:

- Quality assurance (QA) is defined as the system of documented processes and procedures that ensure quality and includes aspects including training, equipment calibration, sampling procedures, and record-keeping.
- Quality control (QC) is defined as the operational activities that confirm the quality assurance methods are functional, and that the information collected is accurate, precise, and properly recorded.

This memorandum provides advice on QA/QC of water quality data once it is entered into the water quality database. It assumed data management processes are appropriate to avoid the input of

erroneous data and that transcription errors are avoided. It is assumed that all chain of custody (COC) forms and certificates of analysis (COA) are stored and are filed in a logical manner to provide proof of data should it be queried.

QUALITY CONTROL

For duplicate samples, replicate testing of the same sample, and inter-laboratory duplicates, a quantitative measure of the variability (or reproducibility of the data) should be undertaken (e.g., precision). Precision should be measured by the relative percent difference (RPD). Note: Small concentration changes at low analyte concentrations (typically defines as <10x LOR) will result in larger calculated variations in precision – the significance of this large change should be considered in the context of the DQOs (e.g., Standards Australia, 2005).

A quantitative measure of the closeness of reported data to the true value is required (e.g., accuracy). One way to determine accuracy of the dataset is to compare the ionic balance of water samples for reference samples and duplicates. This approach provides a larger dataset (rather than one measurement) to consider accuracy.

Recommended QC:

- Calculation of RPD for duplicate samples, replicate samples, inter-laboratory duplicate samples where:

$$RPD = [(R1 - R2) / ((R1 + R2)/2)] \times 100$$

Where:

R1 is sample 1; and

R2 is sample 2.

- Where a RPD of ≤20% should be used as an indicator for determining appropriate discrepancies between laboratories. A RPD of ≤20% was adopted as:
 - o the samples were taken at the same time; and
 - o the water samples are expected to be homogeneous.
- Calculation of ionic balance (IB) for duplicate samples, replicate samples, and inter-laboratory duplicate samples where:
 - o Measured ion concentrations are first converted to milliequivalents per litre (meq/L):

$$Meq/L = (C/MW) \times V \times 1000$$

Where:

C is the concentration in mg/L;

MW is the molecular weight in g/mol; and

V is the valence of the substance

- o Iron and manganese are both assumed to have charge of +2, because the ferrous and manganous species of these elements are the primary water-soluble forms.
- o Positively charged ion concentrations are summed to obtain a Cation Sum, and negatively charged ions are summed to obtain an Anion Sum.
- o An ionic balance (IB) (Charge balance) is determined by:

$$IB = [(\Sigma \text{Cation (meq/L)} - \Sigma \text{Anion (meq/L)}) / (\Sigma \text{Cation (meq/L)} + \Sigma \text{Anion (meq/L)})] \times 100$$

- An Ionic Balance of <10% is considered reasonable.

QUALITY ASSURANCE

Data should undergo quality assurance processes including graphical analysis to identify outlier/anomalous samples. For projects involving the disturbance of sulfide minerals this should include:

- Comparison of field pH and EC to laboratory pH and EC
- Time series plots of PCOC concentrations to identify outliers with checks against water quality guidelines to identify parameters that are elevated.
- Evaluation of sulfate concentrations versus PCOC concentrations to understand any relationships and identify outlier data (noting sulfate is often correlated with other contaminants at mining operations where sulfide minerals are disturbed).
- Evaluation of pH versus metal concentrations. Assessment of pH can be a useful guide to the reliability of data and if metals remain elevated above typical metal hydrolysis pH values (Table 1) then the data reliability should be considered.
- Comparison of Total N measurements against the sum of nitrogenous compounds (Nitrite-N, Nitrate-N, Ammoniacal-N).

Table 1. Minimum metal hydroxide solubility.

Metal	pH corresponding to minimum metal hydroxide solubility
Ferric iron, Fe ³⁺	~3.5
Antimony, Sb ²⁺	4.2
Aluminium, Al ³⁺	4.5
Lead, Pb ²⁺	6.5
Copper, Cu ²⁺	7.0
Ferrous iron, Fe ²⁺	8.0
Zinc, Zn ²⁺	8.5
Nickel, Ni ²⁺	9.3
Cadmium, Cd ²⁺	10.0
Manganese, Mn ²⁺	10.6

Source: INAP (2014).

When outlier/anomalous samples are identified by the QA process, the first step is to check the laboratory COA and confirm there are no transcription errors (i.e., data not loaded into the database correctly). If the reported data are correct, then the next step is to query the issue with the laboratory requesting the data management procedures are checked and for the sample to be retested. If the results are the same, then another confirmatory sample may need to be submitted. If this is not possible then the data should be presented but not used (unless conservative assumptions are being used), with an explanation of why the data are considered erroneous.

LIMITS OF REPORTING

Limits of reporting (LOR) need to be considered as being suitable or whether lower limits are required. For instance:

- Ensuring the LOR is appropriate for the PCOC to confirm whether they are elevated against recommended water quality guidelines. If water quality guidelines are lower than the LOR, then lower LORs may be required.
- However, consideration should be given to practical quantification limits (PQLs). For instance, the typical LOR for HS⁻, Hg, and Ag is often higher than ANZG (2018) guidelines and lower LOR are often not practical.
- LOR need to be clearly recorded in the database noting that LOR can change between laboratories and analytes. Preference is that the '<' symbol is maintained in the database and post processing outside the database (e.g., for analysis purposes) converts this to a number than can be used (e.g., ½ the LOR) with the conversion process clearly explained.

PCOC MONITORING REQUIREMENTS

Generally, if any parameter is within 50% of the adopted trigger limits (e.g., resource consent limits or the ANZG (2018) guideline limits, etc) they are considered potentially elevated and ongoing monitoring is recommended to confirm trends and/or potential hazards. This approach is similar to using 50% of maximum acceptable value (MAV) for drinking water where it is used as a screening level for follow up action (NZ Government, 2022).

If there is a robust water quality database available for a project that includes:

- Multiple sites within the project area to understand typical PCOC concentrations including critical locations;
- Assessment of mineralised and unmineralised areas to understand typical PCOC concentrations;
- Assessment of areas affect by historical mining activities and areas not affected by historical mining activities;
- At least two years of monthly monitoring data¹ (to address seasonality) during different flow regimes (low, median, and high flow);

¹ ANZG (2018) notes that site-specific guideline values should be based on at least 2 years of monthly monitoring data from an appropriate site: <https://www.waterquality.gov.au/anz-guidelines/guideline-values/derive/reference-data>

- Trend analysis to confirm no increasing trends for PCOC or high variability of results;
- Evaluation of whether changes have occurred within the catchment that could affect PCOC concentrations;
- Approval of recommended water quality limits by a subject matter expert in ecotoxicity,

then it would be reasonable to cease routine analysis for the PCOC that are > 50% of the recommended water quality compliance criteria for the BOGP (i.e., a MEQ < 0.5). These proposed water quality criteria are provided in Ryder (2025).

CLOSING REMARKS

Please do not hesitate to contact Paul Weber at +64 3 242 0221 or paul.weber@minewaste.com.au should you wish to discuss this memorandum in greater detail.

REFERENCES

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