# TECHNICAL MEMORANDUM

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| **To:** | **Jenyfer Mosquera and Colleen Prather (Agnico Eagle Mines Ltd.)** | **Date: December 16, 2022** |
| **From:** | **John Dockrey, Scott Jackson, and Cheng Kuang (Lorax Environmental Services Ltd.)** | **Project: A667-1** |
| **Subject:** | **Meliadine Extension In-pit Deposition Alternative WBWQM** | |

## 1. Introduction

Agnico Eagle Mines Ltd. (Agnico Eagle) operates the Meliadine Mine, located 25 km North of Rankin Inlet in the Kivalliq region of Nunavut. The Project Certificate issued in 2015 included approval of a multi-phase approach to development, including mining of Tiriganiaq deposit using open pit and underground mining methods and mining of the Pump, F Zone, Discovery and Wesmeg deposits using open pit methods. The Meliadine Extension proposes to include underground mining and associated saline water management infrastructures at the Pump, F Zone, and Discovery deposits, development of a new portal and associated infrastructures in the Tiriganiaq-Wolf mining area. Lorax Environmental (Lorax) has developed a water balance and water quality model (WBWQM; Lorax, 2022a) and associated geochemical source terms (Lorax, 2022b for the base case mine plan and water management of Meliadine Extension.

The 2022 FEIS WBWQM assumed that waste rock would be stored in waste rock storage facilities (WRSFs) and processed ore would be dry stacked in a tailings storage facility (TSF) adjacent to the mill or backfilled as paste tailings in the mine underground. The 2022 FEIS presented in pit deposition as an alternative strategy whereby waste rock and tailings are backfilled into mined out open pits.

The purpose of this technical memorandum is to assess the potential effects on water quantity and quality of in-pit deposition of waste rock and tailings under the RCP4.5 climate scenario for the Meliadine Extension. The model is intended to represent a waste management scenario whereby backfill opportunities in all mine pits are utilized. This sensitivity uses the WBWQM developed for the 2022 FEIS application (Base Case) using the GoldSim modelling platform, with certain modifications to incorporate backfill placement. The model results are limited to the Active Closure and Post Closure mine phase to support the assessment of in-pit disposal on the water quality of pit lakes and downstream receptors.

A summary of conceptual assumptions related to model setup and inputs are provided in Table 1-1. Section 2 of this technical memorandum describes changes to the mine plan related to in-pit deposition which are incorporated into the WBWQM. Section 3 covers water balance updates, and Section 4 describes geochemical source terms associated with in-pit deposition. Section 5 provides the WBWQM results for Active Closure and Post Closure, while Section 6 provides a summary.

**Table 1-1:**
**Conceptual Assumptions of Backfill Sensitivity Model**

| Model Component | Assumption |
|---|---|
| Model Setup and Initialization | • Model period of Active Closure (2044 – 2050) and Post Closure (2051 – 2119) under climate scenario RCP4.5<br>• Mine pits are assumed to be backfilled at the beginning of Active Closure. Sequencing of backfill placement during operations is not included in the model.<br>• A conceptual site layout based on 2022 FEIS general site arrangement was developed for illustration purposes.<br>• WBWQM completed in GoldSim modelling platform |
| Backfill Placement and Composition | • All mine pits to be backfilled with waste rock or tailings<br>   o Pits without connection to underground are backfilled with tailings slurry and the remaining pits are backfilled with waste rock<br>• Backfill potential for each pit is limited by the bedrock/overburden contact elevation, maintaining an overlying lake depth of at least 8m, and post-closure water quality targets. Maximum backfill capacity of most pits is not fully utilized in this conceptual assessment. Specific volumes would be refined as plans for in-pit disposal are advanced.<br>• Backfill waste rock lithologic composition assumed to be identical to nearest WRSF as per the 2022 FEIS Appendix H-07 (Lorax, 2022b)<br>• Backfill tailings sourced directly from mill and disposed as tailings slurry with properties analogous to Meadowbank Mine<br>• Balance of tailings and waste rock that cannot be backfilled to remain in TSF dry stack or WRSFs, respectively. |
| Water Balance | • Base case RCP4.5 water balance assumptions from 2022 FEIS were applied (*e.g.,* climate record, runoff coefficients, etc.)<br>• Water used to flood the pits during active closure is sourced from Meliadine Lake.<br>• Active Closure and Post-Closure water management guiding principles remain unchanged. |
| Source Terms | • Surface waste facilities (WRSFs and TSF) loading rates modified based on reduced stockpile size.<br>• Tailings slurry consolidation water source term applied to tailings backfilled pits<br>   o Consolidation water volume estimated from Meadowbank Mine consolidation modelling<br>   o Consolidation water chemistry estimated based on metallurgical supernatant, connate water and Meadowbank Mine process water (SNC, 2018).<br>• Waste rock source terms developed for initial flush and long-term diffusion<br>   o Initial flush source term based on scaled shake flask extraction tests<br>   o Diffusive flux based on Fick's law using initial pore water chemistry and Meliadine Lake water chemistry to define concentration gradient. |

## 2. In-Pit Deposition of Tailings and Waste Rock

Seventeen mine pits will be sequentially excavated as part of the Meliadine Extension and can potentially receive backfill. The maximum volume of backfill that can be placed is defined by the overburden/bedrock contact elevation and the spill point as per the following considerations:

- Backfill must remain below minimum overburden/bedrock contact along the pit wall.
- Water cover of at least 8 m must be maintained to allow for re-establishment of aquatic habitat.

The spill point and minimum overburden/bedrock contact elevation are listed in Table 2-1. The final backfill elevation in most mine pits is below the theoretical maximum as defined by the above criteria. Backfill volumes incorporated into the current WBWQM are below maximum values to ensure post-closure water quality remains within water quality guidelines defined in the aquatic effects monitoring program (AEMP) (Agnico Eagle, 2021). Opportunities exist to increase backfill volumes while remaining below guidelines, which could be explored through future model sensitivities before Agnico Eagle decides to execute and implement in-pit deposition for Meliadine Extension.

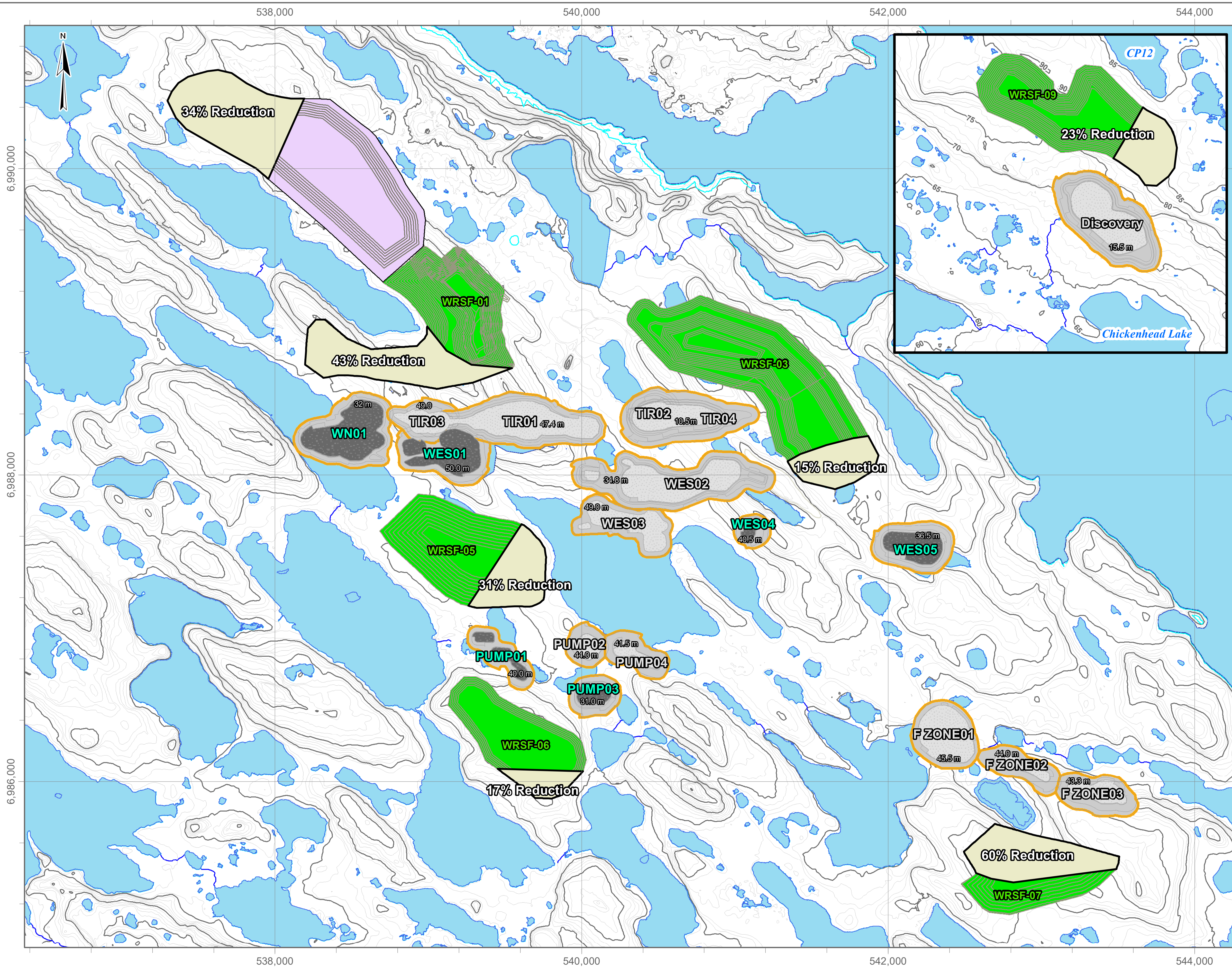
The open pits were designated to receive tailings based on no connection with underground mine workings. Pits considered for in-pit tailings deposition included Pump01, Pump03, Wes01, Wes04, Wes05 and WN01. The remaining open pits were designated to receive waste rock. Open pits designated for tailings backfill were brought forward into a feasibility-level assessment of thermal and groundwater impacts of in-pit tailings deposition presented in Ardent and Lorax (2022).

These assumptions result in 52 Mt of waste rock and 17 Mt of tailings being backfilled under the current model sensitivity (Table 2-1). This constitutes 31% of open pit waste rock and 34% of TSF tailings that would be produced by the Meliadine Extension. The minesite layout used in this model sensitivity is shown in Figure 2-1. The figure provides a conceptual illustration of the reduction in size and footprint of WRSFs and the TSF resulting from in-pit deposition.

**Table 2-1:
In-pit backfill tonnage and volume for Meliadine Extension**

| Pit ID | Waste Type | Spill Point (masl) | Overburden Bedrock Contact (masl) | Backfill Elevation (masl) | Waste Rock Backfill (t)[1] | Tailings Backfill (t)[1] | Backfill Volume ($m^3$) |
|---|---|---|---|---|---|---|---|
| Discovery | Waste Rock | 67 | 56 | 15.5 | 8,485,173 | - | 4,242,587 |
| FZONE01 | Waste Rock | 56 | 47 | 44.5 | 8,944,336 | - | 4,472,168 |
| FZONE02 | Waste Rock | 53 | 47 | 44.0 | 1,010,086 | - | 505,043 |
| FZONE03 | Waste Rock | 52 | 46 | 43.3 | 1,186,095 | - | 593,048 |
| PUMP01 | Tailings | 55 | 47 | 40.0 | - | 309,697 | 187,695 |
| PUMP02 | Waste Rock | 55 | 47 | 44.0 | 466,002 | - | 233,001 |
| PUMP03 | Tailings | 59 | 49 | 31.0 | - | 770,571 | 467,013 |
| PUMP04 | Waste Rock | 50 | 42 | 41.5 | 567,019 | - | 283,510 |
| TIR01 | Waste Rock | 58 | 50 | 47.4 | 12,369,689 | - | 6,184,845 |
| TIR02/04 | Waste Rock | 64 | 53 | 10.5 | 5,041,791 | - | 2,520,895 |
| TIR03 | Waste Rock | 58 | 50 | 49.0 | 1,559,697 | - | 779,849 |
| WES01 | Tailings | 58 | 50 | 50.0 | - | 3,861,938 | 2,340,568 |
| WES02 | Waste Rock | 59 | 50 | 34.8 | 9,275,423 | - | 4,637,712 |
| WES03 | Waste Rock | 59 | 50 | 49.0 | 3,232,050 | - | 1,616,025 |
| WES04 | Tailings | 62 | 57 | 40.5 | - | 48,970 | 29,679 |
| WES05 | Tailings | 64 | 47 | 36.5 | - | 3,556,987 | 2,155,750 |
| WN01 | Tailings | 59 | 44 | 32.0 | - | 8,863,314 | 5,371,705 |
| | | | | **Total** | **52,137,361** | **17,411,477** | **36,621,093** |

[1]Tonnage of waste rock and tailings calculated using dry density of 2.0 $t/m^3$ and 1.65 $t/m^3$, respectively.




## LEGEND

- Backfill Reduction
- Backfilled Pit
- Waste Rock Backfill
- WRSF
- TSF Dry Stack
- Tailings Slurry Backfill
- Waterbody
- 5m Contour
- 1m Contour
- 14 m Maximum Backfill Elevation (in metres)

***Coordinate System:*** *NAD 1983 UTM Zone 15N*
***Projection:*** *Transverse Mercator*
***Datum:*** *North American 1983*
***Units:*** *Meter*

**1:24,000**

0 0.5 1 Kilometers

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|---|---|
| **DATE SAVED:** | Dec 09, 2022 |
| **DRAWN BY:** | DM |
| **REVIEWED:** | JD |
| **VERSION:** | 1 |

CLIENT:

AGNICO EAGLE

LORAX ENVIRONMENTAL

PROJECT:

**Meliadine Extension NIRB Backfill Sensitivity**

TITLE: Proposed Tailings and Waste Rock Backfill Site Layout

PROJECT #: A574-9 FIGURE: 2-1

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# 3. Water Balance Update

This section presents the results of the water balance model, with a focus on changes in pit water balances relative to the 2022 FEIS Base Case (RCP4.5). Of key interest is the maintenance of the target pit lake water cover of at least 8m over the backfill horizon, and time and water volumes required to fill the pits to their spill points during the Active Closure phase.

In pit placement will reduce pumping requirements of Meliadine Lake water to mine pits during Active Closure. The 2022 FEIS Base Case model determined a pumping rate of 13.4 $Mm^3$/year would be required to fill the pits. It was assumed that Meliadine Lake pumping would proceed at this rate until each pit was fully flooded. The in-pit deposition volumes result in lower volumes of water required to fill the pits in Active Closure, with 5 years of pumping from Meliadine Lake required at a slightly lower rate (maximum of 11.3 $Mm^3$/year, average of 6.8 $Mm^3$/year), with a total volume of Meliadine Lake water pumped to the pits of 34 $Mm^3$. The 2022 FEIS model required 90.7 $Mm^3$ over 7 years of pumping (Table 3-1). The in-pit deposition results in a 63% reduction in Meliadine Lake water required to fill the pits during Active Closure. Water balance assumptions are otherwise identical to the 2022 FEIS Base Case model.

**Table 3-1:**
**Open pit water balances in Active Closure phase**

| Year | Meliadine Lake Pumped ($m^3$) | % Total | Surface Contact Water ($m^3$)[1] | % Total |
|---|---|---|---|---|
| 2044 | 11,331,300 | 26% | 1,986,028 | 5% |
| 2045 | 10,536,000 | 24% | 1,986,028 | 5% |
| 2046 | 6,971,800 | 16% | 1,986,028 | 5% |
| 2047 | 4,658,000 | 11% | 1,986,028 | 5% |
| 2048 | 458,512 | 1% | 1,986,028 | 5% |
| **Total** | **33,955,612** | **77%** | **9,930,141** | **23%** |

**Notes:**
[1]Total surface runoff over the 5-year pit filling period is provided as an annual average

Modelling indicates that all pits will maintain at least 8 m of water cover throughout the full Post-closure period (Table 3-2).

**Table 3-2:**
**Modelled minimum daily open pit water cover depth over backfill and average annual discharge volumes for the 2051-2100 period**

| Open Pit | 2051-2100 | | | |
|---|---|---|---|---|
| | Minimum Level (m) | Backfill Elevation (m) | Water Level above Backfill (m) | Average Closure Overflow (m$^3$) |
| TIR01 | 57.8 | 47.4 | 10.4 | 424,476 |
| TIR03 | | 49.0 | 8.8 | |
| WES01 | | 50.0 | 8.8 | |
| WN01 | 58.7 | 32.0 | 26.7 | 135,595 |
| TIR02/04 | 63.8 | 10.5 | 53.3 | 176,386 |
| FZONE01 | 55.8 | 44.5 | 11.3 | 1,374,376 |
| FZONE02 | 52.8 | 44.0 | 8.8 | 37,775 |
| FZONE03 | 51.8 | 43.3 | 8.5 | 13,479 |
| PUMP01 | 54.8 | 40.0 | 14.8 | 48,187 |
| PUMP02 | 54.8 | 44.0 | 10.8 | 7,924 |
| PUMP03 | 58.8 | 31.0 | 27.8 | 11,071 |
| PUMP04 | 49.9 | 41.5 | 8.4 | 137,030 |
| WES02 | 58.8 | 34.8 | 24.0 | 56,894 |
| WES03 | 58.8 | 49.0 | 9.8 | 152,276 |
| WES04 | 61.5 | 40.5 | 21.0 | 162 |
| WES05 | 63.8 | 36.5 | 27.3 | 44,867 |
| Discovery | 66.8 | 15.5 | 51.3 | 31,445 |

To flood the pits, 34 Mm$^3$ of water will be pumped from Meliadine Lake and 9.9 Mm$^3$ will report to the pits via gravity drainage from the surrounding catchments, and meteoric inputs (Table 3-3). Pumping from Meliadine Lake is complete between July 2045 and October 2048, depending on the pit.

## Table 3-3:
## In pit deposition pit lake closure water balance metrics

| | Waste Type | Backfill Volume ($m^3$) | Total Water Volume ($m^3$) | Volume Above Backfill Horizon ($m^3$) | Closure Pump Rate Jun 15-Sept 30 ($m^3$/day) | Total ML Volume Pumped ($m^3$) | Date ML Closure Pumping Complete | Surrounding Catchment Runoff and Meteoric Inputs ($m^3$) |
|---|---|---|---|---|---|---|---|---|
| Discovery | Waste Rock | 4,242,587 | 10,810,380 | 9,744,886 | 24,000 | 10,548,000 | 2048-06-24 | 262,380 |
| FZONE01 | Waste Rock | 4,472,168 | 2,271,561 | 1,082,155 | 9,000 | 2,056,500 | 2046-06-30 | 215,061 |
| FZONE02 | Waste Rock | 505,043 | 490,174 | 363,416 | 2,700 | 398,724 | 2045-07-27 | 91,450 |
| FZONE03 | Waste Rock | 593,048 | 568,948 | 380,024 | 4,200 | 512,400 | 2045-07-01 | 56,548 |
| PUMP01 | Tailings | 187,695 | 544,818 | 544,818 | 1,800 | 399,600 | 2046-06-17 | 145,218 |
| PUMP02 | Waste Rock | 233,001 | 417,349 | 304,428 | 1,600 | 367,089 | 2046-07-02 | 50,260 |
| PUMP03 | Tailings | 467,013 | 1,127,812 | 1,127,812 | 3,700 | 1,072,323 | 2046-08-31 | 55,489 |
| PUMP04 | Waste Rock | 283,510 | 294,827 | 202,793 | 2,400 | 265,200 | 2045-06-08 | 29,627 |
| TIR01[1] | Waste Rock | 6,184,845 | (see TIRI Complex) | | | | | |
| TIR02/04[2] | Waste Rock | 2,520,895 | 7,381,581 | 6,677,317 | 1,000 | 535,000 | 2048-10-07 | 6,846,581 |
| TIR03[1] | Waste Rock | 779,849 | (see TIRI Complex) | | | | | |
| WES01[1] | Tailings | 2,340,568 | (see TIRI Complex) | | | | | |
| WES02 | Waste Rock | 4,637,712 | 5,787,733 | 4,516,042 | 16,000 | 5,401,600 | 2047-07-03 | 386,133 |
| WES03 | Waste Rock | 1,616,025 | 1,484,328 | 892,628 | 3,800 | 1,133,488 | 2046-09-09 | 350,840 |
| WES04 | Tailings | 29,679 | 233,566 | 233,566 | 700 | 212,814 | 2046-09-12 | 20,753 |
| WES05 | Tailings | 2,155,750 | 2,540,661 | 2,540,661 | 5,000 | 2,283,858 | 2048-07-15 | 256,803 |
| WN01[3] | Tailings | 5,371,706 | (see WN Complex) | | | | | |
| | **Total** | **36,621,094** | **33,953,739** | **28,610,546** | **74,900** | **25,186,596** | | **8,767,143** |
| TIRI Complex | Waste Rock and Tailings | 9,305,262 | 4,771,557 | 2,548,783 | 20,000 | 4,489,016 | 2046-06-22 | 282,541 |
| WN Complex | Tailings | 5,371,706 | 5,160,457 | 5,160,457 | 10,000 | 4,280,000 | 2047-10-09 | 880,457 |
| | **Total** | **14,676,968** | **9,932,014** | **7,709,240** | **30,000** | **8,769,016** | | **1,162,998** |

**Notes:**
ML = Meliadine Lake
[1] TIRI01, TIRI03 and WES01 form the TIRI pit lake complex once full
[2] TIRI02/04 is also filled via pumping from CP1, which comprises the majority of the volume shown here.
[3] WN01 joins with Lake B5 to form the WN complex once full

### 3.1 Considerations of In-pit Deposition During Operations

This section provides a qualitative assessment of water balance and management considerations for in-pit deposition. Key assumptions included in the assessment were as follows:

- Placing slurry tailings into mine pits will increase water losses from the mill. Surface water from CP1 would be used to satisfy mill process water make-up requirements, with any excess water treated, as required, and discharged to the environment (i.e., Itivia Harbour as main priority or Meliadine Lake).
- These losses can partially be offset by recycling tailings supernatant, but additional makeup water will still be required to replace evaporative losses and water consumed by tailings pore space. Makeup water would likely be sourced from CP1.
- Open pit dewatering would cease when waste rock backfill placement begins. Once backfill placement begins pit runoff will be lost to waste rock pore space, limiting the potential for continued pit dewatering throughout mine life. This would also serve to reduce the volume of pit dewatering directed to CP1.
- The footprint of mine waste facilities (TSF and WRSFs) will be reduced as a result of in pit deposition, impacting the overall site water balance. This will reduce the volume of runoff from these facilities while increasing non-contact runoff.
- For the Active Closure phase, the in-pit deposition scenario assumes that all supernatant is removed from tailings slurry backfilled pits at the end of Operations before active flooding begins.

## 4. Geochemical Source Terms

Geochemical source terms specific to the in-pit sensitivity WBWQM are developed in this section. These include source terms related to tailings and waste rock backfill, and updates to the TSF and WRSFs for reduced tonnage relative to the 2022 FEIS Base Case. All other source terms applied in the model are consistent with those presented in Section 8.5 of the *Meliadine Extension: Geochemical Characterization and Source Term Report* (Lorax, 2022b).

Two source terms are developed for waste rock backfill: an initial-flush which represents rinsing of water soluble parameters during active flooding of the mine pits with Meliadine Lake water in the first years of Active Closure; and, long-term diffusive flux of constituents from waste rock pore water into the overlying pit lake. The geochemical loadings from backfilled tailings slurry is driven by tailings consolidation. A diffusive flux term was not developed for tailings as this transport mechanism is only significant in the absence of advective flows, which will occur as a result of tailings consolidation.

Waste rock backfill volumes were balanced by volume reductions in the nearest WRSF, while all tailings will be sourced directly from the mill. The assumed sources of waste rock and tailings, and changes in tonnage of surface waste facilities are shown in Table 4-1.

**Table 4-1:**
**Backfill destination, initial tonnage of waste facilities, tonnes removed for in-pit disposal and percent reduction in mass for WRSFs and the TSF.**

| Waste Facility | Pit Backfill Destination | Base Case Tonnage | Backfill Tonnage to Pit | % Reduction in Waste Facility |
|---|---|---|---|---|
| WRSF1 | TIR01 | 28,861,780 | 12,369,689 | 43% |
| WRSF3 | TIR02/04, TIR03 | 44,021,172 | 6,601,488 | 15% |
| WRSF5 | WES02, WES03 | 40,407,891 | 12,507,473 | 31% |
| WRSF6 | PUMP02, PUMP04 | 7,814,617 | 1,033,021 | 13% |
| WRSF7 | FZONE01, FZONE02, FZONE03 | 18,487,019 | 11,140,517 | 60% |
| WRSF9 | Discovery | 36,543,725 | 8,485,173 | 23% |
| TSF | PUMP01, PUMP03, WES01, WES04, WES05, WN01 | 51,599,471 | 17,411,477 | 34% |

## 4.1 Surface Mine Waste Facilities

In-pit deposition will reduce the amount of waste rock and tailings stored at the mine surface and reduce the overall geochemical loading from 2022 FEIS Base Case surface facilities. For instance, 60% of WRSF7 is expected to be backfilled into the three F Zone pits (Table 2-1). Therefore, the annual load of WRSF7 is reduced by 60% in the current model sensitivity. The initial tonnage, tonnes removed for backfill and % load reduction relative to Lorax (2022b) for each mine facility is shown in Table 4-1.

## 4.2 Waste Rock Initial Flush

Flooding of backfilled waste rock with Meliadine Lake water during Active Closure will result in a one-time flushing of water-soluble constituents from waste rock into the pit lake. The water-soluble geochemical load associated with waste rock was developed by scaling shake flask extraction (SFE) results and salinity rinsing tests as described below. All analytical test methods and results incorporated into this source term are originally presented in Lorax (2022b).

The SFE test results were grouped based on lithology and deposit to estimate the water-soluble geochemical load associated with waste rock in different mine pits. The composition of waste rock was assumed to be analogous to the composition of the nearest WRSF, as indicated in Table 4-1. A grain size scaling factor of 0.1 was applied to the SFE loads to correct for the difference between crushed rock samples used in laboratory testing (<2mm) and the full grain size distribution of waste rock in the field (Kempton, 2012). This approach was used to estimate the water-soluble load for all parameters with the exception of nitrogen species.

Shake flask extractions conducted on drill core do not capture nitrogen species present as a result of ammonia-nitrate fuel oil (ANFO) explosive use. Therefore, initial flush loads for nitrogen species were based on median concentrations of salinity rinse tests completed on waste rock samples collected in the field in 2020 and 2021 (Lorax, 2022b). These samples were sieved prior to rinsing tests, therefore a grain size scaling factor of 0.10 was applied, similar to SFE tests. The resulting initial flush loads are shown in Table 4-2.

## 4.3 Waste Rock Diffusive Flux

In the absence of significant advective flux, metal transport will be dominated by diffusion created by a concentration gradient. If concentrations in waste rock pore water are greater than that of the overlying pit lake, then an efflux of metals from waste rock into the overlying pit lake can be expected. Conversely, if metal concentrations are lower in waste rock pore water than in the overlying pit lake, a diffusive influx of metals from the pit lake into the backfill may occur.

**Table 4-2:**
**Waste Rock Initial Flush Loads**

| Pit | TDS | Cl | F | $SO_4$ | $NH_3$-N | $NO_3$-N | $NO_2$-N | Sb | As | Cd | Cr | Co | Cu | Pb | Mn | Na | Ni | P | Se | U | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| Discovery | 14.3 | 0.362 | 0.165 | 0.92 | 0.109 | 0.228 | 0.00626 | 0.000278 | 0.0182 | 0.0000012 | 0.000274 | 0.0000566 | 0.0002 | 0.0000634 | 0.00101 | 2.82 | 0.000232 | 0.00114 | 0.00040 | 0.000127 | 0.0004 |
| FZONE01 | 15.9 | 1.71 | 0.0231 | 0.84 | 0.109 | 0.228 | 0.00626 | 0.000911 | 0.00182 | 0.00000118 | 0.000197 | 0.0000112 | 0.000197 | 0.0000201 | 0.00273 | 3.65 | 0.0000503 | 0.00133 | 0.000395 | 0.00000359 | 0.000395 |
| FZONE02 | 15.9 | 1.71 | 0.0231 | 0.84 | 0.109 | 0.228 | 0.00626 | 0.000911 | 0.00182 | 0.00000118 | 0.000197 | 0.0000112 | 0.000197 | 0.0000201 | 0.00273 | 3.65 | 0.0000503 | 0.00133 | 0.000395 | 0.00000359 | 0.000395 |
| FZONE03 | 15.9 | 1.71 | 0.0231 | 0.84 | 0.109 | 0.228 | 0.00626 | 0.000911 | 0.00182 | 0.00000118 | 0.000197 | 0.0000112 | 0.000197 | 0.0000201 | 0.00273 | 3.65 | 0.0000503 | 0.00133 | 0.000395 | 0.00000359 | 0.000395 |
| PUMP02/04 | 16.4 | 1.53 | 0.0207 | 0.978 | 0.109 | 0.228 | 0.00626 | 0.00095 | 0.00183 | 0.0000012 | 0.0002 | 0.000014 | 0.0002 | 0.0000221 | 0.00533 | 3.29 | 0.0000659 | 0.0014 | 0.000399 | 0.00000575 | 0.000399 |
| TIR01/03 | 17 | 0.817 | 0.0132 | 1.08 | 0.109 | 0.228 | 0.00626 | 0.00136 | 0.00813 | 0.00000146 | 0.000235 | 0.0000172 | 0.000236 | 0.0000282 | 0.000625 | 2.78 | 0.0000862 | 0.000655 | 0.000479 | 0.0000238 | 0.000521 |
| TIR02/04 | 16.7 | 0.572 | 0.00725 | 1.91 | 0.109 | 0.228 | 0.00626 | 0.00125 | 0.0139 | 0.00000127 | 0.000185 | 0.0000165 | 0.000188 | 0.0000208 | 0.000534 | 2.07 | 0.00012 | 0.00013 | 0.000399 | 0.0000502 | 0.000417 |
| WES02 | 15.2 | 0.854 | 0.0141 | 1.31 | 0.109 | 0.228 | 0.00626 | 0.00103 | 0.00391 | 0.00000127 | 0.000185 | 0.000014 | 0.000188 | 0.0000236 | 0.000601 | 2.37 | 0.0000577 | 0.000777 | 0.000399 | 0.00000449 | 0.000423 |
| WES03 | 16.5 | 0.718 | 0.00725 | 1.52 | 0.109 | 0.228 | 0.00626 | 0.00107 | 0.00807 | 0.00000129 | 0.000193 | 0.0000159 | 0.000195 | 0.0000215 | 0.000627 | 2.25 | 0.0000914 | 0.000445 | 0.000411 | 0.0000332 | 0.000491 |

*Analytical Calculations*

Fluxes of dissolved metals species across the sediment-water interface are calculated based on Fick's First Law of diffusion as described in Martin *et al.* (2003a, b). The diffusive flux describes the transfer of dissolved solutes along a concentration gradient from zones of high concentration to zones of low concentration. Such calculations have been used to quantify the benthic exchanges of both nutrients and trace elements in mine-impacted systems (Pedersen *et al.,* 1993; Carignan and Tessier, 1985; Martin et al., 2003 a, b). Fick's First Law describes the diffusive flux of solutes in $mg/m^2/yr$ according to the equation:

$$J_z = D°_J /F\varphi dc/dz$$

where $J_z$ = flux (mass/area/time); $D°_J$ = temperature-dependent diffusion coefficient; F= formation factor (Manheim, 1970); **φ** = porosity; and dc/dz = the concentration gradient across the sediment-water interface, which is defined as the change in concentration (dc) over the gradient distance at the sediment-water interface (dz). The $D°_J$ is an element specific *in situ* coefficient, with estimates provided at 0°C by Li and Gregory (1974). The waste rock porosity is assumed to be 0.25. A gradient distance of 5 cm was assumed to reflect the backfill-water interface. The formation factor is a measure of tortuosity which describes the convoluted (or "tortuous") path ions and molecules must follow to circumvent solid sediment particles (Boudreau, 1997), and can be calculated as follows:

$$F = \varphi^{-m}$$

Where m is the exponent of porosity which was estimated to range from 1.5 when **φ** is <0.6, and to 2 when **φ** is > 0.6 by Taylor-Smith (1971), resulting in an F value of 8.0 for waste rock.

In order to provide an estimate of the diffusive gradient (dc), an estimate of waste rock pore water and pit lake water are required. Pit lake water chemistry is assumed to reflect Meliadine Lake water (Table 4-3) which will be pumped to the mine pits during Active Closure. The pit lakes are expected to show an increase in concentrations after being flooded as loadings from the backfill, pit wall exposures, WRSFs, the TSF, and non-contact runoff enter the pit lakes. Therefore, applying Meliadine Lake chemistry to diffusive flux calculations provides a conservative end-member for determination of concentration gradients.

Estimates of waste rock pore water chemistry are calculated by assuming that a portion of the initial flush load is retained in waste rock pore space (Table 4-2). The retained load is based on the relative volume of pit lake water to waste rock pore water in each backfilled pit, assuming a porosity of 0.25. The nitrogen inventory is assumed to be entirely converted to ammonia in the pore water, due to the potential for development of suboxic conditions in waste rock pore space. The resulting concentrations used to calculate the diffusive gradient are shown in Table 4-3 and the diffusive flux source term applied in the WBWQM is shown in Table 4-4. The diffusive flux source term is applied at a constant rate for the duration of the modelled time horizon.

**Table 4-3:**
**Concentration of Meliadine Lake Water and Waste Rock Pore Water Used to Determine Diffusive Gradient**

| Pit or Lake Water | TDS | Cl | F | $SO_4$ | $NH_3$-N | $NO_3$-N | $NO_2$-N | Sb | As | Cd | Cr | Co | Cu | Pb | Mn | Na | Ni | P | Se | U | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| Meliadine Lake | 25.3 | 8.05 | 0.026 | 3.3 | 0.005 | 0.005 | 0.001 | 0.00002 | 0.00023 | 0.000005 | 8.5E-05 | 0.00001 | 0.00078 | 0.0000298 | 0.00085 | 4.23 | 0.000478 | 0.0026 | 0.00004 | 0.0000133 | 0.00113 |
| Disc | 36.5 | 8.34 | 0.156 | 4.03 | 0.276 | - | - | 0.000239 | 0.0146 | 0.00000595 | 0.0003 | 0.0000546 | 0.00094 | 0.0000797 | 0.00165 | 6.45 | 0.00066 | 0.0035 | 0.00036 | 0.000113 | 0.00144 |
| FZO01 | 82.4 | 14.2 | 0.109 | 6.32 | 1.24 | - | - | 0.0033 | 0.00679 | 0.00000926 | 0.0008 | 0.0000502 | 0.00149 | 0.000102 | 0.0107 | 17.4 | 0.000658 | 0.0074 | 0.00146 | 0.0000262 | 0.00255 |
| FZO02 | 57.9 | 11.6 | 0.0736 | 5.03 | 0.71 | - | - | 0.00189 | 0.00397 | 0.00000743 | 0.00049 | 0.0000329 | 0.00119 | 0.000071 | 0.00646 | 11.7 | 0.000581 | 0.00534 | 0.00085 | 0.0000206 | 0.00194 |
| FZO03 | 58.5 | 11.6 | 0.0745 | 5.06 | 0.724 | - | - | 0.00193 | 0.00405 | 0.00000748 | 0.0005 | 0.0000334 | 0.0012 | 0.0000719 | 0.00658 | 11.9 | 0.000583 | 0.00539 | 0.00087 | 0.0000208 | 0.00195 |
| PUM02/04 | 56.9 | 11 | 0.0661 | 5.19 | 0.668 | - | - | 0.00185 | 0.00376 | 0.00000731 | 0.00047 | 0.0000371 | 0.00117 | 0.0000725 | 0.0112 | 10.6 | 0.000605 | 0.00531 | 0.00081 | 0.0000244 | 0.0019 |
| TIR01/03 | 86.4 | 11 | 0.0736 | 7.18 | 1.24 | - | - | 0.00492 | 0.0295 | 0.0000103 | 0.00093 | 0.0000719 | 0.00163 | 0.000131 | 0.0031 | 14.2 | 0.000788 | 0.00496 | 0.00177 | 0.000099 | 0.003 |
| TIR02/04 | 36.6 | 8.44 | 0.031 | 4.61 | 0.24 | - | - | 0.000878 | 0.00977 | 0.00000587 | 0.00021 | 0.0000213 | 0.00091 | 0.000044 | 0.00122 | 5.64 | 0.00056 | 0.00269 | 0.00031 | 0.0000476 | 0.00141 |
| WES02 | 50 | 9.44 | 0.049 | 5.44 | 0.564 | - | - | 0.0017 | 0.00661 | 0.00000706 | 0.00039 | 0.0000328 | 0.00109 | 0.0000682 | 0.00183 | 8.09 | 0.000572 | 0.00387 | 0.00069 | 0.0000206 | 0.00182 |
| WES03 | 62.4 | 9.67 | 0.0423 | 6.71 | 0.778 | - | - | 0.00244 | 0.0184 | 0.00000791 | 0.00052 | 0.0000457 | 0.00122 | 0.0000781 | 0.00226 | 9.28 | 0.000683 | 0.0036 | 0.00097 | 0.0000879 | 0.00223 |

**Table 4-4:**
**Waste Rock Diffusive Flux Source Terms**

| Pit | TDS | Cl | F | $SO_4$ | $NH_3$-N | $NO_3$-N | $NO_2$-N | Sb | As | Cd | Cr | Co | Cu | Pb | Mn | Na | Ni | P | Se | U | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ | $mg/m^2/yr$ |
| Disc | 589 | 27.3 | 8.21 | 34.4 | 25.2 | | | 0.00785 | 0.562 | 0.0000306 | 0.00557 | 0.00144 | 0.0051 | 0.00216 | 0.0231 | 132 | 0.00539 | 0.0329 | 0.0124 | 0.00185 | 0.01 |
| FZO01 | 631 | 134 | 1.2 | 32.6 | 26.1 | | | 0.0267 | 0.0585 | 0.0000314 | 0.00416 | 0.000296 | 0.00523 | 0.000712 | 0.0647 | 178 | 0.00121 | 0.04 | 0.0127 | 0.0000543 | 0.0103 |
| FZO02 | 346 | 73.6 | 0.657 | 17.9 | 14.3 | | | 0.0146 | 0.0321 | 0.0000172 | 0.00228 | 0.000162 | 0.00287 | 0.00039 | 0.0355 | 97.4 | 0.000666 | 0.0219 | 0.00696 | 0.0000298 | 0.00563 |
| FZO03 | 353 | 75.1 | 0.67 | 18.3 | 14.6 | | | 0.0149 | 0.0327 | 0.0000175 | 0.00233 | 0.000166 | 0.00292 | 0.000398 | 0.0362 | 99.4 | 0.000679 | 0.0224 | 0.0071 | 0.0000304 | 0.00575 |
| PUM02/04 | 357 | 68.5 | 0.612 | 21.6 | 14.9 | | | 0.0158 | 0.0335 | 0.0000181 | 0.0024 | 0.000212 | 0.00301 | 0.000446 | 0.072 | 91.2 | 0.000907 | 0.024 | 0.00732 | 0.0000495 | 0.00592 |
| TIR01/03 | 639 | 64 | 0.684 | 41.9 | 26.1 | | | 0.0398 | 0.261 | 0.0000387 | 0.00494 | 0.000455 | 0.00624 | 0.000999 | 0.0148 | 136 | 0.00208 | 0.0197 | 0.0154 | 0.00036 | 0.0136 |
| TIR02/04 | 558 | 39.5 | 0.33 | 65.2 | 23 | | | 0.0323 | 0.394 | 0.0000296 | 0.00343 | 0.000385 | 0.00438 | 0.000648 | 0.0111 | 88.9 | 0.00255 | 0.00342 | 0.0113 | 0.000667 | 0.00955 |
| WES02 | 474 | 59.1 | 0.646 | 45.1 | 23.1 | | | 0.0265 | 0.111 | 0.0000296 | 0.00345 | 0.000327 | 0.0044 | 0.000738 | 0.0126 | 102 | 0.00123 | 0.0206 | 0.0113 | 0.0000599 | 0.00972 |
| WES03 | 367 | 34 | 0.227 | 35.6 | 15.8 | | | 0.019 | 0.156 | 0.0000207 | 0.00245 | 0.000254 | 0.00312 | 0.00046 | 0.00898 | 66.1 | 0.00133 | 0.00807 | 0.00797 | 0.000303 | 0.00771 |

## 4.4 Tailings Consolidation

Tailings slurry will consolidate over time and produce an efflux of pore water into the overlying pit lake. The chemistry of tailings pore water and rate of tailings consolidation are discussed in this section.

### 4.4.1 Tailings Pore Water Chemistry

Tailings pore water will initially be composed of process solution deposited with the tailings slurry. Process water chemistry was obtained from metallurgical testing on whole ore slurry tailings and analogue data from the Meadowbank Mine, as described below.

An estimate of process water chemistry associated with tailings slurry is provided by metallurgical testing that was completed in support of the 2014 FEIS (Agnico Eagle, 2014). This program included chemical analysis of tailings slurry supernatant produced by processing head samples representing each of the proposed Meliadine Extension deposits. The tailings slurry process water chemistry is estimated using a weighted average of metallurgical supernatant samples based on the relative tonnage of each deposit (Table 4-5). Water quality results for the associated supernatant samples are provided in Table 4-6.

Analogue data from Meadowbank Mine was used to estimate concentrations of residual mill reagents which are optimized during operations (*e.g.*, nitrogen and cyanide species). The Meadowbank Mine operates a whole ore leach tailings slurry process, similar to what would be adopted at Meliadine Mine if tailings slurry were to be produced. Median process water concentrations reported in the Meadowbank Mine 2021 Annual Report (Agnico Eagle, 2022) are shown in Table 4-6. The median concentrations of $NO_3$, $NO_2$, $NH_4$, T-CN and WAD-CN reported for Meadowbank Mine are used to estimate tailings process water chemistry for these parameters. Similar to waste rock, it is assumed that $NO_3$ and $NO_2$ are reduced to $NH_3$ within the suboxic tailings pore water environment.

Connate water present in ore from the mine underground will introduce a source of total dissolved solids (TDS) and major ions to the mill circuit, which was not captured by the metallurgical testing. Median concentrations observed in Tiriganiaq underground mine sumps are shown in Table 4-6 (Lorax, 2022b). This contribution is converted to a major ion and TDS load using the following assumptions:

- 2% pore water content in underground ore brought to the mill;
- 63% of expansion project ore is sourced from underground mines; and,
- Tailings slurry will be 52% solids (Meadowbank tailings slurry, Agnico Eagle (2022)).

This results in connate water contributing an average TDS of 531 mg/L to process water. The contribution of connate water was considered for TDS and major ions (Ca, Cl, Na, $SO_4$ and $NH_3$). Trace metal contribution from underground mine water was found to be insignificant (<0.0001 mg/L), and was therefore not considered in this assessment.

The predicted tailings pore water chemistry used in the current WBWQM assessment is provided in Table 4-6. This concentration is assumed to be constant over time, and is applied to the consolidation flows from tailings backfill into overlying pit lakes described in the next section.

**Table 4-5:**
**Metallurgical test sample IDs and proportion of total ore generated in Meliadine Expansion**

| Deposit | Metallurgical Supernatant ID | % of Meliadine Expansion Ore |
|---|---|---|
| Tiriganiaq and Tiriganiaq-Wolf | CN1, CN2, CN4 | 52% |
| Wesmeg and North Wesmeg | CN3 | 28% |
| Pump | CN7 | 6% |
| FZone | CN6, CN5 | 8% |
| Discovery | CN8 | 7% |

**Table 4-6:**
**Water quality results for metallurgical supernatant, Tiriganiaq underground mine sump, Meadowbank process water, and predicted in-pit tailings pore water source term.**

| Sample ID | Deposit | TDS | Cl | F | $SO_4$ | T-CN | WAD-CN | $NH_3$-N | $NO_3$-N | $NO_2$-N | Sb | As | Cd | Cr | Co | Cu | Pb | Mn | Na | Ni | P | Se | U | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| Met Tailings CN8 | Discovery | 3260 | 12 | 0.29 | 1600 | 15.2 | 0.03 | - | 0.14 | 0.06 | 0.007 | 0.424 | 0.00003 | 0.005 | 0.0512 | 0.059 | 0.0002 | 0.0028 | 762 | 0.008 | - | 0.02 | 0.0102 | 0.002 |
| Met Tailings CN6 | F Zone | 2160 | 12 | 0.07 | 1100 | 0.01 | 0.01 | - | 0.13 | 0.06 | 0.012 | 1.17 | 0.00007 | 0.005 | 0.124 | 0.068 | 0.0002 | 0.0533 | 528 | 0.005 | - | 0.01 | 0.00216 | 0.002 |
| Met Tailings CN5 | F Zone | 2680 | 11 | 0.06 | 1200 | 17.3 | 0.14 | - | 0.13 | 0.06 | 0.024 | 3.33 | 0.00011 | 0.005 | 0.0982 | 0.088 | 0.0003 | 0.0263 | 574 | 0.008 | - | 0.01 | 0.00252 | 0.002 |
| Met Tailings CN7 | Pump | 2880 | 12 | 0.06 | 1200 | 16.7 | 1.55 | - | 0.15 | 0.06 | 0.016 | 4.21 | 0.00003 | 0.005 | 0.195 | 0.111 | 0.0002 | 0.0026 | 677 | 0.005 | - | 0.02 | 0.00315 | 0.002 |
| Met Tailings CN2 | Tiriganiaq | 3710 | 20 | 0.09 | 2200 | 5.95 | 0.04 | - | 0.13 | 0.06 | 0.041 | 9.74 | 0.00003 | 0.005 | 0.0769 | 0.029 | 0.0006 | 0.0109 | 694 | 0.012 | - | 0.01 | 0.00316 | 0.002 |
| Met Tailings CN1 | Tiriganiaq | 2480 | 13 | 0.1 | 1200 | 14.2 | 0.05 | - | 0.12 | 0.06 | 0.032 | 7.6 | 0.00007 | 0.005 | 0.0832 | 0.09 | 0.0009 | 0.0072 | 560 | 0.007 | - | 0.01 | 0.00262 | 0.003 |
| Met Tailings CN3 | Wesmeg | 2790 | 14 | 0.12 | 1500 | 19.5 | 0.06 | - | 0.15 | 0.06 | 0.007 | 0.22 | 0.00003 | 0.005 | 0.113 | 0.052 | 0.0003 | 0.0523 | 584 | 0.008 | - | 0.02 | 0.00296 | 0.002 |
| Met Tailings CN4 | Wolf | 3090 | 16 | 0.15 | 2000 | 0.01 | 0.01 | - | 0.5 | 0.6 | 0.019 | 0.292 | 0.00003 | 0.005 | 0.0805 | 0.061 | 0.0008 | 0.0212 | 877 | 0.012 | - | 0.01 | 0.00446 | 0.002 |
| Tiriganiaq Underground Mine Sump Water[1] | | 55000 | 27500 | - | 2800 | - | - | 140 | - | - | - | - | - | - | - | - | - | - | 14100 | - | - | - | - | - |
| Meadowbank Process Water[2] | | 3180 | 370 | 0.28 | 1550 | 0.76 | 0.05 | 75 | 9.0 | 0.30 | 0.026 | 1.02 | 0.00030 | 0.0032 | - | 2.60 | 0.00 | 0.069 | 378 | 1.31 | 0.175 | 0.147 | 0.010 | 0.0015 |
| In-Pit Tailings Pore Water Source Term | | 3488 | 300 | 0.12 | 1649 | 0.76 | 0.05 | 85.5 | 0 | 0 | 0.021 | 3.58 | 0.00004 | 0.005 | 0.0962 | 0.061938 | 0.000529 | 0.0248 | 811 | 0.00894 | 0.175 | 0.0140 | 0.003633 | 0.0022 |

[1]Median sump chemistry in Tiriganiaq underground mine (2020-2021)

[2]Median from 2020 Mill Monitoring Data (Agnico Eagle, 2022)

### 4.4.2 Consolidation Flows

Tailings consolidation flows are based on modelling that was completed for in-pit deposition of tailings slurry at the Meadowbank Mine (SNC, 2018). Meadowbank results are applied in the current modelling exercise as site-specific consolidation modelling has not been completed for Meliadine at this stage. Future model refinements for Meliadine Extension in pit deposition could incorporate site-specific considerations including tailings permeability, filling rate, pit geometry and depth, available drainage pathways, as well as local ground and rock conditions.

Meadowbank consolidation modelling considered tailings consolidation using a 1-dimensional model to produce seepage fluxes for Goose Pit, Pit A and Pit E (SNC, 2018). Pit A has a capacity of 3.0 Mt of tailings with tailings thickness of 125 m, which is similar to many of the backfilled pits at Meliadine (Table 2-1); therefore, model results presented in SNC (2018) for this mine pit are used to estimate consolidation flows (Figure 4-1). Per unit volume consolidation rates for Pit A are applied to the volume of tailings backfilled in each mine pit at Meliadine (Table 2-1). As such, the consolidation water released to mine pits is a function of time and the initial volume of tailings. These flow rates are combined with the tailings pore water chemistry shown in Table 4-6 to estimate the geochemical loading from tailings consolidation water to the overlying pit lakes.

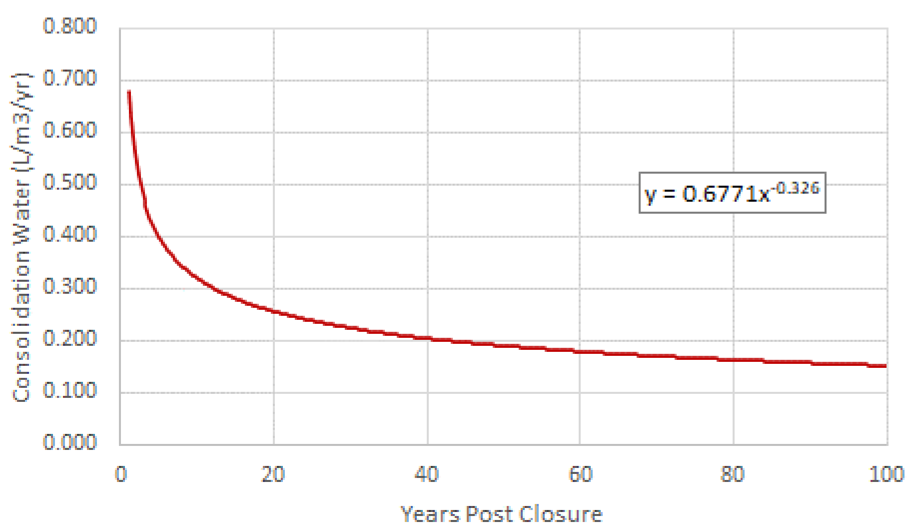


**Figure 4-1: Tailings consolidation rates from Portage Pit A 1-dimensional consolidation modelling (SNC, 2018) extrapolated using power function shown on figure.**

## 5. Water Quality Model Results

This section presents water quality model predictions for the in-pit sensitivity WBWQM under the RCP4.5 climate scenario. Model predictions are compared against water quality guidelines adopted in the 2020 AEMP (Agnico Eagle, 2021) as a screening tool to identify parameters of potential concern (POPCs) (Table 5-1). Pit lakes with concentrations of mine-related parameters above or approaching AEMP guideline values during mine closure are presented in Section 5.1 (waste rock backfill), Section 5.2 (tailings backfill), and Section 5.3 (WN Pit Lake).

**Table 5-1:**
**Water quality guidelines for screening of Post Closure model predictions.**

| Parameter | Unit | [1]Water Quality Guidelines for the Protection of Aquatic Life |
|---|---|---|
| Total Dissolved Solids | mg/L | *1,000* |
| Total Ammonia[2] | mg/L | *0.58* |
| Nitrate | mg/L | *2.93* |
| Nitrite | mg/L | *0.06* |
| Chloride | mg/L | *120* |
| Fluoride | mg/L | *2.8* |
| Sulphate | mg/L | *variable* |
| Silver | mg/L | *0.00025* |
| Aluminum | mg/L | *0.1* |
| Arsenic | mg/L | *0.025* |
| Boron | mg/L | *1.5* |
| Barium | mg/L | *1* |
| Beryllium | mg/L | - |
| Calcium | mg/L | - |
| Cadmium | mg/L | *variable* |
| Cobalt | mg/L | - |
| Chromium | mg/L | *0.005* |
| Copper | mg/L | *variable* |
| Iron | mg/L | *1.06* |
| Mercury | mg/L | *0.000026* |
| Manganese | mg/L | *variable* |
| Molybdenum | mg/L | *0.073* |
| Nickel | mg/L | *variable* |
| Phosphorus | mg/L | *0.01* |
| Lead | mg/L | *0.001* |
| Antimony | mg/L | *0.009* |
| Selenium | mg/L | *0.001* |
| Strontium | mg/L | - |
| Thallium | mg/L | *0.0008* |
| Uranium | mg/L | *0.015* |
| Vanadium | mg/L | - |
| Zinc | mg/L | *variable* |

**Notes:**

1. For waterbodies that are accessible to both aquatic and terrestrial life, generic water quality guidelines and site-specific water quality objectives adopted in the AEMP were used as the screening criteria. Site-specific hardness predicted at each node during Active Closure and Post Closure (2044-2119) was used to derive guidelines for parameters that are hardness dependent. The maximum pH (7.46) and lowest DOC (3.19 mg/L) measured at the MEL-01 monitoring station in 2020 were used to derive conservative guidelines for dissolved manganese and zinc.
2. The total ammonia ($NH_3$-N) guideline was determined conservatively by assuming a pH of 8 and a temperature of 15ºC.

## 5.1 Waste Rock In-Pit Deposition

Water quality predictions are generated for 11 pits to be backfilled with waste rock sourced from adjacent WRSFs. The pits are modelled to receive between 0.46 and 12.4 Mt of waste rock (Table 2-1). Flooding of the backfilled pits with Meliadine Lake water during Active Closure will result in a one-time flushing of water-soluble constituents from waste rock surfaces into the overlying pit lakes. Water quality results for mine-related POPCs, including $NH_3$, As, Cu, and Se are shown for Discovery Pit (Section 5.1.1) and F ZONE03 Pit (Section 5.1.2) as examples to illustrate the influence of waste rock in-pit deposition on pit water quality in mine closure. The maximum Post Closure predictions of POPCs compared to AEMP guidelines are presented in Table 7-1 for all backfilled pits.

### 5.1.1 Discovery Pit

Discovery Pit is modelled to be backfilled with 8.5 Mt of waste rock from WRSF9 at the end of mine life (Table 2-1). During active flooding of the pit, peak concentrations of $NH_3$ (Figure 5-1), As (Figure 5-2), Cu (Figure 5-3), and Se (Figure 5-4) can be expected in association with the initial flush load from waste rock. Effects are predicted to be short-lived, and pit lake quality is predicted to improve as pumping from Meliadine Lake proceeds. Upon completion of pumping (June 2048; Table 3-3), concentrations of these key POPCs are predicted to remain below AEMP guidelines for the remainder of Active Closure and Post Closure (Figure 5-1 to Figure 5-4).

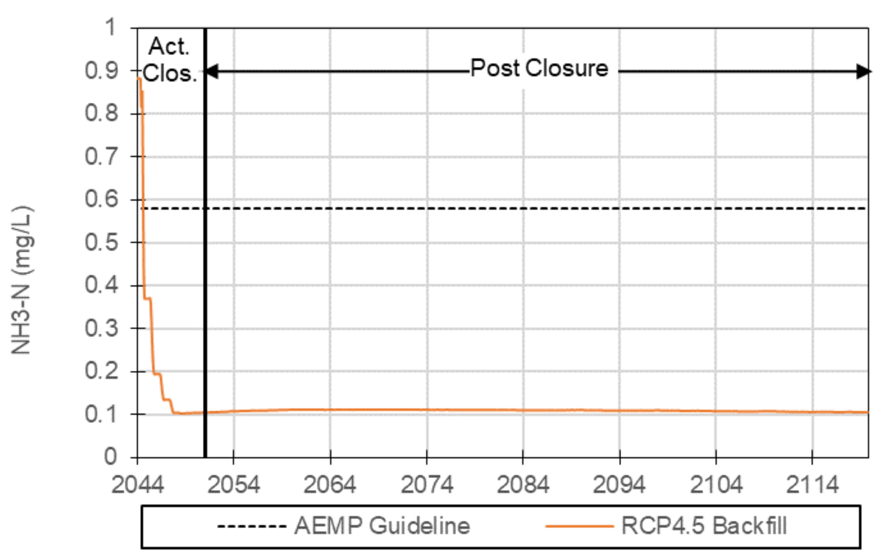


**Figure 5-1: Model predictions of ammonia ($NH_3$-N) at Discovery Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

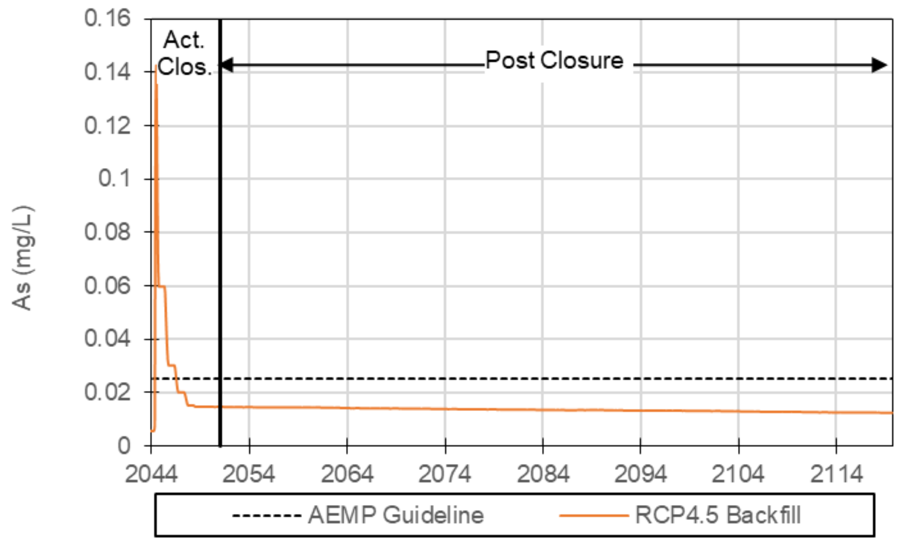


**Figure 5-2: Model predictions of arsenic (As) at Discovery Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

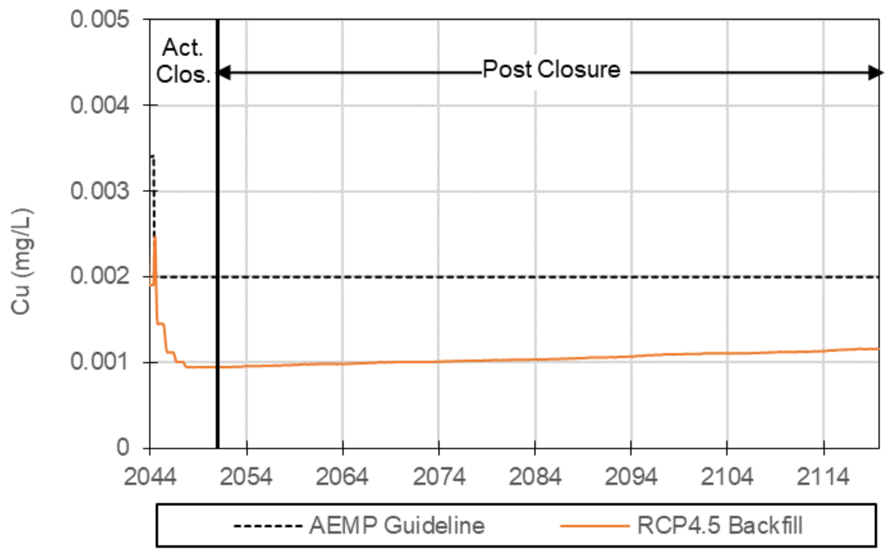


**Figure 5-3: Model predictions of copper (Cu) at Discovery Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

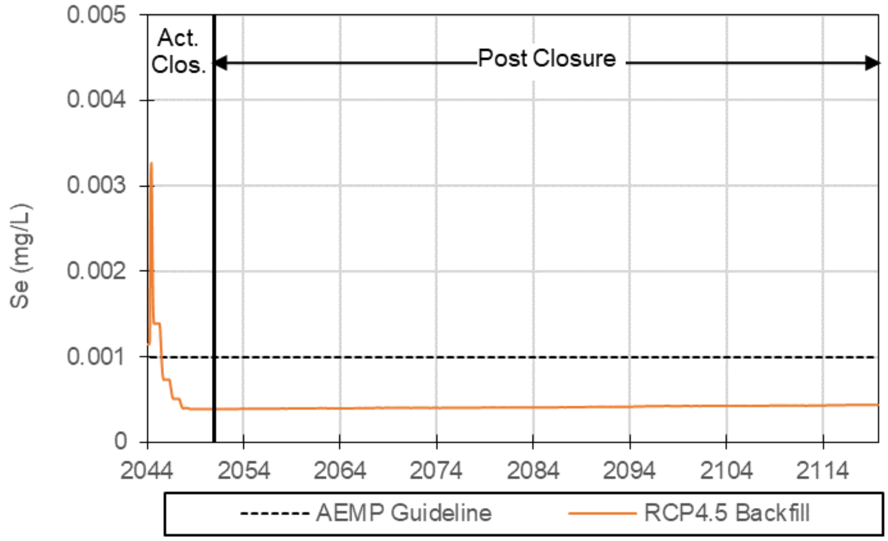


**Figure 5-4: Model predictions of selenium (Se) at Discovery Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

### 5.1.2 FZONE03 Pit

FZONE03 Pit is modelled to be backfilled with 1.2 Mt of waste rock from WRSF7 at the end of mine life (Table 2-1). As the pit is flooded with Meliadine Lake water, the initial flush of waste rock material is predicted to produce peak values of $NH_3$ (Figure 5-5), As (Figure 5-6), Cu (Figure 5-7), and Se (Figure 5-8) at the onset of Active Closure. As pit filling progresses (2044 to July 2045; Table 3-3), rapid declines in the concentrations of these POPCs are predicted. Concentrations continue to decline through the remainder of mine closure as non-contact flows drain into the pit via surrounding catchment runoff and meteoric inputs (Figure 5-5 to Figure 5-8).

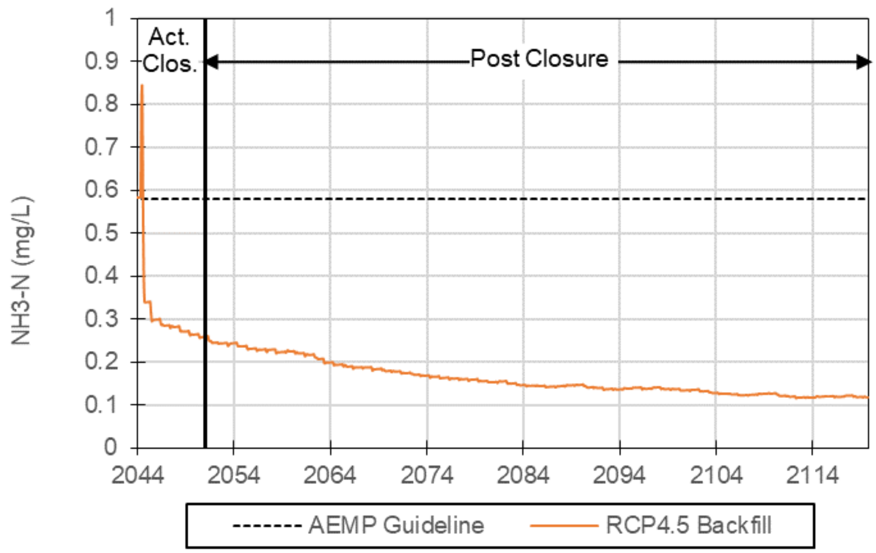


**Figure 5-5: Model predictions of ammonia ($NH_3$-N) at FZONE03 Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

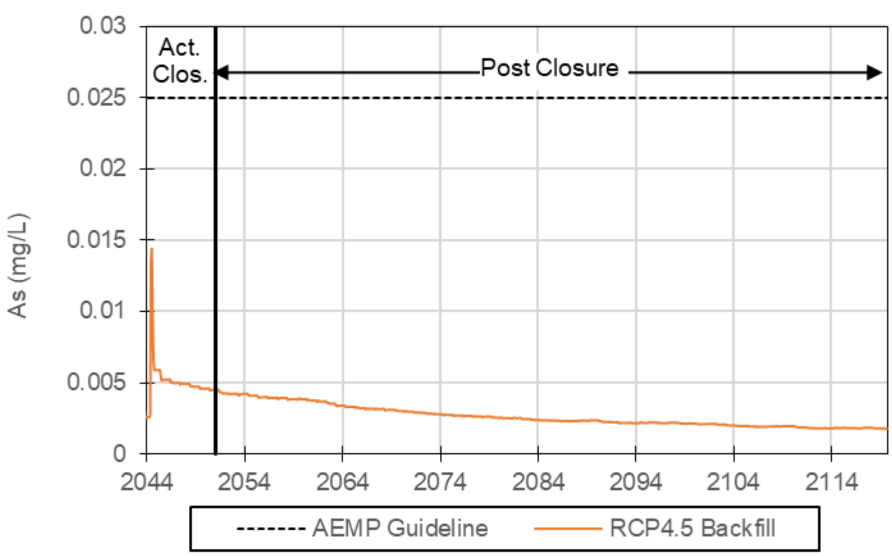


**Figure 5-6: Model predictions of arsenic (As) at FZONE03 Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

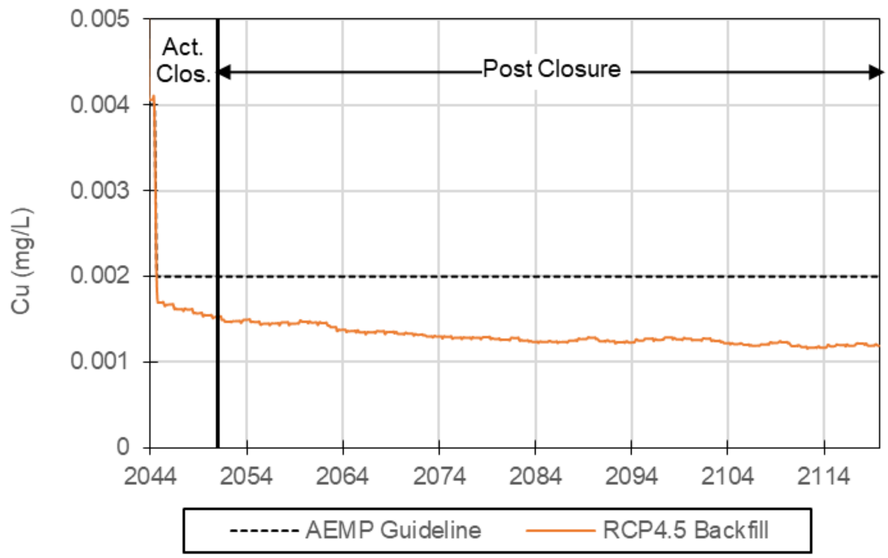


**Figure 5-7: Model predictions of copper (Cu)) at FZONE03 Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

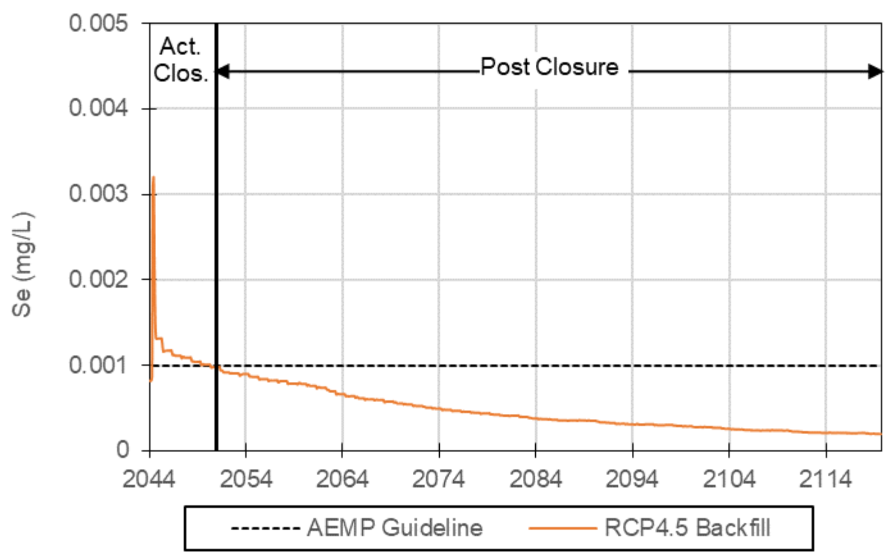


**Figure 5-8: Model predictions of selenium (Se) at FZONE03 Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

## 5.2 Tailings In-Pit Deposition

Water quality predictions are generated for 6 pits that are backfilled with tailings. The backfill tonnage varies from approximately 0.05 to 8.9 Mt (Table 2-1). In each backfilled pit, the rate at which tailings consolidation water is released to the overlying pit lake is a function of time and the initial volume of tailings (Figure 4-1). In general, the impact of tailings on water quality is predicted to be more pronounced for pits with limited catchment areas. Water quality results for key POPCs, including $NH_3$, As, Cu, and Se are shown for PUMP01 Pit (Section 5.2.1) and WES05 Pit (Section 5.2.2) as examples to illustrate the influence of tailings in-pit deposition on pit water quality in mine closure. The maximum Post Closure predictions of POPCs compared to AEMP guidelines are presented in Table 7-1 for all backfilled pits.

### 5.2.1 PUMP01 Pit

PUMP01 Pit is modelled to be backfilled with 0.3 Mt of tailings at the end of mine life (Table 2-1). Pumping of Meliadine water to the pit during Active Closure is predicted to result in an initial improvement in pit water quality, as shown by the concurrent declines in $NH_3$ (Figure 5-9) As (Figure 5-10), Cu (Figure 5-11), and Se (Figure 5-12) concentrations. Once the pit is fully flooded (June 2046; Table 3-3), consolidation of tailings is expected to release tailings porewater and mine-related parameters into the overlying pit lake. The estimated consolidation rate is highest in early Post Closure (Figure 4-1), which translates to increased concentrations of POPCs at PUMP01 Pit (Figure 5-9 to Figure 5-12). As the consolidation load from tailings decreases over time, the rate at which POPCs are released from tailings into the pit lake decays. The impact of tailings consolidation is most evident in the $NH_3$ trend, as this parameter is primarily sourced from tailings consolidation water (Figure 5-9). Other parameters show more stable trends owing to ongoing loading from WRSF6 to PUMP01 (Figure 5-10, Figure 5-11 and Figure 5-12). Model predictions for mine-related POPCs at PUMP01 Pit remain below their respective AEMP guidelines during Post Closure.

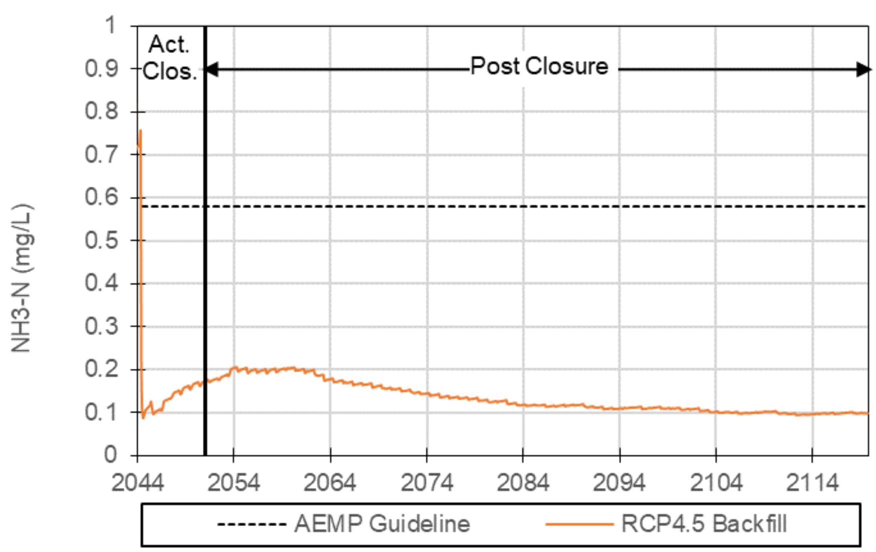


**Figure 5-9: Model predictions of ammonia ($NH_3$-N) at PUMP01 Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

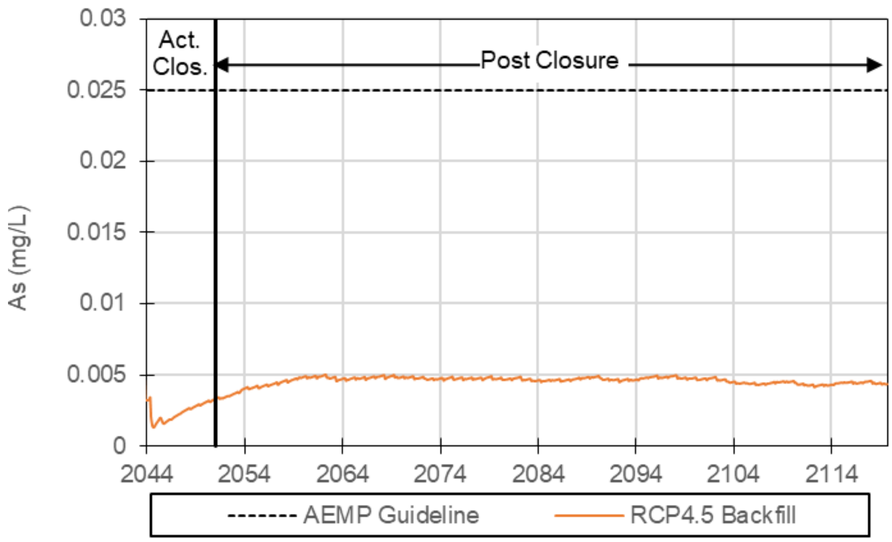


**Figure 5-10: Model predictions of arsenic (As) at PUMP01 Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

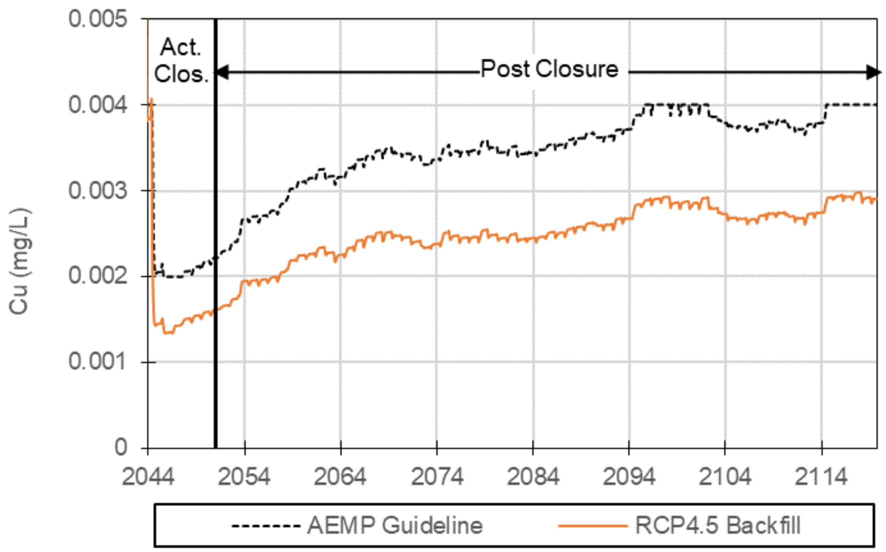


**Figure 5-11: Model predictions of copper (Cu)) at PUMP01 Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

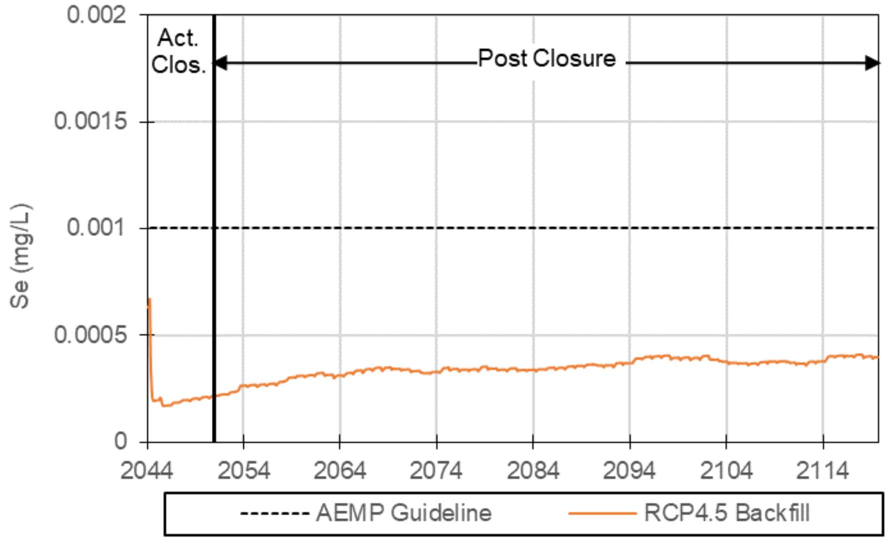


**Figure 5-12: Model predictions of selenium (Se) at PUMP01 Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

### 5.2.2 WES05 Pit

WES05 Pit is modelled to be backfilled with 3.5 Mt of tailings at the end of mine life (Table 2-1). Once the pit is fully flooded (July 2048; Table 3-3), consolidation of tailings is expected to release porewater to the overlying pit lake for the remainder of mine closure. Model predictions for mine-related parameters at WES05 Pit remain below their respective AEMP guidelines during Post Closure. Concentrations of $NH_3$, As, Cu, and Se (Figure 5-13 to Figure 5-16) are predicted to plateau by the end of the model horizon as the tailings consolidation load decays (Figure 4-1).

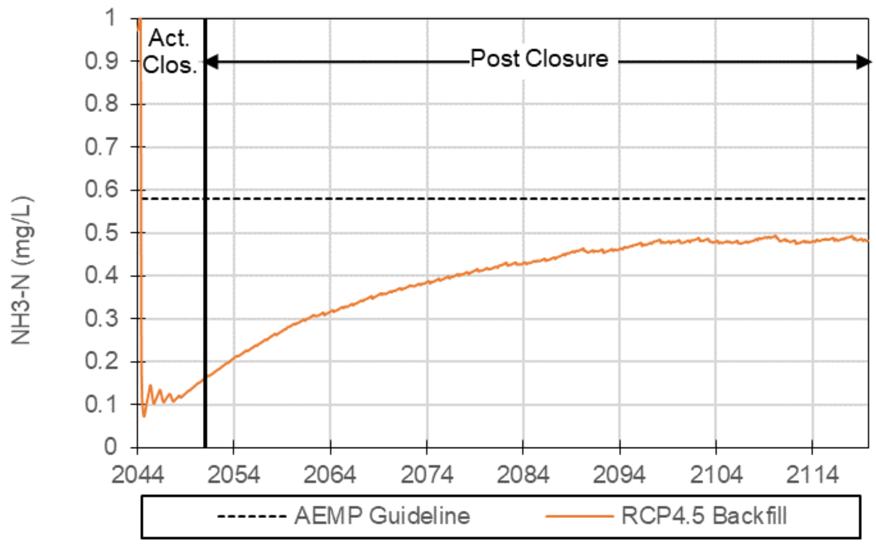


**Figure 5-13: Model predictions of ammonia ($NH_3$-N) at WES05 Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

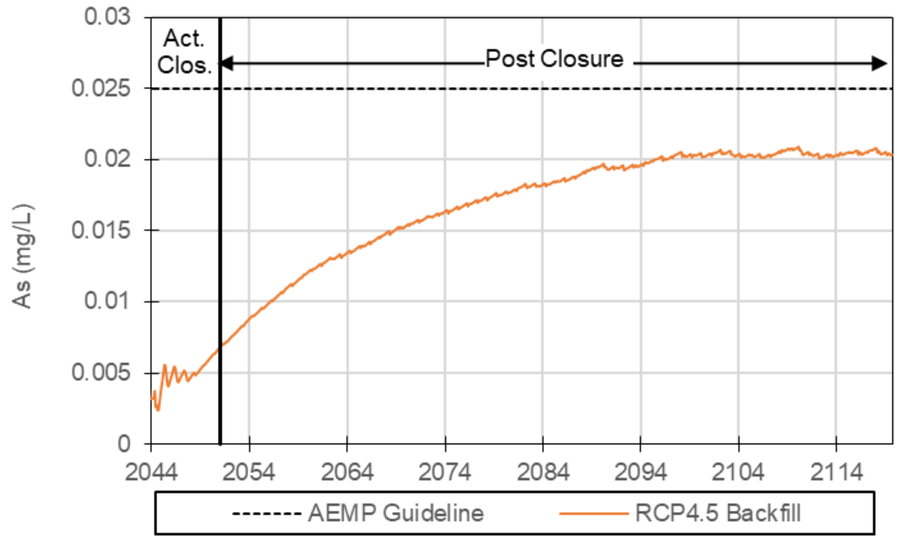


**Figure 5-14: Model predictions of arsenic (As) at WES05 Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

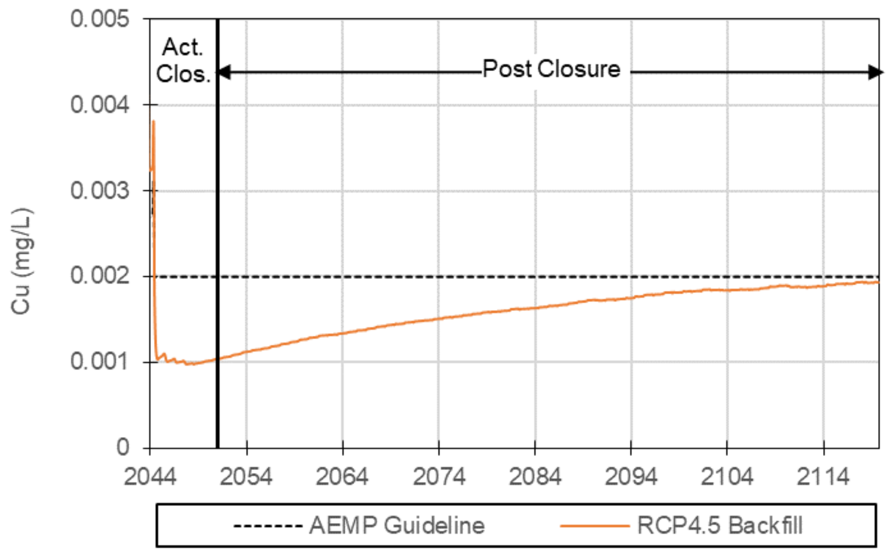


**Figure 5-15: Model predictions of copper (Cu)) at WES05 Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

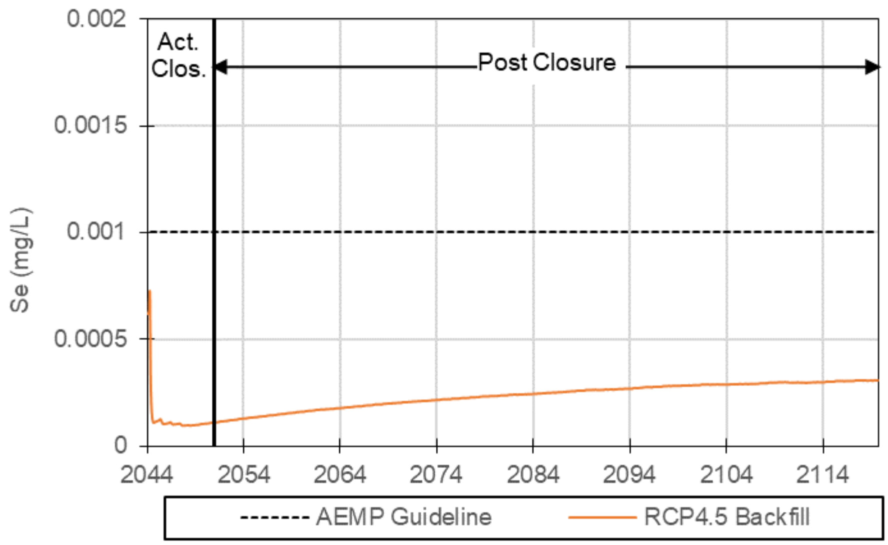


**Figure 5-16: Model predictions of selenium (Se) at WES05 Pit during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

## 5.3 Receiving Lakes

As part of the backfill sensitivity, water quality predictions have also been made for conjoined pit lakes and natural lakes located downstream of mine area. Similar to the 2022 FEIS Base Case model (Lorax, 2022a), predictions for mine-related POPCs during Post Closure are below their respective AEMP guidelines in all mine pits and receiving lakes. Results at WN Pit Lake are shown as an example in Figure 5-17 through Figure 5-20 given the relatively high concentrations of POPCs predicted during mine closure. WN Pit Lake is a conjoined pit lake formed between Lake B5 and the tailings backfilled WN01 Pit. Water quality in WN Pit Lake during Post Closure is driven by the tailings consolidation load originating from WN01 Pit.

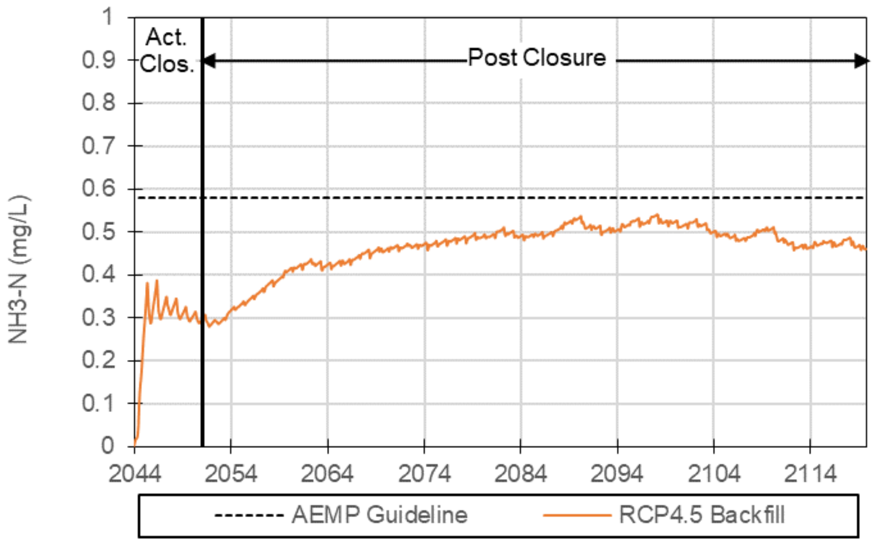


**Figure 5-17: Model predictions of ammonia ($NH_3$-N) at WN Pit Lake during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

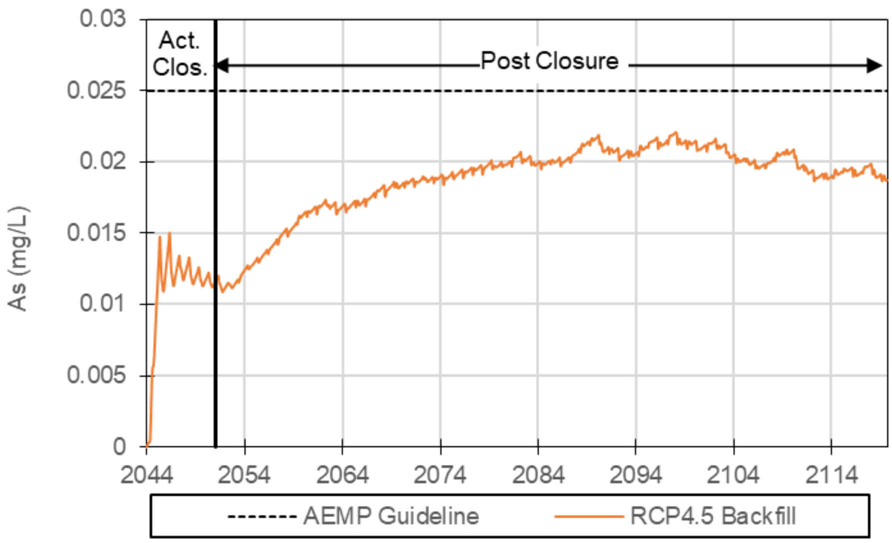


**Figure 5-18: Model predictions of arsenic (As) at WN Pit Lake during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

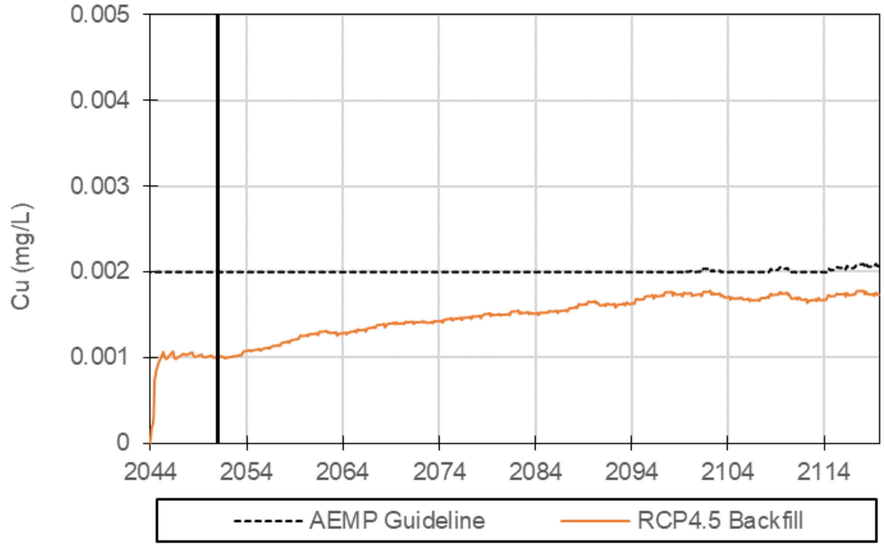


**Figure 5-19: Model predictions of copper (Cu)) at WN Pit Lake during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

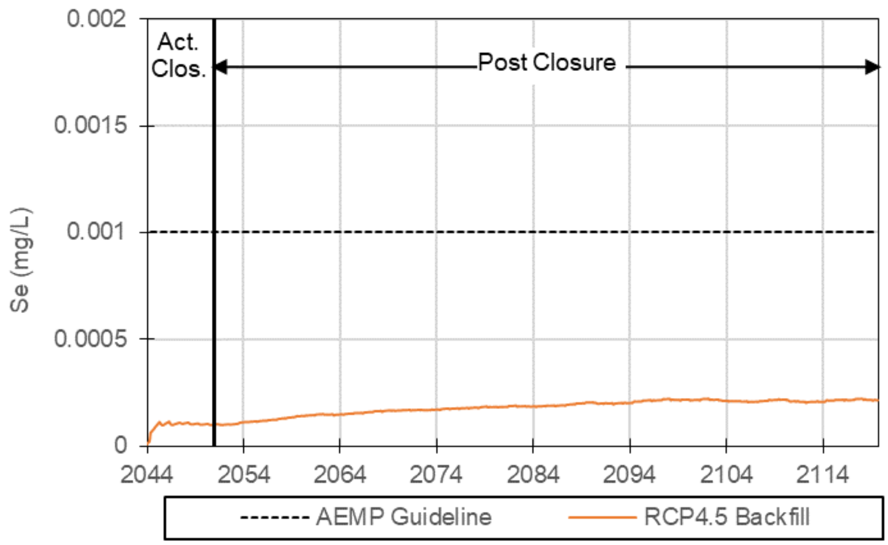


**Figure 5-20: Model predictions of selenium (Se) at WN Pit Lake during Active Closure (2044-2050) and Post-Closure (2051 onwards).**

## 6. Summary

Sensitivity modelling was completed for the Meliadine Extension WBWQM to assess the potential effects of waste rock and tailings in-pit deposition on pit lake water quality during closure and post-closure. In-pit deposition represents an alternative waste disposal strategy that utilizes the backfill capacity of mined out open pits, instead of storing all mine waste in surface WRSFs and the TSF.

The maximum Post Closure predictions for key mine-related POPCs ($NH_3$, As, Cu, and Se) are presented in Table 7-1 for the waste rock and tailings backfilled pits. Model predictions for mine-related POPCs during Post Closure are below their respective AEMP guidelines in all mine pits and receiving lakes.

**Table 7-1:**
**Maximum Post-Closure Predicted Concentrations Compared to AEMP Guidelines**

| Pit ID | Backfill Type | Parameter and AEMP Guideline (mg/L) | | | |
|---|---|---|---|---|---|
| | | $NH_3$-N | As | Cu | Se |
| | *AEMP Guideline* | *0.58** | *0.025* | *0.002-0.004*** | *0.001* |
| Discovery01 | WR | 0.11 | 0.015 | 0.0012 | 0.00043 |
| FZONE01 | WR | 0.21 | 0.0080 | 0.0016 | 0.00048 |
| FZONE02 | WR | 0.24 | 0.0044 | 0.0014 | 0.00087 |
| FZONE03 | WR | 0.26 | 0.0046 | 0.0015 | 0.0010 |
| PUMP01 | Tailings | 0.20 | 0.0050 | 0.0030 | 0.00041 |
| PUMP02 | WR | 0.23 | 0.0041 | 0.0015 | 0.00089 |
| PUMP03 | Tailings | 0.29 | 0.012 | 0.0023 | 0.00027 |
| PUMP04 | WR | 0.20 | 0.0037 | 0.0023 | 0.00060 |
| TIR01 | WR | 0.011 | 0.0040 | 0.0021 | 0.00055 |
| TIR02/04 | WR | 0.41 | 0.0101 | 0.0012 | 0.00041 |
| TIR03 | WR | 0.017 | 0.00066 | 0.00091 | 0.000073 |
| WES01 | Tailings | 0.0060 | 0.00048 | 0.0011 | 0.00010 |
| WES02 | WR | 0.20 | 0.0070 | 0.0012 | 0.00075 |
| WES03 | WR | 0.25 | 0.015 | 0.0013 | 0.00087 |
| WES04 | Tailings | 0.12 | 0.0055 | 0.0019 | 0.00031 |
| WES05 | Tailings | 0.49 | 0.021 | 0.0019 | 0.00031 |
| WN01 | Tailings | 0.018 | 0.00069 | 0.00091 | 0.000081 |

**Notes:** Values that are above applicable AEMP guidelines are shaded grey.
*Ammonia guideline assumes pH 8 and temperature 15°C (2020 AEMP); ** Copper guideline is hardness dependent.

## 7. Closure

We trust that the information provided herein is sufficient for your present needs. Should you require anything further, please contact the undersigned.

Yours sincerely,
**Lorax Environmental Services Ltd.**

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