# MEMORANDUM

| | | | |
|---|---|---|---|
| **TO** | Tim Anderson | **COMPANY** | NRA Environmental Consultants |
| **FROM** | Lee Rigley | **OFFICE** | Brisbane |
| **EMAIL** | leer@atcwilliams.com.au | **PHONE** | 0400 808 767 |
| **PROJECT TITLE** | Mount Carbine Mining Stage 3 Water Management Plan | | |
| **SUBJECT** | Final Void Water Balance Model | | |
| **DATE** | 8 December 2022 | **OUR REF** | 119190.04-M001Rev0 |

# 1 OPEN CUT PIT – FINAL VOID WATER BALANCE MODEL

## 1.1 Model Description

Final void water balance modelling for the Mount Carbine open cut pit has been undertaken as an extension of the GoldSim water balance modelling of the operational mine described in Mount Carbine Mining Stage 3 Water Management Plan (the WMP), completed by ATC Williams Pty Ltd in November 2022 **[1]**. The objective of the final void water balance model was to assess the long-term water balance of the pit in its closed condition following cessation of mining operations at the site. Consideration of climate change impacts (affecting rainfall and evaporation) were also modelled as alternative scenarios.

Daily rainfall applied within the model is outlined in Section 2.2 of the WMP. For the purposes of the final void model, daily evaporation applied was based on *Morton's lake evaporation*, sourced through SILO Data Drill. Morton's shallow lake evaporation model was developed specifically for calculating evaporation over shallow lakes from climatic measurements at nearby land-based meteorological stations. Based on the observed model outcomes of the final void water levels, use of Morton's lake evaporation was considered appropriate rather than applying pan factor adjusted evaporation data, given that the closest sites with recorded pan factors are Mt Isa Aero and Weipa Aero, which may not accurately represent the climatic conditions experienced at the site post-closure.

Rainfall runoff was simulated using the AWBM described in Section 6.3.2.4 of the WMP. Groundwater inflow rates for the final void are described in Section 6.3.2.5 of the WMP. Final void simulations were commenced following the assumed completion date of mining, ore processing and site rehabilitation. The climatic data sequence applied within the model was repeated to simulate a model period of 650 years, from 2027 to 2677

The geometrical shape of the final void was provided by EQ Resources (EQR) **[2]**.

## 1.2 Model Forecast Results

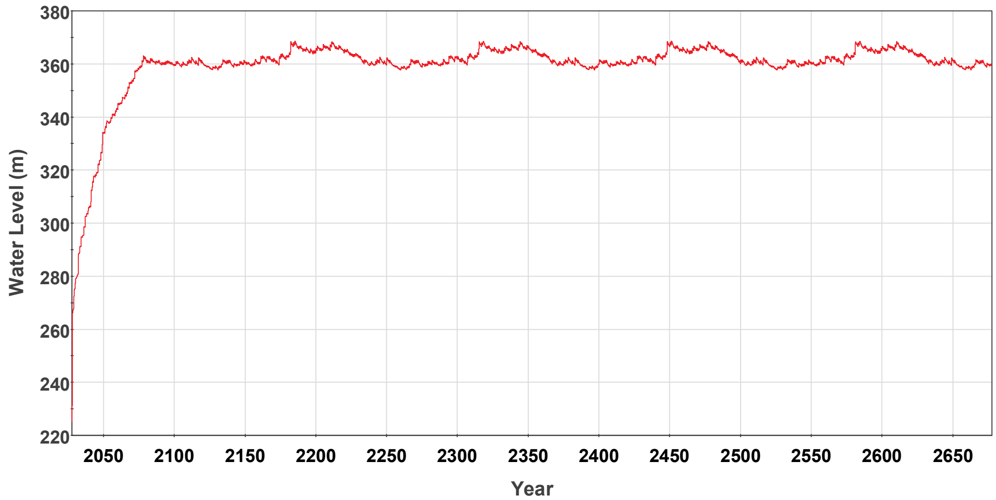
### 1.2.1 Final Void Scenario

Predicted final void water levels are shown in **DIAGRAM 1**, noting that any overflows from the pit would occur at approximately RL 380 m.

Model results indicate the following:

- The Mount Carbine final void water level is predicted to take approximately 51 years to reach an equilibrium and will then oscillate between approximately RL 357 m and 369 m. The maximum forecast water level is approximately 11 m below the final void spill level.
- There is a very low risk of spill from the final void.

**DIAGRAM 1: Final Void Water Level**




### 1.2.2 Climate Change Scenarios

Climate change scenarios based on application of average changes to precipitation and evaporation rates from the Queensland Future Climate Change Models **[3]** were modelled. Data for the RCP4.5 and RCP8.5 Scenarios were applied to the final void model described above. The adopted pan evaporation and rainfall climate change data for these two scenarios are presented in **TABLE 1** and **TABLE 2**. The seasonal climate change factors shown represent the percentage change in rainfall and pan evaporation relative to the historical reference period of 1986 to 2005. This period is adopted as an industry standard baseline.

**TABLE 1: RCP4.5 Adopted Climate Change Rainfall and Pan Evaporation Factors**

| Time Period | Seasonal Climate Change Factors (% change relative to 1986 to 2005 historical reference period) | | | |
|---|---|---|---|---|
| | Summer | Autumn | Winter | Spring |
| **Rainfall** | | | | |
| 2020-2039 | -5.2 | -4.8 | -5.9 | -2.3 |
| 2040-2059 | -1.7 | -3.2 | 0.9 | -3.6 |
| 2060-2079 | -2 | -7.1 | -14 | 0.63 |
| 2080-2099 | -1.1 | -6.5 | -14 | 2.6 |
| **Pan Evaporation** | | | | |
| 2020-2039 | 9.3 | 8.4 | 6.6 | 5.8 |
| 2040-2059 | 10 | 11 | 8.7 | 8.6 |
| 2060-2079 | 13 | 13 | 10 | 9.6 |
| 2080-2099 | 13 | 15 | 12 | 9.8 |

**TABLE 2: RCP8.5 Adopted Climate Change Rainfall and Pan Evaporation Factors**

| Time Period | Seasonal Climate Change Factors (% change relative to 1986 to 2005 historical reference period) | | | |
|---|---|---|---|---|
| | Summer | Autumn | Winter | Spring |
| **Rainfall** | | | | |
| 2020-2039 | -4.4 | 0.69 | -5.1 | 2.4 |
| 2040-2059 | -1.4 | -1.8 | -8 | -7.7 |
| 2060-2079 | -0.073 | -6.4 | -2.2 | 3.1 |
| 2080-2099 | -1.5 | -9.2 | 4.6 | -4.1 |
| **Pan Evaporation** | | | | |
| 2020-2039 | 9.2 | 7.7 | 5.5 | 6.1 |
| 2040-2059 | 13 | 13 | 9.4 | 10 |
| 2060-2079 | 16 | 20 | 15 | 16 |
| 2080-2099 | 23 | 30 | 23 | 24 |

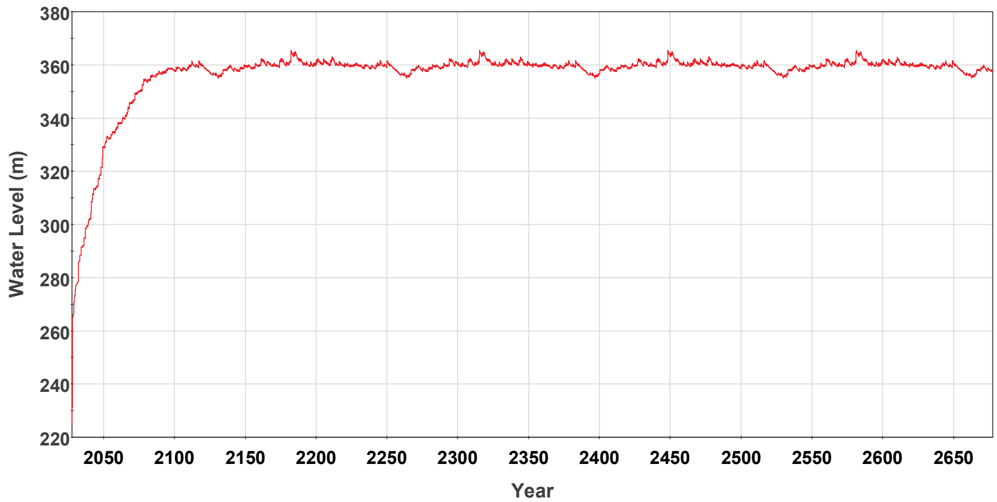
It is noted that GoldSim interprets the climate change factors at the middle of the time period and interpolates the change factors between these central dates. The climate change model scenarios were also run for 650 years, from 2027 to 2677.

#### *1.2.2.1 RCP4.5 Scenario Results*

The RCP4.5 scenario represents the scenario where $CO_2$ concentrations increase steadily until after the mid-century, with $CO_2$ concentrations stabilising around 2060. From the climate change factors for this scenario presented in **TABLE 1**, the Mount Carbine area will likely experience generally decreasing rainfall and increasing evaporation.

Predicted final void water levels under the RCP4.5 scenario are shown in **DIAGRAM 2**.

DIAGRAM 1: Final Void Water Level – Climate Change Scenario RCP4.5




The RCP4.5 scenario model results indicate the following:

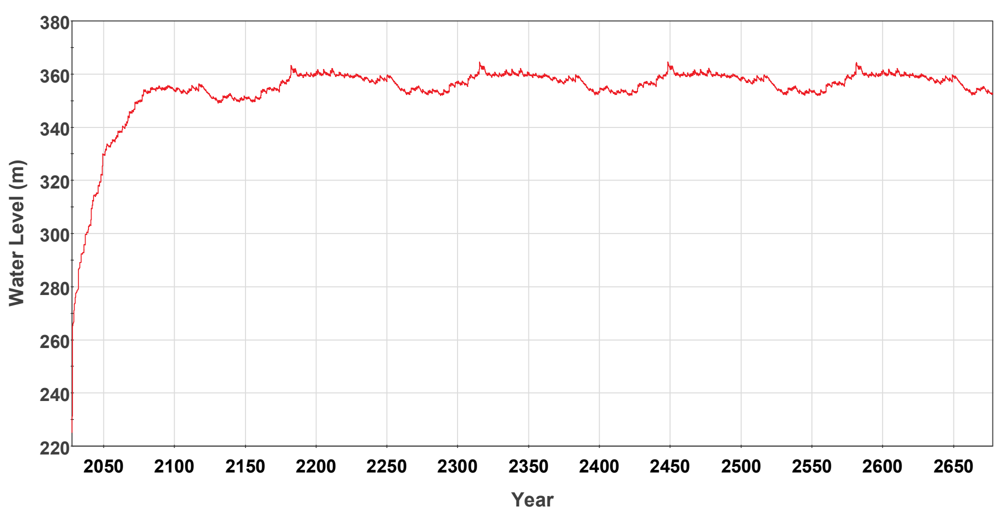
- The final void water level is predicted to take approximately 84 years to reach an equilibrium and will then oscillate between approximately RL 355 m and 365 m. The maximum forecast water level is approximately 15 m below the final void spill level.
- There is a very low risk of spill from the final void.

*1.2.2.2 RCP8.5 Scenario Results*

The RCP8.5 scenario represents a future with little curbing of emissions, with a $CO_2$ concentration continuing to rise rapidly.

Predicted final void water levels under the RCP8.5 scenario are shown in **DIAGRAM 3**.

DIAGRAM 3: Final Void Water Level – Climate Change Scenario RCP8.5



Model results indicate the following:

- The final void water level is predicted to take approximately 154 years to reach an equilibrium and will then oscillate between approximately RL 352 m and 364 m. The maximum forecast water level is approximately 16 m below the final void spill level.
- There is a very low risk of spill from the final void.

## 1.3 Conclusions and Recommendations

### 1.3.1 Conclusions

This memorandum presents the results of final void water balance modelling of the Mount Carbine open cut pit. The modelling is based on information and data provided by EQ Resources and NRA Environmental Consultants. It is concluded that water levels within the final void would reach equilibrium below the final void spill level, and as such is not expected to spill under current climatic conditions nor projected climate change scenarios.

### 1.3.2 Recommendations

The following are recommendations for future water management plans:

- Ongoing monitoring and modelling of groundwater inflows into (and outflows from) the Open Cut Pit be undertaken. This will provide additional information for any future updates to the water balance model and final void model, which will refine the estimates of the expected long-term water levels within the final void and associated probability of spills.
- Implementation of site climate data monitoring, including rainfall and evaporation, to more accurately model the climatic conditions at the Mount Carbine site, will similarly refine future estimates of long-term water levels and associated probability of spills.

## 1.4 References


**[1]** ATCW (2022), Mount Carbine Mining Stage 3 Water Management Plan, Ref 119190.04R01_0, 30 November 2022

**[2]** EQ Resources (2022), 'Final Void Surface Designs', Stage 3_PIT DESIGNS_V2_STAGE 4_SURFACE_3.dxf, 7 October 2022.

**[3]** State of Queensland (2022), "Queensland Future Climate Dashboard', The Long Paddock, https://www.longpaddock.qld.gov.au/qld-future-climate/dashboard/#, Queensland Government.


TAILINGS.WATER.WASTE.