# Appendix 41

# Whale Tail Pit Project Hydrodynamic Modelling of Whale Tail Pit Lake

# TECHNICAL MEMORANDUM

**DATE** June 26, 2018 1789310-181-TM-Rev0

**TO** Jamie Quesnel and Michel Groleau
Agnico Eagle Mines Limited

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**WHALE TAIL PIT PROJECT**
**HYDRODYNAMIC MODELLING OF WHALE TAIL PIT LAKE**

## 1.0 EXECUTIVE SUMMARY

The Whale Tail Pit is an extension of the Meadowbank Project. The Whale Tail deposit is located under the north basin of Whale Tail Lake. Agnico Eagle Mines Limited (Agnico Eagle) proposes to construct a dike across Whale Tail Lake to isolate the Whale Tail North (WTN) basin from Whale Tail South (WTS) basin. During operations, WTN will be dewatered, an open pit mine will be excavated to remove gold ore, and a portion of the dewatered lake bed will be used as a water storage pond called the Whale Tail Attenuation Pond. At the end of mining, the open pit and Attenuation Pond will be reflooded to form Whale Tail Pit Lake. When water quality allows, a breach in the water retention dikes will allow circulation to be re-established between the Pit Lake and Whale Tail South. Water will overflow from the Pit Lake to Mammoth Lake downstream.

The Pit Lake water quality was assessed as part of the Environmental Impact Statement (EIS) that was submitted jointly to the Nunavut Impact Review Board (NIRB) and the Nunavut Water Board (NWB) (Agnico Eagle 2016). The initial conceptual model for pit lake consisted of a container made of 2 cells: a cylindrical bottom cell representing the flooded open pit (i.e., the excavation below the elevation of current lake bottom) and a thin and wide top cell representing the existing Whale Tail Lake (i.e., the water volume above the elevation of the current lake bottom). Each cell was assumed to be fully mixed, but the two cells were assumed not to mix with each other given the anticipated lower density of water in the top cell and potentially higher refresh rate with fresh water runoff.

Subsequent to the EIS, the Whale Tail Project Certificate was issued in March 2018 (NIRB 2018) with a condition to perform hydrodynamic modelling of the Whale Tail Pit Lake to forecast: (i) the time to flood the open pit with the north wall pushback, (ii) future water circulation patterns within the future pit lake, and (iii) the water quality in the pit lake during post-closure.

This technical memorandum presents the results of hydrodynamic modelling of the Whale Tail Pit Lake completed to address Condition 16 of the NIRB Project Certificate no.008 (NIRB 2018). The model ran for a period of 48 years (2022 to 2070) covering mine closure (active flooding: 2022 to 2028) and post-closure (fully flooded WTN connected to both WTS and the downstream Mammoth Lake: 2028 to 2070).

The model results indicate the following:

- The pit lake will be fully flooded by 2028.
- The pit lake will have adequate water quality to meet receiving water quality criteria and site-specific water quality objective (SSWQO) for arsenic, allowing Agnico Eagle to remove the water retaining dikes and reconnect to Mammoth Lake in 2028.
- Spring Freshet is the driving force behind both the rate of water level rise and progressive improvements to lake water quality over time.
- The pit lake sub-basin is predicted to completely mix twice per year during the spring and fall, and to exhibit weak thermal stratification during summer and winter months. The main driver behind mixing is wind energy acting upon the lake surface during periods when the water column has a uniform density at all depths.
- Concentrations of arsenic, total dissolved solids (TDS), nitrate and total dissolved phosphorous are predicted to remain below receiving water quality criteria during the post-closure period.

## 2.0 INTRODUCTION

The Whale Tail gold deposit is part of the Amaruq property located in central Nunavut. The site is located on Inuit Owned Land, approximately 150 km north of the hamlet of Baker Lake, and approximately 50 km northwest of the Meadowbank Mine, in the Kivalliq region. In early 2013, the property was acquired by Agnico Eagle subject to a mineral exploration agreement with Nunavut Tunngavik Incorporated. The Kivalliq Inuit Association issued Agnico Eagle a land use permit, and the NWB issued a water licence for exploration purposes.

The Project will proceed in four periods: construction, operations, closure, and post-closure. During the construction period, Whale Tail Dike will be built across Whale Tail Lake to separate it into the Whale Tail North (WTN) and Whale Tail South (WTS) basins. Water in WTN will be drained to provide access to the Whale Tail deposit located beneath the lake and to an approximately 17-m deep basin south of the deposit which will host the Attenuation Pond. A 115-m-deep open pit will be excavated into the lake floor. During the closure period (2022 to 2027), Whale Tail Pit and the Attenuation Pond will be flooded to the original water level in WTN, resulting in the formation of the Whale Tail Pit Lake, a sub-basin within WTN. In the post-closure period (2028 onwards), the dike between the WTN and the WTS will be breached once the pit lake fills and water quality in the pit lake meets site water quality criteria. Achieving site water quality criteria will allow water from the flooded pit to be released into Mammoth Lake, the receiving, downstream environment. The restored Whale Tail Lake will have a slightly larger surface dimension and a different bathymetry to the original, pre-operations waterbody.

This technical memo provides the methods and results of hydrodynamic modelling performed on Whale Tail Pit Lake during closure and post-closure periods. The goals of the model were:

- To determine the approximate start of the post-closure timeframe based on the completion of filling of the Whale Tail Pit Lake.
- To evaluate the potential for complete mixing in the pit lake verses the potential for the development of permanent stratification (called meromixis).
- To predict and evaluate the water quality within the pit lake over time – specifically, concentrations of TDS, arsenic, and total phosphorous.

# 3.0 METHODS

## 3.1 Model Platform

The pit lake hydrodynamic model was developed in the CE-QUAL-W2 (W2) software package developed by the U.S. Army Corps of Engineers (Coles and Wells 2017). The W2 program is a two-dimensional (2-D, profile-view: horizontal distance vs depth), laterally-averaged, fluid mechanics and water quality model that has been widely used to evaluate the likelihood of complete mixing within lakes and reservoirs worldwide. The program provides 2-D flow fields from which the distribution of heat, momentum and mass can be simulated. The theoretical basis for W2 was the 2-D longitudinal-vertical transport model written by Buchak and Edinger (1984) which formed the hydrodynamic and transport basis of the first version (i.e., W1) of the water quality model (US Army of Engineer Waterways Experiment Station 1986).

## 3.2 Model Segmentation

Model segmentation is the discretization of a physical domain into individual grid cells that can be used by the model to iteratively calculate state variables (i.e., properties such as velocity and concentration) at all locations within the lake within each time step. A 2-D grid was developed to cover Whale Tail Pit and the Attenuation Pond (Figure 1). The horizontal grid spacing varied between 100 and 260 m. The vertical grid spacing varied between 0.5 m near the surface and 5 m near the pit bottom (Figure 2). The model included two branches. Branch 1 represented Whale Tail Pit and included 9 horizontal segments and 69 vertical layers. The deepest layer occurred in Segment 6 and corresponded to a total depth of 117m. Branch 2 represented the Attenuation Pond and included 4 horizontal segments and 15 vertical layers. The deepest layers occurred in Segments 14 and 15, and corresponded to a real depth of 17 m.

Within the model, Segment 16 in the Attenuation Pond (Branch 2) was connected to Segments 6 in the Whale Tail Pit (Branch 1; Figure 1). This connection allowed volume and mass exchange between the two branches above an elevation of 147.1 m (the elevation of the top of the ridge separating these basins). Water and mass were removed from Segment 10 in Whale Tail Pit Lake at an elevation of 152.5 m, which represented the overflow to Mammoth Lake.

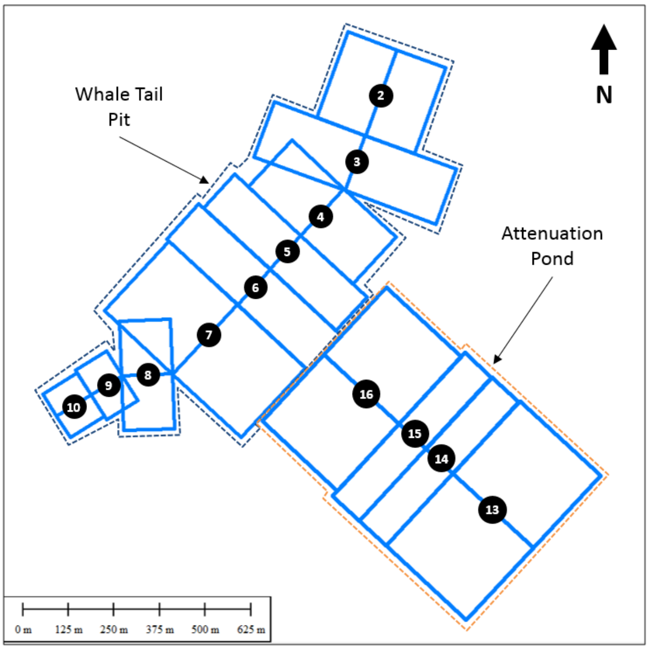


**Figure 1: Plan view of segments (centerline of segment shown) used to represent the Whale Tail Pit and Attenuation Pond in CE-QUAL-W2, adapted from Figure A.3 (Agnico Eagle Meadowbank Division 2017)**

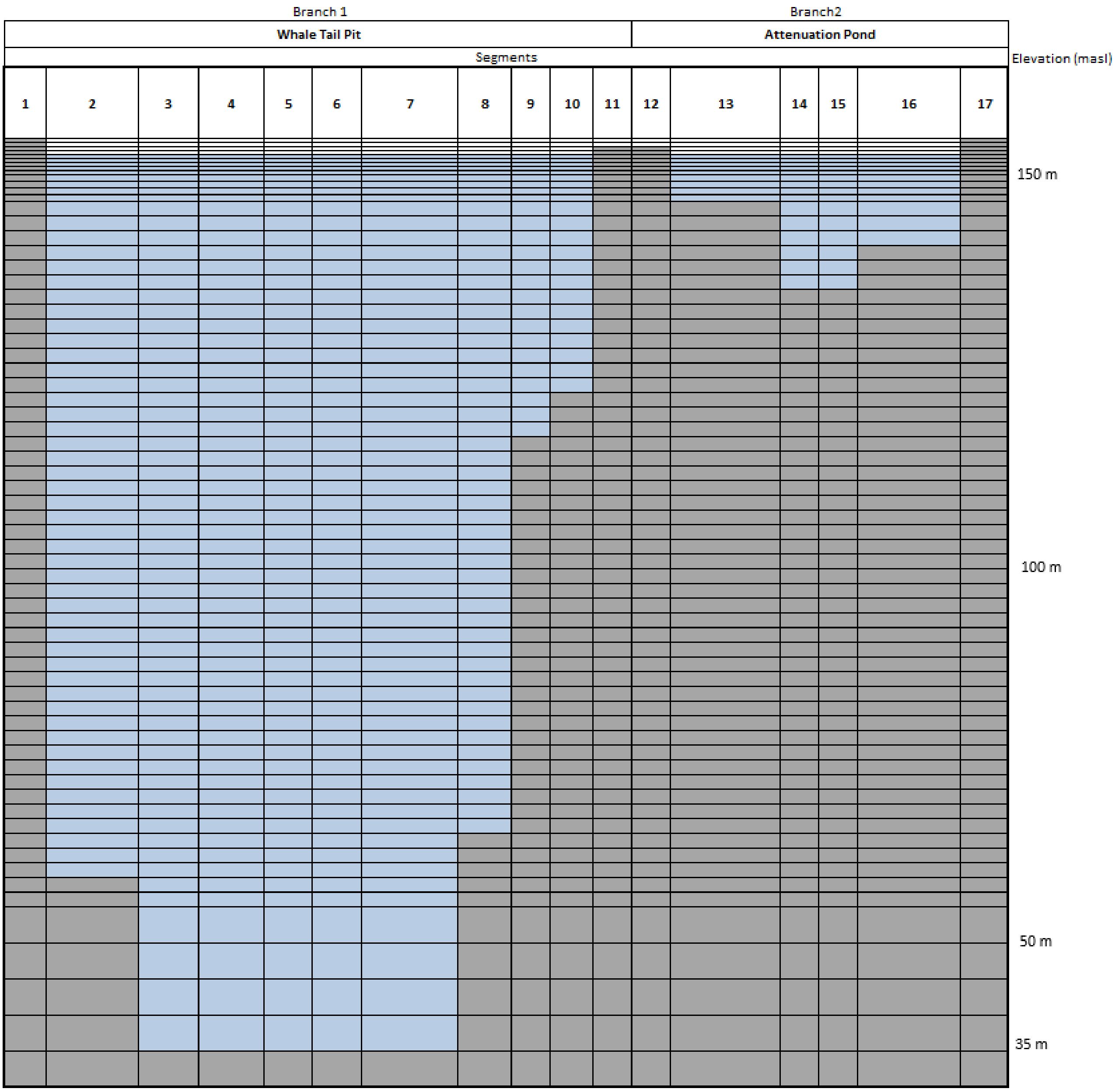


**Figure 2: Profile view of vertical layers in the Whale Tail Pit and Attenuation Pond used in CE-QUAL-W2**

## 3.3 Assumptions

Key assumptions used for this study are outlined below:

- Assumptions regarding inflows:
  - The equivalent water depth of the annual snow precipitation was added in daily increments in the month of June to simulate spring freshet entering the lake once the surface is ice-free.
  - The volume of overland runoff was distributed based on estimated watershed area adjacent to each segment and added daily. Runoff chemistry was determined by the water and mass balance model conducted in GoldSim (Agnico Eagle 2016).

- The volume of groundwater inflow for the closure period was specified based on predictions generated by the hydrogeological model for operations and closure conditions and added daily. Groundwater chemistry was determined by the water and mass balance model.
- The volume of groundwater inflow for the post-closure period was specified based on predictions generated by the hydrogeological model for post-closure conditions and added daily (Golder 2018). Groundwater chemistry was determined by the water and mass balance model.
- With the exception of overflow from the Attenuation Pond (Branch 2) into the open pit (Branch 1), all inflows were added to the upstream segments of each branch (Segments 2 and 13; Figure 1). Inflows were density-placed within each branch, meaning the vertical position of the input corresponded to the depth of neutral buoyancy for the incoming fluid.
- Groundwater discharging from the base of the Attenuation Pond contributes to groundwater inflow added to the open pit.

- Assumptions regarding outflows:
  - Groundwater is the only outflow removed from the Pit Lake with the exception of evaporation (calculated by W2) and overflow to Mammoth Lake.
  - Groundwater was removed uniformly across the saturated depth of Segments 6 and 14, which corresponds to the area within the Talik.
- TDS, arsenic, nitrate, and total phosphorous were modelled as conservative constituents (i.e., reactions such as biological uptake that would reduce concentrations were not modelled, to produce a mass-conservative water quality prediction).
- Frozen, ice-covered conditions were assumed to persist from October to May each year.
- Temperatures and precipitation rates were based on historic observations and do not consider potential climate change.
- The water chemistry profiles used as inputs to the models are assumed to continue to be representative in the future. Inflows to the model were characterized using representative water quality (i.e., water temperature and TDS, arsenic, nitrate, and phosphorous concentrations) from modelled or measured data.
- The total daily arsenic mass contributed to the pit lake from combined site runoff (e.g., pit walls and the Whale Tail Pit catchment area) and pit wall flushing (first submergence of wall rock) was calculated in GoldSim, and was added to the pit lake as part of watershed runoff.
- Existing stage-storage and area-storage curves include the pit wall pushbacks to the north and south previously modelled and described in the FEIS (Agnico Eagle 2016).
- The governing equations in W2 are laterally averaged. Lateral averaging assumes that lateral variations (y-direction) in velocities, temperatures, and constituents are negligible. This limitation is not expected to materially affect pit lake simulations, which are primarily concerned with vertical (z-direction) water stratification.
- Although W2 can model formation of ice cover, it does not consider the exclusion of dissolved constituents upon conversion of water to ice. In reality, ice is composed of only fresh water whereas the constituents dissolved in water are extruded during ice formation and sink downward in the water column

relatively enriching the unfrozen water below in these dissolved constituents. For lakes at high latitude, dissolved constituent exclusion is known to have an important influence on vertical mixing. Golder estimates that the low dissolved constituent load expected in Whale Tail Lake limits the significance of this process because the TDS is low and the lake volume is relatively large.

## 3.4 Model Inputs

The model was run for a period of 17,897 days, representing the period of January 1, 2022 (start of closure) to December 31, 2070 (approximately 43 years of post-closure conditions).

Inputs to the model include lake bathymetry, meteorological, hydrologic, hydrogeologic, and water quality data, as described in the following sections. The temperature, volume, and concentration of each input were specified in the model on daily time steps.

### 3.4.1 Meteorological Inputs

Meteorological input data required for this hydrodynamic model include: air temperature, dew point temperature, wind speed and direction, and solar radiation. An hourly time-series was constructed for each of these inputs during the modelling time period (i.e., 2022 to 2070) based on observed data from the nearest Environment Canada Meteorological Station, Baker Lake A (Station ID 2300500), located approximately 125 km southeast form the Whale Tail Lake. Observations from 1998 to 2017 were repeated for the modelling time period, except for solar radiation, where the record from 1998 to 2012 was repeated.

Where data gaps existed, these were either filled by interpolation (for time gaps < 24 hours) or filled using the previous day or next day's values (for time gaps > 24 hours). The record air temperature was adjusted to compensate for the distance and elevation differences between the Baker Lake A station and the site. The dew point temperature was calculated using the air temperature, relative humidity and air pressure. Solar radiation was calculated from the horizontal irradiance.

Precipitation inputs were provided as monthly values representative of an average year (Agnico Eagle 2016).

Rainfall landing during frozen periods (e.g., between October to May) was applied as rainfall during the month of June of the same year if fallen between the months of January and May, or during the month of June of the following year if fallen between the months of October and December. Snowfall landing outside of frozen conditions, was applied as rainfall during the same month.

### 3.4.2 Hydrologic Inputs

The hydrologic inputs for the model originated from the water balance modelling conducted in GoldSim, and represent average flow volumes from each infrastructure component using average-precipitation-year climate data (Agnico Eagle 2016).

Inflows include:

- direct precipitation over Whale Tail lake
- surface runoff from the site watershed
- surface runoff from the pit walls
- pumped flows from water treatment plant
- water pumped from the south basin of Whale Tail Lake during the closure period, and natural inflow from south basin in post-closure period
- water pumped from facilities and storage basins (North East Pond and WRSF pond)

- seepage flows from the Attenuation Pond
- groundwater inflow

Most of these inflows will decrease over time such that runoff is likely to be the largest contributor during the post-closure period.

Outflows included:

- groundwater outflow
- evaporation
- outflow to Mammoth Lake (calculated by W2)

Inflows were placed within the upstream segments of their respective basins, Whale Tail Pit and the Attenuation Pond, respectively which, together, form the Whale Tail Pit Lake. All inflows were vertically placed in their respective waterbodies based on water density, and the depth of neutral buoyancy within the water column.

Groundwater losses from Whale Tail Lake were removed from segments within the talik based on groundwater modelling (Golder 2018).

Each input was assigned a temperature. Surface runoff and pit wall runoff inflows were set equal to the average daily air temperature in the meteorological data file. Negative air temperatures were converted to 0°C. Pumped flows from storage basins were assigned a constant temperature of 8.1°C based on the average water temperature observed in Mammoth Lake. Groundwater inflows were assigned a constant temperature of 2ºC based on the average value found in a groundwater investigation at the project site (Agnico Eagle 2016).

Finally, each input was assigned a concentration for TDS, arsenic, nitrate and total phosphorous. With the exception of post-closure groundwater inflows, concentrations for each input were calculated in the GoldSim water and mass balance model for the mine site (Agnico Eagle 2016) and included both constant values and time-series, where concentrations changed over time. Post-closure groundwater TDS concentrations were obtained from the groundwater model (Golder 2018).

### 3.4.3 Model Coefficients

Default coefficient values were generally used for hydrodynamic and energy terms. The following coefficients were based on a calibrated W2 model created by Golder for an Arctic lake:

- sediment temperature was set to 2ºC
- the maximum eddy viscosity was set to 0.001 $m^2/s$
- the coefficients in the ice module were modified to reflect a northern environment (Dominion Diamond 2014)

# 4.0 RESULTS

## 4.1 Timing of Post-closure

Based on the storage capacity and water balance alone, it is predicted that the water level in the Whale Tail Pit Lake would rapidly rise during the closure period, 2023-2028 (Figure 3). The major driver for water level rise is the addition of stored snowmelt each June during freshet and pumped flow from WTS early in the closure period. These flows cause the step increases in water level predicted in the middle of each year after the initial transfer of water from WTS, and identifies freshet as the main driver of water quantity, compared to other inflows.

Whale Tail Pit Lake coalesces with the Attenuation Pond to form a single waterbody in the middle of 2026 when the water level reaches an elevation of 147.1 masl. The water level of the Pit Lake continues to rise to 152.5 masl which is reached in mid-2028, at which point, overflow into Mammoth Lake begins. The closure period ends and the post-closure period begins when the water retention dikes are breached and water is allowed to circulate from Whale Tail South Basin into the North Basin and out to Mammoth Lake.

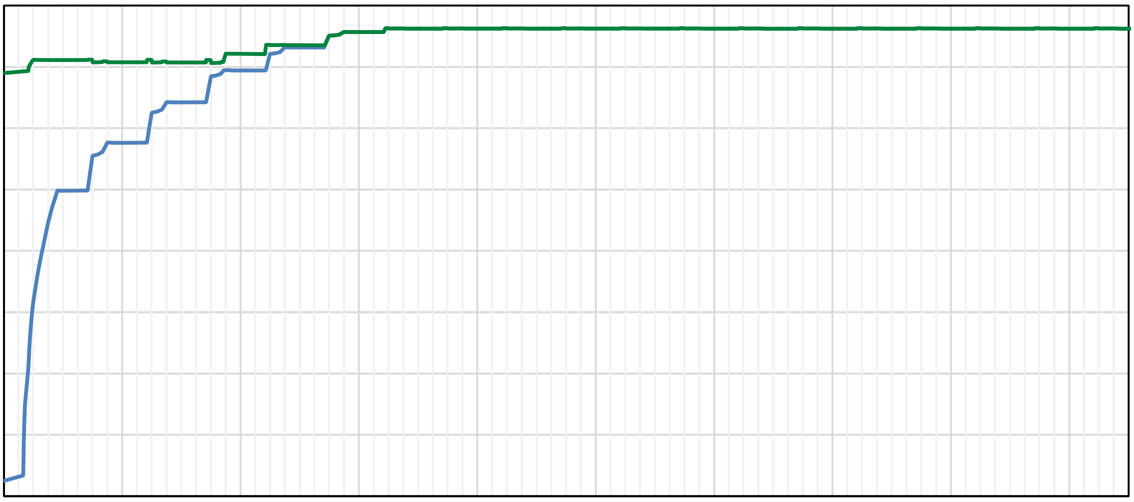

**Figure 3: Predicted water elevations in the Whale Tail Pit and the Attenuation Pond during closure and post-closure periods**

## 4.2 Lake Circulation

Predicted profiles of TDS and arsenic concentrations were used to evaluate seasonal circulation in the Whale Tail Pit Lake at the end of the closure period in 2028 (Figure 4). Although not shown, the same chemical patterns were found for nitrate and total phosphorous profiles.

During October to June, the lake is predicted to exhibit winter stratification, where concentrations show a stepwise increase with depth. The lowest concentrations are predicted to occur immediately below lake ice. The bulk of the lake shows a homogeneous concentration with depth. Groundwater input during winter months causes the TDS, arsenic, nitrate, and phosphate to slightly increase at the lake bottom during winter stratification.

Concentration profiles are predicted to homogenize between June and July each year as a product of complete mixing during spring turnover. Mixing is driven by three factors:

1) the loss of lake ice early June, which allows wind energy to be imparted on the water surface

2) the increase in surface water temperature to 4 °C, the maximum density of fresh water

3) water at all depths below the surface having a lower density than water at the surface

With these conditions in place, wind events in the spring are predicted to drive complete mixing of pit lake water  throughout the 150-m-deep water colum.

Stratification is predicted to return for a brief period during the summer months (July to October, not shown). This period is called summer stratification, and is caused by the warming of surface water relative to deep water by solar radiation. This condition causes the density of surface water to become lower than the density of deep water resulting in thermal stratification. During this period, the surface layer and deep layer would not mix with one another, and inputs to one layer would not affect the chemistry of the other layer. In October, less daylight and cooler air temperatures leads to the cooling of surface temperatures and a second complete mixing event, called fall turnover. Thereafter, the lake is predicted to return to winter stratification.

In summary, the Whale Tail Pit Lake is predicted to exihibit seasonal thermal stratification each summer and winter, and to undergo complete mixing each spring and fall, during both the closure and post-closure periods. This behavoir is characteristic of a dimictic lake (e.g., a lake which experiences bi-yearly mixing), and is consistent to the seasonal behaviour observed in Mammoth Lake.

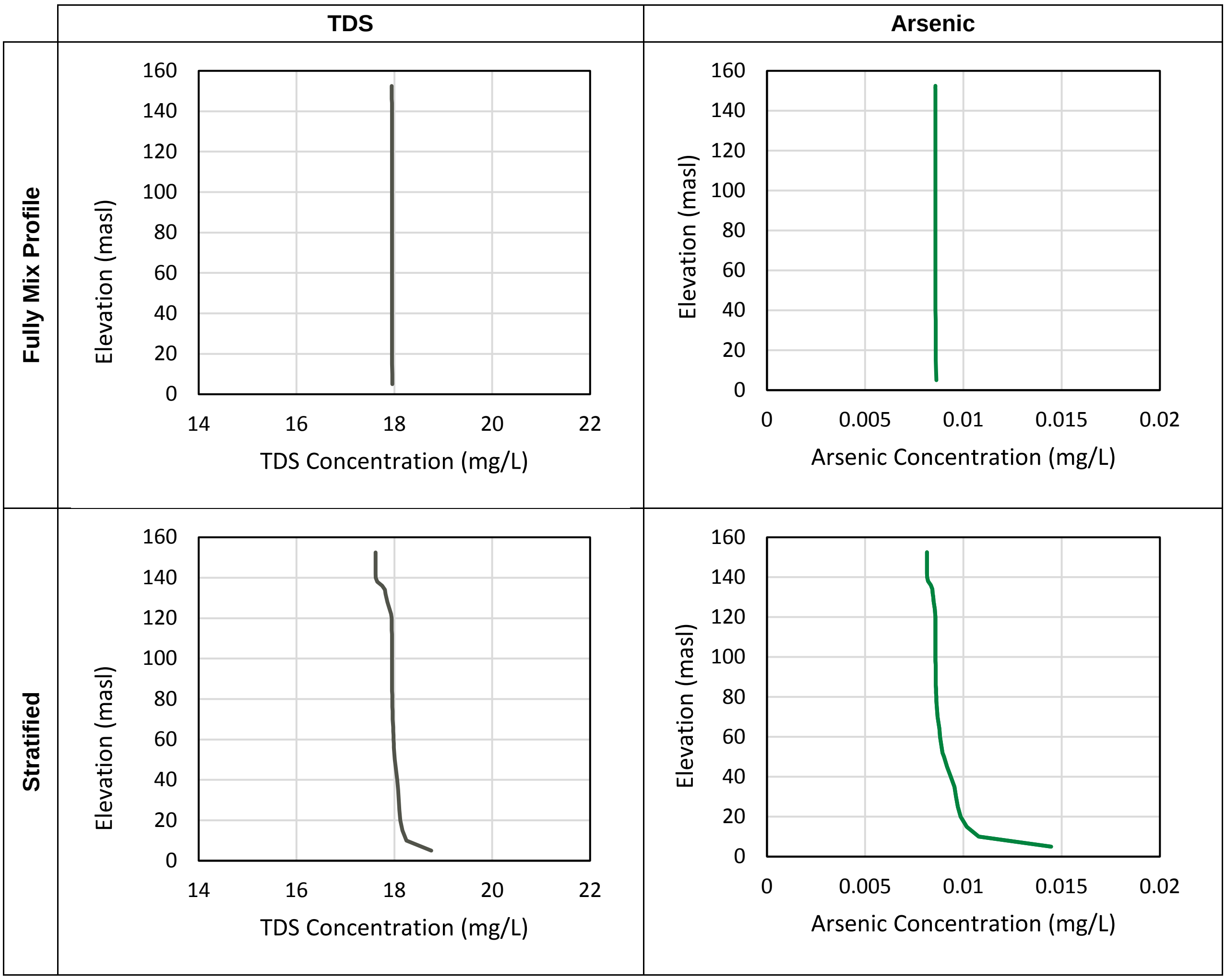


**Figure 4: Concentration profiles of TDS and arsenic predicted for the Whale Tail Pit Lake at the end of the closure Period in 2027. Stratified conditions corresponding to the end of winter. Fully-mixed conditions are shown corresponding to spring turnover**

## 4.3 Water Quality

To illustrate changes in pit lake water quality over time, time series plots of TDS, arsenic, nitrate, and total phosphate concentrations were generated for depths of 5-m, 50-m and 100-m in the Pit Lake (Figure 5 and Figure 6). Pit Lake concentrations are higher at the beginning of the closure period due to the initial flush of mass from the site compared to the relatively small volume of the pit lake. Concentrations decrease annually, in a step-wise manor, owing to:

- the large addition of freshwater from the South basin and during spring freshet of subsequent years (Figure 3)
- the low concentrations of constituents assumed in spring freshet water
- complete annual mixing of lake water (Figure 4)

In the model, spring freshet arrives just before spring turnover, which causes a brief dip in shallow water concentrations (5-m-deep) relative to deep water concentrations (100-m-deep). Complete mixing results in a step reduction in all concentrations, and homogenizes concentrations predicted at each depth. This same pattern occurs each fall, but the brief time (~3 months) between spring and fall turnover events makes these appear as a single mixing event in Figures 5 and 6. The concentrations stabilize within approximately 30 years of post-closure (2057).

For all constituents modelled, TDS, arsenic, nitrate and phosphate, concentrations are predicted to be below site water quality criteria and objectives at the start of the post-closure period (2028) and for the remaining duration of the model (Figure 5 and 6).

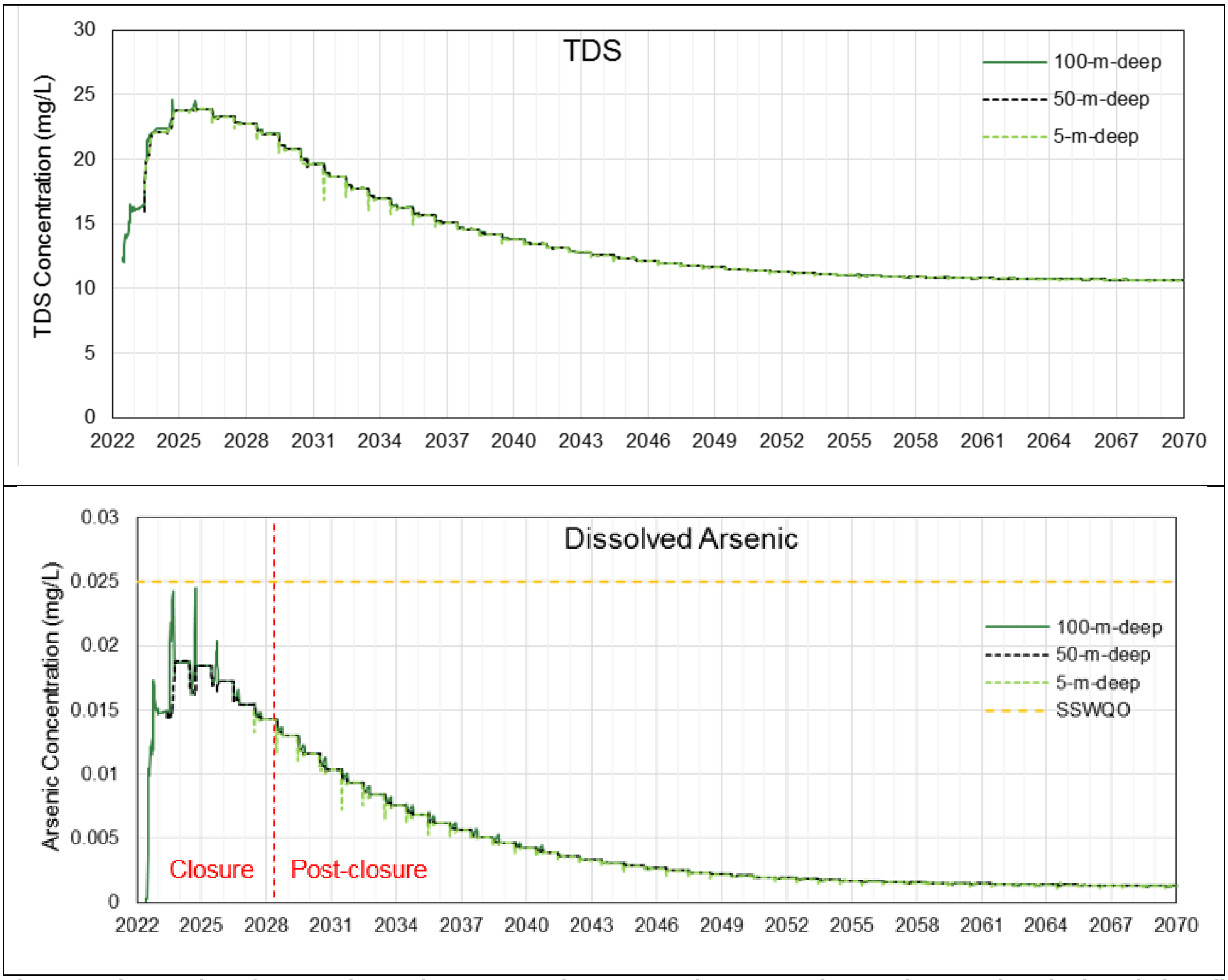


**Figure 5: Time-series of TDS and arsenic concentrations at 5-m-deep, 50-m-deep and 100-m-deep in the Whale Tail Pit Lake**

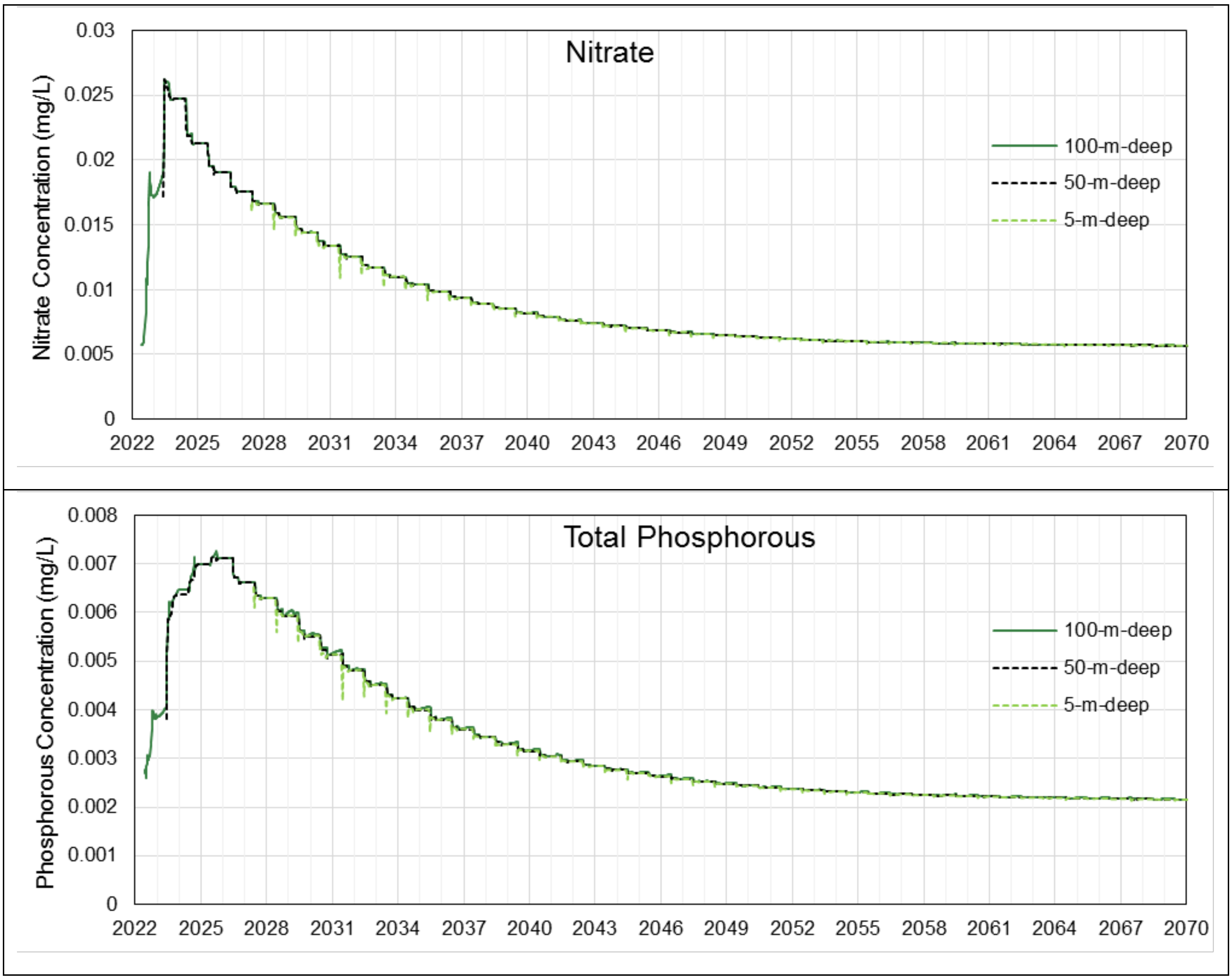


**Figure 6: Time-series of nitrate and total phosphorous concentration at 5-m-deep, 50-m-deep and 100-m-deep in the Whale Tail Pit Lake**

## 5.0 MODEL QUALITY ASSURANCE

Field observations are required for model validation. Because the Whale Tail Pit Lake does not yet exist, Pit Lake model calibration and validation with site data are not possible at this time. However, the model was set up based on calibrated models formerly developed by Golder for Northern Regions that have undergone regulatory review (e.g., multiple pit lakes owned by Dominion Diamond Mines in the Northwest Territories; Golder, unpublished reports). The model presented herein was modified based on Golder's considerable experience modelling existing pit lakes in the Arctic.

The follow additional aspects were investigated to demonstrate internal consistency between the GoldSim and W2 models, and to provide model quality assurance:

- Water Levels: The model was initialized to allow lake filling period during closure period. The predicted water levels generated by W2 for the Whale Tail Pit Lake were compared to predicted water levels generated by the GoldSim water balance model. The W2 model predicted filling of Whale Tail North to the overflow elevation at 152.5 masl by early June 2028, while the GoldSim model predicted the filling to be completed at the end of August 2027. The difference between the two filling times can be explained by the different volumes of the pits used where the W2 model considered the push-back volume, having an additional volume of approximately 5,850,000 $m^3$.

- Evaporation losses: Predicted evaporation losses from the Whale Tail Pit Lake and Attenuation Pond were also compared between by the GoldSim and W2 models (Figure 7). Cumulative losses are in good agreement for the total period of simulation.

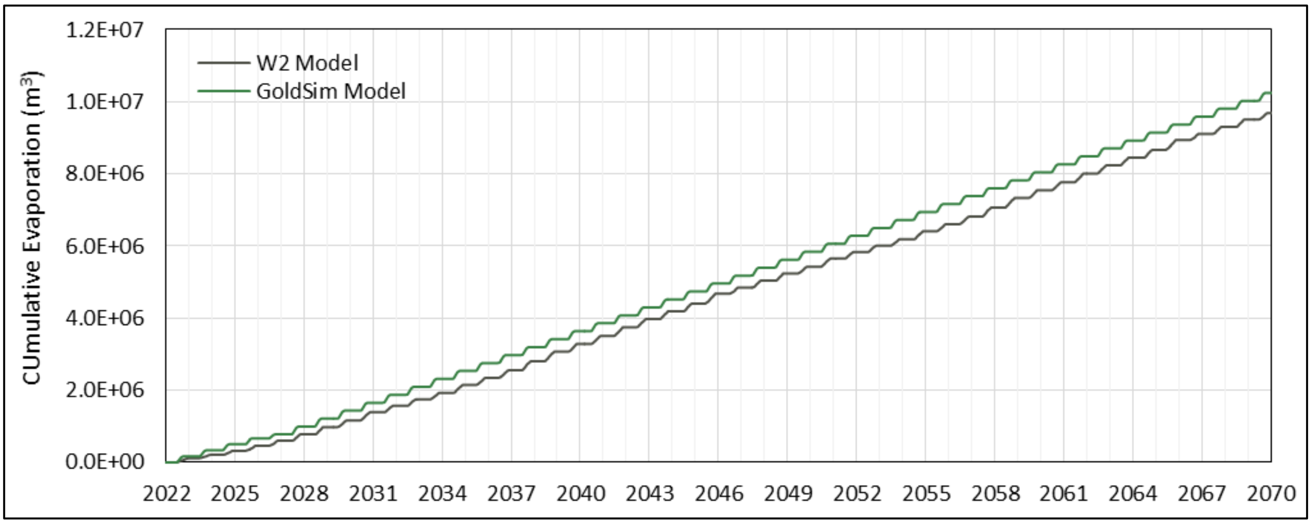


**Figure 7: Cumulative evaporation predicted by W2 and the GoldSim water balance model for the closure and post-closure periods (2022 to 2070)**

- Water quality parameters: Predicted water quality proponent concentrations from the Whale Tail Pit Lake were also compared between by the GoldSim and W2 models (Figure 8). Concentrations are in good agreement.

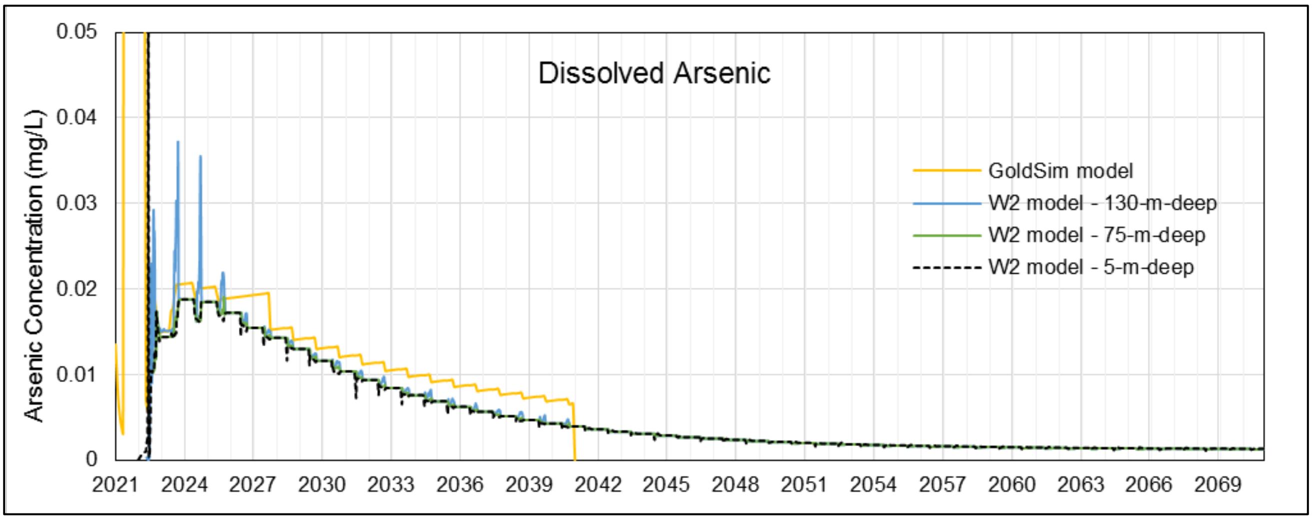


**Figure 8 Comparative plot of predicted dissolved arsenic found using GoldSim model (Agnico Eagle 2016) and W2 model at 5 m, 75 m and 130 m depth**

- Predicted Lake Temperatures: The summer temperature profiles predicted for the upper 15 m of Whale Tail Pit Lake were compared with temperature profiles observed in Mammoth Lake between July and September in 2016 and 2017. The measured data was plotted against statistical data generated from the 48-year prediction at the same depths and during the same months (Figure 8). In general, Mammoth lake data is 2 to 7 degrees warmer than Whale Tail Pit Lake with the greatest differences occurring in July. This to be is expected, as the Whale Tail Lake (150 m) is much deeper than Mammoth Lake (15 m), has a much larger volume, and takes much more energy to warm; a phenomenon called thermal inertia. The closest match occurs for the predicted September data, after Whale Tail Pit Lake has had more time to warm. Overall, observed temperatures in Mammoth Lake plot within the 5th and 95th percentile of predicted shallow temperatures for Whale Tail Pit Lake, suggesting that the model generates reasonable shallow temperatures for a lake in this region.

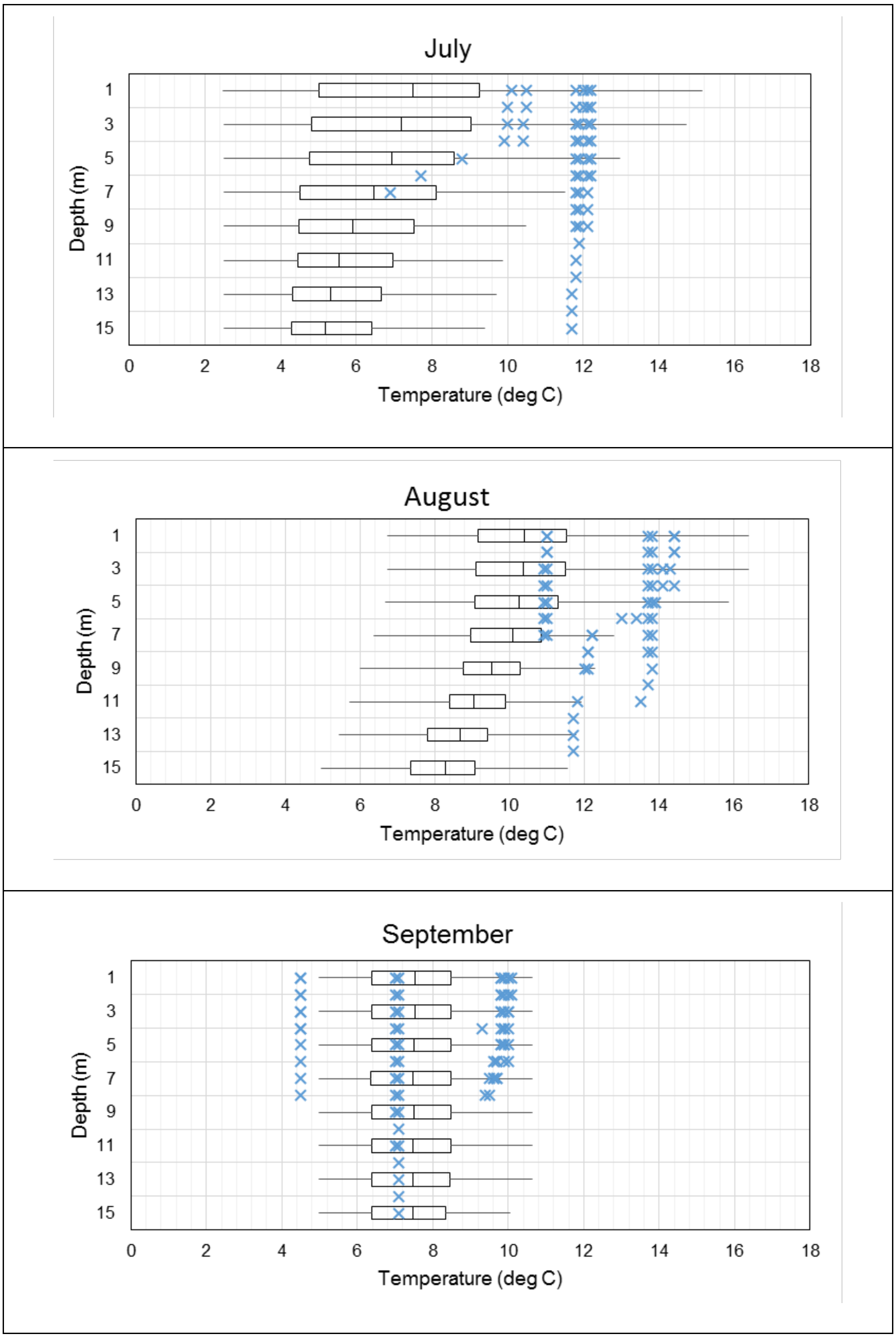


**Figure 9 Comparison of the modelled temperatures predicted for the Whale Tail Pit Lake sub-basin for the months of July, August and September (black box plot with whiskers showing the 5h and 95th percentile), compared against observed temperatures in Mammoth Lake in 2016 and 2017 (blue x)**

## 6.0 CONCLUSIONS

Water balance modelling performed in two programs, GoldSim and CE-QUAL-W2, both predicted the Whale Tail Pit Lake will completely fill by 2028, marking the start date of the post-closure period. These predictions were based on the pit geometry specified in the life-of-mine plan and volumetric inputs.

Hydrodynamic modelling in CE-QUAL-W2 predicted that the Whale Tail Pit Lake will completely mix each spring and fall when the water column has a uniform density. Under this condition, wind energy impacting the lake surface will be sufficient to drive complete mixing.

Water quality modelling in CE-QUAL-W2 predicted the concentrations of TDS, arsenic and phosphorous in the water column over time. Model results show the following:

- The concentration of TDS will remain below site specific water quality objectives at all times. TDS will peak at just below 25 mg/L in year 2025, and thereafter decrease over time. Concentrations will stabilize at approximately 11 mg/L by 2055.
- The concentration of arsenic will remain below site specific water quality objectives at all times. Arsenic will peak at just below 0.025 mg/L in year 2025, and thereafter decrease over time. Concentrations will stabilize at approximately 0.0025 mg/L by 2055.
- The concentration of total phosphorous will remain below site specific water quality objectives at all times. Total phosphorous will peak at just above 0.007 mg/L in year 2025, and thereafter decrease over time. Concentrations will stabilize just below 0.0025 mg/L by 2055.

## 7.0 RECOMMENDATIONS

Golder recommends that Agnico Eagle gather field observations on the volume, timing, and concentration of spring freshet each year. This could be achieved by installing weirs in point-source channels leading to the pit, monitoring hourly discharge rates before, during, and after spring freshet, and collecting daily water samples before, during and after spring freshet. Recording the date of the start and end of freshet each year would also be beneficial. These observations can be used to confirm that the assumptions used by the GoldSim and W2 models are accurate, as this event has a large influence on predicted water quality on an annual basis. Water quality monitoring and model updates are currently part of the management plans for the site.

## 8.0 CLOSING

The reader is referred to the Study Limitations, which follows the text and forms an integral part of this memorandum.

We trust that the content of this technical memorandum meets your expectations. Please do not hesitate to contact the undersigned should you have any questions or comments.

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